

The Cooperation Between the United States and Russia in Human Spaceflights: Understanding Politics Among Human Beings in Outer Space

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Abstract

American-Russian cooperation in human spaceflight constitutes a very interesting geopolitical puzzle to solve. Indeed, it may seem surprising that these two countries have managed to cooperate so extensively in human spaceflight for over 50 years through multiple projects despite the tensions and difficult geopolitical relations that these two countries maintain on Earth. While it is true that the United States and Russia cooperate in other technical areas, a deeper analysis of this puzzle is in order. The thesis therefore asks the following question: how can we explain the US-Russia cooperation in human spaceflights?

Building on the existing literature in the field of international relations, this thesis proposes to explore the question of human spaceflight cooperation between the United States and Russia by adopting a materialist, critical and eclectic approach. This approach uses not states, politicians or international organizations as actors and objects of study, but rather spacecraft. All the human spaceflight cooperation projects between the two countries – namely the Apollo-Soyuz Test Project (1975), the Shuttle-Mir program (1993-1998) and the International Space Station (1998-now) – are covered and for each of them, a specific spacecraft related object is studied in order to account for the whole endeavor of cooperation in human spaceflight between the two countries. To achieve this, the thesis develops a new theoretical toolbox inspired by the approaches of symbiotic realism, new materialism and science and technology studies. This toolbox, called New Space Materialism, constitutes the main thesis of this work and defends that we can understand cooperation between the United States and Russia in human spaceflights through the framework of New Space Materialism which emphasizes the role of precarity, objects and technology.

The main contributions of this thesis are threefold. First, through an analysis of human spaceflight archives on a scale rarely undertaken before, this thesis improves our empirical understanding of the phenomenon of cooperation between the United States and Russia in human spaceflights. Second, there is a theoretical and conceptual contribution with the creation of the New Space Materialism theoretical toolbox that can be used to understand political issues in outer space. Finally, this thesis contributes to improve the understanding of the field of international relations in the face of cooperation between human beings in situations of scarce resources.

This thesis is dedicated to Nathaniel and Adeline

You are my stars

The universe is at your doorstep

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Legend

ASTP: Apollo-Soyuz Test Project

ESA: European Space Agency

ICAO: International Civil Aviation Organization

IR: International Relations

ISS: International Space Station

NASA: National Aeronautics and Space Administration

NSM: New Space Materialism

STS: Science and Technology Studies

UNOOSA: United Nations Office for Outer Space Affairs

US: United States

USSR: Union of Soviet Socialist Republics

“As man draws nearer to the stars, why should he not also draw nearer to his neighbour? As we push ever more deeply into the universe-probing its secrets, discovering its way--we must also constantly try to learn to cooperate across the frontiers that really divide Earth's surface.”

President Lyndon B. Johnson, August 29, 1965

(Woolley and Gerhard 2018)

1. Chapter 1 - Introduction: The Puzzle of the Cooperation in Human Spaceflights Between the United States and Russia

March 18, 2022, the picture is striking. Three Russian cosmonauts from ROSCOSMOS (the State Corporation of the Russian Federation responsible for the country's space program) are boarding the International Space Station (ISS) wearing yellow flight suits with blue accents, colours that match the Ukrainian flag (Harding 2022). Following a successful lift-off from Kazakhstan, the three cosmonauts are joining two national colleagues as well as four American astronauts and a European Space Agency (ESA) astronaut (A. M. Garcia 2022) already aboard the ISS. Media around the globe are, to say the least, surprised by the colour choice of the cosmonauts whose country attacked Ukraine on February 24, 2022. Even if the official version circulated by Russia denies any link between the colour of the space suits and the conflict in Ukraine (Harding 2022), this photograph is yet another testimony to this impressive and improbable cooperation between the United States and Russia in human spaceflights. This scene also highlights the disconnect that seems to exist between politics on Earth and politics in outer space. Indeed, many consider this cooperation within the ISS to be the most important in the history between the two countries. Moreover, it also turns out that the two countries have also collaborated in many other human spaceflights missions. It is on the topic of this interesting US-Russia collaboration in human spaceflights that this thesis focuses.

It is well known that bilateral relations between the United States and Russia (including the former USSR) have never been easy. Since the end of the Second World War, their relations have been marked mostly by difficult moments (Cold War, economic sanctions, geopolitical conflicts, etc.) punctuated by few easier moments (the *Détente* period, the end of the Cold War). It can therefore be said that, as a whole, relations between the two countries since 1945 have been difficult. This situation will be presented in more detail in the following pages. However, it is also important to note that some specific cases of bilateral cooperation do exist in which both countries have cooperated very well and are still continuing to do so. For instance, we can think about their cooperation in the International Civil Aviation Organization (ICAO) and on international waters. Furthermore, another field in which both countries were and are still cooperating extensively is the one of human spaceflights.

The case of US-Russia cooperation in human spaceflights is an interesting one to explore essentially for two main reasons. First, the scale of this cooperation is very important. Indeed, many consider this collaboration to be one of the most important between the two countries ever (M. Garcia 2015). Simply in financial terms, the cooperation between both countries just in the International Space Station (ISS) is on the order of several billion dollars (Lardier 2007a; NASA 2013). Second, it is noteworthy not only because of the generally tense relations between the two countries, but also because the technical and scientific cooperation specific to human spaceflights exists in a very political and geostrategic environment, even if scientific and technical depoliticized cooperation exists elsewhere (ex: ICAO). Indeed, there are no big political and geostrategic debates between the USA and Russia regarding the use of the airspace, but there are important political and geostrategic issues regarding the use of outer space (especially concerning the military and commercial use of outer space). Indeed, it is well known that the first developments related to outer

space were related to technologies for the military field of both countries. We can think of the launch of the first intercontinental ballistic missile, the R7 Soviet rocket in 1957, followed closely by the American Redstone rocket in 1958 (Grossman 2001, 65). Then, it is therefore in the midst of the Cold War, the arms race and then the race for the Moon that the two countries began their discussion for collaboration in human spaceflights as early as 1969 (Sheehan 2007a, 65).

Consequently, the main question driving this thesis is: *how can we explain the US-Russia cooperation in human spaceflights?* This question is very important to answer because it will not only add a better understanding of political issues in outer space (a field that has experienced rapid growth, particularly since the end of the Cold War), but it will also improve the understanding of the discipline of International Relations (IR) in the face of cooperation between human beings in situations of scarce resources. Indeed, a literature exists in the discipline of international relations looking at the relationship between resource scarcity and conflict and cooperation. Both public discourse and scientific research largely tend to demonstrate the link between scarcity of resources and “the likelihood of such scarcity to lead to international conflict” (Dawson, Rosin, and Wald 2017, 1). Additionally, it is also widely claimed that “scarcity portends an unavoidable escalation in tensions among already hostile actors” (Dawson, Rosin, and Wald 2017, 2). On the other end, research arguing that resource scarcity can contribute to cooperation is much less common. This facet of the debate argues that sharing common interests for a scarce resource can enable cooperation that will be far more viable and beneficial to all parties than engaging in conflict (Dawson, Rosin, and Wald 2017, 6). The authors Dawson, Rosin and Wald (2017, 6) argue that such cooperation scenarios already exist, particularly with regard to the management of international waters and nature conservation parks. Our research on cooperation between the United States and Russia in human spaceflights therefore seeks to contribute to this most neglected

portion of the literature on situations of cooperation in the presence of scarce resources. Indeed, there is very little comparable to the situation of scarce resources that exists in outer space and we are witnessing very extensive cooperation in human spaceflights. Our goal is therefore to shed light on this cooperation and it will reinforce the perspective that human beings can cooperate in situations of scarce resources.

However, before proposing an answer to our research question, it is essential to first correctly present this subject. As such, this introductory chapter will be divided into the following sections: first (1) an in-depth examination of the principal topic - cooperation in human spaceflights between the United States and Russia; second (2) a framing of the puzzle which is the extensive cooperation in human spaceflights despite the tense relations between the two countries; third (3) the presentation of the research question driving this thesis as well as the main hypothesis; and; the last part (4) will present the organization of this thesis.

1.1 The topic: Cooperation in Human Spaceflights between the United States and Russia

It should be no surprise that the very beginning of the relationship between the United States and Russia regarding human spaceflight was difficult, to say the least. This tense relationship lasted until the end of the race to the Moon in 1972 when the last Apollo mission landed. Since then, cooperation between the two countries in human spaceflights has steadily improved and grown in importance. However, before further exploring this case, it is important to more precisely define the nature of US-Russia cooperation in human spaceflights.

We can divide the activities in outer space into three distinct fields: military, commercial and civil-scientific. Starting in 1963, outer space was first used for military purposes as a force multiplier. Space resources (imagery, communication, information, etc.) constitute precious military information, multiplying the capacity of military forces on Earth (Peoples 2010a, 104). By

the 2010s, the supremacy of the United States and Russia in this field was undisputed although today, other players like China are beginning to take part (Kogan 2021). It is also important to note that cooperation in this field is almost non-existent (Webb 2009). The second field of use in outer space is commercial. Commercial use includes telecommunication, messaging, broadcasting, Internet services, imagery, etc. (Le May 2021, 114). Although collaboration is more important in the commercial field compared to the military field, it remains an arena where cooperation is very difficult. We can think about the growing US-China competition in the commercial use of small satellite constellations (Rajagopalan 2021, 155) as well as the fierce competition regarding the use of geolocation satellites in which rival countries are using their own system (GPS for the United States, GLONASS for Russia and Beidou for China) (Peoples 2011a). Furthermore, with the rise of private space companies like SpaceX and Blue Origin, everything is now pointing towards a more important role of the private sector in the commercial field of use of outer space (Frankowski 2017). Finally, the third field of use is at the civil-scientific level. It is in this field that human spaceflights occur and is the object of our study, and that in which national space agencies such as NASA, ROSCOSMOS and ESA operate. Unlike the military and commercial field, the civil-scientific field is dedicated to science and technology rather than to commercial or military projects (Magilton 2021, 38). This use of outer space is also the one that is best known to the general public, such as the missions of the Apollo program, the International Space Station or the exploration of deep space using probes such as Cassini and New Horizons or telescopes like Hubble or James Webb. The impact of the civil-scientific field and especially human spaceflight explorations on science and technology is unequivocal since the beginning of the space age. The use of GPS, CAT scanners, cordless vacuums, miniaturization of computers, modern laptops, etc., are all concrete examples of the daily impacts that the civil-scientific field has had on our daily lives (Spadoni 2020). We can sum up the cooperation in human spaceflights between the United States and Russia

in three cases: the Apollo-Soyuz Test Project (1975), the Shuttle-Mir (1994-1998) and the International Space Station (since 1998). These different projects bring together all the instances of human spaceflights cooperation that have occurred between the two countries ever. Moreover, these three projects also constitute the main objects of study of this thesis.

1.1.1 The Apollo-Soyuz Test Project (1975)

In the middle of the Cold War, as ironic as it might seem, the United States and Russia made many efforts in order to cooperate in the field of human spaceflights. The highlight of this cooperation is the Apollo-Soyuz Test Project (ASTP) in 1975 which was the only cooperation in human spaceflights between the two countries during the Cold War (Shaffer 1980, 25). The project consisted of a highly complicated, joint-manned rendezvous and docking mission between the American Apollo and the Russian Soyuz spacecrafts in orbit. This operation was a success and necessitated important contacts, exchanges and collaboration between the two countries. Moreover, the project was very complex, particularly as both spacecraft were totally incompatible: they did not use the same technology or speak the same language. Thus, this project required extensive cooperation between both countries on the technical level as well on the political level (Crouch 1999, 239). It is notably for these reasons that many observers consider the Apollo-Soyuz Test Project as the ancestor of the International Space Station (Babintsev 2010, 19).

1.1.2 The Shuttle-Mir program (1993-1998)

The Shuttle-Mir program was the first human spaceflight cooperation in orbital outer space between the United States and Russia in the post-Cold War era. During this program, American Space Shuttles connected seven times to the Russian orbital space station, Mir, collaborating in hundreds of scientific experiments (Evans 2014, 443). Starting in 1993, the collaboration also included astronauts flying aboard the Russian Soyuz spacecraft as well as cosmonauts flying

aboard the Space Shuttle. One of the primary goals of this program for the two countries was to learn how to jointly build a space station. The program was a success and is considered to be the foundation that led to the creation of the International Space Station.

1.1.3 The International Space Station (1998-now)

Since its origins, with the connection of the American module Unity and the Russian module Zarya in 1998, the International Space Station (ISS) has been a fundamentally collaborative project between the two countries. This enormous outer space laboratory has been built using the American Space Shuttle and the Russian Proton and Soyuz rockets. Furthermore, with the retirement of the American Space Shuttle in 2011, the United States and Russia have further strengthened their cooperation, most notably to send astronauts to the ISS. In the beginning, the United States' reliance on the Russian Soyuz Spacecraft to send astronauts to the ISS was only meant to last until 2014. Meanwhile, NASA was developing the ORION spacecraft which was supposed to enter into service in 2014 to ensure the transportation of astronauts (Lardier 2007b, 84). However, the ORION spacecraft is still in its development phase and now aims for outer space explorations such as a return to the Moon or the human exploration of Mars using the Space Launch System (Northon 2014). As a result, in 2013, NASA signed another contract with ROSCOSMOS to arrange astronauts' transportation services to the ISS until 2017 (NASA 2013). In 2014, in order to end their reliance on Russia, the United States signed a \$6.8 billion contract with two private American companies (SpaceX and Boeing) to provide the transportation of astronauts to the ISS by 2017 (Siceloff 2014). Facing the fact that SpaceX and Boeing's spacecrafts were not ready by 2017, the United States signed in 2015 yet another contract with ROSCOSMOS, which ensures American presence in the ISS until 2019 (Northon 2015). It is finally in November 2020 that the first commercial flight (using the SpaceX Dragon spacecraft) took place (Brown 2020). Despite both countries now having the technical capabilities to send their own space explorers to the ISS,

they are continuing their cooperation with ROSCOSMOS flying cosmonauts on US commercial spacecraft and NASA astronauts continuing to fly on Soyuz (Foust 2016). The first flight of a Russian cosmonaut aboard the new American spacecraft was in October 2022 and a few days earlier an American astronaut flew to the ISS using the Soyuz Spacecraft (Lavelle 2023). In addition, the cooperation between the two countries on the ISS is not just about using vehicles to get to the laboratory or during the construction phase of the station. Inside the ISS, experiments going on are characterized by an important cooperation between the United States and Russia; particularly in regard to experiments on aerospace medicine (Duncan 2007), technology demonstration, microbiology, education (Hasbrook 2016) and astrophysics (Thumm 2011). In short, the cooperation between the United States and Russia on the ISS project is extensive and peaceful. Now that the three major cooperation projects are known, it is time to present the contradictory situations that arise at the same time. Namely, the fact that cooperation between the two countries is very difficult on Earth.

1.2 The Problem: At the Same Time, Very Difficult Cooperation Between the two Countries on Earth

It is important to present more precisely (and synchronously) how the situation on Earth contrasts with the cooperation that prevails in outer space with human spaceflights. Regarding the context on Earth during ASTP, the purpose of this mission as stated by President Nixon and USSR Secretary General Kosygin was to concretize the spirit of the *Détente* period of the Cold War (Crouch 1999, 240; Johnson-Freese 2007, 62). In fact, the year 1975 (in which the orbital spaceflight occurred) is recognized as being the height of the *Détente* period. While the goal of this paper is not to present an overview of USA-USSR relations during the Cold War which are largely documented (Crockatt 1995; Bogle 2001; Shavit 1993), it is important to note that the six years of negotiation, preparation and collaboration which were necessary for the Apollo-Soyuz mission

occurred during the peak of the Vietnam war. Moreover, the discussions and the first cooperations in order to implement ASTP having started as early as 1969, this precedes by more than three years the most important and noted initiatives of *Détente* like the visit of Nixon in Moscow in 1972 or the signing of the SALT 1 (Strategic Arms Limitation Talks) agreement the same year. Thus, the period of 1969 can be considered as being the very slow beginning of the *Détente* with Nixon's recent election in January 1969 and the relations between the United States and USSR still being very tense. This context makes this cooperation especially surprising since the negotiations and preparation surrounding ASTP took place before the end of the Apollo lunar program which was also during the race to the Moon.

However, we can note that between the end of the Cold War and until the beginning of the 2000s, the geopolitical situation had improved; and this could partially explain the cooperation between the two countries during the Shuttle-Mir program and the first phase of the construction of the ISS. That being said, since 2002, we can note important tensions and conflicts between United States and Russia that led to the difficult geopolitical and diplomatic relations that still prevail today. As a result, the 2002 withdrawal of the United States from the Anti-ballistic missiles treaty harmed both countries' relations (Dolman 2002, 133). In 2007, relations further deteriorated due to the deployment of the American anti-missile shield in Poland. At the time, President Putin qualified the situation as being the most dangerous since the Cuban missile crisis in 1962 (Traynor 2007). In 2012, the mutual sanctions between the two countries intensified particularly with the Magnisky case (Camp 2012), increasingly undermining their relationship. Then in 2013, with Russia's acceptance of Edward Snowden's asylum, the United States cancelled a high-level meeting between Barack Obama and Vladimir Putin (Sonne and Entous 2013, A1). In 2014, following the annexation of Crimea by Russia, tensions between Moscow and Washington

heightened. In response, President Obama asserted that, “the United States has mobilized the international community in support of Ukraine to isolate Russia for its actions” (The White House 2014b) and then raised their already heavy sanctions on Russia, also affecting the property and interests of Russian political figures in the United States (The White House 2014a). Rutkin (2014, 11) also identified this contradiction regarding the Crimean events in which “this event significantly aggravated the relations between the United States and Russia on Earth in the 'real-world', but there has been no impacts on the relations between the two countries in the ISS”. Under the Trump administration, sanctions continued to grow, affecting Russian defense and intelligence sectors as well as expelling diplomats (Majumdar 2018; The White House 2017; Rucker, Morello, and Hudson 2018). The presidency of Joe Biden is also marked by very difficult relations between the two countries, particularly as President Biden called President Putin a “killer”. The Kremlin “reacted angrily, calling the comment unprecedented and describing the relationship between the two countries as very bad” (Chernova, Ullah, and Picheta 2021). In addition to the increasing number of sanctions, the difficult situation in Syria where both countries favour very different interventions has contributed to harming their relations and cooperation (Sengupta 2017). Finally, and not the least, as several observers mention, Russia's invasion of Ukraine in February 2022 marks the most difficult moment for US-Russian relations since the end of the Cold War (Galston 2022; Mulligan 2022).

1.3 Research Question and Hypothesis

Before presenting the research question and the hypothesis that will drive this work, it is important to situate the field in which this thesis is situated as well as the audience for which it is addressed. As will be presented in the following pages, this thesis employs a rather eclectic variety of literature. Political science, international relations, history, geography, and science and

technology are among the fields that are explored. That being said, it is important to emphasize that this thesis is aimed at a political science audience, and particularly of “the politics of outer space”, and therefore seeks to contribute to this field. Within this field of the politics of outer space, a dominant approach to understand political issues in outer space is that of *Astropolitik*. As coined by Everett C. Dolman in 2002, *Astropolitik* “is identified as a determinist political theory that manipulates the relationship between state power and outer-space control for the purpose of extending the dominance of a single state over the whole of the Earth” (Dolman 2002, 15). This approach, central to the pragmatic argument to explain cooperation in outer space as presented in Chapter 2, essentially perceives international relations in outer space as being the extension of the power struggle that prevails on Earth (Dolman 2002, 53). In many ways, this approach provides very interesting avenues for reflection. However, the observation of the previous pages where the relations between the United States and Russia in outer space differ from the struggle that the two countries are waging on Earth allows us to question this dynamic where we could simply transpose the balance of terrestrial powers into outer space. This thesis therefore seeks to enter into discussion with the politics of outer space audience, and particularly of *Astropolitik*, in order to be able to offer avenues of analytical reflection that are both complementary and different in order to be able to understand cooperation in outer space.

Thus, in the midst of tense diplomatic relations between the United States and Russia on Earth, the research question that guides this thesis is the following: *how can we explain the US-Russia cooperation in human spaceflights?* In order to answer this question, it is first essential to carry out a substantial literature review in order to determine what has already been written on this subject. Presented in chapter 2, the aim of the literature review is to present the best current explanations for understanding why and how the two countries come to cooperate in human

spaceflight. It will also demonstrate where the explanation of our thesis stands out: the change of object of study.

Some studies are using state-centric approaches and tools to understand the situation of cooperation in human spaceflights such as policies and speeches by heads of State. While this approach may have its merits, the main problem is that such perspectives are understanding international relations in outer space as being essentially a reflection of the relationship that prevail on Earth. However, as presented above, this perspective is not entirely correct since many human spaceflight projects do not constitute a reflection of the relationships that prevail on Earth. We will see that other approaches use much less state-centric perspectives, notably by studying actors other than states such as international organizations, regimes and discourses. However, the missing clue that our thesis seeks to address within the literature review is that the objects of study used to understand cooperation within human spaceflight are not the most appropriate. In fact, if we look more closely at the subject, when it comes to cooperation in human spaceflights, we see that it is much more a question of cooperation between scientists, engineers, astronauts and especially between spacecrafts than cooperation between formal state entities, organizations or regimes. The literature review of this thesis therefore proposes to adopt a new materialist approach by making spacecrafts our object of study and not States or their respective government agencies. Indeed, the spacecrafts used for the cooperation missions embodied and exemplified all the complexities of this endeavor, as well as the complexity of the development, execution and maintenance of the collaborative human spaceflight programs. Moreover, it is also essential that research must move away from state-centered approaches towards a non-state-centered approach. Chapter 2 will present in detail why we must change the object of study towards the spacecrafts and why adopting

a non-state-centered approach is essential in order to explain the US-Russia cooperation in human spaceflights.

To do so, as well presented by Agnew (Agnew 2014), it is essential to get out of the “territorial trap” and one way to achieve this is to embrace an approach based on the “end of territoriality”. The notion of the “end of territoriality”, using pluri-disciplinary tools notably from geography, seeks to explore beyond “earthly” international relations in which territory is a fundamental geopolitical aspect defining, in part, the behaviour of political actors. Lake (2003, 309) explains that at the core of international relations there is the concept of sovereignty defined as “[...] an institutional arrangement for organizing political life that is based on two principles: territory and the exclusion of external actors from domestic authority structures”. Moreover, this notion of territory in international relations is defined as being consisted of “[...] blocks of rigidly bordered space and domination or control as the modality of power upon which the bordering relies” (Agnew 2005, 442). However, the notion of the end of territoriality defends that in order to understand international political phenomena, we must push our understandings beyond the notion of territory especially when it comes to politics in outer space since territory does not exist in outer space. It is simply impossible to establish a physical territory in outer space as it is the case at the land, maritime and air levels. This critical and pluri-disciplinary notion will be essential in order to understand that we cannot simply project state sovereignty on a spacecraft.

It is by having in mind this reorientation of the object of study and the non-state-centered approach that the hypothesis can be clarified. Although it is not new to study a political phenomenon by focusing not on political actors but rather on the material surrounding them – we can think of the work of Rachael Squire *Undersea Geopolitics* in which she demonstrates that the physical environment of and surrounding underwater military laboratories shaped their behaviors

and political purposes (Squire 2021, 124–25) – this thesis is the only one to our knowledge that seeks to understand a political phenomenon in outer space (cooperation in human spaceflights) by focusing on spacecrafts as the main object of study. This approach leads us to explore new avenues of explanation and literature that has been used very little to explain cooperation in outer space. In fact, three different approaches of international relations will be used to make the transition from a state-centred perspective to a post-state-centred approach which will focus on spacecrafts and not on States: (1) symbiotic realism, (2) new materialism and (3) science and technology studies (STS).

Indeed, the field of international relations (IR) is, in our view, the field of political science best equipped to answer our research question. Long criticized for having been structured around major debates and major theories (Wilson 1998; Sylvester 2013), the field of IR has been facing a very interesting multi-disciplinary and critical rise in recent years. Accompanied by a largely post-positivist epistemological approach, this critical field of IR seeks to put an end to the great theoretical "isms" (Lake 2011) and contains a multitude of relevant post-state analytical tools that can help us respond adequately to our research question. The three key approaches identified above (symbiotic realism, new materialism and science and technology studies) fall within this critical field of IR. These approaches, even if they are different from each other, will each contribute to forging a coherent answer to the research question in a multi-disciplinary principle of plural dialogue where each approaches complements each other (van der Ree 2014). Let's now take a closer look at each of these approaches.

The first post-statist approach of is the one of “symbiotic realism”. Proposed by Al-Rhodan (2012, 216) this notion “[...] advocates a symbiotic interdependence between states in a connected and interdependent world, whose security has become intertwined, especially in a global commons domain like outer space”. This notion (which Al-Rhodan seeks to inscribe as a theoretical approach

within IR), which will be presented in depth in Chapter 3, also argues that given the fact that there is no territory in outer space (nor on a spacecraft) and that there are extraordinary dangers and challenges with living in outer space, therefore spacecrafts simply have no choice but to cooperate (hence the use of the word symbiotic). To support this view, Al-Rhodan (2012, 25) explains that this symbiotic situation applies particularly in the field of security in which states must maintain a safe and collaborative environment in outer space because if not “ultimately, space will either be safe for everyone or for no one”. He gives for example that a simple form of aggression in outer space (using a weapon or a defensive system) could have catastrophic consequences. A bullet or a single space debris –going at a relative speed of 7.6 km/seconds– could provoke a chain reaction that could totally destroy all space objects at the same relative orbit. Moreover, laws of physics being what they are, this orbit would therefore be inaccessible for the next several thousand years. Thus, considering the precarious parameters in outer space, Al-Rodhan (2012, 215) explains that in such a situation of conflict in outer space “we would all be losers, no matter which country we are from”.

The second post-statist approach is the one of “new materialism”. “New materialism” is also part of a recent and critical movement within IR seeking to “provide a counter-point to positivistic notions of materiality and promises a corrective to the linguistic excesses of discourse analysis” (Lundborg and Vaughan-Williams 2015, 24). This notion, opposed to a cultural/humanist and anthropocentric approach, perceives that “matter as an active force is not only sculpted by, but also co-productive in conditioning and enabling social worlds and expression, human life and experience” (Sencindiver 2017). In short, this notion defends that the physical environment can also influence social behaviour. This notion has not been adapted to the study of outer space, but

this thesis will use this concept in order to explore how the outer space environment, spacecrafts and space stations can affect social behaviours and interactions.

The third and last key post-statist approach, which may be considered as a field of IR, that will be used to form our hypothesis and answer our research question comes out of Science and Technology Studies (STS). In fact, a major challenge that the approaches of “symbiotic realism” and “new materialism” cannot overcome in understanding the US-Russia cooperation in human spaceflights is that the decision of making compatible spacecrafts and devices to cooperate in outer space irremediably comes from political decisions taken on the ground, on Earth. This is where STS comes in. As a relatively recent notion, STS brings together works in IR that seek to fill the gap in the classical literature by "integrating technology more systematically into analyzes of global politics" (Hoijtink and Leese 2019, ii). More specifically, STS seeks to demonstrate that it is not only human beings who can have political agency, but technology itself (such as a spacecraft, a technological device or a scientific report) can also do so. Consisting of an amalgam of different studies focusing on the role of technology on politics and IR, STS and its various tools have the main benefit that “this conceptualization of technology as capable of affecting social relations in ways that cannot be reduced to the results of human intent, realized through technology, [...] enables new types of analyses by following power into places where current social theory seldom thinks to look for it” (Lindskov Jacobsen and Monsees 2019, 24). Thus, STS will be able to investigate the work of scientists, engineers and technologies of both United States and Russia on the ground so that we can understand the origins of the decision to make cooperative spacecrafts (therefore sending human beings to cooperate in outer space) because this venture cannot be realized without the help of scientists and technology. Studying how scientists and technology influenced the creation, and even the idea of building these cooperative spacecrafts, is key to

understanding how these scientific devices have intrinsically contributed as actants for human beings to cooperate in outer space. In fact, much more than what States have done. Indeed, all cooperation projects in human spaceflights between the United States and Russia (Apollo Soyuz Test Project, Mir-Shuttle and the ISS) necessitated an important upstream work from the scientists on spacecrafts on Earth because as mentioned above the apparatus of both countries were and are still highly incompatible. STS will also help to determine how the creation of these collaborative spacecrafts had an impact on the decision to cooperate in human spaceflights. In reality, it is the scientists and space engineers that possess the highly complex knowledge which allows for the survival of human beings in spaceflights. They know what the intrinsic dangers of space venture are and the ways to counter them. It is therefore essential to examine whether space scientists managed to convince politicians that the best outcome (if it is not the only outcome possible) in human spaceflight is for nations to cooperate by creating and using collaborative spacecrafts. If this dynamic can be detected, it will then help to overcome the lack of the post-statist approaches which have challenges to explain why and how the cooperation in human spaceflight starts on the ground. Works in the field of STS studies that will greatly influence this thesis are notably the work of Timothy Mitchell in *Carbon Democracy* in which he demonstrated that the use of new technology like coal fostered the emergence of democracy in the 1800s (Mitchell 2011, 12). Could the use of new technology in outer space ventures have a similar impact on cooperation? We can also think of the work of the Bruno Latour in *Science in Action* in which he states the important impact that that scientists can have when there are several people, network and organizations working together on a same topic (Latour 1987, 145). It is very likely that space scientists can have an important impact on the cooperation between the United States and Russia in human spaceflights through their work on the collaborative spacecrafts. In fact, some research has briefly explored this phenomenon and has demonstrated that “virtually all enterprises involving space are heavily

dependent on modern technology. Space technology is developed mainly in response to the demands of missions that are deemed worthy and feasible, thus creating a ‘technology pull’ dynamic” (Lawrence et al. 2009, 27). Lawrence et al. (2009, 27) also come to the conclusion that “technology defines the feasibility of specific space capabilities”.

In essence, it is the combination of these three approaches in a post-state-centered, critical and multidisciplinary spirit (symbiotic realism, new materialism and STS) that inform the hypothesis of this thesis. In order to give a heuristic meaning to this theoretical conceptualization, our hypothesis proposes to answer our research question by grouping these three major approaches under a theoretical framework: *New Space Materialism*. Having as pillars the 3 approaches mentioned above, *New Space Materialism* aims to be a theoretical toolbox which can be used in order to explain social and political relations among human beings in outer space, using US-Russian cooperation as its first case. Chapter 3 is entirely dedicated to the construction of this new framework. As such, our main hypothesis can be formulated as follows: *we can understand cooperation between the United States and Russia in human spaceflights through the framework of New Space Materialism which emphasizes the role of precarity, objects and technology.*

1.4 Organization of the Thesis

This thesis is divided into eight chapters. This introduction being the first one, Chapter 2 is dedicated to the literature review. The most relevant explanations for human spaceflight cooperation will be analyzed and it will be presented how they contribute to build the approach of this thesis. Chapter 2 also presents in-depth the need to change the object of study towards spacecrafts.

Building on the reflections of chapter 2, chapter 3 focuses on the theoretical framework. First, it is important to present the need to build a new international relations framework that fits

to the outer space context and how this can be concretely achieved. The chapter then tackles the theoretical construction of New Space Materialism. The three pillars of the framework (symbiotic realism, new materialism and STS) are presented extensively and then combined together to present a coherent theoretical framework that enables us to escape the state centric approaches in outer space and to adopt spacecraft as the main object of study. It will also reveal how this new framework constitutes the main hypothesis of the thesis proposing an answer to the research question.

Chapter 4 is dedicated to the methodology. It outlines concretely how *New Space Materialism* will be used to answer the research question. Two main methods will be used together: archival analysis and decoding. The goal is to determine what is the impact of spacecrafts on the cooperation between the United States and Russia in human spaceflights and if their creation by scientists is driven by the factors emphasised by *New Space Materialism* framework. It is very difficult, if not impossible, to evaluate the direct impact of a spacecraft or a scientific device on a space policy. In order to do this analysis, we must explore the link between the creation of the spacecrafts and policy indirectly. Therefore, archival analysis is the chosen technique. The goal is to determine if a document related to the conception of a spacecraft had an impact on a space policy. This kind of research is in line with the work of Florian Weisser (2014) in which he states that certain documents must be considered as “actant” in a political process. He explains that documents can have a “performative” role:

They are neither just a way of getting things done, nor do they act only via the discursive power they comprise by producing certain normativities and subjectivities (Reed, 2006). Rather, they supplement human activity and co-constitute organisations (Geisler, 2001). As artefacts they act in their own right and hold organisations together (Weisser 2014, 49).

Concretely, archives will be analyzed using mainly qualitative content analysis in order to find “tendencies, sequences and patterns” that could demonstrate the impacts that spacecrafts and space scientists (through scientific documents) can have on human spaceflight cooperation projects (May 2001, 193). This qualitative analysis will be standardized using the decoding technique. Thus, chapter 4 will present the construction of a decoding table inspired by the theory of *New Space Materialism*. In this table, the three constituent pillars of *New Space Materialism* will be divided into different precise codes (7 codes). Each relevant archival documents will be decoded using this table. This technique will allow qualitative analysis to be both systematic and quantifiable.

Chapters 5, 6 and 7 constitute the heart of the concrete scientific work of this thesis. These three chapters will subsequently analyze the three cases of cooperation between Russia and the United States (ASTP: chapter 5, Shuttle-Mir: chapter 6 and the ISS: chapter 7) using the decoding table of *New Space Materialism*. The archive documents analyzed will be presented in detail as well as all the decoding tables used. For each document and case, it will be demonstrated in which ways they corroborate the thesis of *New Space Materialism* or not.

Finally, following the analysis of archives, the decoding and the analysis of the results, the thesis ends with chapter 8. This chapter has two objectives. First, an overall assessment of the archival analysis will be made and the extent to which the *New Space Materialism* approach was successful in answering the research question will be determined. Second, this concluding chapter aims to step back and determine what is both the theoretical and empirical contribution of our thesis within the study of international relations in outer space and within the field IR as a whole. It will also determine to what extent our research findings challenge international relations notions of cooperation under scarce resources. The purpose of this chapter is therefore to add heuristic potential to this thesis beyond the better understanding of space cooperation between Russians and

Americans. Indeed, improving the understanding of the discipline of IR in the face of cooperation between human beings in situations of scarce resources is one of the main contributions of this thesis.

2. Chapter 2 – Literature Review

The question driving this thesis is *how can we explain the US-Russia cooperation in human spaceflights?* Answering this question requires a comprehensive literature review which at first may seem, like a colossal task. Indeed, one can expect that such a literature review will take stock of the current body of literature concerning cooperation in human spaceflights, and that the argument of the thesis will then address the gaps and shortcomings of the literature. This approach however offers little heuristic potential and risks falling into the Straw Man Fallacy. As such, this chapter will focus on presenting the strongest arguments, rather than the weakest. In taking this approach this thesis therefore has the potential of offering a larger and beneficial addition to the literature on the topic of cooperation within human spaceflights. Accordingly, this chapter is divided into two sections. The first part presents the three most convincing arguments explaining cooperation in human spaceflights. The second section situates the main contribution of this thesis within this literature (and as well as the first step towards New Space Materialism¹): the need to change the object of study towards spacecrafts.

2.1 Existing Explanations for Human Spaceflights Cooperation

Three main approaches within the literature can be identified in order to explain cooperation in human spaceflight. The first approach is the pragmatic argument which explains that cooperation in outer space is possible because it essentially benefits the interests of States. The second approach is the argument of the regime theory which argues that it is more thanks to the presence of the international outer space governance regime that cooperation is made possible. The third major

¹ Concerning precisely New Space Materialism and its 3 main pillars, the literature review concerning these will be treated in chapter 3 which is entirely dedicated to the theoretical construction of the thesis.

approach is the one of securitization, which argues that cooperation is possible because the issues related to human spaceflights are desecuritized.

2.1.1 The Pragmatic Argument: Outer Space Cooperation as The Reflection of Political Reality on Earth

One cannot perform a literature review on politics and human spaceflights without mentioning the pragmatic argument, which posits that cooperation in human spaceflights is enabled by states' pursuit of their individual political interests and consequently reflects the political situation prevailing on Earth. This state-centric approach, which hails from the Realist school of IR, considers the state to be the essential and ultimate actor in world politics. We will explore this argument in detail, given not only its opposition to the post-statist-centered approach advocated by our thesis (as briefly presented in the introductory chapter), but mainly due to its prevalence within the scientific literature.

Inspired by realist authors like Waltz (1979), who argues that states and their capacity within the anarchic international system are the elements to take into account in order to understand international issues, the pragmatic argument seeks to identify historical elements that can explain the outcome of a political event. Thus, the situation which prevails in outer space would constitute a reflection of the situation which prevails on Earth. This approach is quite interesting because it allows to situate and historically contextualize the events marking human spaceflights between the United States and Russia. Moreover, its emphasis on states as the main actors contains some merits since after all the latter have been central actors in the human exploration of outer space. However, we will see that this approach also contains some blind spots insofar as it leaves aside the contribution of other actors other than the State. As such, the following section will explore concrete examples of pragmatic arguments which explain the chronology of cooperation in human

spaceflights according to the interests of States. It will then explore some blind spots that this approach is not able to grasp in its analysis.

The 1975 Apollo-Soyuz Test Project (ASTP) (the first cooperation in human spaceflight between the United States and Russia), is understood by pragmatists as an instrument for “the promotion of *détente* and international cooperation” by both countries (Sheehan 2007b, 55). Sheehan explains that once the USSR had lost the race to the Moon, it was no longer in the state’s interest to use the space program as a weapon of the Cold War (Sheehan 2007b, 55). Then, in a perfect alignment of interests “the idea of the ‘hand-shake in space’ [both a symbolic and literal event] was coined by Secretary of State Henry Kissinger. Kissinger promoted this enterprise as an effective way to symbolize the *détente* foreign policy being pursued by the Nixon administration” (Sheehan 2007b, 65). This pragmatic view considers the ASTP as a demonstration that human spaceflight “was a reflection of improving interstate relations, not a generator of them” (Sheehan 2007b, 66). The historical sequence of events leading to the end of *détente* and a revival of the Cold War only strengthens this pragmatic argument; once the *détente* period was over the relations between the two countries “disintegrated” making all forms of cooperation in human spaceflight impossible (Moltz 2007, 173). However, although this analysis has interesting foundations, a historical analysis allows us to nuance this perspective. Indeed, the analysis of the archives carried out in the context of chapter 5 of this thesis demonstrates that the arrangements and cooperation which led to the realization of ASTP dates back to early 1969, which is before the end of the Apollo program (even before the first lunar landing) and at the start of the period of *Détente*.

When applied to the Shuttle-Mir project, the second case of human spaceflight cooperation between both countries, the pragmatic argument continues to be salient, particularly in terms of strategic analysis and the selfish interests of States. Crawley and Rymarcsuk (1992a, 32) posit that

it was only once the Cold War was over, that rapprochement between the two countries was made possible. As the authors state, their interests were now better aligned and “the benefits of cooperation may be realized”. Several observers explain that cooperation with Russia in human spaceflight following the end of the Cold War was essential, not only in order to ensure and promote Russia's economic transition towards capitalism, but also because it allowed the US to take advantage of Russian space knowledge and technology for its own benefit. Moreover, the US was also preoccupied with preventing the flight of Russian space scientists to countries hostile to the US who could have benefited from the scientists' knowledge in missiles and military technologies (Logsdon and Williamson 1995). In addition, the pragmatic approach also borrows from economic arguments to explain the cooperation between the two countries, in particular by stating that “in the present political and economic environment it is difficult to justify the development of two costly and uncoordinated national programs for manned exploration of the Solar System” (Crawley and Rymarcsuk 1992b, 32). Although several elements evoked by the pragmatic approach are very interesting explanations of the cooperation in the Shuttle-Mir project, it also contains some blind spots particularly regarding the various actors involved. Indeed, the pragmatic approach is mainly interested in the State and has little interest in other actors such as international organizations, scientists, individuals or even international regimes. It seems necessary that a more complete analysis should focus on a wider variety of actors in order to have a more complete picture of the situation, particularly with regard to Shuttle-Mir.

Finally, the pragmatic approach understands the third and last case of cooperation between the two countries, the ISS, in essentially the same way which is through an analysis of States' selfish and strategic interests. For Logsdon and Millar (2001, 171), the objective of the ISS project for the United States was to take “advantage of Russian space capabilities and experience to

enhance US space program efforts and potentially to reduce the costs of achieving various space objectives, particularly with respect to the space station program”. Continuing to offer employment opportunities to Russian scientists also remains an important strategic argument in protecting the United States. This cooperation was also intended for the US to “build[ing] ties between US and Russian elites in the aerospace sector linked to shared Western values” (Logsdon and Millar 2001, 172). This pragmatic approach is present in more contemporary analyses. In the context of the Russian intervention in Crimea in 2014, the United States had increasingly turned to investing in private companies such as Boeing and SpaceX to ensure the transport of astronauts to the ISS; collaborating with the Russians in this instance, was against the interest of the American State (Paikowsky, Baram, and Ben-Israel 2016, 188). This argument has interesting foundations, but as was the case with the pragmatic analysis of ASTP, it is possible to identify blind spots that exhibit rather contrary dynamics. Specifically, the American leveraging the private sector to transport astronauts, is also part of a collaborative logic where American astronauts will continue to use the Soyuz spacecraft and Russian cosmonauts will use American private shuttles. This is notably the case with Expedition 68 to the ISS (September 2022 to March 2023) where an American astronaut headed for the ISS aboard a Russian Soyuz spacecraft (MS-22) and a Russian cosmonaut went aboard the American spacecraft Dragon (SpaceX Crew-5) (M. Garcia 2022).

In short, Sheehan (2007b, 183) sums up the pragmatic approach well, stating “in one sense, space can be seen as a ‘final frontier’, to be crossed, but in another sense, humanity has brought its frontiers with it into space, replicating the political divisions and tensions that characterize global politics”. Although this approach contains several interesting arguments, it seems necessary to push the analysis further, notably by taking into consideration a greater variety of actors. The next two approaches that are presented fill this gap by focusing on actors other than the State.

2.1.2 The International Outer Space Regime's Role in Human Spaceflight

An interesting argument in the literature to explain cooperation in human spaceflight addresses the role and influence of the international outer space governance regime. Largely embodied by the United Nations Office for Outer Space Affairs (UNOOSA), IR scholars who support regime theory specifically assert the international outer space governance regime role. This significant aspect of the literature will be presented first by providing a brief overview of what constitutes regime theory and by providing a portrait of the outer space regime in question. Finally, this section presents some challenges related to the regime as well as a possible solution to these challenges, namely taking into account more varied objects of study.

2.1.2.1 Regime Theory

As mentioned above in the introductory chapter, the field of IR has long been criticized for being essentially anchored in “great debates” (Sylvester 2013). In IR’s “great debate” on the subject of cooperation, realists and neorealists have characterized cooperation between States as being very difficult, even impossible. A notable example includes Kenneth Waltz’s argument in *Theory of International Politics* wherein he asserts that it is the intrinsic anarchical structure of the international system that inhibits inter-state cooperation (Waltz 1979, 105). Regime theory was developed, among other things, to provide a counterweight to this neorealist and above all pessimistic perspective. In fact, regime theory explains that international regimes can have an important impact on cooperation among States particularly through international institutions and international law (Keohane 1984, 25). Though regime theory does not support the idea that international cooperation means a complete absence of conflict, supporters of this approach explain that cooperation is possible thanks to regimes because they allow a better coordination among

States (Keohane 1984, 51). Keohane identifies several functions of a regime that favour cooperation and assure stability. One of these functions is to reduce transaction costs in numerous ways (hence helping cooperation) notably by implementing rules that help to overcome the Prisoner's Dilemma and by putting in place economies of scale (Keohane 1984, 90). Furthermore, international regimes have the function to favour cooperation "by reducing asymmetries of information through a process of upgrading the general level of available information" (Keohane 1984, 94). A regime also tends to be more efficient if the numbers of actors implied is relatively small; a surplus of actors can inhibit cooperation as it becomes harder to identify defectors and punish them (Axelrod and Keohane 1985, 235). Keohane also explains that regimes can facilitate cooperation even in situations of international instability or hegemonic decline as it was the case during the end of the Gold exchange standard system where the rules and founding principles of international trade such as the balance of payments, the IMF and the World Bank remained intact (Keohane 1984, 186).

That being said, as is the case for almost all approaches in IR, it would be difficult, even wrong, to put under the same hat a set of proposals from different authors. This is also the case with the terminology "regime theory". Far from the idea of wanting to amalgamate different approaches together in order to make a coherent and united whole, the use of this term in this analysis of the literature is intended more as a practical initiative in order to be able to simply group together certain approaches that propose a different and more structural path compared to the pragmatic approach mentioned above in order to understand cooperation in human spaceflight. Thus, to the theory of regimes presented by Keohane, we could also add the contribution of other structural and functionalist approaches which can provide more than interesting complementary insights in order to understand the importance of the role of the outer space international governance regime. Indeed,

Barnett and Duvall explain that proponents of an approach supporting structural power in IR argue that international structures such as an outer space regime actually constitute actors with the capacity to influence and produce the social capacities of international actors (Barnett and Duvall 2005, 52). A functionalist approach inspired by David Mitrany can also bring its very interesting conceptual lot to the theory of regimes. Such an approach, reducing the importance and the role of States, defends that international cooperation is possible by establishing essentially "functional" cooperations not at high political levels, but rather in sectors of simple activities, flexible in their constitution and restricted in their fields of action. We can think among others of the sectors of air or maritime transport. In short, well beyond a great world governance, Mitrany defends that the international system should first be pluralist and especially functionalist, made of an extended network of activities and international agency (Devin 2008, 145).

This brief presentation of regime theory quickly helps to explain why several studies interested in outer space cooperation consider this theory to be convincing. In fact, the situation in outer space, particularly within human spaceflights, fulfills several criteria of a regime as identified by Keohane and Axelrod. Indeed, the outer space international governance regime implies very few actors, and it is equipped with several treaties and organizations (which are presented in detail below) whose role is to reduce transaction costs and produce symmetrical information. Stuart (2009) agrees with this by explaining more precisely that the international space regime has made it possible to unbundle the sovereignty of States, making cooperation between States possible in outer space devoid of territory. By "unbundling sovereignty" Stuart means that "through established norms and principles [by the regime], states have agreed to treat outer space as neutral territory, but also to treat human-made objects there as pieces of each state's sovereign territory" (Stuart 2009, 12). Dolman corroborates this perspective by clarifying that the outer space regime

provides the necessary mechanisms to govern the intrinsically transnational issue which is outer space. These mechanisms notably include that the regime is allowing a delimitation of space activities, a registration of space objects and the notion of innocent passage (Dolman 2002, 114–19). Moreover, it also appears evident that an organization like UNOOSA represents very well what Mitrany had in mind as an agency with an essentially functional purpose that acts within a very specific sector, namely the use of outer space. Moreover, existing since 1958, approaches which place more emphasis on the aspect of structural power will argue that such a regime has both been able to develop, but also acquired and maintained a structural power having a certain influence on the role and interests of the actors within its regime. Now, in order to explore more in depth this argument, we need to analyze the regime in question.

2.1.2.2 Portrait of the Regime

Similar to other international regimes, such as the international regime for the fight against climate change, the international outer space governance regime falls largely under the role of the United Nations. Indeed, we can summarize this regime as consisting of 4 major treaties which are all governed by UNOOSA. Created in 1958 in response to the launch of Sputnik 1, UNOOSA has grown over the years from an ad hoc committee to an entire UN organization based in Geneva since 1993. The mandate of UNOOSA is rather broad ranging from helping developing countries to access the benefits of space resources, space risk management, educating countries on the fundamentals of international space law, and supporting transparency in space activities (UNOOSA 2022).

The Outer Space Treaty (1967) is the first major treaty that lays out the governance of outer space activities. On January 1, 2024, the treaty was ratified by 114 countries including the major space powers such as the United States, Russia, China, India, France and Germany (United Nations

2022, 10). The treaty forms the basis for international space law, and at its core stipulates that the exploration and use of outer space must be conducted in the common interest of all mankind (Dolman 2002, 129). Therefore, the treaty also establishes that outer space, including the Moon and all celestial bodies, cannot be subject to national appropriation or claims of sovereignty and that scientific investigations of all celestial bodies shall be open with free access to all (Dolman 2002, 129). Moreover, the treaty also seeks to define outer space as fundamentally a collaborative enterprise appealing that all “States shall endeavor to explore outer space in a spirit of cooperation, allowing observation of space activities where equitable, and with regard to the ecology of Earth and outer space” (Dolman 2002, 130). In this same collaborative enterprise, the treaty asks that all stations, installations, equipment, and space vehicles on any celestial bodies to be open to representatives of all nations. Finally, and perhaps most importantly, the Outer Space Treaty prohibits States from placing weapons of mass destruction in orbit around the Earth and installing such weapons on the Moon or any other celestial body (Dolman 2002, 130).

The Rescue Agreement (1968) is an addition to the Outer Space Treaty which specifies the obligations of states concerning the rescue of individuals in space, stating “all astronauts are envoys of mankind and so every effort shall be made to render them assistance in the event of accident, distress or emergency” (Dolman 2002, 130). Thusly, states share an obligation to return safely and promptly any personnel of a spacecraft that may land in the territory of a Contracting Party, whether in high seas or in any other place not under the jurisdiction of the launching authority of the spacecraft. On January 2024, 100 countries including the major space powers had ratified the Agreement (United Nations 2022, 10).

The third piece to be added to the international outer space regime is the Convention on the International Liability for Damage Caused by Space Objects (1973) which has been ratified by 100

countries including the space powers (United Nations 2022, 10). It “recognizes that damage can be caused by space operations despite precautionary measures undertaken by States involved” (Dolman 2002, 132). Therefore, the convention seeks to establish an international legal regime that can mitigate liability and strengthen international cooperation. It states that all launching States are totally liable for damage caused by their spacecraft on the Earth or to aircraft in flight (Dolman 2002, 132).

The fourth and last major piece of foundation of the international outer space regime is the Convention on Registration of Objects Launched into Outer Space (1976). Ratified by 75 countries including the major space powers (United Nations 2022, 10), this Convention seeks to codify space registration. For instance, it states that at a minimum, countries must provide the launching date of the space object, the territory and location of the launch, the basic orbital parameters of the space object (period, inclination, apogee, perigee) and its general functions (Dolman 2002, 132).

2.1.2.3 Challenges of the Regime

Though the outer space international governance regime offers multiple frameworks to support cooperation, it appears in fact that it contains challenges that invite us to push our analysis beyond this approach in order to fully understand cooperation between the United States and Russia in human spaceflights. Among the arguments that call into question part of the effectiveness of the outer space regime is the idea that the regime in practice, does not entirely separate the notions of sovereignty and territory. Stuart (2009, 13) explains that, as observed on the ISS, states do maintain their own sovereignty over their individual modules, therefore highlighting that notions of sovereignty and territory still remain present to some extent in orbital human spaceflights projects. Furthermore, it appears that the regime has challenges in respecting the three essential functions of

a regime as identified above by Keohane (reducing asymmetry of information, assuring stability and lowering transaction costs between States).

2.1.2.3.1 An Uncertain Regime: Militarization and Weaponization of Outer Space and the prisoners' dilemma

As stated above, one of the essential functions of a regime identified by Keohane is to reduce the asymmetry of information between actors. By doing so, it helps to counter the prisoners' dilemma and the problem of collective action (Keohane 1984, 93). However, it appears that the outer space international governance regime has some difficulty in fulfilling this function because it contributes indirectly to an uncontrolled militarization and weaponization of outer space. This makes us question the effectiveness of the regime not only because it contributes to outer space not being a safe environment but also because the different actors involved can not have the access to the right information regarding the weapons and military uses in outer space.

Indeed, since the beginning of the outer space regime, both United States and Russia/USSR have held different understandings of one of the core elements of the Outer Space treaty: the notion of a "peaceful use" of outer space. For the USSR, a "peaceful use" of outer space was a synonym of "wholly not military" (Indian Pugwash Society 2009, 53). In practice, the USSR has interpreted this as meaning that space objects could not carry any weapons but could also not be integrated to the military complex particularly through military intelligence. However, for the United States, Johnson-Freese (2007, 108) explains that the definition of a "peaceful use" of outer space was interpreted as synonymous with "non-aggressive". Moreover, the definition of what constitutes a non-aggressive outer space object has evolved over time. Between the Kennedy and Carter administrations, a non-aggressive space object referred to one that did not carry ammunitions or have a defensive or disarmament capacity. However, a "non-aggressive" outer space object could

contribute to the military complex through collection of military intelligence. Since the Reagan administration, the vision of a “peaceful” use of outer space as being non-aggressive has evolved and space objects could be equipped with firepower of disarmament capacity in order to defend themselves (Johnson-Freese 2007, 108). What is clear is that these two definitions of what constitutes a “peaceful” use varies significantly between the interpretation of “wholly not military” to equipped with firepower. Consequently, this ambiguity created by the Outer Space Treaty directly contributed to the militarization and weaponization of outer space by allowing “legal differences of opinion on which types of space hardware are subject to international law and under what circumstances” (Johnson-Freese 2007, 109).

This observation that the Outer Space Treaty does not fully succeed in resolving the prisoner's dilemma between actors in outer space makes us question the full effectiveness of the regime. Its ambiguity, combined with a lack of prohibition of weaponry, has contributed to the evolution of outer space as an unsecured environment, where cooperation is not easier than what it is on Earth (Su 2010, 268).

2.1.2.3.2 An Unstable Regime: Political Influences on Its Legal Framework

Another challenge facing the outer space international governance regime is that it is subject to numerous political influences which render its legal structure unstable. This dynamic is demonstrated in the cases of the failures of the Anti-Ballistic Missile (ABM) Treaty in 1972 and the Moon Treaty in 1979. Thus, Keohane would argue that this regime cannot be considered as stable because it can not “[...] establish stable mutual expectations about others’ patterns of behavior” (Keohane 1984, 89).

Indeed, the ABM Treaty is a good example of politics taking precedence over the outer space international governance regime. Dolman (2002, 133) explains that the ABM Treaty as a

bilateral agreement between United States and the USSR, was intended to ban the development, testing and deployment of anti-ballistic systems that are land, air, sea or space-based. The sole exceptions included in the treaty allowed for one ABM site in defence of the national capital (Washington and Moscow) and a single testing site in each country. The USSR accepted this exception, and effectively created an ABM ring around Moscow, which it maintains to this day. However, the case of the United States was more complex. Following the ratification of the treaty, public opinion framed this exception as highly controversial, focusing not on defense of the capital, but instead on the creation of ABM capacities as defense for only D.C. elites, leaving the rest of the country undefended (Dolman 2002, 133). For this reason, the Reagan administration unilaterally decided to develop the Strategic Defense Initiative (development of space-based and ground-based ABMs) which render the treaty almost inoperable (Dolman 2002, 133). In 2002, following the events of 9/11, the United States officially withdrew from the ABM Treaty. This withdrawal exemplifies how public opinion and the constraints of partisan politics maintain important influence on the legal framework of the outer space regime.

A second example which demonstrates the instability of the outer space regime due to political precedence is the Moon Treaty of 1979. This agreement was meant to clarify an important element of the Outer Space Treaty: the “equal access” to outer space. The Moon Treaty attempted to revise the traditional Western view of “equal access” to space, accommodating the view defended by the former Soviet Bloc and less developed countries, who argued for “equal benefit” (Dolman 2002, 133). This distinction between “equal access” and “equal benefit” is important, the latter being more in line with the goal of outer space as being for the “benefit of all mankind” as stated in the Outer Space Treaty. The vast majority of countries debating the Moon Treaty asserted that since celestial bodies are not subject to national appropriation, anything brought back from

them could not belong to one country but rather to all humanity. This challenged the United States' view concerning appropriation of extraterrestrial resources like Moon rocks, and subsequently they refused to ratify the treaty (Driscoll 2003, 50). Thus, the Moon Treaty has been ratified by only 17 countries so far and by no major space powers (United Nations 2022). This second example of the Moon Treaty also corroborates the fact that states' interests still surpass the legal framework and thus we can question the full capacity of the regime to explain cooperation in human spaceflight between the United States and Russia.

2.1.2.3.3 An Inefficient Regime: Need for a New "Space Code of Conduct"

Through the years, notably due to the instability of the outer space international governance regime, this regime has been contested and important pressures are being made by the United Nations General Assembly to establish a new "Space Code of Conduct". Indeed, beyond the fact that the definition of a "peaceful" use of outer space continues to be contested, the regime still has challenges in its capacity to settle disputes regarding issues on properties in outer space and "today some nations view treaties only as a roadmap for future treaties – not as law themselves (Grunner 2004, 306). Moreover, several studies noted that the outer space regime lacks a real governing body capable of implementing and enforcing the dispositions of the regime (Grunner 2004, 331).

Indeed, history has shown that the regime has had difficulties in settling disputes between its members, and the case of the Kosmos 954 accident is a good example. On January 25, 1978, a Soviet satellite (Kosmos 954) crashed into north western Canada, scattering radioactive debris from the satellite's nuclear reactor over an area of several thousand kilometers. Only after arduous negotiations (where Canada received less than half of the cleanup costs requested from the USSR) and years of work was Canada able to resolve the situation. Not only has this situation demonstrated that the *Convention on the international liability for damage caused by space objects* is imprecise

and ineffective in reducing transaction costs but it also demonstrated the “areas in which it created legal uncertainty” (Brearley 2008, 315).

Thus, if we stick to a more Keohane-inspired approach to regime theory, it is clear that the international regime of space governance faces challenges. It presents a lack of stability, is unable to provide symmetry of information and it has challenges in reducing transaction costs. This observation invites us to explore further, beyond the regime, in order to understand the cooperation between the United States and Russia within human spaceflight. That said, it is important to emphasize that this approach is not without merit, particularly if we focus on the more structural and functionalist aspects of the international space governance regime. Indeed, despite its flaws, it is clear that the actors of the regime succeed in cooperating on practical aspects and specific and niche sectors such as the International Space Station for example. Moreover, despite its flaws, it is clear that the laws of outer space and the structures of UNOOSA have acquired a certain agency and a co-constitutive relationship with its various actors. This is precisely the point that this thesis seeks to explore and one of its main contributions to this literature of the study of space politics: the actors to be studied in outer space. Indeed, it appears that one actor is missing within regime analyses as well as functionalist analyses and it is the spacecrafts. That being said, before we get into this topic, one last part of literature must be explored and it is the literature of securitization.

2.1.3 The Securitization Argument: Cooperation in Human Spaceflights Is Due to Desecuritization

Another interesting approach in the literature which offers an explanation of politics and cooperation in outer space is the securitization approach. The securitization approach is considered more critical within the field of IR and it seeks to explain political phenomena by focusing on the importance of the language and words used by the different actors. The following section will first

present a brief portrait of the securitization approach, going on to consider its application to outer space. Finally, this section will unpack the challenges of the securitization approach in understanding the cooperation in human spaceflights.

2.1.3.1 Securitization theory

As is the case with many approaches in international relations, it is difficult to identify a precise body of work as constituting “securitization theory”. It is possible, however, to identify that the term “securitization” was coined by Ole Waever in the early 1990s. In an era teeming with perspectives seeking to move away from the notion of state security to human security, Waever warns that there is a danger in broadening the notion of security to a concept such as human security because the latter may simply be conceptually too broad and of little use for analysis. Indeed, he argues that a notion such as human security can easily become synonymous with “human conditions” and can encompass the entire social and political agenda (Waever 1995, 1). Without denying the importance of the security of human beings, Waever argues more for a co-constitutive notion between the security of the State and that of individuals. Waever and other authors associated with the Copenhagen School in critical security studies therefore asked themselves the question: What really makes something a security problem? They came to the conclusion that security is in reality a “speech act” (Peoples 2011b, 80).

The Copenhagen School adopts a fundamentally constructivist approach in their understanding of security issues and “... refute the claim that there are (any) inherent security issues” (Peoples 2011b, 81). Thus, applying securitization theory to outer space issues, Columba Peoples explain that the focus in understanding security issues in space goes beyond the issues of militarization, weaponization and international regime. Security must be understood as a constructed and intersubjective issue “between those claiming an issue as security and a relevant

target audience” (Peoples 2011b, 81). Securitization then understands security as intrinsically dependent on how security actors do or do not frame issues as matters of national security. Columba Peoples (2011b, 80) explains securitization as “[...] the process through which an issue comes to be seen as an issue of security. When an issue comes to be treated as an issue of national security, it is justifiable to use exceptional political measures to deal with it. It is securitized: that is, treated with the same degree of urgency as military threats have been historically”.

Furthermore, language constitutes the main tool through which one communicates the degree to which a matter is securitized. Ole Waever (1995, 5) notes that by stating an issue is vital to national security has a very important and transformational impact on the issue. Thus, a complete understanding of security issues cannot only stand on a purely textualist analysis of reports, policies and programs (Peoples 2011b, 87). Indeed, Waever demonstrates that the utterance itself is a security act: “by uttering 'security', a state-representative moves a particular development into a specific area, and thereby claims a special right to use whatever means are necessary to block it” (Waever 1995, 5). Likewise, the reverse process of desecuritization is equally affected by verbal communication, allowing securitized issues to return to the table of “normal” politics. Thus security is the outcome of a social process (“speech-act”) in which political leaders position a particular issue as a threat to survival and are establishing emergency measures to deal with this issue (Waever 1995, 5). Waever goes on to explain that the use of the label “security” on an issue is a political choice and leads to specific way of addressing a problem (Waever 1995, 10). Thus, something is a security problem when elites declare it to be so.

2.1.3.2 Applying securitization theory to outer space politics

As demonstrated in Section 2.1.1., it can be hard to transpose the political situation prevailing on Earth to understand the situation in outer space. Authors such as Columba Peoples

corroborate this idea noting that “focusing on militarization and weaponization alone simply isn’t sufficient” (Peoples 2010b, 208). He explains that securitization theory provides a better framework for understand security issues in outer space. Indeed, the spacefaring powers are making many “securitizing moves that identify space as crucial to national security and survival in a variety of ways” (Peoples 2010b, 206). Peoples (2010b, 207) gives the example of the 2006 US National Space Policy in which the country identified “US military capabilities as ‘critically dependent upon space capabilities’”. On the opposite side of the spectrum, Peoples explains that we can use securitization theory to understand how an outer space issue can become peaceful and collaborative through the process of desecuritization. This process of desecuritization (bringing an outer space issue out of the arena of the exceptional means and security concerns) could be achieved using arms control measures and the signature of treaties and conventions (Peoples 2011b, 93). More concretely, it is easy to demonstrate according to securitization how an issue can be desecuritized. Take for example, the case cooperation between the United States and Russia in the ISS during the crisis of the annexation of Crimea in 2014. Despite the relationship between the two countries being securitized on Earth, they were desecuritized in outer space within human spaceflight. The following paragraphs demonstrate a more detailed original analysis of this situation.

As discussed in the introductory chapter, though US-Russian relations warmed in the post-Cold War context, since the early 2000s tensions have steadily mounted, perhaps best exemplified by the 2014 Russian annexation of Crimea and the 2022 Russian invasion of Ukraine. Through the lens of securitization theory, the speech act reveals a dynamic in which political leaders seek to define the relationship between the two states as dangerous and warranting of exceptional measures. Here, for example, is a speech given by US President Barack Obama during the Crimean crisis in 2014:

I, BARACK OBAMA, President of the United States of America, find that the actions and policies of persons -- including persons who have asserted governmental authority in the Crimean region without the authorization of the Government of Ukraine -- that undermine democratic processes and institutions in Ukraine; threaten its peace, security, stability, sovereignty, and territorial integrity; and contribute to the misappropriation of its assets, constitute an unusual and extraordinary threat to the national security and foreign policy of the United States, and I hereby declare a national emergency to deal with that threat. (The White House 2014a)

The day following this declaration by the American president, it was the turn of the Russian leaders (Russia's deputy minister for foreign relations) to adopt a securitized discourse considering the other country as being a danger requiring exceptional measures to be taken:

It is yet another sign of a reckless behaviour of the U.S. administration. No lessons are learned from the past. The U.S. does literally nothing to impress its cronies and clients in Kiev on whom there is full responsibility for constant deterioration of the situation in Ukraine. This is what needs to be changed and not the policy of Russia. [...] A response of Moscow will follow, and it will be painfully felt in Washington D.C. (Levs and Labott 2014)

If we analyze both the situation on Earth through the lens of securitization theory, relations between the two countries are indeed securitized. Still however, in the context of Russia's annexation of Crimea, Sergei Krikalev (ROSCOSMOS executive director for manned programs) asserts that "despite any political issues between Russia and the United States, the space cooperation continues, and the current cooperation is a good example of how we should collaborate, because the space collaboration is important and it should be systematic" (Spacedaily 2016). On the American side, Charles Bolden (NASA Administrator) used an even clearer desecuritized speech act by asserting that:

The political and diplomatic changes and trauma that goes on down here on Earth, I think we can survive that," he said. "As we have demonstrated, looking at incursions by one of our partners into other countries, that has not deterred or slowed work we have done on the International Space Station. (Foust 2016)

Thus, we can see that both countries are using securitized speech acts on Earth that consider the behaviors of each other as a vital threat to their national security while both countries, in their

deseccuritized speech acts referencing outer space, consider their relations not as vital threats but as very important peaceful cooperation. It would therefore be tempting to conclude that the cooperation between the United States and Russia in human spaceflight could be explained because of the use of deseccuritized speech. The next section argues that although this argument is very interesting, there are still some challenges to be addressed.

2.1.3.3 Deseccuritization : how can it explain cooperation in human spaceflight?

Although securitization theory posits some very interesting explanations for US-Russian cooperation in human spaceflight, there are still challenges to be addressed within this analysis. Indeed, scholars note that securitization theory is not very convincing in explaining the mechanisms and dynamics pushing a political actor to securitize or deseccuritize an issue. Williams (2003, 521) reflects this view in his critique of securitization theory, positing that “[focusing] too narrowly on the search for singular and distinct acts of securitization [can] lead one to misperceive processes through which a situation is being gradually intensified, and thus rendered susceptible to securitization, while remaining short of the actual securitizing decision”. Aradau (2004, 393) goes in the same direction as Williams arguing that securitization theory should be more critical of political implications within the speech act itself. These critiques are relevant within the framework of the study of cooperation within human spaceflights. Indeed, securitization theory is not fully able to explain why discourses regarding human spaceflights and earthly relations are securitized or not. What are the motivations behind these discourse differentiations? Let us take for example the case of the differentiation of discourses concerning American-Russian relations in outer space and on Earth at the time of the ISS. Although it is clear that the respective leaders of the two countries use securitized and deseccuritized speeches, we do not understand the reasons which pushed the Russian leaders to evoke that “the space collaboration is important and systematic” or

those which pushed the Americans to declare about the subjects of the important tensions between the countries: “we can survive that”. In short, though it is interesting to understand the *how* of this phenomenon, it is also essential to understand the *why*, and to grasp the real reasons which motivated the decision of these two countries to cooperate so extensively in human spaceflight. Moreover, it turns out that to better understand the *why* of such a phenomenon, it is necessary to explore the subject beyond words, beyond a speech act. Williams agrees, arguing that it would be difficult to understand a security crisis like the 9/11 attacks without paying close attention to the impact and role of images in the framing of the security issues related to the War on Terror (M. C. Williams 2003, 526). The same kind of question can also be asked regarding cooperation and security within human spaceflight. Beyond words and speech act, should we pay attention to other security objects such as the spacecraft themselves? McDonald would also support such a perspective by arguing that the Copenhagen School places too much emphasis on elites and not enough on marginal actors and voices (M. McDonald 2008, 574). There are indeed marginal voices within the human spaceflight enterprise, and these are the space engineers and scientists who make this whole phenomenon possible. Far be it from us to discredit the merits of securitization theory, on the contrary it allows us to grasp how political issues can be formulated in outer space, this study of the literature invites us to push beyond these identified challenges by drawing inspiration from these challenges in order to formulate an innovative approach.

2.2 Summary of the Main Challenge and How to Overcome It

The exploration of the literature has made it possible to provide important contributions to the understanding of our studied phenomenon, which is the cooperation between the United States and Russia within human spaceflights. Let's be clear: the goal here is not to discredit the three approaches identified above. Quite the contrary. In an eclectic spirit, these approaches allow us to

identify the different challenges that remain to be met in order to understand our studied phenomenon. It is by keeping all their contributions in mind that it is possible to push the reflection a little further. Thus, the pragmatic approach has allowed us to identify that it is necessary to analyze beyond the sole state actor. The theory of regimes allowed us to explore a multitude of other actors such as international institutions and international law while proposing to further broaden our horizons towards a greater multitude of actors. Securitization approach moves in the same direction by showing us the need to study more marginal voices and actors in order to understand the *why* of a phenomenon.

From this study it is possible to identify some common denominators that contribute to our thinking and one of them is that the State is still a central actor within the dominant literature. The pragmatic argument essentially focuses its analysis on the State and its selfish interests when in reality there are many other actors that must be considered. Regime theory is an approach that gives more importance to non-state actors, but the main explanatory mechanisms of the theory (stability, transaction costs and information asymmetry) are all fundamentally bound to the State which ultimately remains the central concept and actor of the international. As for securitization theory, it is essentially considering the speeches of political leaders and this approach helps to perceive the State as a billiard ball that is very difficult to crack. Thus, the analysis of this literature invites us to explore the topic of cooperation in human spaceflight going beyond the state-centric approach. As mentioned briefly in the introductory chapter, one of the simplest and most effective ways to get away from the state-centric approach and the territorial trap when it comes to human spaceflight is to embrace the notion of the end of territoriality.

2.2.1 *End of territoriality*

By carefully studying cooperation within human spaceflight, we are able to demonstrate a fundamental aspect of politics in outer space for human beings: the end of territoriality. The notion of the end of territoriality is not new and has been studied by many scholars of international relations. Sassen defines territoriality as “the sovereign authority of the state over its territory” and scholars like her argue that this notion is increasingly outdated in the study of world politics and international relations (Sassen 2013, 21). She defends her argument in various ways, notably from a historical angle, explaining that the importance of territory has not always been the same over time, as was the case in medieval times when authority had clear precedence over territory. She explains that territoriality must be better understood as a “diverse complex organizational assemblages, with variable performance in relation to authority and rights, depending on the properties of such assemblages” (Sassen 2013, 23). She also explains that the reality of the modern world cuts across national borders and greatly weakens the sovereign power of the State over its territory. Territory therefore takes on various forms that can vary greatly from its classic national character and notion of territoriality. She mentions in particular the “denationalized components of state authority” that leave the national in favor of the global (Sassen 2013, 38). It is such an approach inspired by Sassen and the questioning of state authority over the territory which constitutes one of the founding stones of the contribution of this thesis to a better understanding of political issues in outer space.

In addition to recognizing the end of the State as a central actor, the end of territoriality in outer space means that we are also faced with a unique context. Historically, the concepts of territory, borders and sovereignty have been central to IR. However, it turns out that these concepts are very difficult to transfer to spacecraft in outer space. Beyond a conceptual notion as developed by Sassen, the end of territoriality in outer space can be divided into two main criteria. The first

criterion identifies that outer space constitutes a unique environment in IR and the second argues that spacecrafts are non-territorial, non-sovereign and borderless objects.

2.2.1.1 The Unique Outer Space Environment

Outer space has been widely considered to be a “global commons” in much the same way as the management of Antarctica, the high seas and international airspace are treated (Beery 2016, 92). This aspect of outer space is also legally confirmed by the Outer Space Treaty of 1967 which stipulates that “the exploration and use of outer space shall be carried out for the benefit and in the interests of all countries and shall be the province of all mankind”(UNOOSA 2023). However, although it is legitimate to consider outer space as a global commons for humanity, the possible comparisons between outer space and the high seas, Antarctica and international airspace end at this aspect given the absence of the notions of territory, border and sovereignty.

Studying more in the context of a critique of the outer space governance regime, Beck (2009, 5) explains that the very nature of spaceflight poses a unique problem in terms of international law “that are not posed by other frontiers of human transportation such as the high seas, atmospheric flight, or polar exploration”. Beyond the fact that spacecrafts in orbit cannot stay in place above a single State (apart from in a single geosynchronous orbit at 35,600 km of altitude) and must actually fly over dozens, if not hundreds of states in the space of a few ten minutes, Beck notes that “the things that can be done in space are sufficiently different from what can be done on the high seas or in Antarctica to require different rules from these other areas traditionally not subject to national sovereignty” (Beck 2009, 5). Indeed, the nature of orbital flight poses unique sovereignty challenges that are not present on the high seas. Beck (2009, 7) explains that “a ship on the high seas, traditionally defined as the parts of the seas or oceans at least twelve miles from the nearest shore, cannot substantially affect inland areas by accident”. However, a spacecraft in

orbit can not only cross but also observe large areas of the globe very quickly, but it can also cause damage to many countries at the same time if it crashes into Earth. These parameters are very different from the capacities that a ship can have on the sovereignty of States 12 nautical miles from the coast. The logic is the same with regard to Antarctica, where an individual or any installation cannot have a direct impact on the sovereignty of a State like a spacecraft can do. In terms of airspace comparison, even aircraft with the greatest technology available cannot match the range and impact that a spacecraft can have on several States (Beck 2009, 7). This unique situation in outer space means that we cannot simply extend national borders skyward as we do with airspace. Taking all of this into consideration, Beck believes that the outer space international governance regime needs to be revised because space law should develop on its own and not as an extension of existing laws on Earth (Beck 2009, 8).

Having demonstrated earlier that the regimes' approaches have challenges in explaining cooperation in human spaceflights between the United States and Russia, this analysis by Beck corroborates the fact that sovereignty, borders and territories are concepts simply obsolete in outer space. Indeed, even the 1967 Outer Space Treaty rejects territorial sovereignty in outer space by stating that no territorial claims can be made in space (Pop 2008, 60). This situation makes the role as well as the purpose of the State in outer space difficult to define given that sovereignty, territory, and borders are among the constituent elements of what a State is. By rejecting the latter as being the essential actor of IR, this approach recalls that of Agnew who explains that analyses in IR must avoid the “territorial trap”. Agnew (2014) argues that identity and political actions should not be defined in state-centric terms and especially to the detriment of other types of identity. The notion of the *end of territoriality* in outer space therefore explains that it is impossible to establish borders, territory, or any notion of sovereignty in the vacuum of outer space. For example, a State cannot

claim sovereignty over a particular orbit or establish territory and boundaries on the Moon or any moons, planets or asteroids. But what about our object of study: spacecrafts? Do they also respond to this unique aspect of the outer space environment that is without territory, border and sovereignty? The following section explains that yes indeed spacecrafts meet these criteria as well.

2.2.1.2 Spacecrafts as Non-Territorial, Non-Sovereign and Borderless Objects

To demonstrate how spacecrafts do constitute non-territorial, non-sovereign and borderless objects, this section will define and outline the lack of application of the concepts of border, territory and sovereignty. To maintain a broad scope, the simplest and most common definitions have been retained.

“Territory” can be simply defined as “an area of land, or sometimes sea, that is considered as belonging to or connected with a particular country or person” (Cambridge University 2023b). While it is true that technically a state's sovereignty and territoriality carry over to its spacecraft as will be discussed below, in reality it turns out that this “territory” within a spacecraft is very malleable compared to our understanding of what is territory on Earth. Indeed, during takeoff, the spacecraft does not have its own territoriality. It is only an object located within a sovereign state. It is when the ship climbs to an altitude of more than 100 kilometers, thus passing the Kármán Line which constitutes the frontier of outer space (NASA 2023), that the latter then leaves the sovereign territory of the State in which it was located to enter non-territorial outer space. However, what happens once the ship descends below the altitude of 100 km in the course of landing, and while below this threshold, flies over a number of different countries? Does the vessel in question lose its territoriality at the expense of the State it flies over as is the case for aircraft that fly over the airspace of a country where they are then entirely objects flying over the territory of a State? This situation is vague, and it is even more so when we focus on the concept of border. This also joins

Agnew's argument of the territorial trap which argues that the notion of territory in the contemporary world should not be understood as being a fixed and precise unit as it was the case for the classical approaches of international relations (Agnew 2014, 26).

“Border” can be simply defined as “a line that has been agreed to divide one country from another” (Cambridge University 2023a). The concept of a border here becomes even more abstract than that of territory when one tries to apply it to a spacecraft. Let's say for example that the walls of a spacecraft constitute the border of the territorial State that it represents, does this mean that when an individual leaves a spacecraft in orbit this one leaves the border of the State in question? It should be noted that extravehicular activities or more commonly known as “spacewalks” in outer space are not anecdotal events since nearly 500 spacewalks have been carried out since the first spacewalk in 1965 (Mars 2020). The notion of the border in this case seems to be little applicable, even ignored. Such a questioning of the notion of border is not foreign to critical IR studies with analyses that note the profound changes that borders undergo in contemporary globalization. This is notably the case of Lipschutz who recognizes that IR must recognize the essentially permeable aspect of modern borders (R. D. Lipschutz 2001, 89).

“Sovereignty” can be defined as “the claim to be the ultimate political authority, subject to no higher power as regards as enforcing of political decisions” (Buzan 2009). From the outset, it is difficult to establish that a spacecraft constitutes an actor of sovereignty since the latter has very vague borders and territory. Moreover, it is important to underline that the decisions made on board a spacecraft are rarely made by the crew on board, but rather by the flight directors on Earth. In fact, the most widely used spacecraft in history (since 1967) and still in operation today, the Russian Soyuz spacecraft, is a self-piloted spacecraft (The European Space Agency 2018). It is therefore difficult to conclude that the ultimate political authority aboard a spacecraft is the spacecraft itself

or its crew. This ultimate political authority falls more into the hands of the control center of the State which is not located on the same territory and the same borders if one considers the spacecraft as having its own territory and its own border. In short, these incongruities show that the concept of sovereignty over a spacecraft remains very vague. Stuart (2009, 8) supports this view by explaining that classical Westphalian sovereignty “which delineates a clear relationship between sovereignty, territory and the State, does not conceptually grasp sovereignty in outer space”. Williams (2010) also argues that outer space is a non-sovereignty zone and this fact explains why the international community quickly included this principle of non-sovereignty in the Outer Space Treaty of 1967.

This context, where spacecrafts constitute objects without borders, territory and sovereignty is even more convincing when one is in the presence of a multinational space endeavor where the spacecrafts of more than one State are connected together in orbit, as seen in our objects of study: the Apollo-Soyuz Test Project, the Shuttle-Mir Program and the International Space Station. As mentioned above, it is true that States technically retain jurisdiction and control over their ships and modules in outer space, even if they are part of a station made up of several modules and ships belonging to different states. Thus, in the context of the ISS, Landfester (2011, 19) explains that “different States own – enjoy sovereignty over – different parts of the ISS, and different laws apply to different parts of the ISS”. However, although this situation seems on paper to support the fact that spacecrafts and space stations constitute objects of territories, borders and sovereignty, the reality of the facts is quite different. Yes, it is true that there is a “Russian” part in the ISS and an “American” part, but these different parts constitute one entity in order to ensure their very existence. Indeed, in the ISS and as was also the case during ASTP and Shuttle-Mir, these stations cannot exist without the connection, collaboration, and symbiosis between these distinct vessels.

This symbiosis between spacecrafts is well illustrated in the ISS where the altitude and navigation control of the whole station is located in the Russian part (NASA 2015, 41) while the part responsible for the distribution of electricity for the whole station is located in the American part (NASA 2015, 32). It is difficult to conceive of the ISS as made up of distinct territories and borders when the station needs to be unified under a single entity in order to be able to exist. The situation is also valid during the ASTP mission in 1975. When the Soyuz and Apollo spacecrafts connected, the procedure to achieve the exchange of the crews required the development of an international adapter. Once the atmospheres between the spacecrafts were balanced, it was simply impossible for the two spacecrafts to be able to unilaterally separate from each other without causing the destruction of the other. We will go into the details of ASTP in chapter 5, but it demonstrates that once the two spacecrafts were connected, they constituted only one “territory” in order to exist. Moreover, it is important to emphasize that the notions of “boundaries” do not exist in a multinational space station. No need for a passport or any form of national control to enter any other part of the station.

Finally, given that borders and territories are very vague and malleable concepts within a multinational spacecraft or station, it is difficult to identify “sovereignty” in a station like the ISS. Moreover, even by further complexifying the notion of sovereignty as does Lake (Lake 2003, 309) who defines sovereignty as being “[...] an institutional arrangement for organizing political life that is based on two principles: territory and the exclusion of external actors from domestic authority structures”, it is more and more clear that the situation of spacecraft in outer space does not adequately fit to this notion of sovereignty. Landfester corroborates this perspective by arguing that exporting the concept of Westphalian sovereignty to the situation in spacecraft like the ISS is highly problematic (Landfester et al. 2011, 20).

2.2.2 *The Need to Use a Non-State-Centric Approach*

Beyond the fact that it seems obvious and necessary to get rid of state-centric approaches given the situation of the end of territoriality in outer space, it also turns out that epistemologically state-centric approaches and even those focused on individuals are misguided in answering our research question. Indeed, the state-centric approach sees the State as the main actor in international relations. Whether through the individuals who represent it (heads of State), a particular group (the civil service), an institution (NASA) or simply the State as a unique and proper entity (Russia), the state-centric approach identifies States as the most important actors in international relations (Macleod et al. 2004, 13). The various state-centric approaches are not homogeneous; some see the role of the State as being less predominant or, on the contrary, more important. One can think of the realist theory which sees the State (and particularly the powerful States) as the most important actors, while an institutionalist approach will dedicate a greater importance to the international institutions and organizations without denying the aspect of dominance of the State (Macleod et al. 2004, 14).

One of the main criticisms of the state-centric approach is that it ignores a multitude of other actors who have a role to play in international relations and have no connection with the State (Macleod et al. 2004, 14). Examples include, transnational groups, terrorist groups or the cross-border digital universe. However, one of the most important criticisms to consider concerning the state-centric approach is that of agency. Considering the State as the central actor of IR excludes the essential notion of agency. Indeed, for an actor to have a role in IR, it must act (voluntarily or even involuntarily) and these actions (or inactions) have an impact on other actors. However, the state-centric approach treats agency in IR (the capacity to act in international politics) as being simply given to States. This way of seeing things does not allow us to understand how this actor came to develop this agency, to make decisions and to become an acting agent on the international

scene (Braun, Schindler, and Wille 2019, 788). The importance of agency is key to understanding why state-centric approaches fail to explain cooperation in human spaceflight. Admittedly, it is indeed States (represented by humans and spacecrafts) that are present in outer space, but the States' agency is very difficult to grasp. Indeed, as seen a little above, the end of territoriality where borders, territory and sovereignty are very vague concepts in outer space makes the agency of the State difficult, even diffuse, to understand. Certainly, American and Russian flags are visible on spacecrafts and spacesuits, but it takes more than symbolic state representation in order to be able to understand the agency and the role that the State had behind this decision to send collaborative human spaceflights missions. Thus, we cannot understand why the State decided to act in outer space by considering the State as the self-creator of its own agency. We need to dig deeper to understand what prompted the State to make this decision. In short, to understand the agency of actors in outer space, the analytical framework must go beyond the state-centric model.

A common alternative to the state-centric approach is that which considers the individual as the main and central actor in IR. Indeed, authors like Franke and Roos (2010, 1058) argue that States are not even actors. They explain that “due to their corporeality, reflexivity, and aptitude for abduction human beings are the sole actors in our model of the social world instead” (Franke and Roos 2010, 1058) of States. Moreover, considering the individual as the central actor of IR gives greater explanatory power by considering the State as being more of an assemblage of corporate practices and structures. Such an approach not only diversifies the number of actors considered, but it also explains from where a single actor, or “the State” derives its agency. Hudson (2005, 2) corroborates this perspective by explaining that without agency, States are merely abstractions, as this agency stems from the individuals who possess it and actually compose it. She also adds that:

All that occurs between nations and across nations is grounded in human decision makers acting singly or in groups. In a sense, the ground of IR is thus the same ground

of all the social sciences. Understanding how humans perceive and react to the world around them, and how humans shape and are shaped by the world around them, is central to the inquiry of social scientists, including those in IR. (Hudson 2005, 1)

Approaches centered on individuals are therefore intended to be much more rigorous than those focusing only on the State as a unitary actor. However, these individualistic approaches face a similar dilemma to state-centric approaches: how to explain the decisions and actions of individuals? What motivates their agency and actions on the international scene? Many theories and approaches exist to explain the political choices of individuals in IR ranging from liberalism, Marxism, postmodernism and many others. However, individualistic approaches do not provide greater explanatory potential than state-centric approaches when explaining American-Russian cooperation in manned spaceflights. Instead of being confronted with the riddle of what constitutes the decision-making motivations of a State, we are left to determine the motivations behind the decisions of a large number of individuals. Even if we decide to take into consideration the speeches and decisions taken by the highest political authorities (such as those announced by an American President for example), these are not able to account for the multitude of causes and reasons that motivated such collaboration. If one decides to focus on individual decisions made at a much lower level of the political scale or even at a technical level (e.g. decisions or recommendations made by NASA officials), these may also be of interest, but they will not be able to explain the full picture of this political decision. Such an approach would not be more promising as the options and answers seem endless. The solution that this thesis proposes is to leave the state-centric framework and to draw inspiration from the individualistic approach in using spacecrafts as the main object of study rather than individuals. Why spacecrafts? Spacecrafts encompass everything that constitutes human spaceflights. Without spacecrafts, human presence in outer space is impossible. Thus, the objective of the analysis is not to understand why individuals or States made the decision to send humans into outer space, but rather to determine how spacecrafts have influenced, even inspired

this endeavor. This very important change of perspective makes it possible to change the object of analysis which is therefore no longer the State or individuals, but spacecrafts.

2.2.3 The Need to Change the Object of Study Towards Spacecrafts

Leaving the state-centric approach to understand a political phenomenon is not a new undertaking. As mentioned earlier in Chapter one, new materialism and other concepts take a similar approach, focusing on the material surrounding individuals and political actors. Adopting such a perspective is central in order to use spacecrafts as the main object of study. Indeed, it allows us to better understand how objects can be considered as actants in the political field, since they have in a way their own agency, influencing social and political relations through their own actions, and parameters. Some authors have already approached the use of objects in such a way. In his book *Aircraft Stories*, John Law analyses how the reconnaissance and strike aircraft TSR-2 (which ultimately never entered the production phase) contributed to British foreign policy. In his work, Law argues that objects “are not coherent whole [...] instead, they are multiple assemblages” (Law 2002, 2). He also argues that in order to understand the role and impact of objects on politics and social interactions, we must put aside our “assumptions of singularity, the presupposition that, whatever we might study and whatever we might interact with is indeed a single, coherent and centered object that is out there” (Law 2002, 32). Understanding that an object is not only a single entity that people can use is notably what allows us to understand that objects can have a certain agency. Law explains that it is the fundamentally multiple and diverse nature of the TSR-2 object itself that influenced British foreign policy in numerous ways and not people’s use of the object. Laet and Mol also consider objects as actants in their research on the Zimbabwe bush pump device. In their paper, they present how the pump acts well beyond its initially planned parameters and proves that “actors do not have to be humans” (Laet and Mol 2000, 254). Indeed, the authors demonstrate that this pump system also acts as a “health provider and a nation-building apparatus”

(Laet and Mol 2000, 252) even if it was by no means within the intended functions of the device. Their work therefore reaffirms the argument that “not only can actors be non-rational and non-human; they can also – or as we hope to demonstrate – be fluid without losing their agency” (Laet and Mol 2000, 228). Probably one of the most convincing demonstrations of the role and agency of objects is presented by Tobias Wille in his analysis of diplomatic cables. Using three historical case studies on the use of the telegraph, Wille manages to demonstrate that it is not only traditional actors (whether human or institutional actors) who play a role in diplomacy, but also “objects and their materiality play an important role in their making ” (Wille 2016, 167). He argues that the telegraph should be viewed as much more than just an intermediary or a tool to transport information. It is a mediator that can “transform, translate, distort, and modify the meaning or the elements they are supposed to carry” (Wille 2016, 173). Indeed, his analysis clearly demonstrates that “the cable played its part in a tragic plot of war, espionage, and betrayal. It became an actor on the stage of international politics” (Wille 2016, 173). It is by following this same logic of idea that this thesis seeks to understand the role, agency and influence of spacecrafts on US-Russian cooperation in human spaceflight.

The focus of our research is therefore on the American and Russian spacecrafts. For each of the three collaborative missions (Apollo-Soyuz Test Project, Shuttle-Mir and the International Space Station), the object of study will be the spacecrafts involved. More specifically, given the great complexity of these machines and also for reasons of understanding and decision-making processes, three specific objects will be studied: a space connector (for ASTP), a space module (for Shuttle-Mir), and emergency devices and protocols (for the ISS). The reason why these objects are chosen is presented in detail in chapter 4. Now that we have detached the emphasis from our

research from the state-centric approach and that we are using spacecrafts as our main objects of study, the next chapter presents the theoretical construction adapted to this situation.

3. Chapter 3 – Theoretical Construction

Understanding the cooperation between the United States and Russia in human spaceflight using a post-state-centric approach and considering spacecrafts and their components as the main objects of study require the construction of a new theoretical framework. This third chapter first presents in detail why it is necessary to build a new IR framework adapted to the outer space context. Secondly, the theoretical framework of New Space Materialism (NSM) as such will be presented as well as its three constituent pillars (symbiotic realism, new materialism and science and technology studies). The third section of this chapter presents a coherent summary of the framework in the form of a table. It is this table that constitutes the foundation of the main tool that will then be used to test NSM in subsequent chapters. Finally, the fourth and last short section of this theoretical chapter reiterates the main research question of this thesis as well as the general thesis.

3.1 Building a New IR Framework Adapted to the Outer Space Context

3.1.1 *Why Is It Necessary?*

The field of IR experienced significant evolution after both the Second World War and Cold War, with the rise of multi-disciplinary and reflectivist approaches (Waever 1996, 164). It may therefore seem surprising that there is no suitable theoretical approach for the study of politics in outer space that could be applied to this thesis. To our knowledge, our thesis is the first study seeking to understand politics in outer space through an analysis of spacecrafts. The novel nature of spacecraft-as-subject, requires the creation of a new theoretical framework. The following section will explore and justify this need to carry out a new theoretical construction.

As demonstrated by the previous chapter, it is necessary to adopt an approach that is fundamentally non-state centric. Indeed, Sheehan explains that IR has mostly analyzed politics in

outer space through two theoretical lenses. There is the realist approach which sees that “the movement into space was very much an outgrowth of the terrestrial superpower competition for planetary hegemony” (Sheehan 2007b, 9) and there is the liberal approach, which “provides a mechanism for seeing national space policy not as the output of a unitary national government, but as the end product of complex political interactions between domestic actors” (Sheehan 2007b, 12). Such approaches remain too state-centric and are therefore inappropriate for our thesis. Even those theoretical approaches designed specifically to understand international relations in outer space, tend to err to far on the side of state-centrism. This is notably the case of Everett Dolman whose “Astropolitik” (a nod to the notion of *Realpolitik*) approach contends that States will always seek to dominate according to a rational logic and outer space will be conquered by States just as it was the case for the Earth: “the healthy world-state will spill over into outer space and continue its physical expansion” (Dolman 2002, 53). This tendency to stick to the state-centric model is also the case of Al-Rhodan, who seeks to explain politics in outer space using an original, post-structuralist approach that leaves liberal and realist paradigms behind. His approach entitled “meta-geopolitics of outer space” has potential applications to our thesis (as outlined in section 3.2.2.). Nevertheless, it remains grounded in a state-centric approach by considering State powers essential in the analyses (Al-Rodhan 2012, 1). However, as presented in the previous chapter, it is essential to adopt an approach that fundamentally rejects the state-centric paradigm not only because of the presence of the end of territoriality in outer space, but also because epistemologically these approaches are facing challenges in particular by giving an innate agency to the State).

It is also necessary to build a new theoretical framework because it must be adapted to the unique context and conditions of outer space. Indeed, the parameters in which human beings must operate in outer space constitute an unparalleled situation and challenge. In order to properly

analyze the social and political behavior in outer space, one must consider the profound impact this has on any human beings involved. Indeed, outer space is fundamentally hostile to human beings. Without a spacecraft or space suit, the vacuum effect of outer space results in hypoxia, rendering anyone unconscious in less than 15 seconds. Simultaneously, the absence of atmospheric pressure has a decompressing effect, resulting in a fatal condition known as ebullism, in which the blood literally begins to boil (Springel 2013). Moreover, even aboard a spacecraft, the environment remains inherently hostile to human beings. For example, exposure to radiation or the short and long-term effects of microgravity, can have detrimental effects on the functions of the human body (Peters 2020, 239). Such settings in outer space pose unique challenges for human beings and their social interactions on a level not otherwise encountered, even in the most hostile environments on Earth such as the high seas and Antarctica.

3.1.2 How Can It Be Achieved?

To create a post-state-centric approach adapted to the context of outer space and using spacecrafts as the main object of study, it is essential to adopt a critical and multidisciplinary approach. As briefly mentioned in the introductory chapter, the critical and multidisciplinary field of IR is very relevant for this thesis because it contains a multitude of relevant post-statist analytical tools, and it is not confined to great theoretical debates. More specifically, Lake (2011) explains that IR has long been divided into “sects” that use different units of analysis, assigning different interests and agency to actors and who have a different perspective on what decision logic is for these actors. These different theoretical camps, be it realism, liberalism, Marxism or others, have become sectarian insofar as they have been theologially reified by placing the other camps as being in essential error. Lake explains that the solution is to be open to eclecticism, seeking instead to choose the most applicable approach, depending on the circumstances. It is a view that sees IR theories more as tools to be used within a greater chest of possibilities (Lake 2011, 466). Sylvester

supports Lake's point but also suggests taking eclecticism beyond just using theories as a tool. She explains that one must connect the different camps to encourage collaboration. She goes on to argue that the way to advance IR today is to facilitate exchange and dialogue between the different camps (Sylvester 2013, 621). Van der Ree (2014) offers an answer as to how such a dialogue between the camps can be possible. He explains that we must be careful with approaches that claim to be plural, but which ultimately carry out more of a logic of “extending the hand” seeking to convince others that their approach is superior. The same is true with plural approaches seeking to “seize the middle ground” which, by choosing a compromise between two approaches, does not carry out a real work of plurality. He contends that a true plural approach seeks to “reground the field” by recognizing that the discipline of IR is by its very essence plural and that this plurality does not harm the discipline. This approach, without carrying out any ranking or comparison between the different approaches, considers that they are simply different. Sil and Katzenstein also offer a very interesting approach to addressing eclecticism by explaining that it is an “an intellectual stance a researcher can adopt when pursuing research that engages, but does not fit neatly within, established research traditions in a given discipline or field” (Sil and Katzenstein 2010, 412). Such approach also seeks “to complement, engage, and selectively utilize theoretical constructs embedded in contending research traditions to build complex arguments that bear on substantive problems of interest to both scholars and practitioners” (Sil and Katzenstein 2010, 411). Certainly one of the conceptions of IR theory which best completes this debate (and which proves to be the most useful for this thesis) is that of Zalewski (1996) who explains that theory should not only be seen as a tool to be used according to certain circumstances or even as an essentially critical framework, but rather as an “everyday practice”. She explains that all actors involved in a political process, be it the subjects, the researchers or even the environment around them, do theory, use theory and they “theorize about each of these everyday activities, mostly subconsciously”

(Zalewski 1996, 346). Understanding that the theory constitutes an everyday practice implies taking into consideration a multitude of factors and not only specific States or individuals.

It is by adopting such a critical and eclectic view of the use of IR theory that it is ultimately possible to construct a new theoretical framework. This vision certainly embraces the critical aspect of IR which does not consider certain notions as being useful (for example the state-centred perspective of IR), it also sees a certain usefulness in considering the different theories as tools because it allows to choose the most appropriate concepts under certain specific circumstances. Above all, this vision considers that such a theoretical construction must be done in a plural, eclectic way, considering theory as part of the daily practice of all actors. It is such a vision of things that will allow us to understand the American-Russian cooperation in outer space by analyzing the role of machines that are spacecrafts.

3.2 New Space Materialism

As explained in the introductory chapter, the theoretical framework this thesis is building is named New Space Materialism (NSM). It is very important to emphasize that New Space Materialism does not claim to be a new grand “Theory” or conceptual approach within the field of international relations studies within the logic of “isms”. On the contrary, New Space Materialism wants to be first and foremost a toolbox. A theoretical toolbox precisely created from different approaches and theories thanks to an eclectic analysis inspired by Katzenstein. NSM therefore wants to be a practical and pragmatic tool to help better understand cases of political relations in outer space and not to be a theory with a causal explanatory power that explains the entire phenomenon of politics in outer space. It is a toolbox from which one can pick relevant and useful tools to explain a phenomenon. It is not an instruction manual that claims to have the ability to explain the entire causal universe of the phenomenon.

Thus, NSM and has 3 main pillars (symbiotic realism, new materialism and science and technology studies). These 3 post-state-centric pillars, juxtaposed together using a multi-disciplinary approach of theory as a tool, are presented in detail and operationalized in the next pages. This operationalization is concretized by the creation of 7 criteria which together constitute a detailed description of what NSM is. These criteria are compiled in *Table 1* in section 3.3 of this chapter. Thus, although NSM is presented, detailed and divided into different criteria, these should be seen as all equally important, mutually dependent and co-constitutive. In short, although NSM is made up of multiple elements, it remains a theoretical framework adopting a holistic approach.

3.2.1 Symbiotic Realism

The first pillar of NSM is Symbiotic Realism. Developed by neuroscientist Nayef Al-Rodhan, Symbiotic Realism is “a theory of [international] relations in a globally anarchic world of instant connectivity and interdependence” (Al-Rodhan 2007, 11). Symbiotic Realism relies heavily on “the neurobiological substrates of human nature” in order to explain phenomena in international politics (Al-Rodhan 2007, 98). Despite its certain links with the realist theory of IR, Symbiotic Realism is a theory that “aims to go beyond the state centrism of realism, integrating a number of actors that have thus far been either underemphasized or ignored by the realist paradigm” (Al-Rodhan 2007, 11). In the same way as we demonstrated in chapter 2, Al-Rodhan contends that the realist approach (which perceives the State as being the only important actor of IR and as acting according to a rational logic of cost/benefit calculation) “does not stand up to scrutiny” (Al-Rodhan 2007, 14). Using a dual materialist and idealist ontology, Al-Rodhan explains that the global system is characterized by four interlocking dimensions: interdependence, instant connectivity, global anarchy and the neurobiological substrates of human nature (Al-Rodhan 2007, 98). As part of this thesis, we use more particularly two of these key dimensions (interdependence and the neurological substrates of human nature) and we apply them to the situation of cooperation between humans

and spacecrafts in outer space. Al-Rodhan has already attempted such an application in his book *Meta-Geopolitics of Outer Space: An Analysis of Space Power, Security and Governance* (Al-Rodhan 2012), but here we will do it in a more precise and in-depth way in connection with our subject of study. Thus, we can divide symbiotic realism within the framework of our thesis as having two main criteria: (1) Interdependence and the survival of human beings in outer space; (2) the human neurobiological nature favors symbiosis in microgravity environment.

3.2.1.1 Interdependence and the Survival of Human Beings in Outer Space

In his application of Symbiotic Realism to outer space, Al-Rodhan explains that this approach “advocates [for] a symbiotic interdependence between states in a connected and interdependent world, whose security has become intertwined, especially in a global commons domain like outer space” (Al-Rodhan 2012, 216). What is important to understand is that beyond the impacts of globalization on the interdependence and the instant connectivity between States, the unique situation prevailing in outer space forces objects and people into a situation of interdependence because the absence of conflict (requiring a minimum degree of collaboration) is essential in order to carry out activities in outer space. The word “symbiosis” here is also very important and it can be defined as “characterized by or being a close, cooperative, or interdependent relationship” (Merriam-Webster 2023). Al-Rodhan defends the importance of symbiotic interdependence in outer space by explaining that the use of force is not an option because “outer space will either be safe for everyone or for no one” (Al-Rodhan 2012, 215). He gives as an example of how the destruction of a satellite resulting from an attack by another country could have effects beyond the typical parameters of attacks on Earth; the debris that would result of such an attack would render the use of this orbit impossible for several hundreds, even thousands of years.

To fully understand this argument and this phenomenon specific to outer space, it is necessary to understand the concept of kinetic energy. Kinetic energy can be defined as the amount of energy that an object has due to its motion (Encyclopedia Britannica, n.d.). Two variables influence the kinetic energy of an object: its mass and speed. The unit of measurement for kinetic energy is the joule. Thus, the greater the mass of the object, the greater the kinetic energy of the object. On the other hand, the greater the speed of the object, its kinetic energy will be exponentially greater. The formula for kinetic energy is: $E_k = \frac{1}{2} \times m \times v^2$ where E_k is kinetic energy (measured in joules), m is mass (measured in grams) and v^2 is velocity (speed measured in meters per second). In order to demonstrate how destructive the impacts of debris or projectiles in outer space can be, the formula of kinetic energy is appropriate. For example, let's compare the kinetic energy deployed by a baseball thrown on Earth with the energy deployed by the same baseball in orbit. A 250 grams baseball travelling at 40 meters per second (which is a pretty good pitch) will have a kinetic energy of 200 joules.

$$E_k = \frac{1}{2} \times m \times v^2$$

$$E_k = \frac{1}{2} \times 0.250 \times 40^2$$

$$E_k = 200$$

This ball can be caught by an individual using a suitable glove without causing any damage. However, the same ball travelling at a speed of 10 kilometers per second in orbit will deploy a kinetic energy of 1,250,000 joules, the equivalent of a large stick of dynamite (Hickman 2012).

$$E_k = \frac{1}{2} \times m \times v^2$$

$$E_k = \frac{1}{2} \times 0.250 \times 10,000^2$$

$$E_k = 1,250,000$$

It goes without saying that the collision of this ball with a spacecraft would cause important if not catastrophic damage. Moreover, the laws of physics being what they are, any object orbiting the Earth must have a speed of about 7.8 km/second at 300 km altitude (the speed increases with the altitude). If the object has a lower velocity, it does not reach the escape velocity and will simply fall to Earth (ESA 2011). At this speed, even a single fragment of paint can cause damage to a spacecraft window (Peake 2016), a 1 centimeter object can “strike a satellite with the force of an exploding hand grenade” (European Space Agency 2016, 7), and a 5 centimeter object “imparts as much energy as being hit by a bus” (Grego 2021, 272). Finally, not only can a single object cause catastrophic damage to a spacecraft, but since this takes place in a zero-gravity environment, the “Kessler’s syndrome” must also be considered. Kessler's syndrome states that “when debris is travelling at hypervelocity in an area of dense satellites or other space objects concentration, there is significant potential for space debris to multiply as a result of subsequent collisions. Such potential has exponential effect and is theoretically mappable to an infinite scale” (Steer and Stephens 2021, 49). Such a situation where a cloud of space debris caused by confrontations or even accidents following a lack of collaboration or communication is entirely plausible and could “deny use of Earth orbit to all spacecraft virtually forever” (Steer and Hersch 2021, 8).

This example illustrates the interdependence that spacecrafts and the humans on board have with each other in outer space. These parameters where a simple baseball has the potential to destroy a spacecraft and make an orbit or even outer space inaccessible are once again beyond what prevails as conflict situations on Earth. To this must also be added the considerable impacts that

the loss of outer space would have on the Earth. In November 2022, the leaders of the US Space Force as well as the 3 Canadian Space Division corroborated this claim by affirming that confrontations as simple as they are in outer space would have catastrophic consequences: “life as we know it would no longer be as we know it. Attacks on satellites can take out GPS systems, banking systems, power grids, first responders’ communications, and impact military operations” (Shepherd 2022). Thus, as Al-Rodhan mentions, all these existing dynamics and parameters in outer space create interdependence between all those who venture into space and that “it is important to remember that we would all be losers in such a case, no matter which country we are from. Space is a global resource where careless behavior by one actor will affect all other users, including the perpetrator” (Al-Rodhan 2012, 215).

3.2.1.2 The Human Neurobiological Nature Favors Symbiosis in Microgravity Environments

The second notion of Symbiotic Realism that is useful for our thesis is the one of the neurobiological substrates of human nature. Al-Rodhan argues that the neurobiology of the human brain leads to three essential facets of human nature: basic needs, ego and fear. He recognizes, like the realists, that fear and ego have an important role to play in driving human behavior (and political actors), but he insists that the “predominant part of human nature is driven by basic survival instincts that ensure the satisfaction of basic needs such as food, shelter and personal safety” (Al-Rodhan 2007, 70). He then explains that it is only when these basic needs are met that humans can act morally. He recognizes however, that though human morality does not operate in a vacuum and that it depends on the values and education of individuals, the satisfaction of basic needs is vital in order to arrive at moral political behavior. Given the situation of anarchy existing in international relations, Al-Rodhan argues that some form of governance structure will help moral political behaviors to emerge and endure over time (Al-Rodhan 2007, 72). Without this governance, human

neurobiology will tend to push human nature towards immoral emotional excesses. He explains for example that emotional excess of basic needs can lead to greed, excess fear can lead to aggression or the pursuit of power, and excess ego can lead to domination, arrogance and hegemony. He states:

Given these various innate survival instincts and drivers of behaviour, we should be under no illusions about the possibility of morality in the absence of an overarching institutional framework capable of guaranteeing security and mitigating against excesses related to the fulfillment of ego and basic needs. It is clear from human history that beings cannot prosper in an ungoverned state of nature (Al-Rodhan 2007, 71–72).

This notion that moral political behaviors are enabled by governance structures which prioritize individual's essential needs and limit excesses is interesting when applied to cooperation within human spaceflights. Indeed, we know that it is the spacecraft that provide 100% of the essentials required for the survival of human beings in outer space. Moreover, the interdependence in which spacecrafts and humans find themselves in outer space creates a de facto governance structure, without which the existence of spacecrafts and humans in space would be perhaps impossible. Here again, the term symbiosis is appropriate insofar as the human neurobiological nature combined with the parameters existing in outer space push humans and spacecraft to live in a relationship of interdependence and collaboration essential to ensure their survival.

By further unpacking the neurobiological nature of human beings, we uncover information more relevant to understanding cooperation in outer space. As Al-Rodhan explains, once basic human needs are met, immoral situations frequently arise in situations of emotional excesses without the presence of an overarching governance structure. However, it turns out that the emotional capacities and responses of human beings are diminished when they find themselves in a microgravity environment such as in outer space. Thus, following Al-Rodhan's neurobiological logic, we can deduce that these potentially problematic emotional excesses are less likely to occur in outer space since human beings in microgravity environment exhibit significantly less emotion

recognition and process. This parameter is therefore added to the situation of symbiosis which exists in outer space. Indeed, the majority of studies done by humans in outer space are dealing with human health and many studies have shown that spaceflight significantly affects emotional processes. Arshad and Ferré (2022, 5) explain that spaceflight affects the speed at which astronauts recognize emotions even after sufficient rest. This dynamic can be explained by the balance and chemical changes that take place in the brain in outer space, more precisely in the exchanges between the different lobes of the brain. Schneider et al. (2008, 1317) explain that the left frontal cortex is responsible for the expression of positive emotions while the right lobe is more responsible for the expression of negative emotions. However, electroencephalogram tests have shown that the balance between the two brain lobes is significantly compromised in a microgravity situation, thus affecting the perception and expression of emotions. Stahn and Kühn (2021, S108) also demonstrated that microgravity and other factors present during spaceflight (altered day and night cycles, isolation, confinement and sensory deprivation) affect the plasticity of the hippocampus (a major component of the temporal lobe) which is critical for emotion processing. Certainly one of the most convincing studies on this topic is that of the “NASA Twins Study” (Perez 2015) involving American astronauts and identical twins Mark and Scott Kelly. Scott spent a year on the International Space Station while Mark stayed on Earth. A multitude of tests and studies have been conducted and one of them demonstrates that Scott experienced a significant decline in emotion recognition task while in orbit (Garrett-Bakelman et al. 2019, 14). Thus, since the perception, processing and expression of emotions is significantly affected in outer space and it is the latter which, according to Symbiotic Realism, are particularly responsible for immoral behavior, we can deduce that the impact of the outer space environment on humans fosters the situation of interdependence and symbiosis.

In summary, in the context of our thesis, symbiotic realism argues that the outer space environment contributes to a situation of interdependence between human beings and spacecrafts in order to ensure their survival and that the neurobiological substrates of nature of humans favors a situation of symbiosis in microgravity environment.

3.2.2 *New Materialism*

The second pillar of New Space Materialism (NSM) is new materialism. As mentioned in Chapter 1, new materialism is a recent and critical movement within IR which seeks to provide a counterpoint to positivistic notions of materiality (Lundborg and Vaughan-Williams 2015, 24). It is also an approach that seeks to counterbalance linguistic and discourse analysis approaches in IR. New materialism therefore opposes anthropocentric approaches and takes the stance that “matter as an active force is not only sculpted by, but also co-productive in conditioning and enabling social worlds and expression, human life and experience” (Sencindiver 2017). This new materialism, which sees that matter can have a strong performative potential, is to be distinguished from what Gamble, Hanan and Nail (2019, 113) call “old materialisms”. Indeed, giving importance to the material and the environment around us is not new in philosophical, sociological and political studies. The thinkers of Greek antiquity granted a certain importance to matter, to the atoms which constitute all things. However, this matter remained eminently passive from their perspective. Renaissance thinkers also addressed the importance of materiality and could give it a certain role. However, any agency coming from matter was only possible, according to them, thanks to immaterial help, whether it comes from humans, from an exterior force or from God (Gamble, Hanan, and Nail 2019, 116). The turn to new materialism distinguishes itself from these historical perspectives by arguing that matter should instead be seen as “alive, lively, vibrant, dynamic, agentive, and thus active” (Gamble, Hanan, and Nail 2019, 111).

It is also important to note that the notion of “new materialism” does not constitute a single, coherent and unified approach. Indeed, Lundborg and Vaughan-Williams explain that there is “a range of scholarship variously referred to as 'New Materialisms', 'New Vitalism', and the 'Materialist Turn' produced by diverse social and political theorists” (Lundborg and Vaughan-Williams 2015, 4). These different approaches are not all the same beyond the fact that they share “a common attempt to thematise the concept of materiality, its relationship with politics, and how an emphasis on material factors might lead to a refashioning of our understanding of the concept of 'the political’” (Lundborg and Vaughan-Williams 2015, 4). It is therefore important to situate our thesis within these new materialism approaches. Thus, the new materialist approach of our thesis draws on currents such as those of Gamble, Hanan and Nail (2019), which seek to understand how matter can be considered as having a performative capacity.

The next two sections present in more detail what new materialism consists of using concrete examples relevant to this thesis. Then, it will be presented how new materialism can be applied to our study of human spaceflight. In fact, new materialism allows us to identify spacecrafts as performative actors. Thus, new materialism within the framework of our study can be divided into three main components: (1) spacecrafts as autonomous objects, (2) spacecrafts as ongoing iterative processes and (3) spacecrafts as relational actors.

3.2.2.1 Material Objects as Political Actants

As said above, there is no universally agreed upon definition of new materialism. Especially since it is a multidisciplinary approach used in both sociology and political studies (Gamble, Hanan, and Nail 2019, 111). However, key to this thesis is new materialism’s conceptualization of matter and objects as having a performative agency separated from humans. As Salter (2015, vii) explains in *Making Things International. 1, Circuits and Motion*: “things play a crucial role in the

assemblage of the international”. He explains that central concepts of international relations such as borders, war or security are in fact all essentially made up of objects (fences, guns, passports, cell phones, etc.) and that these objects “fundamentally alter the condition of human possibility in ways that are unpredictable and irreducible to their constituent elements” (Salter 2015, vii).

To underline the importance of objects means recognizing the role they play in the formation of the very identities of political actors. Mutlu (2013, 173) explains that “we practice and perform our identities through objects”, giving the examples of how weapons contribute to the identity and role of the soldiers, cars to that of the taxi drivers and computers to that of programmers. Thus, “the material turn is based on the understanding that objects are central to our identities; as such, they are central to our practices” (Mutlu 2013, 179). In addition to being essential to the formation of identities and social practices, the new materialism defends that objects also possess their own identity. This identity should not, however, be considered as being stable, fixed and inert, but rather as being relational and constantly changing (Fox and Alldred 2017, 3). This identity ensures that nature and culture (or in other words matter and the social universe) should not be treated as two different fields. Rather, they should be seen as part of a continuum of materiality where both the social and the material world affect international relations. This situation therefore recognizes that objects and matter possess a certain agency and have the capacity to influence the world in an autonomous way without the influence of humans (Fox and Alldred 2017, 3). This notion of agency is central to the new performative materialism and Fox and Alldred (2017, 6) explain that it is a perspective that is post-anthropocentric and seeks to understand the production of the world beyond humans. Finally, the notions of identity and agency also lead to the understanding that matter and objects must be understood relationally and that they “gain ontological status and integrity only through their relationship to other similarly contingent and

ephemeral bodies, things and ideas” (Fox and Alldred 2017, 13). Thus, this approach seeks to study objects and matter not for what they are, but for what they do: “what associations it makes, what capacities it has to affect its relations or to be affected by them, what consequences derive from these interactions” (Fox and Alldred 2017, 13).

It is obvious that the new materialism considering the importance of matter and objects is present in an important way within our thesis. Indeed, simply considering spacecrafts as the main objects of study constitutes a fundamentally materialistic undertaking. However, it is important to reiterate the importance of new materialism within New Space Materialism theoretical framework because this conceptualization operationalizes the way in which we will comprehend spacecrafts as performative actors. Several studies have already demonstrated that objects should be considered as political actors. As mentioned earlier in chapter 2, it is the case of Law (2002) who demonstrates that the TSR-2 aircraft has, by its fundamentally multiple and complex nature, influenced British foreign policy. It is also the case Wille who demonstrates that the telegraph had become an actor within the international political scene because it was able to “transform, translate, distort, and modify the meaning or the elements they are supposed to carry” (Wille 2016, 173). To this we could add several other relevant examples, notably the very relevant case of Jason Dittmer who demonstrates that an object as simple as the sheet of paper was able to influence British foreign policy through its design and its materiality within the British Foreign Office (Dittmer 2017, 31). There are also cases that are quite close to spacecraft in their nature and composition. Thus, Grayson (2016, 326) identifies that drones, by their capacity and their involvement in world politics are “productive of the international”. Piché (2015, 88) defends that the refugee boats are an excellent demonstration that these objects “play a significant role in making possible the international” and it is thanks in particular to these boats that certain flows of refugees have been

able to take place. Now, it is important to understand that what these objects have in common is that they are all political actants, are all performative actors. The next section demonstrates how one can understand and operationalize spacecrafts as a performative actor.

3.2.2.2 *Spacecraft as Performative Actors*

Gamble, Hanan et Nial (2019) present three essential criteria in order to recognize an object or a material as being performative. As several authors have done, the criteria presented by Gable, Hanan and Nial focus on the notions of autonomy, change and interaction which are, in our opinion, essential in order to understand the agency of spacecraft. More precisely, they explain that new performative materialism can be understood using three co-constituent theses: (1) the activity of matter itself must be pedetic, (2) matter must be an ongoing iterative process, (3) matter must be relational (Gamble, Hanan, and Nail 2019, 125). It will be concretely demonstrated how our objects of study, spacecrafts, correspond to these three theses and can thus be considered as performative actors.

3.2.2.2.1 *Spacecrafts as Pedetic Actors*

Gamble, Hanan and Nail (2019, 125) use the word “pedetic” in order to qualify the importance of autonomy for an object to be considered as performative. They explain that “pedesis” (from the PIE root *ped-, meaning “foot”) is the motion of semi-autonomous self-transport: the motion of the foot to walk, to run, to leap, to dance somewhat unpredictably. In contrast to deterministic, probabilistic, or random theories of motion, pedesis is directly and iteratively related to its immediate past but is not determined by it. This notion is very important because it makes it possible to determine that the actions of objects and matter are not the result of chance and are not determined or even the result of probability. We must consider the actions and movements of objects as being generatively indeterminate. Without the notion of pedesis, the agency of the object

could quite simply be explained by a phenomenon other than the object itself, whether it is chance, probability or even the help of an external agent such as a human being. This conceptualization of the notion of pedesis in objects can be simplified with the concept of “autonomy” where one can consider matter and objects as not being fundamentally dependent on human beings and other factors. This intrinsic autonomy of objects means that we cannot predict all the effects, movements, or actions of an object. This notion of pedesis is highly relevant to spacecrafts.

Spacecrafts can easily be considered as pedetic objects since they have a relatively high autonomy of action and movement. From the very beginning of human spaceflight, spacecrafts were basically autonomous objects. Given the multitude of variables considered during a space mission and particularly during the critical phases of liftoff and atmospheric re-entry, spacecrafts must undertake several actions autonomously. To name just two examples of autonomous actions carried out during the first two human spaceflights in 1961 (Vostok 1 followed by Mercury-Redstone 3), the altitude control of Yuri Gagarin's Vostok spacecraft was automatically controlled by the spacecraft (ESA, n.d.) and the crucial launch escape system that would have propelled Alan Shepherd and his Mercury capsule to a safe distance from the Redstone rocket in the event of a malfunction also operated automatically (Warnock 2015). Even today and throughout the history of human spaceflight, the automated aspect of spacecraft is very important. Launch of the Soyuz spacecraft, the American space shuttle, the SpaceX's Dragon are automated. Once in outer space, all docking procedures between spacecrafts (the first having taken place in 1967) or between a ship and a station are also done automatically (M. Garcia 2017). We could still cite a multitude of examples demonstrating the autonomous aspect of spacecrafts but specific aspects of the autonomy of our case studies will be presented in chapters 5, 6 and 7.

3.2.2.2.2 Spacecrafts as Ongoing Iterative Indeterminate Process

The second criterion identified by Gamble, Hanan and Nail (2019, 126) in order for an object to be considered as performative is that it must be “understood to be an iterative, ongoing, indeterminate process”. In other words, this means that a performative object must act in a repetitive way with a certain continuity (therefore not the result of a single action), but also in an unpredictable, changing and unfixated way. This criterion is complementary and essential to the pedetic criterion because without this aspect of continuity and possible change, the object in question would only have a partial agency with the sole aspect of an endless pedetic process. This notion of ongoing iterative indeterminate process also makes it possible to detach the agency of the object from humans or any other external factors since the continuity of the action and the agency of the object essentially depends only on the object itself. As it is the case for the pedetic notion, the notion of ongoing iterative indeterminate process applies very well to the case of spacecrafts.

There are a multitude of examples related to spacecraft demonstrating that they are ongoing iterative indeterminate processes. Two examples will be presented here and of course several other examples will be demonstrated in our analysis chapters. The two examples selected are those of the assembly and launch of the Soyuz spacecraft and the American Space Shuttle. Let's start with the Soyuz spacecraft. Used continuously since 1967, the expandable Soyuz spacecraft is an object that reflects the iterative notion since this spacecraft's assembly, configuration and main characteristics have remained relatively unchanged since 1967. Thus, for nearly 60 years, the Soyuz spacecraft has consisted of an orbital module, a descent module, a service module and a pair of solar panels. Moreover, beyond the iterative aspect of the Soyuz, it also reflects very well the notions of change and indeterminacy since the spacecraft has evolved considerably since its first human spaceflight in 1967. Indeed, even if in appearance it seems that the Soyuz of 1967 has

evolved little compared to that of 2024, the spacecraft has been constantly evolving in all aspects (electronics, navigation, communication, etc.). Figures 1 and 2 demonstrate that despite the continuous evolution and adaptation of the Soyuz, it constitutes a certain repetitive and iterative process. The same goes for the American space shuttle, which was in use from 1981 to 2011.

Figure 1 - Soyuz ASTP in 1975.



Source: NASA.

Figure 2 – Soyuz TM-09M in 2013



Source: NASA.

Throughout its 135 missions, the 5 reusable shuttles have undergone major evolution and changes while maintaining their own iteration and identity as we can see on Figures 3 and 4. Moreover, just as it is the case with the Soyuz, all the infrastructure surrounding the assembly, launch and maintenance of the space shuttles has remained the same during the 30 years of service and the vast majority of this infrastructure is still in use today for the Artemis program. Even the main engines of the Space Shuttle are still in use today for the Artemis rocket (Harbaugh 2022).

Figure 3 – STS-1 in 1981



Source: NASA.

Figure 4 – STS-135 in 2011



Source : NASA

A last example which demonstrates the fundamentally iterative aspect of the Soyuz spacecraft and the American space shuttle is that of their mode of transport to the launch platform. Since 1967, the Soyuz spacecraft has been travelling to its launch site by train (using the same circuit and train system ever since). The same goes for the space shuttle which used two “crawlers” to get from the hangar to the launch site. It is also the same crawlers that were used for the Saturn V rocket and the Apollo program as well as the same crawlers that are used today for the Artemis program. Thus, these two objects which are the train of the Soyuz spacecraft and the crawlers of

NASA (Figure 5 and 6) constitute objects that have an iterative process exceeding by far the longevity of any human being having worked within these programs.

Figure 5 – NASA crawler supporting the Space Shuttle



Source: NASA.

Figure 6 – Soyuz transported by train.



Source: NASA.

3.2.2.2.3 Spacecrafts as relational objects

The last criterion identified by Gamble, Hanan and Nail (2019, 127) in order to identify an object as being performative is the relational one. Indeed, it would be difficult to recognize a certain agency in an object without it having a relational capacity with respect to the world around it. “Otherwise it remains the merely passive object of another non-material agency such as God, nature, or anthropic structures” (Gamble, Hanan, and Nail 2019, 126). As it is the case with previous criteria, it can easily be determined that spacecrafts constitute highly relational objects.

First, we can affirm that spacecrafts are relational objects because they are in constant relation and interaction with the crew on the ground but especially with the human crew on board as they provide the habitable environment, including water and oxygen. The International Space Station even succeeds in producing its own drinking water. We should not underestimate the relational importance that spacecrafts have with humans in simple acts of everyday life such as breathing, drinking and even urinating. Indeed, the example of urine is convincing enough to demonstrate the importance of the relationship between spacecraft and the humans on board. On May 5, 1961, a few weeks after Gagarin's historic flight, Alan Shepard became the first American to fly in outer space aboard the Mercury spacecraft. As the flight was scheduled to last 15 minutes, no one had thought of equipping the spacecraft with a device to be able to accommodate the astronaut in the event that he had to urinate. However, technical problems on the ground delayed Shepard's takeoff for more than 4 hours. It came to a point where Shepard absolutely had to urinate and for multiple technical reasons this could most certainly have resulted in the liftoff being cancelled. After multiple debates with the ground crew, Shepard ended up emptying his bladder directly into his space suit, rendering vital electronic sensors inside the suit inoperable. Although the flight had taken place regardless, it could very well have led to the cancellation of the mission

and in fact deprived the mission of essential scientific data about the biometric evaluation of Shepard in outer space since the sensors had been damaged by urine. Since then, all spaceflight has ensured that spacecrafts or at least spacesuits have a urine collection device at a minimum (Shepard 1994, 107). This relationship between urine and spacecraft safety, as anecdotal as it may seem, testifies to the important symbiotic relationship that exists between humans and spacecrafts. Without this relationship, the very integrity of spaceflight can be called into question.

Beyond this symbiotic environmental relationship, spacecraft also maintain a direct and communicative relationship with the crew on board and the crew on the ground. Indeed, as explained above, the automation present since the very beginning of space age has also given spacecrafts the ability to communicate directly and automatically. Thus, vital information concerning the state of the spaceflight, notably with regard to navigation, atmospheric pressure or others, is only given automatically by the spacecraft on-board computer. The case of the Apollo missions is very telling to illustrate this dynamic. In addition to having been absolutely essential for the success of the missions in several respects (take-off, navigation, lunar landing, etc.), the on-board computer of the Apollo spacecraft (the brain of the spacecraft) also communicated crucial messages to ensure the integrity of the mission (Parker 1974). It is in particular this computer which communicated to Neil Armstrong the alarm codes 1201 and 1202 which guided him towards a manual piloting of the lunar module and eventually to the successful first Moon landing (Adler 1998). It was also this computer that communicated the essential "Master Alarm" to the crew of Apollo 13, allowing them to then take the necessary actions to preserve the spacecraft's hydrogen reserves, without which the Apollo 13 mission would have suffered a most tragic end (Redmond 2004).

Another noteworthy aspect underlining the relational characteristic of spacecrafts is that the vast majority of spacecrafts that have existed have the ability (and often their main objective) to enter into a relationship with other vessels and station through the docking process. Indeed, whether the Soyuz or Apollo spacecraft, the American space shuttle, the SpaceX or Boeing capsules or even the Gemini spacecrafts of the 1960s, all have the main function of being able to dock with another spacecraft. This fundamentally relational aspect between two performative objects that are spacecrafts demonstrates that at the very heart of their function and their existence, spacecrafts aim to be relational actors whether with humans on board, on Earth or with the other spacecrafts.

Finally, beyond the very concrete relationships that a spacecraft maintains with its crew on board, the personnel on Earth or even other spacecraft, it is also important to emphasize that the very existence of a spacecraft (from the design stage through construction to use) is fundamentally marked by a complex assemblage of multiple relations. Indeed, building and operating a spacecraft requires a collection of people and objects that are marked by multiple relationships. Thus, to achieve the realization of a spacecraft, complex relationships are necessary between scientists, engineers, administrators, civil servants, astronauts, factories, companies, research centers, laboratories, etc. For example, 5 major manufacturers contributed to the realization of the Apollo spacecraft, notably North American Rockwell and Grumman Aircraft (Jones and Glover 2006) and 3 manufacturers built the Saturn V rocket: Boeing, North American Aviation and Douglas Aircraft (Pyle 2019, 48). This is not without taking into account the multitude of sub-contractors who have been called upon. This complex assemblage surrounding the building and existence of a spacecraft also includes interaction with a wide variety of objects and raw materials such as new alloys, plastics, glasses and ceramics. One can in particular think of various cordless tools such as a

cordless vacuum cleaner or a cordless drill which were invented within for the Apollo program and which had an important role to play within the missions (NASA 2004).

It is abundantly clear with new materialism, but also with Symbiotic Realism, that in order to fully understand US-Russian cooperation in human spaceflight using spacecraft as object of study, a special attention must be paid to science and to technology. Whether it is to determine the different essential parameters of Symbiotic Realism or to understand how spacecrafts can be considered as performative actors, we cannot ignore science and technology. On the contrary, science and technology actually constitute the third pillar of New Space Materialism and supplement the theoretical construction.

3.2.3 Science and Technology Studies

The third and final pillar of NSM is Science and Technology Studies (STS). As mentioned in the lines above, STS is a must in the context of this thesis since the notions of Symbiotic Realism and new materialism have very close links with notions of science and technology. In addition, our objects of study (spacecrafts) constitute objects that required unparalleled scientific prowess as well as groundbreaking technological innovations. It is therefore necessary that New Space Materialism has Science and Technology Studies as one of its main pillars in order to be able to fully account for the complexity of the subject. Moreover, as mentioned briefly in Chapter 1, one issue that the notions of Symbiotic Realism and new materialism cannot overcome, regardless of the arguments stated above (impacts of the outer space environment, human neurobiology, the agency of spacecraft, etc.), is that the decision to send human beings into outer space is made by people on Earth. Moreover, the final decision is taken by political governmental bodies like NASA and Roscosmos. This does not mean that we should consider State representatives and individuals on Earth as the primary force encouraging human beings to cooperate in outer space. Rather, it

encourages us to investigate the role of individuals on Earth and their impact on the decision to cooperate in outer space. However, as we demonstrated in Chapter 2, focusing on the State or its various representatives to explain cooperation in human spaceflight is not a very constructive approach. Indeed, although we can understand *how* political leaders manage to cooperate, notably thanks to a discourse of desecuritization, such an approach does not allow us to explain *why* they arrive at this discourse. This is where STS comes in play and help to explain the process leading to the decision on the ground to send cooperative spacecrafts in outer space. In short, STS allows us to understand that it is scientists and technology that ultimately have the knowledge and capacity necessary to make the decision to conduct collaborative missions in outer space.

With many common ties to new materialism, STS brings together works in IR that seek to fill the gap in the classical literature by “integrating technology more systematically into analyses of global politics” (Hojtink and Leese 2019, ii). More specifically, STS seeks to demonstrate that it is not only human beings who can have political agency, but technology itself (such as a spacecraft, a technological device or a scientific report). Consisting of an amalgam of different studies focusing on the role of technology in politics and IR, STS and its various tools have the main benefit of conceptualizing “...technology as capable of affecting social relations in ways that cannot be reduced to the results of human intent, realized through technology, [...] enables new types of analyses by following power into places where current social theory seldom thinks to look for it” (Lindskov Jacobsen and Monsees 2019, 24). We must therefore see the role of STS as being fundamentally complementary to the two previous theoretical pillars of NSM. Thus, being aware of the various parameters of outer space mentioned since the beginning of chapter 3, it is ultimately scientists and technology that have the ability to materialize this situation of New Space Materialism by building collaborative spacecrafts. However, as Bruno Latour argues very well in

his book *Science in Action - How to Follow Scientists and Engineers through Society*, it is very difficult, if not impossible, to study the impacts of scientists and technology only by analyzing their machines, inventions, or scientific results. He explains that these scientific devices are ultimately black boxes that are very difficult to open. He therefore explains that to understand the impact of STS, it is necessary to investigate the process that created the black box by focusing on the scientific process rather than the result (Latour 1987, 21). Latour also explains that it is quite rare for scientists to leave behind traces detailing their decision-making process such as testimonials or even biographical accounts. In contrast, it is more effective to focus on the technical texts related to the different devices. This particular method will be detailed in Chapter 4.

To operationalize the STS approach within the framework of this thesis, it is divided into two main criteria: (1) Spaceflights as fundamentally technology dependent and (2) scientists as collaborative spacecrafts advocates.

3.2.3.1 Spaceflights as Fundamentally Technology Dependent

Human spaceflight is not the first social-political domain to be existentially dependent on technology. As mentioned in Chapter 1, this dynamic in which technology has a clear and major impact on politics and society has already been identified by Mitchell where he explains that the use of coal and the steam engine had an immense impact on the growth of democracy around the world in the 19th century (Mitchell 2011, 12). In his book *Technology and International Transformation - The Railroad, the Atom Bomb, and the Politics of Technological Change*, Herrera also offers multiple examples where technology has had a defining impact on international politics. For instance, he explains that in the Middle Ages the use of a new type of spear by the Swiss army contributed to the “shift from the feudal social system from which the knight drew his power and position and toward states and other large military political organizations that were capable of

building and maintaining large armies” (Herrera 2006, 1). The same goes for the railway, which notably enabled Germany to rise to power at the end of the 19th century, but which above all “made preindustrial society and great power incompatible” (Herrera 2006, 193). Again, technology here has had a profound impact on politics and on international relations. This impact is significant in the context of this thesis, perhaps as best explained by Herrera. He explains that given the profound impact that technology can have on society and politics, we must consider technology as also being a critical part of the international system. “It is much more than a power resource; it is the medium of interaction for international actors” (Herrera 2006, 2). This relationship between technology and international politics is also co-constitutive; technology is indeed part of the structure of the international system, but international politics is “part of the factors governing technological changes”. Herrera posits that technologies are sociotechnical systems that contribute to the identity of international politics. The relationship between international politics and technology is “everywhere we look” since the latter is “deeply embedded in international and domestic political practices (Herrera 2006, 4).

Such an approach to the role of technology in international relations applies most clearly to cooperation in human spaceflight. Indeed, Lawrence et al. (2009, 27) explain that “all enterprises involving space are heavily dependent on modern technology”. This dependence is in fact so strong, that the technologies developed for the various space missions are in fact those which are deemed to be feasible “thus creating a technology pull dynamic”. This situation is very important because it means that in many respects it is in fact technology that defines “the feasibility of specific space capabilities” (Lawrence et al. 2009, 27).

Many examples could be cited to explain this strong relationship of dependence between technology and what was feasible to achieve even politically in the field of human spaceflight. A

convincing example is that of the space race between the United States and Russia. As we all know, it was the Soviets who first managed to put a man in orbit thanks to Yuri Gagarin's Vostok 1 spaceflight on April 12, 1961. The Americans followed closely with Alan Shepard's Mercury-Redstone 3 spaceflight on May 5, 1961. However, Shepard's flight was in fact suborbital with a duration of 15 minutes covering a distance of 487 km, contrasting with the 108-minute orbital flight of Gagarin covering an orbit or a distance of more than 40,000 km. Although the stated purpose of the Mercury program was to place a human in orbit (Loff 2015), Shepard's flight could not have been in orbit simply because the Redstone rocket was not powerful enough to place a human in orbit (Mohon 2016). It was not until the development of the new Atlas rocket that the United States successfully put one of their nationals into orbit on February 20, 1962 (Warnock 2015). Moreover, beyond the technological necessity, the essential scientific mathematical calculations in order to carry out an orbital flight were not yet developed by the Americans at the time of Shepard's flight (Loff 2016). This additional link between scientists and technology and their co-constitutive relationship with the politics of the space race only confirms the fact that human spaceflight is fundamentally a technology-dependent enterprise. Finally, ending the space race and reiterating the preeminent role of science and technology in human spaceflight projects, many observers attribute the defeat of the USSR in the race to put a human being on the Moon upon the death in 1966 of Sergei Korolev, the chief engineer of the Soviet space program since its inception (Siegel 2019; Siddiqi 2019). Indeed, although the USSR had developed the N-1 rocket with capabilities similar to that of the Saturn V which transported the astronauts to the Moon, following the death of Korolev who was its prime contractor, the rocket N-1 had only 4 test flights which all resulted in significant failures (ESA 2007).

3.2.3.2 *Scientists as Collaborative Spacecrafts Advocates*

The STS approach perceives technology as an actor in its own right within IR, influencing policy (Kaufman 2019, 141). However, as this technology is designed by human beings, the necessity of accounting for the specific role and influence of scientists as political actors remains. Callon (2012) presents a concrete example that clearly demonstrates the politico-social role that scientists can have. He explains that in France, in the 1970s, the idea of introducing electric vehicles on the roads first came from scientists. While this claim is not surprising, Callon goes on to demonstrate that scientists have gone far beyond designing an electric machine that can transport humans on the road. They have also sought to promote certain specific social collaborative parameters in which these electric vehicles should work (Callon 2012, 84). Ranging from the configuration of cities, to battery management and social consumption habits, scientists have sought to transform French social structures and went “from electrochemistry to political science without transition” (Callon 2012, 86). In a more specific context of cooperation in the fields of common goods such as the environment and outer space, Moltz (2019, 61) also argues that scientific experts have and play a central role in the development, implementation and durability of the agreements. Latour also gives a very interesting explanation to understand how scientists manage to cooperate with each other. Indeed, he explains that there are dynamics specific to the work of scientists that facilitate cooperation even in a difficult relational context. He argues that when scientists do not agree on scientific conclusions, mechanisms are put in place to resolve disagreements. First, there is “the argument from authority” where it is possible for a scientist to demonstrate the merits of his position by citing other authors and research supporting his conclusions (Latour 1987, 31). It is also possible for scientists to come to a mutual understanding by dissecting the text or work in question in order to identify its evidence and foundations:

There is a point in oral discussions when invoking to her texts is not enough to make the opponent change his or her mind. The text itself should be brought in and read. The number of external friends the text comes with is a good indication of its strength, but there is a surer sign: references and other documents (Latour 1987, 33).

Finally, Latour identifies a third process by which scientists can come to an agreement, and that is when a work is then referenced in other works of literature (Latour 1987, 38). Latour's analysis is very inspiring for our work in order to understand how scientists of very different origins (American and Russian space scientists) come to collaborate so effectively within human spaceflight.

In connection with this thesis and objects of study, one may note that American and Russian scientists and engineers have been at the forefront of major collaborative agreements in the field of human spaceflight. For example, in the case of the Apollo-Soyuz Test Project, the Nixon-Kosygin agreement that laid the foundations for this collaboration was signed by the respective political authorities of the two countries on May 24, 1972. However, as early as 1970, delegations of both American and Russian scientists collaborated exhaustively in order to lead the way to what was to become ASTP. Indeed, it could not be clearer that this technical collaboration preceded the political. During the first trip of American scientists to the Soviet Union in October 1970 Soviet representatives mentioned to their American counterparts "that they were relying upon them to exert their influence on the American government to ensure cooperation in space" (E. C. Ezell and Ezell 1978, 110). We find a similar dynamic with the Shuttle-Mir missions where although the *Joint Statement on Cooperation in Space* was signed in June 1992, scientists and engineers were involved upstream in the planning and development of this agreement which would lead to 4 years of collaboration within the Mir orbital station and lay the foundations of the current international space station (Davison 1998).

3.3 Synthesis of the Theoretical Toolbox: The New Space Materialism Table

Now that New Space Materialism (NSM) has been presented in detail, it is necessary to synthesize this theoretical toolbox in a concise manner for the research purposes of this thesis. The challenge here, as presented in section 3.2, is that although NSM has been presented, detailed, and divided into different pillars and then different criteria, each of these elements bears equal importance. To fully grasp the particularities specific to cooperation within human spaceflights in outer space, we cannot simply focus on a single pillar of NSM such as symbiotic realism or even on a single criterion like that of spacecrafts as pedetic actors. For this framework to make sense of a given situation, it must be used as a whole and not only with the help of only one of its facets. One can see the theoretical dynamics of NSM as analogous to those surrounding the technicalities leading to the success of a spaceflight. The success of a spaceflight cannot be attributed to a single component, be it the rocket, the vessel, the control center or even the astronaut on board. The success of such an enterprise depends on the overall interaction of these different components which, although they all have the same objective, namely the success of a spaceflight, they can only achieve this through their mutual dependence and the co-constitutive aspect of the very existence of their function. NSM functions in the same fashion: the different pillars and criteria, although crucial in their role within the framework, must be seen as actually part of a whole. NSM must therefore be approached in a holistic way.

Thus, to be able to see and understand NSM as a whole and in its complexity, the simplest format is to present it in the form of a summary table. This table presents both the pillars and the criteria in a single matrix. This NSM table will be crucial in the next chapter because it essentially forms the foundation of the decoding table that is used for archival analysis.

Table 1 - The NSM Table

	NSM Pillars	NSM Criteria
New Space Materialism	Symbiotic realism	Interdependence and the survival of human beings in outer space
		The neurobiological nature of human beings favours symbiosis in microgravity environment
	New materialism	Spacecrafts as pedetic actors
		Spacecrafts as ongoing iterative indeterminate process
		Spacecrafts as relational objects
	Science and technology studies	Spaceflights as fundamentally technology dependent
		Scientists as collaborative spacecrafts advocates

3.4 The Main Hypothesis Answering the Research Question

To conclude this theoretical chapter, it is necessary to reiterate the research question as well as the main hypothesis that guide this thesis. The research question is formulated as follows: *how can we explain the US-Russia cooperation in human spaceflights?* The hypothesis, as presented in the introductory chapter, is formulated as follows: *we can understand cooperation between the United States and Russia in human spaceflights through the framework of New Space Materialism which emphasizes the role of precarity, objects and technology.* As the theoretical construction presented above details the 3 pillars and 7 criteria of NSM, it could be tempting to finally specify this main hypothesis in 3 or even 7 sub-hypotheses. However, keeping in mind the holistic approach of NSM, it must be considered as a whole, by the sum of its parts and not for its precise particularities. The primary hypothesis therefore remains relevant given its consistency with the holistic approach advocated for by NSM.

4. Chapter 4 – Method

This chapter aims to present the method that will be used to concretely demonstrate that *we can understand cooperation between the United States and Russia in human spaceflights through the framework of New Space Materialism which emphasizes the role of precarity, objects and technology*. However, it is important to remember that the main objects of study to demonstrate this hypothesis are spacecrafts rather than the human beings who are involved in human spaceflights. Studying spacecrafts as a means of understanding international political phenomena requires the use of a particular methodological approach. Although the preceding chapter demonstrated that objects and matter can have their own political agency, the fact remains that spacecrafts are not humans who can be questioned or interviewed. Nor can they be observed, evaluated, or made to participate in experiments as it is possible to do with individuals. We also don't want to assess and understand the role of spacecrafts through the interpretation that individuals would make of them. The risk of substituting the agency of the object of study by the perception that an individual has of it would be too great and would not correspond to the desired approach for this thesis.

We therefore need to trace the impact that spacecraft have had on cooperation in outer space in an indirect way through archival analysis. This chapter first presents how archival analysis is the appropriate method for understanding the impact of spacecrafts, going on to present how New Space Materialism will be assessed using the decoding technique. The different databases that will be used are also presented and their choice is not random. Indeed, to have an overall portrait of the phenomenon of cooperation within human spaceflight between the United States and Russia, the three objects of study (ASTP, Mir-Shuttle and ISS) will each be studied under a different theme. These three themes, grouped together, present an overall portrait of human spaceflight cooperation.

Thus, the databases concerning ASTP will specifically study the connection between two spacecrafts. For Shuttle-Mir, the data investigated will focus on the construction of a collaborative spacecraft. Finally, for the ISS, the data presents the operating of a collaborative spacecraft. These three themes will be explored in detail in section 4.2.

4.1 The Chosen Method: Archival Analysis

4.1.1 A Method that Matches Spacecrafts and New Space Materialism

As mentioned in the introductory chapter, this thesis is faced with a major challenge in terms of method given the nature of the object of study. Indeed, the challenge is fundamentally to determine how one can correctly assess the impact of a spacecraft on a space policy. Archival analysis is the methodology of choice to achieve this due to its potential to determine whether the contents of an archival document can relate the influence of a spacecraft on space policy. But what are archives? “Broadly speaking, archives are collections of records—both paper and electronic records—that are generated by, and reflect the efforts of, an individual, organization, or institution” (Frisch 2012, 2). Archives can of course also reflect the nature and importance of specific objects. Archival research makes it possible to assign agency to spacecrafts since their influence will not be determined and evaluated by a third party (such as an individual), but by archival documents very close to the spacecraft in question which can relate its nature, its existence and or its very functioning. This method is in line with the work of Florian Weisser (2014) in which he states that certain archival documents must be considered as actant in a political process and can have a performative role.

A challenge posed by archival research is its infrequent use within the field of political science. Indeed, as Frisch (Frisch 2012, 1) mentions: “in the discipline of history, archival research is common. In political science, it is not” (Frisch 2012, 1). Nevertheless, this thesis veers from the

beaten track, motivated not only by archival analysis' relevance when it comes to studying the political impact of objects like spacecraft, but also by its utility when it comes the construction of theoretical frameworks. Indeed, Frisch explains that working with archives can be very useful to carry out theoretical constructions because this method makes it possible to understand the reasons and variables motivating certain political decisions. More specifically, he explains that the analysis of archives "provides a look behind the curtain of political process" (Frisch 2012, 11). This aspect is very important because the behaviors and political phenomena that we seek to explain are often the result of a much more complex process than what we can observe. In other words, going beyond observation, archival analysis "peeking into that ordinarily opaque process can help to build theories of political behavior that are more reflective of the actual political process" (Frisch 2012, 11). Working with archives also means being aware of the context in which political events take place and recognizing that "decisions are not made in a vacuum, and decision makers are not singular actors" (Frisch 2012, 11). The analysis of archives therefore makes it possible to better account for the diversity of variables influencing a political phenomenon because although in the end politics is very often the result of spoken or written speeches, the important decisions underlying the politics can "find their way into written documents" (Frisch 2012, 15). Such an approach fits well with New Space Materialism because it will take into consideration the variables that make up the three pillars of NSM (symbiotic realism, new materialism and science and technology studies).

One of the definite advantages of archival analysis is that this method gives great importance to qualitative analysis. As mentioned in the introductory chapter, this thesis embraces a multidisciplinary approach that is inspired by sociological postpositivist approaches rather than economic positivist approaches. Admittedly, quantitative and more positivist methods and

techniques exist in archival analysis. We can think in particular of the various techniques of computer coding where a software identifies and groups together certain precise keywords within an archival text in order to detect trends. Although such an approach might seem appropriate for the purposes of this thesis, it would provide weak explanatory potential. As mentioned in the previous chapter, spacecrafts are scientific devices that are ultimately black boxes and in order to fully grasp this object of study it is essential to investigate the process that created the black box by focusing on the scientific process rather than the result (Latour 1987, 21). Thus, opening such a black box requires going beyond a mere collection of keywords. One must read between the lines, interpret and make associations that a software formula cannot. This is where qualitative archival analysis takes on its full meaning. Franklin (2012, 218) explains that qualitative analysis helps one to understand and analyze opaque objects of study (like spacecraft). It allows you to pay attention to the subtext, to what is hidden “between the lines” and this analysis “is as important, if not more significant in psychological or political terms than the manifest, explicit message” (Franklin 2012, 218). Franklin explains that in qualitative analysis it is therefore much more appropriate to have a “decoding” process rather than a “coding” process: “the assumption here is that there is a hidden message, if not several. Texts are treated here as phenomena, representations of thought and experience, and as sociocultural artefacts” (Franklin 2012, 218). A compelling example of qualitative archival analysis is made by Jason Dittmer about the paper's influence on British foreign policy. He posits that in the 19th century, the physical sheet of paper must be considered as an actor who co-constituted British foreign policy with the other human actors present within the foreign office. Going from a volume of 6,000 correspondences per year in 1821 to a volume of nearly 60,000 correspondences per year in 1857, the presence of paper and its accumulation pushed the British foreign policy to adapt policies for logistical and security reasons surrounding this new reality brought by the paper. Beyond the numbers, it is thanks to his qualitative analysis of the

archives that Dittmer comes to the conclusion that “from this point of view, the diplomatic archive is not just a tool to enable foreign policy and the production of a transnational governmentality (power), but also a material force that shapes human action (power)” (Dittmer 2017, 39).

It is by following a logic like that of Dittmer that this thesis seeks to use qualitative archival analysis in order to understand and measure the impact of spacecraft on space policy through the lens of the New Space Materialism theoretical framework. Like Dittmer who came to conclude that the sheets of paper had an influence on British foreign policy, spacecrafts are also expected to influence the foreign policies of the United States and Russia towards human spaceflights. As was the case with the analysis of Dittmer's sheets of paper, spacecrafts are also expected to have an unexpected influence, emanating from the very agency of the object.

4.1.2 The Technique: Qualitative Decoding Process

It may seem less common for archival analysis to use a coding technique that is essentially qualitative. Indeed, very often coding techniques turn out to be essentially quantitative by seeking to associate a code with certain words, sentences or themes present in an archival document and then make a statistical analysis of the occurrences. Inferences, patterns, and conclusions can then be made from these statistical results. More precisely, the coding process that will be used to determine the influence of spacecrafts on politics through the glasses of NSM is a “closed coding qualitative process”. Halperin explains that there are two main types of coding: “open coding” and “closed coding”. Open coding means that the researcher does not use pre-existing code or data when analyzing archival documents. Rather, he or she identifies the codes and themes familiar while reading the texts. Halperin calls such codes “grounded codes”: “grounded codes emerge from the data as the researcher reads it. The researcher puts aside presuppositions and previous knowledge of the subject area and concentrates, instead, on finding themes in the data” (Halperin

2012, 323). Such grounded codes are not useful in the context of this thesis since the goal of this research is to assess the impact of spacecrafts on politics using the theoretical framework of New Space Materialism. The codes that will be used to analyze the various archival documents are therefore essentially given by NSM through its three pillars and 7 criteria. Halperin (2012, 323) calls such codes “closed codes” or more precisely “a priori codes [that] are based on a research hypothesis or a range of sources relating to it, such as previous research or theory”. Halperin illustrates the difference between open and closed coding by describing open coding as using colored highlighters, circling text, underlying words and running lines down the margins to indicate meanings, association and comparison. “In closed coding, the coder simply marks the boundaries of the recording unit and write the code in the margin of the document, perhaps using different coloured pens for each variable” (Halperin 2012, 324).

Although this process of closed coding may seem mechanical, most of the work occurs afterwards when the researcher analyzes the data obtained thanks to the coding. It is at this point that the distinction between quantitative and qualitative coding takes on its full meaning. Thus, the quantitative analysis will examine the data obtained by making “inferences based on the frequency, amount, salience, or intensity of a category” (Halperin 2012, 327). For its part, qualitative analysis is non-numerical and seeks more to retain themes and patterns from the data. Moreover, while the quantitative analysis will seek more to analyze the manifest content through specific words and sentences, the qualitative analysis is more interested in the latent content through the meanings, motives and purposes. The quantitative approach (more mathematical) will tend to present its results in the form of graphs, tables and statistics while the qualitative approach (more conceptual) will present more its results with quotations, concepts and narrative frameworks (Halperin 2012, 327). Concretely, this means that the archival documents related to our objects of study (Apollo-

Soyuz, Shuttle-Mir and the International Space Station) will be analyzed through the lenses of the NSM codes in order to understand how these texts help us understand and conceptualize the narrative pattern where spacecrafts have impacted the space policies of the United States and Russia. No statistics will be used to analyze the results of the coding. This process of qualitative analysis following the coding of meanings, motives and purposes within archival texts is therefore much more like a decoding process than a coding process as such. Indeed, even if the coding process can make it possible to extract essential information and data, these must be analyzed (decoded) to be able to give them a heuristic meaning.

4.1.2.1 The Coding Table

The coding table is created using the NSM Table. Given that NSM constitutes the original theoretical framework for this thesis which seeks to explain the influence of spacecrafts on space politics, it goes without saying that all the constituent elements of NSM are indeed present in the form of codes in the coding table. So, in a very concrete way, here is the coding table that will be used to analyze the archives.

Table 2 – NSM Coding Table

	Pillars	Codes	Codes Description
NSM Coding Table	Symbiotic realism	SRA	Interdependence and the survival of human beings in outer space
		SRB	The neurobiological nature of human beings favours symbiosis in microgravity environment
	New materialism	NMA	Spacecrafts as pedetic actors
		NMB	Spacecrafts as ongoing iterative indeterminate process
		NMC	Spacecrafts as relational objects
	Science and technology studies	STSA	Spaceflights as fundamentally technology dependent
		STSB	Scientists as collaborative spacecrafts advocates

Two important methodological elements should be noted in connection with the NSM coding table. First, to ensure a clear separation with the quantitative analysis which is not appropriate for our study, the codes have not been assigned any numerical value. This therefore respects one of the fundamental logics of NSM that its different criteria all have equivalent importance. Thus, no code has precedence or greater importance over another. Also, the codes reproduce word for word the criteria of the MSN table and there are essentially two reasons for that. The first obvious reason is because the objective of the coding is essentially to check whether the theoretical toolbox offered by NSM allow us to account for the political influence of spacecraft. The second reason is one of simplicity, openness, and operationalization. It could indeed be tempting to specify the criteria of NSM in a much more precise way, for example by giving a number of precise sub-criteria determining how a spacecraft can be considered as a pedetic actor (code NMA). However, such an approach would be antithetical in the spirit of qualitative analysis because not only would we end up with dozens of codes that would be too precise and too difficult to operationalize, but it is also essential to let the text and the data speak for themselves as much as possible. For instance, this way of doing things gives us the chance to discover other reasons that we would never have suspected for defining a spacecraft as being a pedetic actor. Thus, in this decoding process, although we work with “closed codes”, these leave a lot of room for interpretation, analysis, and comparison.

4.2 The Databases and Justification for the Choice of the Objects of Study

Since Gagarin's first flight in 1961, it can be said that all human spaceflights share three crucial steps in order to ensure mission success: (1) liftoff (2) completion of the mission in outer space and (3) landing. Obviously, significant variations between these different stages are possible except for the first stage of liftoff; still today the only possible way that we know of to send humans

into outer space is by using a rocket or at least using some type of machine equipped with a powerful reactor projecting fuel at a dizzying velocity. However, regarding the mission in outer space and the landing important and obvious variations exist. For example, there are differences between a mission sending a human into orbit (as it was the case for Gagarin) and a mission sending individuals into outer space but without carrying out an orbit (as it was the case for Alan Sheperd). In terms of the spaceflight's landings, Shepard's was made at sea aboard his Mercury capsule while the landing of Gagarin was made in the steppes of Kazakhstan by parachute after he was ejected outside of his capsule. However, despite these notable differences, these three essential components of liftoff, mission and landing remain essential and mandatory for human spaceflight. It is by taking a similar approach that this thesis addresses cooperation within human spaceflight by seeing the three essential steps for the successful completion of a cooperative mission.

The first essential step to carry out a mission of collaboration between humans in outer space is to successfully connect spacecrafts in orbit. Indeed, all our objects of study (ASTP, Shuttle-Mir and ISS) have as a primary step to connect the spacecraft from two different countries together. For ASTP it was the connection of the Apollo spacecraft to the Soyuz spacecraft, for Shuttle-Mir it was the connection between the American Space Shuttle and the Russian space station Mir and for the ISS it was the connection between the Russian Zarya module and the American Unity module. The centrality of this first essential step of the connection between two spacecrafts inspires the angle of approach of our first case study. Thus, the aspect that will be studied for the ASTP study object will be the connection between the two vessels. Not only does this choice make sense given that this is the first case of a connection between two foreign spacecrafts, but also due to the mission's primary objective of the rendezvous and docking between two spacecrafts.

The second step required to carry out a mission of collaboration between humans in outer space is to build a cooperative spacecraft or module. Indeed, we can note that all our objects of study required the construction of at least one common spacecraft. In the case of ASTP, it is the docking module that was built in close collaboration between the two countries. For Shuttle-Mir, an entire station scientific module and living quarters (the Spektr module) was jointly developed and built. As far as the ISS is concerned, the number of modules built collaboratively is very large. Given its novelty as the first jointly built module attached to a space station, the case of Shuttle-Mir and its Spektr module will be used for investigation of this second crucial stage of building a collaborative spacecraft.

The third fundamental step to carry out a collaborative mission in outer space is to establish operating protocols and specifically joint emergency measures. As demonstrated by NSM, interdependence requires both parties to adopt common protocols and measures. Each of the three case studies has such protocols and emergency measures, however the case of the ISS is retained here given its pioneer status. In fact, not only is the ISS the longest collaborative mission in the history of human spaceflight, but the ISS is also the first space station to have been built from its origins with a fundamentally collaborative vocation. This was not the case, for example, with the Shuttle-Mir program which had initially been an exclusive enterprise of the Soviet Union.

These three specific cases of our objects of study (the ASTP docking module, Spektr module and the emergency protocols and procedures of the ISS), therefore constitute the precise data which will be investigated within the archives. These three cases represent ideal candidates to study for a myriad of reasons. The first is a question of operationalization and feasibility. The challenge is that our three objects of study (ASTP, Shuttle-Mir and the ISS) constitute extremely complex objects. Many say that these spacecrafts and space stations constitute the most complex

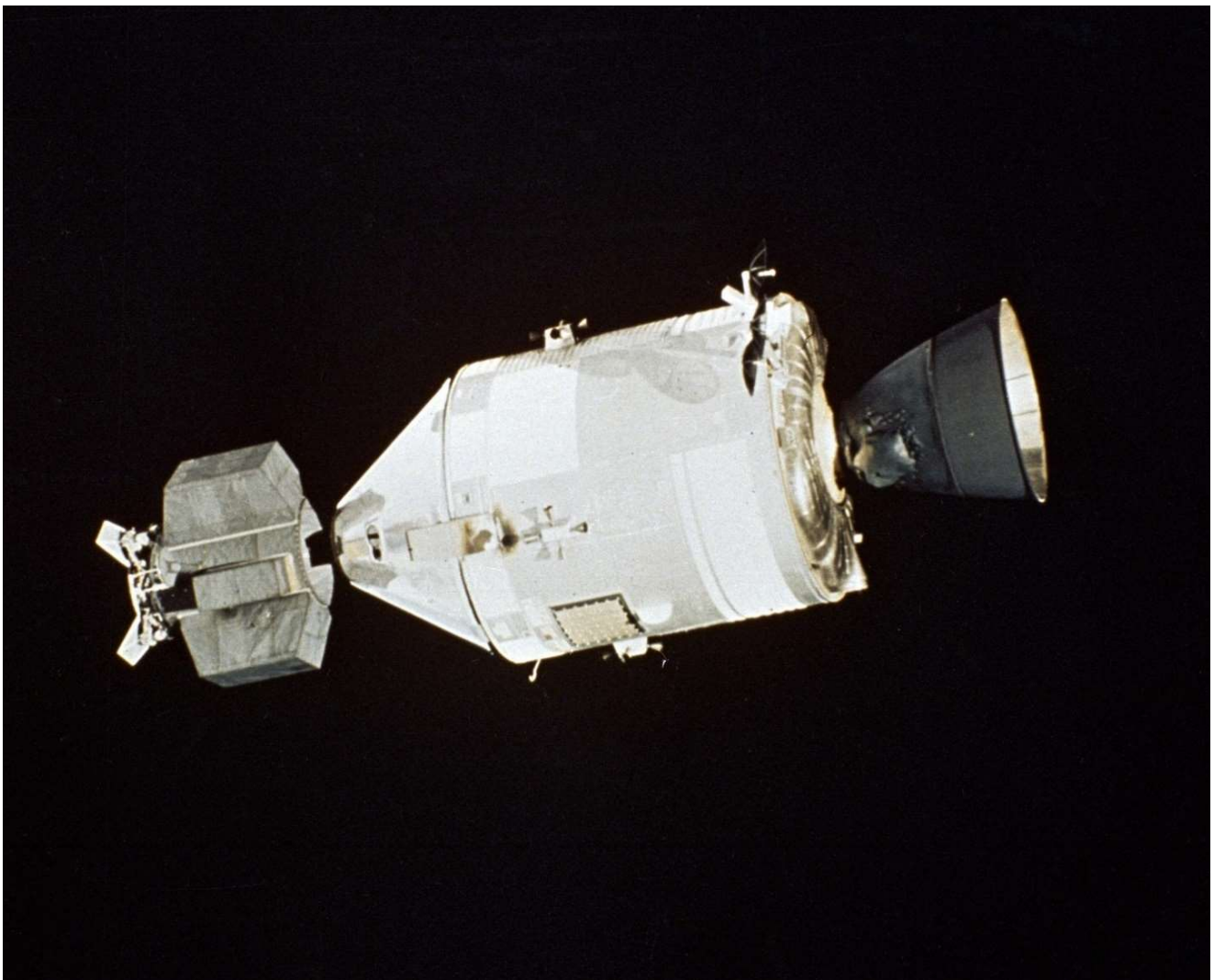
objects built by humankind at the time of their realization. It would simply be inconceivable and unachievable to be able to investigate these objects in their entirety without getting lost in an endless sea of data and information. Thus, to effectively operationalize NSM using archival analysis and decoding method, it is necessary to limit our choice of specific objects studied to those that are the most significant, namely those presented above. The second reason, and the most important one, is one of coherence with what constitutes cooperation within human spaceflight as well as with the theoretical construction of New Space Materialism. Indeed, as presented in the paragraphs above, collaborative human spaceflights are essentially characterized by three essential elements (connecting spacecrafts, building collaborative spacecraft, and operating common emergency procedures) and combining the three specific objects stated (ASTP docking module, Spektr module and ISS emergency procedures) is the best possible representations of these three steps. It is important to underline that the choice of these three objects of study is therefore not the result of chance or that of a simple convenience in order to apply them to NSM. It constitutes in reality the best objects available in order to understand both the entire phenomenon of cooperation in human spaceflight, but also because they allow to cover all the instances of cooperation between the two countries, from ASTP to the ISS. This approach is also consistent with NSM since it considers this process of collaboration in outer space in a holistic way by considering these different objects as being essentially interconnected and allowing together to explain the whole picture. The following section will unpack in detail the specific databases related to these three objects of study that will be analyzed using the NSM coding table.

4.2.1 Step 1: Connecting two Spacecrafts (Apollo-Soyuz Test Project)

As presented in the introductory chapter, Apollo-Soyuz Test Project (ASTP) is the first-ever cooperative human spaceflight mission between the United States and Russia. The mission took place in July 1975, but its origins can be traced back to 1969, even before Apollo 11 landed

on the Moon. The primary objective of the mission was the rendezvous and docking between the Apollo and Soyuz spacecrafts and, as presented above, the specific object investigated in the archives is the docking module. Before presenting the different databases that will be investigated, since we are talking about concrete objects, here are some images and sketches of the docking module in question:

Figure 7 - The ASTP docking module (dark grey part on the left side of the picture) and the Apollo spacecraft on the right side of the picture during the 1975 ASTP flight.



Source: NASA.

Figure 8 - Technical sketch of the ASTP docking module.

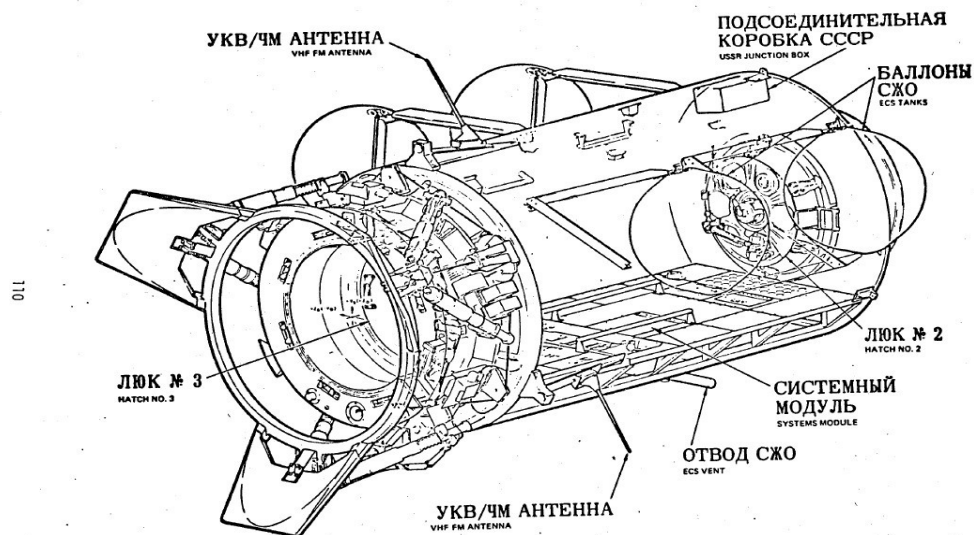


РИС 4-15 КОНФИГУРАЦИЯ СТЫКОВОЧНОГО МОДУЛЯ
FIGURE 4-15 DOCKING MODULE CONFIGURATION

ASTP 40001.1
ЭПС 40001.1

Source: NASA.

Figure 9 - Artist impression of ASTP. The Docking module is the black part attached to the Apollo spacecraft facing the Soyuz Spacecraft.



Source: NASA.

The archive documents that will be analyzed concerning the docking module are numerous and the following section will outline their necessity and utility. First, ASTP is the first mission of human spaceflight cooperation between the two countries, and this novelty required the creation of not only new procedures and protocols, but also the necessary documentation and paperwork. Though this may seem obvious, when reading documents related to the subsequent human spaceflight cooperation missions (Shuttle-Mir and ISS), numerous references are made to ASTP and its docking module. The second reason explaining the large quantity of documents to analyze is because of the very nature of the mission. Indeed, the main objective of ASTP was the docking and crew transfer between the Apollo and Soyuz spacecraft. Admittedly, other objectives were also targeted like common scientific missions, but the ultimate objective was docking and crew transfer. This has the consequence that the vast majority of documents and archives about ASTP touch directly or indirectly on the docking module and crew transfer. This is not the case, for example,

of our second research object (the Spektr module of the Mir station) which was only one secondary objective among many others within the Shuttle-Mir program. Finally, the large volume of archival material studied in this thesis is due to availability. ASTP will soon be 50 years old, and this means that the vast majority of mission-related documents are now archived and declassified. This is far from being the case for the Mir-Shuttle program and for the ISS (this important issue will be addressed in their respective sections). It is also important to note that it is not necessary to analyze the archives covering the entire ASTP period up to 1975. Indeed, since we seek to understand the influence and importance of the docking module on the cooperative mission, it is not necessary to study in detail the archives of the mission after the decision to set up the docking module had been made. It is therefore more the archives related to the design, proposal and negotiations related to the docking module that are relevant to analyze in this case much more than archives related to its use or performance for example. Now, here are the different archive databases that will be analyzed.

The first database to be analyzed was provided by NASA's Johnson Space Center National Archives in Fort Worth, Texas. These archives are not available online, but fortunately a recent digitization work has been carried out and we have received the archival documents on DVDs sent by mail. This database is divided into broad themes such as "Apollo Spacecraft Program Office Files", "Chronological Files", "Flight Related Documents", "Joint Meeting Documents" and "Working Group Documents". In total, 197 different archival documents will be analyzed within this Fort Worth database.

The second archival database studied for ASTP is that of the Johnson Space Center Oral History Project. This project aims to collect "history from the individuals who first provided the country and the world with an avenue to space and the moon. Participants include managers,

engineers, technicians, doctors, astronauts, and other employees of NASA and aerospace contractors who served in key roles during the Mercury, Gemini, Apollo, Skylab, and Shuttle programs” (NASA and Johnson Space Center 2021). This database is an important resource as it contains multiple interviews transcripts and testimonials from scientists and NASA personnel about ASTP and its docking module. These interviews are available online at the NASA History Program Office website (NASA and Garber 2013). In total, 27 interviews will be analyzed.

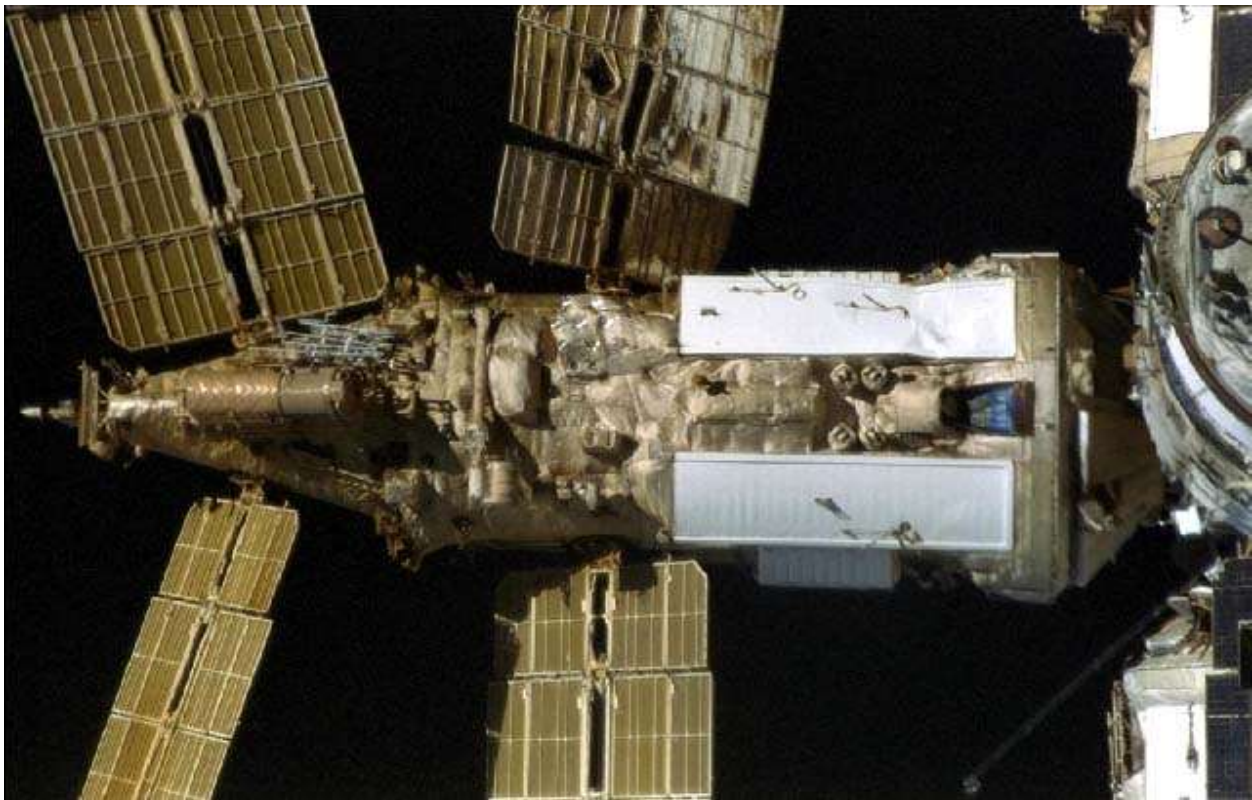
The last database for ASTP that will be analyzed is a book, that can easily be considered as an archival element in its own right of ASTP. The book in question is called *The Partnership: A History of the Apollo-Soyuz Test Project* (E. C. Ezell and Ezell 1978). Written by Edward Clinton Ezell and Linda Newan Ezell, this book is a comprehensive biography of ASTP commissioned by NASA and published in 1978. This 560-page book therefore contains valuable information about ASTP and its docking module.

4.2.2 Step 2: Building Collaborative Spacecrafts (Mir-Shuttle)

The second step required to carry out a human spaceflight collaborative mission is to jointly build a spacecraft and the case of the Spektr module of the Shuttle-Mir program is studied for this purpose. The Spektr module was originally intended to be a Soviet military station module in the late 1980s. However, the context of the end of the Cold War and the fall of the Soviet Union redirected the use of this module for civilian scientific purposes. Although its origins are Soviet and essentially Russian-made, it was the United States that financed the launch of this module in 1995 and completely remodeled it in collaboration with Russia, in particular to serve as living quarters for American astronauts aboard the Mir station. It is important to note that although Spektr was used as a module of a space station, it is also a device that can serve as an autonomous spacecraft as such being equipped with all the apparatus necessary for orbital flight like a

propulsion system. In more detail, the Spektr module is actually quite large. Weighing 19.6 tons and measuring 12 meters by 4.4 meters, the module can hold 62 cubic meters of pressurized volume which is more than 10 times the total habitable size of ASTP (NASA and Dismukes 2023). Here are images and sketches of the Spektr module:

Figure 10: Picture of the Spektr module taken in 1997 by the American Space Shuttle Atlantis.



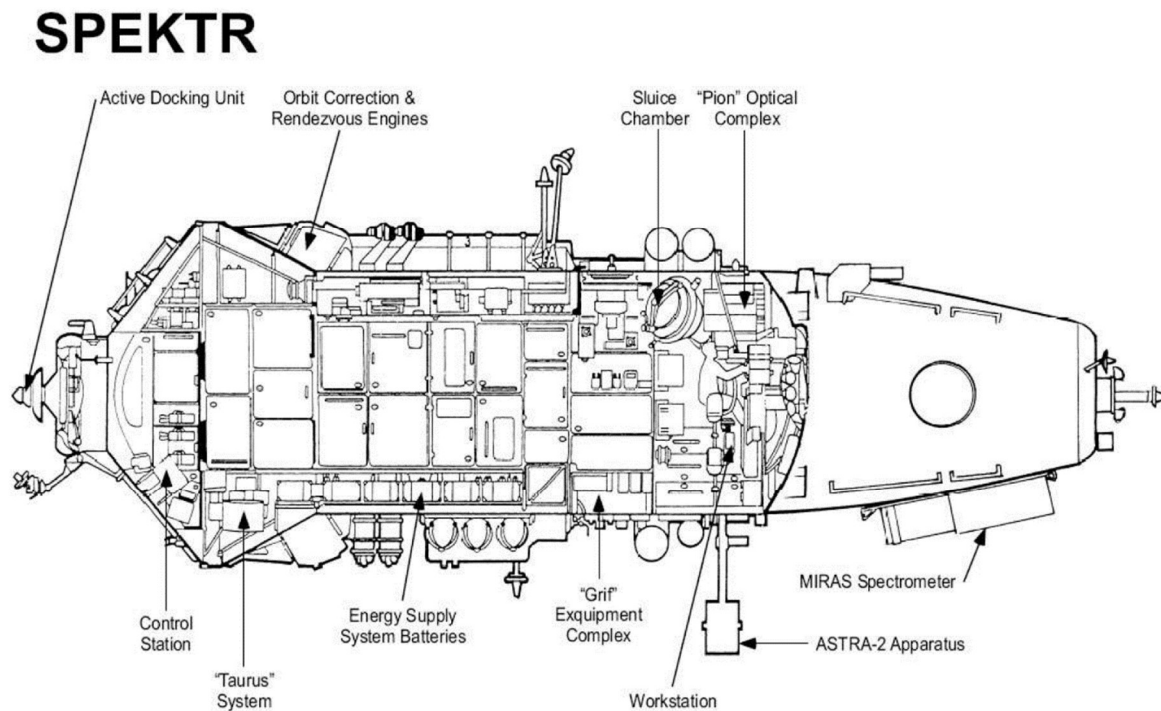
Source: NASA.

Figure 11: Picture of the inside of the Spektr module taken in 1996.



Source : NASA.

Figure 12 – Sketch of the Spektr module.



Source: NASA.

Since the Mir space station is made up of 7 distinct modules (multiple Soyuz and Progress spacecrafts, and at one point the American Space Shuttle as well) the Spektr module is therefore only one element among many within the Mir program. This aspect is very different from the ASTP docking module because unlike the latter, the Spektr module is a much less central and priority element than the docking module of ASTP. This is the first reason why the amount of information and archives to be analyzed for the Spektr module is much less than what is the case for the ASTP docking module. The second reason explaining why the number of archives is smaller because a large part of the documents related to the Shuttle-Mir program are not yet declassified, archived, and available at the time of writing this thesis. This information was confirmed by Jennifer Ross-Nazzal, PhD who is the Chief Historian of NASA Johnson Space Center. A Freedom of Information Act request was made to NASA for access to all records related to the Spektr module,

but their response was negative. The main hypothesis explaining why NASA does not archive these documents, which are more than 25 years old, is because the current Russian modules of the International Space Station are largely copies of the modules of the Mir space station. Indeed, the Zarya module of the ISS (the first Russian module of the ISS launched in 1998) comes from the same family of modules as Spektr and are therefore identical on several levels (M. Garcia 2018). It is therefore plausible that all the archives related to Spektr are not available for security reasons since a module like Zarya is still in operation today. Finally, the third reason explaining the fewer archives related to the design of the collaborative Spektr module is because of the severe collision that the module experienced in 1997. On June 25, 1997, an unmanned Progress cargo spacecraft collided into the Spektr module. This accident, which can be considered as one of the most important non-lethal accidents in space history, had significant consequences. The accident caused severe damage to the module as well as its complete depressurization. After a few repair attempts, the module was able to perform some functions again, notably its electricity supply via its solar panels. Spektr, however, remained depressurized for the rest of the Mir station's existence, making all scientific experiments on board impossible. Although this incident has no connection with this thesis, given that we are interested in the construction of this collaborative module and not in its use or its risk management, this event has a significant impact on the archives and particularly on the Oral History Project. Indeed, as explained a little below, the archives of the Oral History Project in connection with Shuttle-Mir are very relevant in the context of our research, yet it turns out that a large proportion of the interviews in connection with the Spektr module concerns this accident and not its construction and elaboration. It seems reasonable to believe to believe that the content of these interviews about Spektr would have been different if the collision had not taken place.

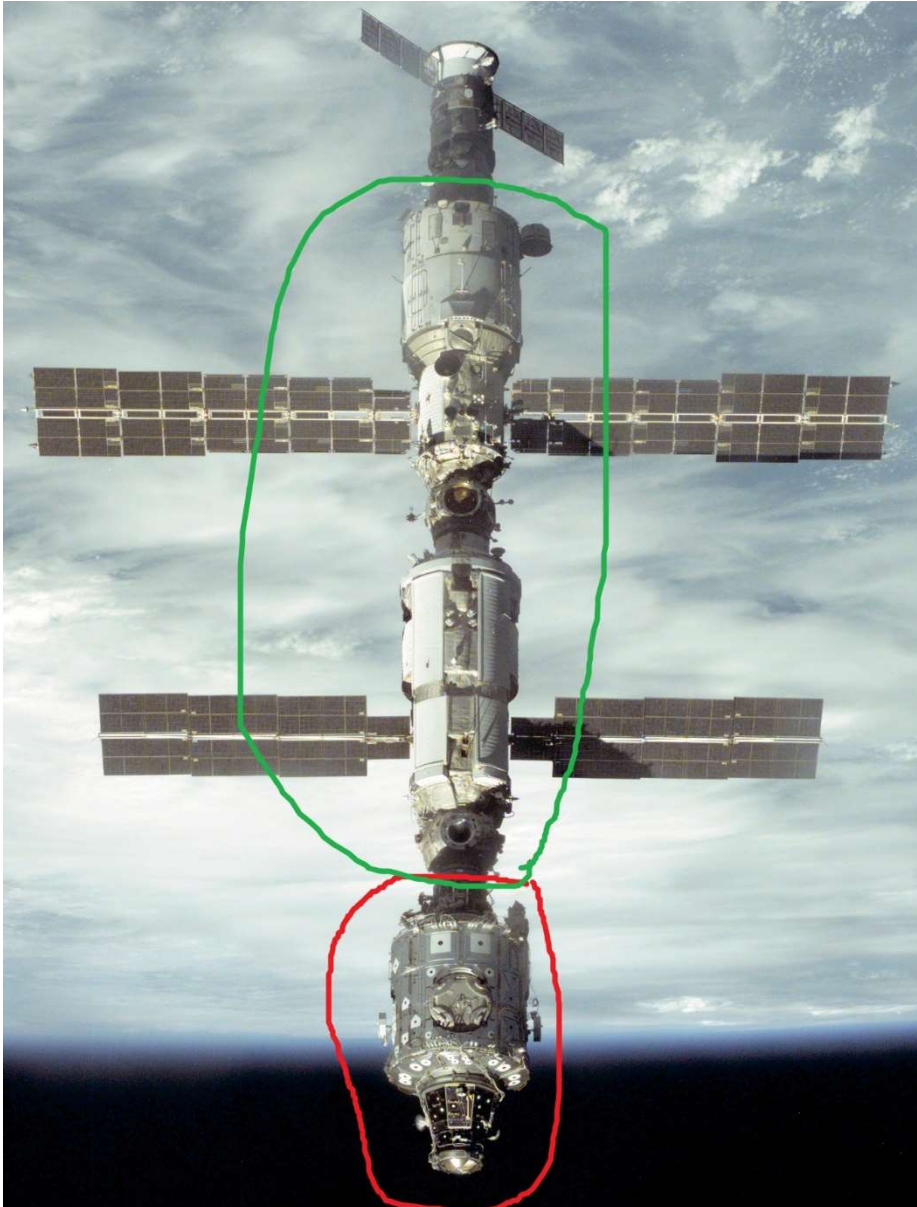
Three archive databases will therefore be studied in the case of the Spektr module. The first database contains documents related to the proposal for collaboration between the Americans and the Russians within the Mir station and concerning, among other things, the Spektr module. These documents, predating 1995 and the launch of Spektr, were collected from the NASA Technical Reports Server (NASA NTRS 2023). Four documents will be analyzed in this series. The second database that will be studied is the database containing technical reports related to the Mir station and the Spektr module. These reports, also available on the Nasa Technical Reports Server, written after the sending of Spektr in orbit present notably a history of the Spektr module. Three reports will be analyzed in this database. Finally, as briefly explained above, the last archival database to be studied is that of the Shuttle-Mir Oral History Project. 10 interviews involving NASA managers, technicians, engineers and employees will be analyzed. These interviews were retrieved from the NASA Johnson Space Center Mir-Shuttle Oral History website (NASA and Johnson Space Center 2020).

4.2.3 Step 3: Operating a Collaborative Spacecraft (International Space Station)

The third fundamental step required to carry out a collaborative mission in outer space is to have well-established operating protocols and joint emergency measures in place and the case of the ISS is retained for this study. Indeed, the ISS, constituting an unparalleled space collaboration enterprise involving the United States, Russia, Europe, Canada and Japan, is the best case to investigate when it comes to studying the protocols and collaborative emergency measures. It is important to note that although the ISS is a collaboration involving more than the United States and Russia, the station remains first and foremost a connection between a Russian segment and an American segment (a European module as well as a Japanese module are connected within the American segment). This detail is important because it means that fundamentally, technically, and structurally the ISS remains an American-Russian collaboration since its beginning and until today.

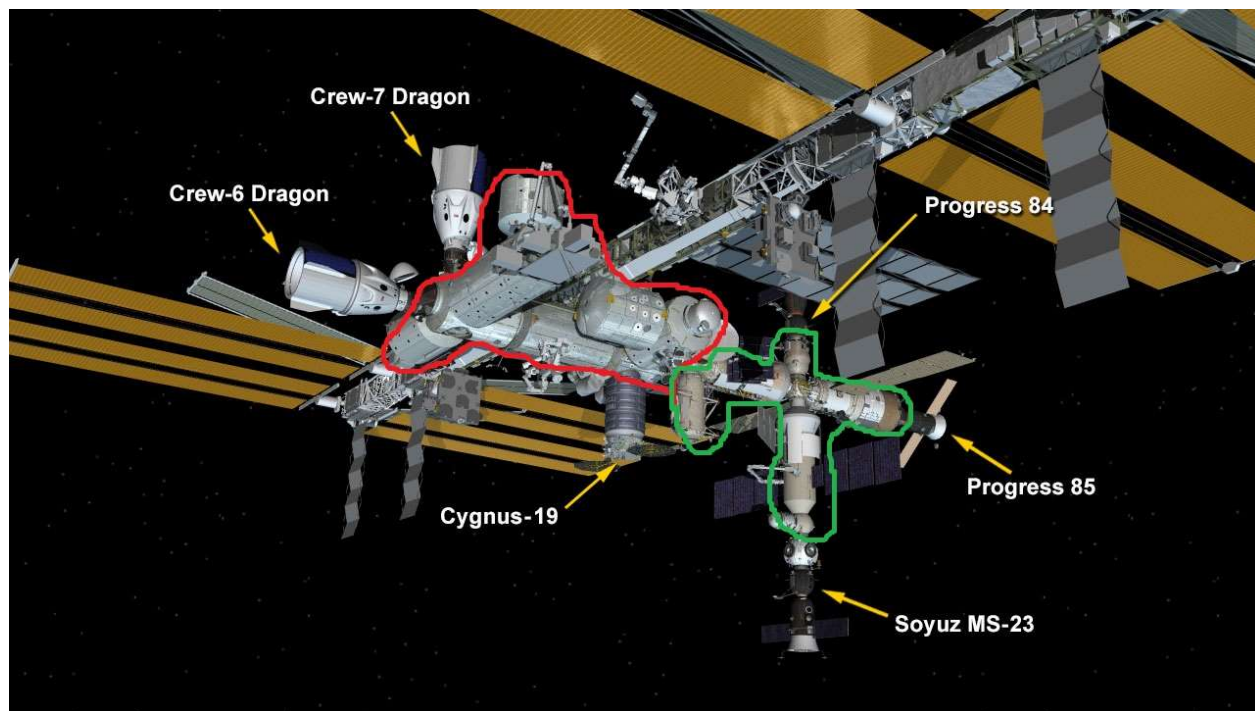
Here are two photos showing the evolution of the ISS over time and its division between the two Russian and American segments:

Figure 13 - The ISS in September 2000. Identified in red is the US segment and in green the Russian segments (excluding transportation spacecraft).



Source : NASA.

Figure 14 - The ISS in August 2023. Identified in red is the US segment and in green the Russian segments (excluding transportation spacecrafts).



Source : NASA.

An important point to emphasize in the investigation of this third case study is that contrary to the two previous objects (the ASTP docking module and the Spektr module), what is studied in the case of the ISS is not a concrete physical object, but a set of emergency procedures and protocols. This might seem contradictory from the outset, but in the end there is very little difference between studying textual documents from archives about physical modules and studying textual documents addressing emergency protocols. Methodologically, the method of analysis and the technical coding remain the same. Moreover, as mentioned above, to have a full picture of the cooperation between the United States and Russia in human spaceflight, we must go beyond the connection between two spacecrafts and building a collaborative station; it is essential to study how this cooperation is operationalized concretely through, in particular, emergency protocols.

Thus, although these emergency protocols are technically just papers, they contribute to constitute and to create the social and political reality within the ISS. These protocols and emergency procedures are integral parts of the spacecrafts and as much as spacecrafts and space modules can have an impact on the reality of cooperation in outer space, these emergency protocols (integral to the missions on board these vessels) are just as responsible for the social reality of this collaboration between spacecrafts.

For this study of the ISS emergency protocols, the volume of archives to be analyzed is also smaller than what is for the ASTP docking module. There is essentially one reason explaining this and it is one of accessibility. Since the ISS is still in operation, some interesting documents about the station's emergency protocols are still in NASA's possession. This information was also confirmed by Jennifer Ross-Nazzal, PhD who is the Chief Historian of NASA Johnson Space Center. A Freedom of Information Act request to NASA was made to access the very first emergency protocols of the ISS but their response was also negative. Despite this, the exploration of the available archives has nevertheless made it possible to target several very interesting documents which will make it possible to investigate emergency protocols efficiently. The first series of documents concern studies carried out by NASA prior to the first manned mission of the ISS presenting safety measures and important elements to be taken into consideration in terms of joint risk management. These documents can be considered as part of the foundation of the first emergency protocols of the ISS and two documents will be analyzed for this purpose. The second series of documents analyzed concern four ISS operational documents closely related to ISS emergency protocols. For example, the first document titled "International Space Station Evolution Data Book" was published in 2000 and the last document that will be analyzed is titled "ISS Safety Requirements Document" and was published in 2019. These first two sets of archival documents

were all retrieved via the NASA Technical Reports Server (NASA NTRS 2023). The last set of documents that will be studied is, again, from the NASA Johnson Space Center Oral History Project. Four interviews with astronauts who have stayed on board the ISS address the emergency protocols of the ISS.

5. Chapter 5 – The Apollo-Soyuz Test Project: Understanding the Connection Between two Spacecrafts Through the Framework of New Space Materialism

As presented in the previous chapter, following the successful launch, the first step to carrying out a collaborative international human spaceflight mission is to connect two spacecrafts in orbit. ASTP is the very first mission of this kind where two foreign spacecrafts (the American Apollo spacecraft and the Soviet Soyuz spacecraft) docked in orbit on July 15, 1975. Attempts at cooperation mainly in the field of astronomy and meteorology have been carried out since 1962 (E. C. Ezell and Ezell 1978, 40), but in 1969, a true project of a human spaceflight cooperation emerged between the United States and the USSR. At that time, discussions between the administrator of NASA, Thomas O. Paine, and the Soviet director of the Academy of Sciences, Anatoly Blagonravov, were so advanced that Paine invited Blagonravov to witness the takeoff of the Apollo 11 mission in July 1969 which led its crew to the first lunar landing (E. C. Ezell and Ezell 1978, 2). Blagonravov declined the offer, but by early 1970, high-level technical discussions were taking place between the parties, which would eventually lead to the establishment of the ASTP (E. C. Ezell and Ezell 1978, 8). The study of the archives reveals that the beginnings of the cooperation project are eminently scientific and technical in nature. Indeed, neither country's political administration had approved that such cooperation would take place when collaborative discussions began. Scientists from both countries were therefore entrusted with the task of demonstrating to their respective administrations that such a cooperation project would be both feasible and desirable. Thus, there were dozens of meetings and correspondences exchanged between the administrations and scientists of NASA and the Soviet Academy of Sciences between early 1970 and May 1972 when the *Agreement Concerning Cooperation in the Exploration and*

Use of Outer Space for Peaceful Purposes, which formalized the Apollo-Soyuz Test Project, was signed by American President Nixon and USSR Prime Minister Kosygin.

Additionally, it is important to remember that the Apollo and Soyuz spacecrafts had very significant differences. Indeed, the variances between the two spaceships include the use of a different radio navigation system, a different orbital navigation system and the use of a different atmosphere. This last detail is very important because the atmosphere used in the Soyuz is composed of oxygen and nitrogen at high pressure while the Apollo spacecraft uses an atmosphere composed of pure oxygen at low pressure. This entails that the direct connection between the two vessels is impossible not only because the sudden mixing of the two atmospheres could cause the death of the astronauts and cosmonauts, but pressure exchanges would also result in a violent explosion of the respective spaceships. In order to remedy these significant incompatibilities, the solution that was quickly considered was to build a docking module that would allow the transfer between the two vessels in which the astronauts and cosmonauts could slowly prebreathe an air corresponding to the atmosphere of the neighboring ship while maintaining the integrity of the atmosphere of its host ship. Thus, the crucial element of ASTP allowing its realization is the docking module. Without the joint development of this device, such a cooperative enterprise would simply not have been possible. As mentioned in the previous chapter, the object of study which is therefore analyzed through the archives using the NSM coding table is this docking module and everything that concerns it (its idea, its conceptualization, its design, and its operationalization). This analysis section therefore first presents the result of the coding table. We can see the most relevant extracts from the archives which were retained using the coding technique to carry out the analysis. Subsequently, each pillar of NSM (symbiotic realism, new materialism and science and

technology studies) will be studied and the correspondence between the analysis of the archives of ASTP and NSM will be evaluated qualitatively.

5.1 ASTP Docking Module Coding Table Results

Table 3 – ASTP Docking Module Coding Table Results

Pillars	Codes	Extract from archives
Symbiotic realism	SRA (Interdependence and the survival of human beings in outer space)	<p>In this context, the document defines the methods by which the two parties will work together to control those project elements which must be made compatible or jointly agreed to for the proper conduct of the mission (G. Lunney and Bushuyev 1972, 8).</p> <p>Maximum allowable leaks through interface seals must be agreed upon. All the materials used in the construction should be mutually evaluated from the viewpoint of minimizing their fire hazard and toxic effect (Bushuyev and Lunney 1972, 59).</p> <p>In addition to serving the goals mentioned above, this mission also represents a step toward the development of an international space rescue capability and would be a most significant advance toward international involvement in future space programs (NASA 1971, 3).</p> <p>Preparations for return of the U. S. crew to the CSM will include a prebreathing operation to prevent dysbarism which can be caused by a transfer from the high-pressure oxygen and nitrogen Salyut environment to the low pressure pure oxygen CSM atmosphere (NASA 1971, 5).</p> <p>If such arrangements prove feasible and desirable, the way will be open for a variety of possible joint activities in space, including enhanced possibilities for the rescue of astronauts in distress (Low 1971, 4).</p> <p>This sad accident has further strengthened our emphasis on the solution on the common docking problems (G. S. Lunney 1971c, 1).</p> <p>We believe that 2 hours of uninterrupted inhalation of oxygen at 14,7 psia will suffice to bring tissue nitrogen to acceptable levels and prevent dysbarism upon exposure to 5 psia (Berry 1971, 3).</p> <p>And I think this is basically necessary before any joint venture in the future. And I think joint ventures in the future are mandatory (E. Ezell 1975a, 28).</p> <p>I think a joint docking system for joint operations in space is the real game. I think with joint docking, universal docking systems that three, four, five nations can eventually bring up their modules (E. Ezell 1975a, 29).</p>

	SRB (The neurobiological nature of human beings favours symbiosis in microgravity environment)	
New materialism	NMA (Spacecrafts as pedetic actors)	<p>This system consists of a set of indicators and automation apparatus. All main mechanisms of the assembly are equipped by marginal switches and electromagnetic sensors that receive information about operations of the mechanisms to the instrument panel through the telemetry system to the earth and to an automation apparatus to achieve control of electromotors of the assembly and also to automatically perform a sequence. The automation apparatus provides for electrical connection with the other spacecraft systems, performs logical processing of signals from the control panel or from the earth through a command radio link, processes signals from docking assembly sensors, controls electromotors, transmits electric signals about the operation of mechanisms and apparatus to the instrument panel and to the earth (Bushuyev and Lunney 1972, 139).</p> <p>On structural ring contact, the structural latches drive is automatically initiated, to effect the interface locking, and 15 seconds later the retraction drive is disengaged (G. Lunney et al. 1973, 14).</p> <p>In the normal mode the Soyuz active system mechanisms are automatically controlled for docking and undocking (G. Lunney et al. 1973, 8).</p>
	NMB (Spacecrafts as ongoing iterative indeterminate process)	<p>There is a desire for a long term capability for spacecraft of the USA and the USSR to rendezvous and dock with each other and/or space stations of each country (Cheatham 1971, 14).</p> <p>As you know, this mechanism is envisioned as the Shuttle system and is being scaled down for the CSM/Salyut application for our late fall discussions with the Soviets (G. S. Lunney 1971b, 49).</p> <p>As you can see from the enclosure, we foresee continuing work on the technical requirements and solutions for long-term capability (G. S. Lunney 1971b, 59).</p> <p>North American Rockwell has developed and fabricated a CSM/LM docking system. This docking system will be utilized in the CSM/DM interface (G. S. Lunney 1971b, 160).</p>

		<p>If you wonder why we would proceed that way. There has been concern for many years that we did not have a rescue capability in case something went wrong in space, that we each would have the option of rescuing the other. Future spacecraft beyond 1975, which is the planned date for this mission, will all have the capability (“Press Conference of The Vice President, Dr James C. Fletcher, Administrator, NASA; Glynn S. Lunney, Assistant to the Manager for Operational Experient and Government Furnished Equipment, NASA; and Dr Edward E. Dvid, Jr., Science Advisor for the President.” 1972, 5).</p>
	NMC (Spacecrafts as relational objects)	<p>The docking systems of each country must be capable of performing all of the following functions under specified environmental conditions and within the specified initial contact conditions (Bushuyev and Lunney 1972, 54). The design of the docking module and the docking system is heavily dependent on the CSM. In fact, following transposition and docking, the entire assembly may be considered to be a single vehicle. DM/DS reliance on the CSM consists of direct dependency for required capability in the areas of electrical power, communications, environmental control following docked operations and stowage (NASA, Manned Spacecraft Center 1971, 187).</p>
Science and technology studies	STSA (Spaceflights as fundamentally technology dependent)	<p>Already aerospace engineers of the USA and USSR have found common ground for understanding and improving complex docking apparatus. Operational methods are developing among another branch of technically oriented personnel towards the goal of developing a space rendezvous and rescue capability (Scott, n.d., 8).</p>
	STSB (Scientists as collaborative spacecrafts advocates)	<p>Both parties will develop their respective hardware and will, in concert, arrive at mutual development of common documents that will define the interfaces necessary to achieve project compatibility (G. Lunney and Bushuyev 1972, 9). In the discussion of the coordinate systems and units, it was very easy to arrive at agreement for common usage. Our paper suggested additional information and refinements past the contents of the Soviet paper. Once these were understood with the aid of blackboard and chalk, the agreement were quickly reached (G. S. Lunney 1971a, 1). The objective of developing the international docking capability is not only for rescue, but to enable one country to share the others facility (Swigert 1971, 127). Yes; we had done enough work on the Apollo command module possibility to arm George with some ideas and to tell him that at least we thought it was a technical possibility of doing (E. Ezell 1975b, 7).</p>

5.2 Application of Symbiotic Realism to the ASTP Docking Module

Symbiotic realism, as presented in Chapter 3, is a theory of international relations developed by neuroscientist Al-Rhodan which seeks to understand global phenomena by focusing on the neurobiological nature of human beings and the interdependence and interconnectivity between actors while adopting an approach that remains essentially post-state-centric. By adapting and applying this approach to the ASTP docking module, symbiotic realism argues that the outer space environment is contributing to a situation of interdependence between human beings and spacecrafts in order to ensure their survival (code SRA) and that the neurobiological nature of humans favours a situation of symbiosis in a situation of microgravity (SRB).

5.2.1 SRA : Interdependence and the Survival of Human Beings in the ASTP Docking Module

If we focus on the first pillar of Symbiotic Realism (Interdependence and the survival of human beings in space), we see that following the coding, the links between the ASTP docking module and this SRA code are multiple. Indeed, the aspect of interdependence between human beings and spacecrafts (whether between humans and spacecrafts from the same country, but especially between humans and spacecrafts from two different countries) is fundamentally anchored in the origins of ASTP. Thus, a good way to understand the importance of SRA code for ASTP is to analyze its presence and importance chronologically. First, one of the primary objectives and considerations for undertaking human spaceflight collaboration between the two countries was to improve security in outer space by developing a space rescue capability. In 1969, during NASA's first approaches to the Soviet Academy of Science, NASA Administrator Thomas O. Paine initiated a discussion with the Academician Blagonravov about working together toward astronaut and cosmonaut safety (E. C. Ezell and Ezell 1978, 7). The first in-person meetings concerning a possible human spaceflight cooperation project took place when NASA sent a delegation of scientists and administrators to Moscow in 1970. Most of the discussions concerned

possible scenarios for a space rescue capacity (E. C. Ezell and Ezell 1978, 14). This emphasis on the importance of the survival and security of humans in outer space as the primary objective of cooperation is significant for this analysis. The investigation of the archives reveals that it is this consideration, rather than financial, political, prestige or other concerns, that motivated this first collaboration in human spaceflights. The safety of the astronauts and cosmonauts took precedence. This fact corroborates strongly with the SRA code which stipulates that there is a situation of interdependence between humans and spacecrafts in outer space to ensure their survival. Without a situation where the safety and survival of astronauts and cosmonauts in outer space can be guaranteed, a collaborative project does not seem to be possible. Thus, from the beginning of 1971, NASA Director George M. Low worked to convince American congressmembers of the need to collaborate with the USSR to set up a compatible docking system which would increase the safety of astronauts in an emergency situation. Events that followed in 1971 reinforced the importance of the space rescue capacity as evidenced by a letter from Glynn S. Lunney (Technical Director, U.S. Compatibility Study) dated from August 3, 1971, and addressed to Academician Bushuyev (G. S. Lunney 1971c, 1). Indeed, on June 29, 1971, the Soyuz 11 spacecraft experienced a pressurization difficulty causing the death of the three cosmonauts on board. To this day, these are the only fatalities that have occurred in outer space since all other fatalities related to spaceflight have occurred under the Kármán line. In his letter, Lunney offers his condolences and emphasizes that “this sad accident has further strengthened our emphasis on the solution of the common docking problems” (G. S. Lunney 1971c, 1). During the multiple meetings between the two parties in 1971, the aspect of space rescue capability was underlying and intrinsic to all the archives analyzed. Furthermore, it was during the year of 1971 and the beginning of 1972 that we really began to see the very precise dynamics of interdependence focused on ensuring the survival using the ASTP docking module. It is during these discussions that the engineers from the two countries agreed on

multiple central elements allowing ASTP to be carried out successfully. They also insisted on the fact that multiple elements must be put in place in a collaborative manner and that these elements must absolutely be compatible to ensure the survival and safety of humans on board the docking module. For example, the degrees of “maximum allowable leaks through interface seals” (Bushuyev and Lunney 1972, 59) were mutually agreed upon in addition to decisions surrounding all the materials that were used to construct the docking module. The composition of the two vessel’s atmospheres as well as the prebreathing period and methods were also developed jointly in order to avoid a situation of dysbarism which could quickly lead to the death of an individual coming into contact with a different atmosphere than that of their vessel or by breathing inappropriate prebreathing air (Berry 1971, 3). It therefore appears obvious that the central aspect surrounding the need to have a space rescue capability corroborates the SRA code, furthermore the exchanges and work between engineers from NASA and the Soviet Academy of Sciences leading up to the Nixon-Kosygin agreement in May 1972 also confirms that cooperation and interdependence between humans and spaceships is essential to ensure survival.

5.2.2 SRB: The Neurobiological Nature of Human Beings Favours Symbiosis in the Microgravity Environment of the ASTP Docking Module

The second pillar of symbiotic realism argues that the neurobiological nature of humans favours a situation of symbiosis between astronauts, cosmonauts, and their spacecrafts in outer space (SRB code). Two aspects constitute this premise. First, the application of Al-Rhodan’s theory to outer space explains that moral behaviours among human beings are much more likely to take place in situations where the basic needs of individuals are met and where there is a certain structural governance. The second aspect argues that immoral situations arise when there is an excess of essential needs motivated by emotions such as envy and ego. However, it turns out that in the situation that prevails in outer space, the perception and expression of emotions in human

beings are neurobiologically impacted by the micro-gravity environment. Thus, given that it is the spacecraft (and in the case that interests us here the ASTP docking module) which provide 100% of the essential vital needs of human beings and that their perception and expression of emotions are affected by the microgravity environment, the SRB code seeks to determine whether these factors contribute to a situation of symbiosis and interdependence between humans and the docking module in outer space favouring cooperation. The analysis of the ASTP archives following the SRB code is more mixed. On the one hand, the interdependence between astronauts, cosmonauts, and the docking module to ensure their survival is clear as demonstrated by the SRA code. On the other hand, it is much less obvious that the precarious environment of the docking module (ensuring all of the essential needs of the humans on board and the governance structure) explains their moral behaviour. Certainly, it is true that the discussions surrounding the creation of the docking module were essentially technical and beyond politics, thus avoiding political biases that could lead to different opinions, different morals and perceptions linked to the collaborative project (E. C. Ezell and Ezell 1978, 40). However, we cannot pretend that this decision to lay the foundations of the project with the sole morals of scientists and engineers was motivated by the precarious environment of the docking module. Furthermore, it is obvious that the SRB code is more interested in the relationship between individuals and spacecraft since it seeks to respond to questions about the influence of a spacecraft on the morale of individuals and the consequences of a micro-gravity environment on the perception and expression of their emotion. However, it turns out that the ASTP archives cover very little - if not at all - the morals and emotions of individuals during the mission. Several reasons can explain this. First, it is important to remember that the primary objective of the mission (and by far the most important) was the docking between the two spacecrafts. For the next collaborative missions such as Shuttle-Mir and ISS, docking only constitute a step to be carried out in order to achieve another higher objective. For ASTP, docking was the heart of the mission. Thus,

unlike several other subsequent missions which will notably study the effects of microgravity on human beings, very little attention was given to astronauts and cosmonauts during ASTP beyond the technical tasks and science that they had to accomplish. Additionally, if we focus on the specific individuals who took part in the orbital mission, all members were seasoned military personnel except for one member of the Soyuz crew and all had extensive experience in the space field. These individuals were certainly the ideal candidates to carry out an essentially technical mission, all having training as pilots and engineers and not as scientists, doctors or members of some other research field which do not have the individual as a central object of study. It is therefore not possible in the case of the ASTP docking module to be able to corroborate the SRB code, namely that the moral behaviours of individuals in outer space are influenced by their spacecraft and that the micro-gravity environment affects the perception and expression of emotions. The explanations given in this paragraph make it possible to understand why such data do not feature in a significant manner in the archival record and this does not justify that the SRB code will not be relevant to the analysis of the two other cases.

5.3 Application of New Materialism to the ASTP Docking Module

As presented in detail in Chapter 3, the second central pillar of New Space Materialism is new materialism. Indeed, a single word distinguishes these two notions. This is significant given that new materialism accords considerable importance to objects in politics. By studying concrete objects such as spacecrafts, new materialism occupies a very important place in the analysis of this thesis attribute that it is the tools of this theoretical framework which enable us to give agency and performativity to our objects of study. By adapting this approach (where objects are considered as being active and performing within their respective socio-political context) to outer space, three criteria can be identified in order to recognize a spacecraft as being a performative actor: spacecraft

as pedetic actors (code NMA), spacecraft as ongoing iterative indeterminate process (NMB) and spacecraft as relational objects (code NMC). The analysis of ASTP archives and its docking module using these three codes is presented below.

5.3.1 NMA: The ASTP Docking Module as a Pedetic Actor

As presented in chapter 3, the idea of pedesis for new materialism is the motion of semiautonomous self-transport. It can be conceptualized and simplified through “autonomy,” where one can consider matter and objects as not being fundamentally dependent on human beings and other factors. This notion therefore considers that objects have a certain intrinsic autonomy through which we cannot predict all the effects, movements or actions. Spacecraft have been repeatedly shown to possess this type of pedetic autonomy from the very first human spaceflight until today. In the relevant case study, the analysis of the archives therefore seeks to determine whether this notion of pedetic actor can also be applied to the ASTP docking module.

Archival analysis clearly confirms the pedetic aspect of the docking module. In fact, it could be noted that the docking module constituted an actor with even more autonomy than the Apollo and Soyuz spacecrafts. Indeed, in the very first Project Technical Proposal (ASTP 10000) presented by the USSR in July 1972, we can identify that the autonomous characteristic of the docking module is the foundation of its conceptualization:

This system [the control, display and Automation System of the docking module] consists of a set of indicators and automation apparatus. All main mechanisms of the assembly are equipped by marginal switches and electromagnetic sensors that receive information about operations of the mechanisms to the instrument panel through the telemetry system to the earth and to an automation apparatus to achieve control of electromotors of the assembly and also to automatically perform a sequence. The automation apparatus provides for electrical connection with the other spacecraft systems, performs logical processing of signals from the control panel or from the earth through a command radio link, processes signals from docking assembly sensors, controls electromotors, transmits electric signals about the operation of mechanisms and apparatus to the instrument panel and to the earth (Bushuyev and Lunney 1972, 138).

This excerpt demonstrates that essential elements to the success of the docking mission depended on its autonomy, which must be able to act and accomplish its tasks without direct external influence. Furthermore, beyond the elements mentioned above such as the automation of the electrical connection between the two spacecrafts or even the access to essential telemetry instruments, in 1973 the document *Apollo Soyuz Docking System Sequence of Docking and Undocking* also explains that the mechanical structural connection between the docking module and the two spacecrafts also had to be done automatically (G. Lunney et al. 1973, 16). Thus, the very connection between the two vessels was the result of the fundamentally autonomous nature of the docking module. Without this specific characteristic, the mission may not have taken place. Of course, these automatic actions on the part of the docking module were originally programmed by humans and the actions linked to the programming of this automation are expected. However, given that we have recognized the relationship of extreme interdependence that exists between spacecrafts and humans to ensure their mutual survival, it may seem surprising that elements as crucial as the physical connection between ships or even information telemetry essential to the survival of astronauts and cosmonauts are left to the automatic actions of a machine. Indeed, we know that poor coupling between spacecrafts and incorrect atmospheric exchange could be catastrophic for the spaceships and the humans onboard. Thus, although the autonomous action of the docking module is not unpredictable and therefore not 100% pedetic, the fact remains that this relationship of extreme interdependence depends on the autonomy of the docking module, giving it agency. In short, this docking module is not a simple piece of equipment that must accomplish a task, it is an actor who must accomplish tasks by itself, autonomously to ensure the survival of all. It goes without saying that the cooperation and coordination between the engineers of the two countries to achieve the creation of such a machine must have been of the highest quality.

5.3.2 NMB: *The ASTP Docking Module as an Ongoing Iterative Indeterminate Process*

The second criterion for an object to be considered as performative is that it must be understood to participating in an iterative, ongoing, and indeterminate process. In other words, this means that a performative object must act in a repetitive way with a certain continuity (therefore not the result of a single action), but also in an unpredictable, changing, and unfixed way. This criterion is complementary and essential to the pedetic requirement because without this aspect of continuity and possible change, the object in question would only have a partial agency with the sole aspect of an endless pedetic process. In chapter 3, it was presented that the Soyuz spacecraft and the America Space Shuttle meet this criterion of ongoing iterative indeterminate process because both spacecrafts have maintained the same appearance, but also upheld processes and dynamics for decades while also constantly evolving. The archive analysis therefore also aimed to determine whether the ASTP docking module similarly responded to this dynamic of ongoing iterative indeterminate process.

It may seem contradictory to analyze the ongoing process of an object like the ASTP docking module given that the latter's use was ephemeral. Indeed, this specific type of docking module which was used for the ASTP mission in 1975 was never subsequently fully reproduced. However, beyond its concrete use, the idea and especially the conceptualization of the docking module had an incredible long-term effect on the future of docking missions in outer space. Indeed, not only do we now know a posteriori that it is essentially the same docking mechanism which was subsequently used for Shuttle-Mir and ISS, but the archives from the ASTP era already show this aspect of continuity that was central to the creation of the docking module. In April 1971, during the rounds of negotiations between the teams of American and Soviet engineers, a memorandum from one of the American engineers in the group responsible for the "mutual Rendezvous and Docking Program" stated that: "There is a desire for a long term capability for spacecraft of the

USA and the USSR to rendezvous and dock with each other and/or space stations of each country” (Cheatham 1971, 14). The priority given to this aspect of long-term continuity in the development of a possible docking mechanism for ASTP is corroborated by Glynn Lunney in a letter addressed to the head of the Academy of Sciences of the USSR Professor K. Bushuyev in which he stated that “we anticipate continuing work on the technical requirements and solutions for long-term capability” (G. S. Lunney 1971b, 59). A September 1971 memorandum from Lunney also confirms that the ASTP docking module was conceptualized so that it would ultimately be only a scaled down version of the docking module that would be used for future Space Shuttle missions (G. S. Lunney 1971b, 49). It was at a press conference in May 1972 during the signing of the Agreement between President Nixon and Prime Minister Kosygin that the NASA administrator finally explained that the new capacity provided by the ASTP docking module allowing two foreign spacecrafts to dock together would be standard in future operations (“Press Conference of The Vice President, Dr James C. Fletcher, Administrator, NASA; Glynn S. Lunney, Assistant to the Manager for Operational Experient and Government Furnished Equipment, NASA; and Dr Edward E. Dvid, Jr., Science Advisor for the President.” 1972, 2). The making of the ASTP docking module a lasting object over time with a certain impact corresponds well to the code of ongoing iterative indeterminate process. Indeed, throughout its heritage, the docking module has retained continuity over time with a subsequent repetition of its characteristics and especially its autonomous capabilities in the Shuttle-Mir and ISS projects. Obviously, the docking modules succeeding the ASTP docking module also had to adapt to their new environments making the continuity of the latter also a changing, unpredictable, and unfixed process.

5.3.3 NMC: The ASTP Docking Module as Relational Object

The last criterion to identify an object as being performative is the relational one. Indeed, it would be difficult to recognize a certain agency in an object without being able to identify its ability

to maintain a relational capacity with the world around it. On multiple occasions, it was noted during the analysis of the archives that the docking module sustained a relationship and an interaction with its crew on board. This was the case not only to ensure the pressurized environment and oxygen for the latter, but it also provided important telemetry information to the crew. This symbiotic relationship between the docking module and the humans onboard is important, but it is not different from the situation that prevails in any other spacecraft. Rather, it is the relational aspect that the docking module had with the other spacecrafts of the ASTP mission (the Apollo and Soyuz spacecrafts) that makes this situation unique, even unprecedented at the time, and which underscores the fundamentally relational aspect of the docking module. Combined with its pedetic and ongoing indeterminate iterative aspects, the important relational aspect of the docking module confirms that the latter can be considered as a performative actor.

Even though the three spacecrafts constituting the ASTP mission all technically constitute independent and autonomous vessels (even the docking module as seen in section 5.3.1.), to carry out the mission successfully, the relationship aspect between the docking module and the two other spacecrafts was essential. Obviously, to be able to dock it is essential that the spacecrafts come into contact with each other (and therefore be in relationship), but this goes further than a simple physical connection. In fact, an important early draft of the *International Rendezvous and Docking Mission Program Plan* prepared by NASA in 1971 (NASA 1971, 187) explains that following transposition and docking, the spacecrafts must be considered as a single vehicle and not a combination of two or three spacecrafts. Thus, once docking is carried out, the relationships between the vessels become intrinsic and multiple (even interdependent) in terms of “electrical power, communications, environmental control following docked operations and stowage”.

5.4 Application of Science and Technology Studies to the ASTP Docking Module

As presented in Chapter 3, science and technology occupy a special place in this thesis given that the links between politics and science and technology are multiple when it comes to understanding cooperation between the United States and Russia in human spaceflight. Furthermore, within our theoretical framework that is New Space Materialism, science and technology play a very important and transversal role. They allow us to understand the impact of spacecrafts on social behavior (Symbiotic Realism) and to establish that spacecrafts are performative actors (new materialism). In addition, science and technology studies play an important role in the analysis of archives by allowing the study of the impact of scientists and technology on decisions leading to interstate cooperation in space. After all, it is scientists and technology that ultimately have the knowledge and capacity necessary to make and conduct collaborative missions in outer space. Thus, sharing many common ties with new materialism, STS seeks to understand how science, scientists and technology can also have a political agency. Furthermore, it is expected that the importance and impact of science and technology is especially central regarding ASTP and its docking module given that the very existence of the docking module was the result of an unprecedented technological feat. To operationalize this approach, the two codes (as conceptualized in chapter 4) that were used to analyze the archives of the ASTP docking module are (STSA) spaceflights as fundamentally technology dependent and (STSB) scientists as collaborative spacecrafts advocates.

5.4.1 STSA: the ASTP Docking Module as Fundamentally Technology Dependant

Analysis of the archives clearly demonstrates that the entire enterprise which led from the conceptualization to the creation of ASTP and its docking module was fundamentally dependent on technology. It corroborates what was presented in chapter 3 by Lawrence et al. (2009, 27) in regards to the dynamic where “all enterprises involving space are heavily dependent on modern

technology” and that the technologies developed for the various space missions are those which are deemed to be feasible “thus creating a technology pull dynamic”. It would have been possible to code hundreds of passages of text corroborating the STSA code but given that in the case of the ASTP docking module, the presence of this code was obvious, a specific and relevant archival passage was noted in the coding table. Indeed, in 1972, NASA astronaut David R. Scott published a paper presenting the ASTP project (purpose, objectives of the mission, technical requirements, expected results, etc.). In his paper, Scott writes clearly that rendezvous and docking capabilities are developed by engineers and technicians and collaboration between these experts from both countries is essential to successfully complete the mission:

Already aerospace engineers of the USA and USSR have found common ground for understanding and improving complex docking apparatus. Operational methods are developing among another branch of technically oriented personnel towards the goal of developing a space rendezvous and rescue capability (Scott, n.d., 8).

On the other hand, this second constituent code of STS studies where scientists are collaborative spacecraft advocates (even if the extract from Scott’s paper corroborates it) is less obvious to demonstrate than is the case for the dependence of the docking module on technology and engineers.

5.4.2 STSB: Scientists of ASTP as collaborative spacecrafts advocates

This last code of Science and Technology Studies argues that scientists and engineers can have a certain capacity to influence politics. As presented in chapter 3, we can think of the engineers in France who brought the electric car project into the political sphere (Callon 2012, 84). Regarding the case of the ASTP docking module, given that we know the central role that scientists and engineers played since 1969 preceding the formal political decisions in 1972 leading to the realization of the mission, it would be safe to assume that the scientists played a role in the decision to come to a political collaboration between the two space powers. However, knowing that

scientists and engineers do not systematically keep logs indicating their political actions, it was unclear that the analysis of archives would make it possible to detect such a dynamic which would have established scientists and engineers as political advocates in favour of a collaborative mission between two foreign spacecrafts. That being said, the analysis of the archives nevertheless proved to be conclusive, and we can emphasize that such a dynamic was indeed present in the case of the ASTP docking module in a more or less indirect way.

Let's be clear, the analysis of the archives did not allow us to identify a specific document where we can read unequivocally that an engineer or scientist tried to directly influence American or Russian policy to lead a human spaceflight cooperation project. However, it was possible to identify several passages demonstrating that scientists and engineers played a fundamental and pioneering role in leading to the idea of having a collaboration mission and to the conceptualization of the docking module. First, the analysis of the archives highlights the excellent collaboration which took place between American and Russian engineers (before the official political agreement of 1972). Beyond a simple question of mood, the archives show that it was easy for the two groups to reach an agreement quickly. This detail, although it may seem trivial, is very important because it contributes to the observation that scientists and engineers are collaborative spacecraft advocates because, even beyond politics, the ease of achieving collaboration and cooperation on such a complex technical-political subject only had the effect of encouraging the process:

In the discussion of the coordinate systems and units, it was very easy to arrive at agreement for common usage. Our paper suggested additional information and refinements past the contents of the Soviet paper. Once these were understood with the aid of blackboard and chalk, the agreement were quickly reached (G. S. Lunney 1971a, 1).

In September 1971, Tony England, a senior NASA scientist-astronaut, corroborated this collaborative aspect between the teams of Russian and American engineers. In his memorandum,

he notes that the objective for the scientific teams in the ASTP negotiations “is not only for rescue [capability], but to enable one country to share the others facility” (G. S. Lunney 1971b, 127). These examples of cooperation and collaboration from scientists only help to make them collaborative spacecraft advocates. Certainly, one of the most significant archival elements in this regard is the transcription of the interview with Phil Culbertson (NASA scientist for the Apollo program) conducted by Ezell in 1975. In the interview, he explains that the essence of the idea leading to the reuse of excess material from the Apollo program (command module, rocket, etc.) to carry out a collaborative mission with the Soviet Union in space was an idea prepared by its team of scientists and engineers. He notes that “we had done enough work on the Apollo command module possibility to arm George [Low (NASA administrator)] with some ideas and to tell him that at least we thought it was a technical possibility of doing” (E. Ezell 1975b, 7).

5.5 Summary of ASTP Archive Analysis

As explained in the previous chapter, although the archival coding technique is regularly used for quantitative methodological purposes, within the framework of this thesis the evaluation of the archival analysis is done in an essentially qualitative and interpretive manner. As presented in section 4.1, qualitative analysis is essential in allowing us to understand the complexity of our objects of study (spacecrafts) and the impact of the latter on politics. Indeed, it is the qualitative analysis which allows us to be able to read between the lines, to amalgamate the different variables of New Space Materialism into a complex theoretical framework and possibly be able to open these black boxes that spacecrafts can constitute. Thus, the analysis of the ASTP archives using the NSM coding table allows us to produce the following summary table:

Table 4 – NSM Analysis of ASTP - Summary Table

Pillars	Codes	Connection with ASTP docking module
Symbiotic realism	SRA (Interdependence and the survival of human beings in outer space)	Convincing connection
	SRB (The neurobiological nature of human beings favours symbiosis in microgravity environment)	No connection
New materialism	NMA (Spacecrafts as pedetic actors)	Convincing connection
	NMB (Spacecrafts as ongoing iterative indeterminate process)	Convincing connection
	NMC (Spacecrafts as relational objects)	Convincing connection
Science and technology studies	STSA (Spaceflights as fundamentally technology dependent)	Convincing connection
	STSB (Scientists as collaborative spacecrafts advocates)	Mixed connection

This table collating the different results of the analysis of the archives allows us to conclude that there is without a doubt a relatively convincing connection between the analysis of the ASTP docking module archives and New Space Materialism. In more detail, there is no doubt that there is a strong connection between the pillar of New Materialism and ASTP. The ASTP docking module can very well be considered as a pedetic actor as well as a relational actor with an ongoing iterative indeterminate process. The documents analyzed within the archives are unequivocal and corroborate the dynamics of New Materialism. Regarding the Science and Technology pillar, it is also evident that the latter is also corroborated by ASTP. The archives speak for themselves, and the coding demonstrated very clearly that the entire enterprise leading to ASTP was technologically dependent. Certainly, the analysis of the archives has been less convincing regarding the impact of engineers and scientists as “collaborative spacecraft advocates” to the extent that no precise

archival document was able to explicitly demonstrate that the engineers and scientists influenced policy. However, the analysis of the archives made it possible to identify several dynamics leading to this archival absence and allowing us to infer that this dynamic was present even if it was not formally written in a document. Finally, the pillar of NSM that has the weakest connection with ASTP is that of Symbiotic Realism. Indeed, although it was obvious in the archive analysis that the mission and the docking module were largely influenced and sculpted according to the criterion of interdependence and the survival of human beings in outer space, the second criterion of the neurobiological nature of human beings that favours symbiosis in microgravity environment found no match. As explained in the section 5.2.2., this situation could be explained by the significant lack of attention in this regard during the mission.

We can nonetheless conclude that there is a strong correspondence between ASTP and New Space Materialism. Indeed, in accordance with the methodology presented in the previous chapter, the evaluation and qualitative assessment of this archive analysis is not done in its particularities, but in its entirety. This respects, among other things, our approach according to which the different variables are all as important as each other and interrelated. The less conclusive results of a specific code therefore do not discredit the work as a whole. We can therefore say that the summary of ASTP coding allows us to conclude that there is a relatively convincing connection between this mission and New Space Materialism.

Although this may seem encouraging in that it corroborates the main hypothesis of this thesis, it is now essential to look at the next two cases that are Shuttle-Mir and the International Space Station because in the same logic where it is important to consider evaluating ASTP as a whole and not in its particularities, it is also essential to analyze this phenomenon of human

spaceflight cooperation between the United States and Russia in its entirety and this includes an equally rigorous analysis of our two other cases of study.

6. Chapter 6 – The Shuttle-Mir Program and the Spektr Module: Understanding the Building of a Collaborative Spacecraft through the Framework of New Space Materialism

The previous chapter allowed us to explore a fundamental aspect of collaborative human spaceflight: the connection between two foreign spacecrafts. An equally important aspect that arose after the first step of connection is the collaboration to jointly build a collaborative spacecraft, module or station. This was notably the case for the ASTP docking module which also constituted a joint construction between the United States and the Soviet Union. However, as mentioned in Chapter 4, it is worth exploring this process of joint construction of a collaborative spacecraft through an analysis of the Spektr module of the Shuttle-Mir program. Having an objective beyond the simple connection between two spacecrafts, the Spektr module concretely constitutes the first long-term collaborative project between the two countries to develop a vessel dedicated to multiple aspects of cooperation within human spaceflight. The Spektr module was therefore dedicated to numerous collaborative tasks, including joint scientific experiments.

To properly understand the context in which the Spektr module operates, a brief review of the Shuttle-Mir program is necessary. The Mir space station, entered service in 1986, was a large orbital station made up of multiple modules all constructed and operated by the USSR. In the aftermath of the end of the Cold War, Russia and the United States formally agreed to conduct a fundamentally new program of human cooperation in outer space. In June 1992, a new agreement was signed between the two countries entitled *Agreement concerning cooperation in the exploration and use of outer space for peaceful purposes* (The United States of America and The Russian Federation 1992). It was only a few months later, in October 1992, that the agreement materialized between the two countries with the implementation of a new cooperation project in human spaceflight involving “the flight of Russian cosmonauts on the U.S. Space Shuttle; the flight

of U.S. astronauts on the Mir Space Station; and a joint mission involving the rendezvous and docking of the U.S. Space Shuttle with the Mir Space Station. These will be jointly referred to in the future as the “Shuttle-Mir Program” (The United States of America and The Russian Federation 1992). In November 1993, collaboration between the two countries increased further when the Shuttle-Mir program effectively became the “Phase 1 of the International Space Station Alpha program” (Stafford 1994, 1). Thus, beyond improving cooperation in human spaceflight, one of the primary goals of Shuttle-Mir was to lay the foundations of what would become the International Space Station (ISS). In fact, one of the stated goals of the Phase 1 Program was to “provide valuable experience and test data that would greatly reduce technical risks associated with the construction and operation of the international space station” (Stafford 1994, 1). That being said, the Shuttle-Mir constitutes a very relevant case, and is of use to evaluate the crucial stage of the collaborative construction of a spacecraft or a space module, particularly through the Spektr module. Furthermore, as was previously the case for the Apollo-Soyuz mission, the Shuttle-Mir program can be considered as the largest collaborative mission ever undertaken at that time between the two countries given that it involved an unprecedented level of cooperation requiring “carefully orchestrated mission sequence and up to ten rendezvous and docking operations” (Stafford 1994, 3). In short, the 4 main objectives of the Phase 2 Program were:

1. “Learn how to work with international partners,
 2. Reduce risks associated with developing and assembling a space station,
 3. Gain operational experience for NASA on long-duration missions,
 4. Conduct life science, microgravity, and environmental research programs”
- (Nield and Mikhailovich Vorobiev 1999, 3).

It is important to remember that the object of study is not the entire Shuttle-Mir program, but a specific module of the station: Spektr. As presented in Chapter 4, the Spektr module is a large 19.6 tons Soviet-designed module that was later revitalized, reconfigured, and funded by the United States in a very collaborative way. The analysis of the archives employing the NSM coding table uses the same technique as for the ASTP docking module and analyzes everything that concerns the Spektr module (its idea, its conceptualization, its design, and its operationalization). This analysis section therefore presents the result of the coding table analysis of the Spektr module. We can see the most relevant extracts from the archives which were retained using the coding technique to carry out the analysis. Subsequently, each pillar of NSM (symbiotic realism, new materialism and science and technology studies) will be studied and the correspondence between the analysis of the archives of Spektr and NSM will be evaluated qualitatively. It is important to mention that the different theoretical pillars of NSM will not be explained again in detail as it was the case in Chapter 5.

6.1 Spektr Module Coding Table Results

Table 5 – Spektr Module Coding Table Results

Pillars	Codes	Extract from archives
Symbiotic realism	SRA (Interdependence and the survival of human beings in outer space)	<p>The unparalleled successful experience in implementing the Shuttle/Mir program (ISS, Phase 1) has taught us how to assure the safety of complex operations in space in spite of intergovernmental boundaries (Nield and Mikhailovich Vorobiev 1999, 141).</p> <p>Some of the unfortunate events we had, such as the fire and the collision, made us become even more aware of how the Mir systems operate, and, of course, we became much more integrated into the Russian system on the ground, in terms of working these problems and other issues. The shuttles became very integral in maintaining the Mir, in terms of resupplying it with new hardware for hardware that had broken, resupplying water. We also tend to refill them with air during the docking phases (Wright and Davison 1998, 8).</p> <p>The high point, I think, was right after the collision, where everybody came together, on our side, on the Russian side, worked together to overcome that very serious problem. From a science perspective, we were practically dead in the water right after the collision. We had no power, we had lost the module where our life sciences hardware was. Some of our samples are still there in that freezer that was stuck in Spektr. We'll probably never get those back. And all of a sudden, we said, "Well, this is Mike's flight. We've got two more after him. If we continue the program, we'd better figure how to work around him. How are we going to get through and finish the program as successfully as we want?" So we all got together on our side and with the Russians (Wright and Davison 1998, 15).</p> <p>It's an application of the experience and the new trust. I mean, the level of trust that the Russians have in us and we in them as a result of these events is dramatically greater than it was before, as it has to be. Only people who have been in an emergency situation together are going to have the same common sense of mutual dependence and so on as we do now with them. I think it is a tremendously valuable thing for Space Station (Wright, Davison, and Rollins 1998b, 22).</p>

	<p>SRB (The neurobiological nature of human beings favours symbiosis in microgravity environment)</p>	<p>The process is that there were procedures on board that authorized the crew to leave if the leak rate exceeded a certain level. The way to view this is, if you were sound asleep and a piece of orbital debris punctured a module and you didn't have any idea what module it was, you need to go figure out how much time you have to look for it. So the first step is to go find out how much time you have. In parallel, the flight engineer goes and starts getting the Soyuz ready. Then I won't try to trace all the steps, but fundamentally if you have sufficient time, you start looking for the leak. If you don't have sufficient time, you're authorized to get in the Soyuz and leave (Wright, Davison, and Rollins 1998b, 31).</p> <p>The next major activity, of course, was the collision, and a lot of things happened as a result of the collision. One of the most important is that we undertook another review of what we were doing. Were we putting our crew members at risk? Were we doing something fundamentally foolish? I think Frank [Culbertson] and I arrived at the conclusion more or less simultaneously that whatever else might be true about the history of the Russian program and so on, they had had a couple of significant events in a fairly short period of time, and we simply couldn't ignore that. We could not continue unless we had a lot more insight into what was going on and direct participation in key decisions, key operational decisions that could affect the safety of our crew. We informed the Russians that that basically was where we were, that we were not going to be able to continue without that kind of understanding. I think in a fairly remarkable turn of events, the Russians said, "We understand, and that will be fine." (Wright, Davison, and Rollins 1998b, 21).</p>
New materialism	<p>NMA (Spacecrafts as pedetic actors)</p>	<p>The module was equipped with orbit correction and rendezvous engines and attitude control and docking thrusters. A Kurs guidance system provided automatic rendezvous and docking guidance (S. McDonald 1998, 14).</p>
	<p>NMB (Spacecrafts as ongoing iterative indeterminate process)</p>	<p>The Spektr incident and late crew changes proved that the developed training processes were flexible, yet structured enough to hold up under changing programmatic conditions (Niell and Mikhailovich Vorobiev 1999, 118).</p> <p>Spektr Repair Hardware - Another example of rapid response to on-orbit problems is exemplified by the Spektr leak repair equipment delivered to Mir by STS-86. Joint efforts included late training of the Shuttle EVA crew to transfer a large sealing cap from the cabin interior to the DM exterior for later use by Mir cosmonauts. Information exchanged on the devices and materials involved in</p>

		<p>finding and fixing module pressure shell leaks was mutually beneficial for ISS (Niield and Mikhailovich Vorobiev 1999, 183). Most of their stuff was in the Spektr when they shut it down, plus Mike's personal stuff. But they came up with a plan that got the most out of what they had remaining. They scrambled and put together some spare parts and some backup experiment and put it on the next Progress that went up, so they were able to regain some of the experiments. Then, of course, they had to replan the next couple of increments because of the loss of Spektr, and they had to come up with a new plan for them, too, and put either replacement experiments on the shuttle or plan a whole new program (Wright, Davison, and Rollins 1998a, 12). Another benefit of the Phase One Program is that that is the very technique we're going to do on Space Station with the first node that we take up. It's almost a repeat of the flight, but it's a little different configuration, but the principles are the same. We now know how to do it (Wright, Davison, and Butler 1998, 12). Unfortunately, the module slipped. The launch of it slipped, and it didn't get there till well into Norm's flight, so we had to regroup again and put some of the hardware back on Progress to get them there in time for Norm. So that was, I think, also a very good learning experience for station, that you always have to plan for unexpected things. They have a very well thought out program, but one little thing happens, and it upsets the apple cart, and you have to go back and replan (Wright and Davison 1998, 5). Most of the individuals, if you look on the Russian side, have been in the space program since they joined it in the sixties, and they're an older crowd. It's a matter of pride that they've been there. Even the infrastructure within the Mir Program was set up back in Apollo-Soyuz. The individuals that we interfaced with were dedicated back in Apollo-Soyuz that this was going to be a long-term relationship (Wright, Farrell, and Butler 1998, 3).</p>
	<p>NMC (Spacecrafts as relational objects)</p>	<p>The pair on the pressurized compartment supplies power for the module's own systems; the V-shaped pair on the unpressurized compartment was added to supplement power to the station complex (S. McDonald 1998, 14). That was seven days a week, multiple hours a day, trying to figure out how to recover from that particular incident and get our program back on track, because from a human life science perspective, which is what most of the hardware was</p>

		<p>that was in the Spektr module, we had almost totally obliterated that program with that accident, and we needed to come up with some way that we could get hardware back up there and recover. Fortunately, we got some of it back. We didn't ever get all of it back, but we got a fair amount of it back, but we lost things like our ergometer, our freezers, our centrifuges, that kind of stuff, which are big pieces of hardware that have to be structurally mounted (Wright, Davison, and Bergen 1998, 19).</p>
<p>Science and technology studies</p>	<p>STSA (Spaceflights as fundamentally technology dependent)</p>	<p>The requirements definition, design to fabrication, and final testing processes that were developed for Phase 1 were examples of these accomplishments. All these achievements were a result of the intense technical and programmatic negotiations among multiple interagency and international partners that were driven by tight development and launch schedules (Nield and Mikhailovich Vorobiev 1999, 125).</p>
	<p>STSB (Scientists as collaborative spacecrafts advocates)</p>	<p>That's right. I mean, much of the work that we were doing was either scientific or technical in nature, and once you understood what the goals of the activity were, it was very easy to communicate. Once you understood and outlined the details that needed to be provided, it was very easy because people were driving towards the same set of information to be exchanged (Wright, Rollins, and Butler 1998, 18). We all talked about it and thought, well, you know, why is that? And I guess our best explanation is, if you take a technical problem and you lay it on the table with a bunch of engineers, I don't care what part of the world they come from, sooner or later you're going to get to pretty much the right answer, and the right answer always kind of looks the same, no matter where you're coming at it. I would like to believe that that's what happened. That's the way we got to where we are (Wright, Davison, and Butler 1998, 19).</p> <p>On the technical side, fortunately, we all had technical common basis. Engineering is engineering. Math is math. Physics is physics. So, regardless of our personal difficulties, you couldn't dispute the math, the numbers (Wright, Farrell, and Butler 1998, 2).</p>

6.2 Application of Symbiotic Realism to the Spektr Module

6.2.1 *SRA: Interdependence and the Survival of Human Beings in the Spektr Module*

The first pillar of Symbiotic Realism defends that the outer space environment is contributing to a situation of interdependence between human beings and spacecrafts to ensure their survival. So far, this thesis demonstrated on multiple occasions that a situation of interdependence between human beings on board a spacecraft and the latter is strongly present. The case of the Spektr module of the Shuttle-Mir program corroborates this dynamic, but the analysis of the archives also demonstrates that such a situation of mutuality is as present between individuals and their spacecraft as it is with their foreign partner counterparts. Indeed, the case of the Spektr module clearly demonstrates that the Americans using the Spektr module were dependent on the Mir station to ensure their survival and conversely, that this was also the case for the Russians who needed the Spektr module and the American Space Shuttle to ensure the survival of their mission. This dynamic is exemplified by the collision which took place in June 1997 between a Progress spacecraft and the Spektr module. Following the incident, the American astronauts followed the established procedure which was to close the Spektr airlock and take refuge in the Russian part of the station. This collision was far from trivial. Dr John Uri, Shuttle-Mir mission scientist during the collision, mentioned that the situation was critical and that “from a science perspective, we were practically dead in the water right after the collision” (Wright and Davison 1998, 15). Dr Uri also mentioned in the Oral History Project interview that the moments directly after the collision constituted the high point of the program “where everybody came together, on our side, on the Russian side, worked together to overcome that very serious problem” (Wright and Davison 1998, 15). Indeed, it turns out that the high level of mutual interdependence between the different actors (human beings from the two different countries and their respective spacecrafts) contributed not only to ensuring the survival of the crew and the station, but it also had

the consequence of further strengthening the links of interdependence between the actors. Dr Uri explains that

The unfortunate events we had, such as the fire and the collision, made us become even more aware of how the Mir systems operate, and, of course, we became much more integrated into the Russian system on the ground, in terms of working these problems and other issues. The shuttles became very integral in maintaining the Mir, in terms of resupplying it with new hardware for hardware that had broken, resupplying water. We also tend to refill them with air during the docking phases (Wright and Davison 1998, 8).

Thus, the case of Spektr is a clear demonstration of the mutual interdependence that exists between the spacecrafts of the two countries and their respective occupants. The situation also testifies to the fact that the interdependence is reinforced in situations of emergency, which put the lives of the occupants and the integrity of spacecrafts in imminent danger. James Van Laak, Deputy Program Manager for NASA's Phase 1 Shuttle-Mir Program, illustrates this dynamic eloquently by explaining that:

I mean, the level of trust that the Russians have in us and we in them as a result of these events is dramatically greater than it was before, as it has to be. Only people who have been in an emergency situation together are going to have the same common sense of mutual dependence and so on as we do now with them (Wright, Davison, and Rollins 1998b, 22).

Such an observation is also corroborated by NASA's Phase 1 Program Joint Report which clearly explains that "the unparalleled successful experience in implementing the Shuttle/Mir program (ISS, Phase 1) has taught us how to ensure the safety of complex operations in space in spite of intergovernmental boundaries" (Nield and Mikhailovich Vorobiev 1999, 141).

6.2.2 SRB: The Neurobiological Nature of Human Beings Favours Symbiosis in the Microgravity Environment of the Spektr Module

As presented in detail in Chapter 3, the second pillar of Symbiotic Realism defends that the neurobiological nature of humans favours a situation of symbiosis between astronauts, cosmonauts, and their spacecrafts in outer space (SRB code). Two aspects constitute this premise. First, it defends that moral behaviours among human beings are much more likely to take place in situations where the basic needs of individuals are met and where there is a certain structural governance. The second aspect argues that immoral situations arise when there is an excess of essential needs motivated by emotions such as envy and ego. However, it turns out that in outer space the perception and expression of emotions in human beings are neurobiologically impacted by the micro-gravity environment. As was the case with ASTP, Symbiotic Realism SRB code was difficult to identify through the Spektr archives. Indeed, concerning the second portion of SRB, namely that environmental conditions in outer space alter the perception of emotions in individuals aboard spacecrafts, no archival document has noted this dynamic. However, concerning the first portion of SRB (that moral behaviors in outer space occur in a context of a certain structure and governance) this dynamic was noted during the archival analysis.

Indeed, the case of the Spektr module collision constitutes a convincing example where the moral behaviours of individuals on board the spacecraft and the station were decidedly influenced and guided by structure, governance, and protocols. This citation from a James VanLaak interview (Deputy Program Manager for NASA's Phase 1 Shuttle-Mir Program) about the collision corroborates this dynamic, where the basic needs of individuals were put in serious danger during the collision, the protocols and structure in place allowed the astronauts and cosmonauts to act in symbiosis to resolve the problem of depressurization endangering their existence:

The process is that there were procedures on board that authorized the crew to leave if the leak rate exceeded a certain level. The way to view this is, if you were sound asleep and a piece of orbital debris punctured a module and you didn't have any idea what module it was, you need to go figure out how much time you have to look for it. So the first step is to go find out how much time you have. In parallel, the flight engineer goes and starts getting the Soyuz ready. Then I won't try to trace all the steps, but fundamentally if you have sufficient time, you start looking for the leak. If you don't have sufficient time, you're authorized to get in the Soyuz and leave (Wright, Davison, and Rollins 1998b, 31).

Following the Spektr collision, VanLaak identified that this event encouraged the two countries to cooperate even more by sharing “key decisions, key operational decisions that could affect the safety of our crew. We informed the Russians that that basically was where we were, that we were not going to be able to continue without that kind of understanding. I think in a fairly remarkable turn of events, the Russians said, "We understand, and that will be fine" (Wright, Davison, and Rollins 1998b, 21). The fact that VanLaak identified that the Shuttle-Mir program could not continue without this mutual agreement on greater cooperation within operational and structural decisions testifies to the importance and impact of the structure and governance within cooperation in human spaceflight.

6.3 Application of New Materialism to the Spektr Module

6.3.1 NMA: *The Spektr Module as a Pedetic Actor*

The first NMA code of New Materialism is the one which considers objects as being pedetic actors (having a certain autonomy). This autonomy essentially means that objects such as spacecrafts are not fundamentally dependent on human beings. Their autonomy also means that we cannot predict all the effects, movements, or actions of the object. As demonstrated in the previous chapter, the pedetic aspect of the ASTP docking module was very clearly noted by the archives. Regarding the Spektr module, although the evidence for the pedetic character of this module was less abundant in the archives, it was possible to note some aspects of the latter in the archives which corroborate NMA very well.

As explained above, although Spektr constitutes concretely a module of the Mir station, it is also a spacecraft on its own since it has all the necessary propulsion and navigation tools, and it can operate autonomously. Most modules do not have this capacity and must therefore be integrated into a station manually, whether with the help of astronauts during an extra-vehicular activity or with the help of a machine such as the Canadian robotic arm used aboard the American space shuttle. Furthermore, in addition to having a certain ability to act on its own with its navigation capabilities, Spektr also has a guidance system providing automatic rendezvous and docking (S. McDonald 1998, 14). These automated aspects are not negligible in the analysis of new materialism – as was the case for the ASTP docking module – because they are a key aspect allowing an object to acquire a pedetic character thanks to a certain autonomy. However, although it is obvious that Spektr has autonomy through its automatic systems, it is important to emphasize that this aspect does not only constitute an automatic repetition chain which is 100% predictable. Spektr is a perfect example demonstrating that despite expected automatic behavior, an object can act in a different and unpredictable way and (as presented in Chapter 3) this aspect where it is not possible to predict all the effects, movements and actions of an autonomous object unpredictability is at the heart of what constitutes the pedetic aspect of an actor. The example in question is that of the Spektr docking with the Mir station. Indeed, analysis of the archives shows that during a test of Spektr's autonomous docking system with a Soyuz spacecraft, it turned out that the system did not act as expected and the cosmonauts on board the Soyuz had to carry out the docking manually. Following testing, verification and adjustments, the final docking of Spektr with the whole Mir station using the automatic docking system was attempted and completed. NASA's *Mir Mission Chronicle* report explains that “despite anxieties about the automatic docking, the Spektr module successfully docked to the -X port under control of the Kurs system on June 1 [1995]” (S. McDonald 1998, 16). This situation where human personnel feel anxiety, worry and uncertainty

about the behaviour of their spacecraft is another testament to the pedetic aspect of the Spektr module and its agency.

6.3.2 *NMB: The Spektr Module as an Ongoing Iterative Indeterminate Process*

As demonstrated in Chapter 3, beyond the pedetic aspect of an object, to be considered as performative the object must also be considered as an ongoing iterative indeterminate process. This means, among other things, that the object must act in a relatively repeated manner which is not the result of a single action. Furthermore, the outcome of these actions should not be 100% predictable and fixed. It is this dynamic that makes it possible to detach the agency of the object from humans or any other external factors since the continuity of the action and the agency of the object essentially depend on the object itself. The case of the ASTP docking module presented in the previous chapter corresponded well to the NMB code since the latter proved to have continuity over time while having unpredictable actions and results. It turns out that the situation is similar when it comes to Mir's Spektr module. Indeed, although it may seem ironic to study the ongoing aspect of a module used barely two years before a collision which made it nonoperational, the analysis of the archives demonstrates that Spektr had an ongoing indeterminate dynamic with results and impacts that are still being felt today.

First, the Spektr module constitutes a useful demonstration of the “ongoing” aspect with actions that have been repeated over time, but it is also a good example of the indeterminate aspect. Indeed, the Spektr module showed several reversals that were not planned for in the program, starting with its launch. The launch of the module was delayed, and this had subsequent unexpected consequences on the Shuttle-Mir program itself. Dr John Uri mentioned that all these unexpected and indeterminate actions from Spektr were “I think, also a very good learning experience for station [ISS], that you always have to plan for unexpected things. They have a very well thought

out program, but one little thing happens, and it upsets the apple cart, and you have to go back and replan” (Wright and Davison 1998, 5). Thus, not only do we see that Spektr had an impact on the ISS, but we also can recognize that its indeterminate dynamics played an important role during its existence. The Phase One Joint Report also corroborates this indeterminate and changing dynamic by mentioning that “the Spektr incident and late crew changes proved that the developed training processes were flexible, yet structured enough to hold up under changing programmatic conditions” (Nield and Mikhailovich Vorobiev 1999, 118). Probably the most compelling aspect of Spektr that supports the NMB code is its aspect of continuity and long-term impact. Indeed, just as the ASTP docking module did, the Spektr module will have served as a founding basis for the ISS. Bill Reeves from the flight director’s office during the Shuttle-Mir program noted that the Spektr module essentially constituted a dry-run in preparation for the construction of the ISS. As mentioned earlier, the Zarya module constituting one of the first two ISS modules is a copy of the Spektr module. The techniques and knowledge gain from Spektr continue to have an iterative impact on ISS: “[it] is the very technique we're going to do on Space Station with the first node that we take up. It's almost a repeat of the flight” (Wright, Davison, and Butler 1998, 12).

6.3.3 NMC: The Spektr Module as Relational Object

The last criterion used to identify an object as being performative is the relational one. Indeed, it would be difficult to recognize a certain agency in an object without being able to identify its ability to maintain a relational capacity with the world around it. As it is the case for all spacecrafts and in particular, for the ASTP docking module, the Spektr module is also in a close symbiotic relationship with the human occupants on board, assuring their mutual survival. However, it turns out that just like the ASTP docking module, the relationship between Spektr and the other spacecrafts and modules on Mir station was of very high importance. The analysis of the archives allows us to precisely note the importance of the relationship between Spektr and the other

spacecrafts given that in the case of Spektr, we are facing a situation of a complete loss of relationship. Indeed, following the collision involving Spektr, the module became inoperable, breaking its relationship not only with the humans on board but also with the station's other spacecrafts. This loss of relationship, which has never happened in the case of the ASTP docking module, clearly illustrates the importance of the presence of this relationship. Combined with its pedetic and ongoing indeterminate iterative aspects, the important relational aspect of Spektr confirms that the latter can be considered as a performative actor.

Thus, first, the analysis of the archives clearly demonstrates that the connection between Spektr and the rest of the station includes an important relational component because Spektr had several roles including providing electrical power to the Mir station. Spektr had 2 pairs of solar panels, one of which served as a power supply for the rest of the station (S. McDonald 1998, 14). Then, following the loss of Spektr, Rick Nygren, assistant director for Russian programs, explained that the loss of the relationship between Spektr and the astronauts who lived and worked aboard it had a considerable impact on the mission and the Shuttle-Mir program. He explained that

That was seven days a week, multiple hours a day, trying to figure out how to recover from that particular incident and get our program back on track, because from a human life science perspective, which is what most of the hardware was that was in the Spektr module, we had almost totally obliterated that program with that accident, and we needed to come up with some way that we could get hardware back up there and recover. (Wright, Davison, and Bergen 1998, 19).

Nygren explains that although they managed to recover some essential equipment aboard Spektr, the majority was lost, significantly affecting the rest of the program. This loss of relationship with Spektr and the significant consequences that followed speaks to the importance of the relationship that existed between Spektr, the humans aboard Mir, and the other spacecrafts.

6.4 Application of Science and Technology Studies to the Spektr Module

6.4.1 *STSA: the Spektr Module as Fundamentally Technology Dependant*

It may seem obvious, at this point, that we can consider all human spaceflight endeavor as being dependent on technology. This observation is conclusive, as evidenced by the great dependence on technology that has been identified in Chapter 3 but also within the archives regarding the ASTP docking module. However, beyond the fact that outer space projects are technology dependent, what the STSA code seeks to determine is if there is a certain preponderance of the technological variable in the decision-making to carry out a project. This preponderance of technology as a decision-making factor to complete the ASTP docking module was very obvious, but concerning the Spektr module, the importance of the technological variable was less obvious to identify. This can be explained by the fact that the Spektr module was not the main and central object of the Shuttle-Mir program as the docking module was for the ASTP program. However, although there were fewer archival records on this subject, very relevant extracts were noted which allow us to convincingly corroborate that the Spektr module project was indeed fundamentally technology dependent. This dynamic is corroborated by the Phase One Joint Report which highlights that with Spektr, “all these achievements were a result of the intense technical and programmatic negotiations among multiple interagency and international partners that were driven by tight development and launch schedules” (Nield and Mikhailovich Vorobiev 1999, 125). This important observation made by the report reflects a dynamic well observed in the Shuttle-Mir archives where it is clear that it is the technology and especially the technical collaboration surrounding it that made a collaborative program like Spektr possible. Speaking of scientific collaboration, this time in the case of the Spektr module, an opposite dynamic was observed in connection with the STSB code where the latter was abundantly identified within the archives compared to the ASTP docking module.

6.4.2 *STSB: Scientists of the Spektr module as collaborative spacecraft advocates*

This last code of science and technology studies argues that scientists and engineers can have a certain capacity to influence politics. This influence can be both direct and indirect. In the case of the ASTP docking module, a more indirect influence was noted. In the case of the Spektr module of the Mir station, similarly, no archival documents have been identified indicating a clear and direct influence of engineers on space policy. On the other hand, within the interviews of the Shuttle-Mir Oral History Project, it was possible to identify on multiple occasions that American and Russian engineers acted as collaborative spacecraft advocates. A clear dynamic can be identified where when engineers and scientists from different political and cultural backgrounds meet, there is a strong tendency for them to put aside their political divergences in favor of a common collaborative solution. And this is exactly the dynamic that is identified as part of the conceptualization of the Spektr module. Bill Reeves explains this dynamic well in his response during the Oral History Project interview by mentioning that although the political and cultural differences between the two countries were very present, at the end of the day his team of scientists and their Russian counterpart were working towards greater cooperation:

We all talked about it and thought, well, you know, why is that? And I guess our best explanation is, if you take a technical problem and you lay it on the table with a bunch of engineers, I don't care what part of the world they come from, sooner or later you're going to get to pretty much the right answer, and the right answer always kind of looks the same, no matter where you're coming at it (Wright, Davison, and Butler 1998, 19).

Charles Stegemoeller, NASA's project manager for the Mir Spektr module agrees, mentioning that science and the technical work of scientists from both countries were likely pushing towards greater collaboration:

On the technical side, fortunately, we all had technical common basis. Engineering is engineering. Math is math. Physics is physics. So, regardless of our personal difficulties, you couldn't dispute the math, the numbers (Wright, Farrell, and Butler 1998, 2).

Gary Kitmacher, NASA's project manager for the Priroda module, notes that on both the Priroda and Spektr modules, significant cultural differences between scientists of both countries were easy to resolve given shared technical language:

I mean, much of the work that we were doing was either scientific or technical in nature, and once you understood what the goals of the activity were, it was very easy to communicate. Once you understood and outlined the details that needed to be provided, it was very easy because people were driving towards the same set of information to be exchanged (Wright, Rollins, and Butler 1998, 18).

The dynamic detected in the interviews, which outlines the presence of political and cultural differences but notes that these were relatively easy to put aside thanks to technical and scientific collaboration, corroborates very well the STSB code where we note that scientists and technicians from both countries have contributed, through their role and their work (and to a certain extent by their technical identity) to foster collaboration between the two countries within the Spektr module program.

6.5 Summary of the Spektr Module Archive Analysis

Just as it was done for the analysis of the ASTP docking module, we now must summarize the qualitative analysis of the Spektr module archives:

Table 6 – NSM Analysis of Spektr - Summary Table

Pillars	Codes	Connection with Spektr module
Symbiotic realism	SRA (Interdependence and the survival of human beings in outer space)	Convincing connection
	SRB (The neurobiological nature of human beings favours symbiosis in microgravity environment)	Mixed connection
New materialism	NMA (Spacecrafts as pedetic actors)	Convincing connection
	NMB (Spacecrafts as ongoing iterative indeterminate process)	Convincing connection
	NMC (Spacecrafts as relational objects)	Convincing connection
Science and technology studies	STSA (Spaceflights as fundamentally technology dependent)	Convincing connection
	STSB (Scientists as collaborative spacecrafts advocates)	Convincing connection

This table collating the different results of the analysis of the archives allows us to conclude that there is without a doubt a convincing connection between the analysis of the Spektr module archives and New Space Materialism. In more detail, as it was the case for the ASTP docking module, there is no doubt that there is a strong connection between the pillar of New Materialism and the Spektr module. Spektr can very well be considered a pedetic actor as well as a relational actor with an ongoing iterative indeterminate process. The documents analyzed within the archives are unequivocal and corroborate the dynamics of New Materialism. Regarding the Science and Technology pillar, it is also evident that the latter is also supported by Spektr. Even if the archives were less abundant on this subject, relevant extracts were noted which allow us to convincingly corroborate that the Spektr module project was indeed fundamentally technology dependent. However, unlike ASTP, it was much easier to identify that Spektr scientists and engineers acted as

collaborative spacecraft advocates. As it was the case for ASTP, no technical document explicitly stated that engineers and scientists influenced collaborative politics, but the archives made it possible to identify several relevant dynamics that indicated that they acted as such collaborative agents. Where Spektr's analysis differs most from that of ASTP is in connection with the pillar of Symbiotic Realism. Indeed, the analysis of the archives and coding of Spektr made it possible to demonstrate a stronger connection with Symbiotic Realism. Just as it was the case for ASTP, the link between Spektr and the SRA code (interdependence and the survival of human beings in outer space) was strong and easy to identify. However, contrary to the SRB code (the neurobiological nature of human beings favours symbiosis in a microgravity environment) which had not been identified in the ASTP analysis, we can say that there is a mixed connection of this code when it comes to Spektr. Indeed, no archival documents have noted the dynamic that the environmental conditions in outer space would alter the perception of emotions in individuals aboard spacecrafts. However, concerning the dynamic that moral behaviours in outer space would occur in a context of a certain structure and governance, this dynamic has been coded and identified by the analysis of the Spektr archives. As was the case in the ASTP analysis, it is possible that the absence of the dynamic where the environmental conditions in outer space would alter the perception of emotions in individuals aboard spacecrafts can be explained by the fact that Spektr's mission program did not focus on this aspect and was therefore simply not addressed. It will be interesting to see if this dynamic is repeated in the context of the analysis of the ISS.

Thus, we can conclude that there is a strong correspondence between Spektr and New Space Materialism — a stronger correspondence than with ASTP. Indeed, by maintaining our qualitative methodological approach which analyzes the different variables as a whole and not in their particularity, it is possible to draw up a more convincing portrait of the connection between NSM

and Spektr. It remains significant that the SRB code is not corroborated convincingly by the archival analyses of ASTP and Spektr. After all, Symbiotic Realism is one of the founding pillars of New Space Materialism and the fact that one of its codes is not yet convincingly corroborated could lead us to put into question the importance of Symbiotic Realism to answer this thesis' research question. In the same way that the analysis of the coding of the different cases must be done as a whole, the same must be completed for the overall analysis of our three objects of study which are ASTP, Spektr and ISS. Indeed, perhaps it will be possible to identify SRB unequivocally within the analysis of ISS archives.

7. Chapter 7 - The International Space Station: Understanding the Operation of a Collaborative Spacecraft Through the Framework of New Space Materialism

Chapter 5 explored the importance of the connection between two foreign spacecrafts orbiting in outer space, and the Apollo-Soyuz mission and its docking module were analyzed for this purpose. Chapter 6 then explored the second crucial step of collaboratively building a spacecraft. This time, it was the Spektr module of the Mir-Shuttle program which was the object of study. Finally, the last step in carrying out a collaborative mission in outer space is that of operating a collaborative spacecraft, in particular through its various emergency procedures and protocols. For this last stage of the analysis, the case of the International Space Station (ISS) is retained. It is important to remember that for this step of the analysis, it is not possible to study only one or more specific physical objects such as spacecraft or a space module. Indeed, in order to understand how to operate a collaborative spacecraft, it is essential to go beyond precise physical objects and also to look at humans and a range of behaviors and actions resulting from both machines and humans. Thus, as explained in Chapter 4, this case study differs somewhat from the two previous cases because the concrete object of study does not constitute a single tangible physical object like a connector or a spatial module, but rather procedures, various machines and spacecraft emergency protocols. Although this may at first glance seem contradictory with the materialist approach of this thesis, studying the emergency measures and protocols of the ISS is not only essential to have a complete portrait of collaborative dynamics in human spaceflight, but this approach is also identical from a methodological point of view to studying a concrete object. Indeed, as was the case for the ASTP docking module or the Spektr module, the method essentially studies documents, making use of concrete papers. No observations or direct interviews were required for this research, but rather focused on the reading and coding of papers. This is exactly

what was done for the first two cases, the dynamics are therefore the same with the ISS. Indeed, even if these emergency protocols are technically just papers, they contribute to constituting and creating the social and political reality within the ISS. They are integral parts of the spacecraft and can have an impact on the reality of cooperation in outer space. These emergency protocols (integral to the missions on board these vessels) are just as responsible for the social reality of this collaboration between spacecraft. Such an approach is also inspired by Barkawi and Ansorge who argue that bureaucratic procedures and objects (which they define as "useful forms") can indeed have a certain influence on political and social reality. Indeed, they argue that in the context of war, useful forms such as field manuals, smartcards, PowerPoint presentations and software can have an important effect on politics: "‘utile’ forms are more than simply vital links between institutional power and everyday practices - they are also significant political phenomena of their own, characterised by distinct properties and effects" (Ansorge and Barkawi 2014, 10). Thus, such an approach would be more than interesting to apply not to a war situation but to the situation of cooperation that persists within human spaceflight.

Furthermore, it is important to emphasize that the New Space Materialism approach that guides this thesis is of course largely influenced by the new materialism approach and the latter, although it grants a central importance to objects and matter, also considers that the discursive aspect of a social phenomenon must be taken into account. As Lundborg and Vaughan-Williams (2015, 23) explain, one must be careful not to fall into the trap of drawing a too categorical distinction between language and materiality. On the contrary, they emphasize that it is more promising to embrace an approach that, without negating material factors, recognizes the co-constitutive aspect of language and matter. This is exactly the contribution of the analysis ISS to this thesis. The analysis of emergency procedures that have an eminently more discursive character

allows us to take into account the importance of language within our analysis and New Space Materialism.

Before presenting the results of the coding of the ISS emergency protocols archives, context is in order. Much better known than the Spektr module or the ASTP docking module, construction of the ISS began in 1998 as a direct result of the Shuttle-Mir program. The goal here is not to present an exhaustive history of the ISS (see Chapters 1 and 4 for more details about the ISS), but it is important to remember that, as explained in Chapter 4, although the ISS program has involved many countries including the United States, Russia, Japan, Canada and the European Union, the origins and nature of the operation of the ISS is essentially and fundamentally an American-Russian cooperation. Indeed, the ISS is divided into two sections “American” and “Russian”, and it is the collaboration between these two sections that allows the station to exist. The ISS also has a unique feature as it is the first international space station intended to be permanently occupied on a long-term basis. The Station has been permanently occupied since November 2, 2000, with the arrival of Expedition 1. As of this writing on June 2024, the ISS has reached Expedition 71 and is planned to remain in operation until 2030.

Focusing more concretely on our objects of study which are the emergency protocols of the ISS, the analysis of the archives clearly underlines that these protocols were built and developed on the lessons learned from previous programs such as ASTP, Skylab, but especially Shuttle-Mir. This was noted by NASA's Aerospace Safety Advisory Panel in 1997, stating that: “The collision with the Progress module, the several oxygen generator problems, and the multiple computer failures have all served as strong indicators that, for safe operations, it is imperative to plan ahead and provide and train on well-thought-out emergency procedures” (Johnstone 1998, 33). In addition, another particularity that distinguishes the ISS from other previous stations is that the ISS

“is almost completely controlled by computers” (Dempsey 2017, 107). We will see in the analysis of the coding of archives that this has a certain impact on emergency protocols and on the fact that we can consider the ISS as being the most autonomous spacecraft there is. In short, it is difficult to identify an actor more performative than the ISS. Finally, to give an idea of the extent of the importance of emergency measures and protocols for the ISS, the case of the danger linked to space debris is revealing. Indeed, the whole ISS is about the size of an American football field and has the living capacity of a six-bedroom house. It constitutes the largest object ever built in outer space. Due to its size, the station is therefore much more vulnerable to the impact by space debris. These impacts can have disastrous consequences as evidenced by this extract from NASA's operational guide on the ISS *The International Space Station: Operating an Outpost in the New Frontier*:

A hole that measures 0.6 cm (0.25 in.) in diameter will cause the ISS to depressurize to the minimal atmospheric level for supporting human life (490 mm Hg, 9.5 psi) in about 14 hours, whereas a 20 cm (8 in.) hole will reach that level in about 50 seconds (Dempsey 2017, 348).

Finally, it is also important to remember, as explained in Chapter 4, that it has not been possible to have access to the official emergency measures and protocols of the ISS despite requests for access to information. That being said, it was possible to access three series of highly relevant documents to study the emergency protocols of the ISS. As explained in detail in Chapter 4, the first series concerns studies by NASA before Expedition 1 about the safety and emergency measures to follow. The second series deals with operational documents related to the station and the third series contains interviews with astronauts who have stayed on the ISS, in which they address the subject of emergency measures and protocols. Thus, although we have not been able to analyze the official emergency measures, the content of these archives allows us to draw up a faithful portrait. The next section therefore presents the result of the coding table analysis of the ISS emergency protocols. We can see the most relevant extracts from the archives which were

retained using the coding technique to carry out the analysis. Subsequently, each pillar of NSM (symbiotic realism, new materialism and science and technology studies) will be studied and the correspondence between the analysis of the archives of the ISS emergency protocols and NSM will be evaluated qualitatively. As it was the case for the Spektr module, it is important to mention that the different theoretical pillars of NSM will not be explained again in detail, as they've already been elaborated on in previous chapters.

7.1 ISS Emergency Protocols Coding Table Results

Table 7 - ISS Emergency Protocols Coding Table Results

Pillars	Codes	Extract from archives
Symbiotic realism	<p>SRA (Interdependence and the survival of human beings in outer space)</p>	<p>Besides being an Earth-to-orbit vehicle (ETOV) used for crew rotations, Soyuz is the Russian element that provides the crew emergency return ("lifeboat") capability, prior to the delivery of the U.S. CRV. After the U.S. CRV delivery, the Soyuz will continue to be used for rotation and emergency return of crewmembers, at least through AC. As such, a Soyuz is always docked to the Station whenever the Station crew is onboard. At least every 6 too, the docked Soyuz is replaced with a "new" Soyuz (Jorgensen 2000, 2–6).</p> <p>The initial ECLSS [environmental control and life support system] equipment is included in node 1. This equipment consists primarily of ventilation and FDS components. The Lab will contain equipment to remove carbon dioxide, humidity, and detectable (sensorable) heat from the cabin atmosphere. Water supply and gases will be provided by the Russians to sustain the crew if the Lab is occupied before the airlock is launched. Gases will be onboard the airlock that will sustain the crew (Jorgensen 2000, 3–43).</p> <p>As mentioned previously, MCC-H and MCC-M must be notified no later than 5.5 hours before the TCA to configure the systems (primarily solar arrays), start the burn sequence on board the Russian Segment, and actually perform the burn. If insufficient time is available, "safe haven" procedures allow the ISS crew members to close hatches in the USOS, enter their respective Soyuz vehicles (which are used to transport crews to and from the ISS), and close the hatches in the Soyuz to be best set up for withstanding an impact and performing an emergency departure and deorbit, if required (Dempsey 2017, 151).</p> <p>Without a crew onboard, we were at risk of losing the ISS (Dempsey 2017, 215). Some critical-but-redundant items were not operational. For example, the United States On-orbit Segment (USOS) oxygen generator was not being used; therefore, the station relied on the Russian oxygen generation system for the time being (Dempsey 2017, 361).</p>

	<p>SRB (The neurobiological nature of human beings favours symbiosis in microgravity environment)</p>	<p>The ISS Phase I Shuttle-Mir program has reaffirmed what was learned on Skylab: that a manned space station can be surprisingly resilient in emergency situations (Johnstone 1998, 16).</p> <p>The ISS team should continue to examine the Shuttle-Mir program carefully for examples from which ISS operations can benefit and to provide policies and procedures to implement effective action should similar events occur on the ISS. The effort should be expanded beyond Mir to focus as well on possible weaknesses in the ISS design and operations. The ISS should assemble a special team, including persons with system-level perspectives as well as with design, operations, and human factors experience, to address these issues (Johnstone 1998, 16).</p> <p>Emotions on board ran the gamut. Members of the Expedition 27-28 crew were supposed to head home in a couple of weeks, but immediately started hearing rumors of a 2-month extension [...] In the end, everything worked out very well. The Expedition 27-28 crew returned home with only a 1-week delay (Dempsey 2017, 375).</p>
<p>New materialism</p>	<p>NMA (Spacecrafts as pedetic actors)</p>	<p>On January 14, 2015, this scenario happened on the International Space Station (ISS). Data on the ETHOS console indicated toxic ammonia could be bleeding in from the external loops, through the water-based IFHX, and into the cabin (see Chapter 11). Software on the ISS immediately turned off the fans and closed the vents between all modules to prevent the spread of ammonia. At the sound of the alarm, crew members immediately began their memorized response of getting to the Russian Segment (considered a safe haven, since that segment does not have ammonia systems) and closed the hatch that connected to the United States On-orbit Segment (Dempsey 2017, 174).</p> <p>Automated software response to a fire is to shut down both intra-modular ventilation and IMV fans (see Chapter 19). This is based on the fact that there is no convection in microgravity. Without convection or forced ventilation, fires will consume the locally available oxygen and then extinguish due to a lack of additional oxygen (Dempsey 2017, 217).</p>
	<p>NMB (Spacecrafts as ongoing iterative indeterminate process)</p>	<p>The number of alarms include approximately 80 emergencies, 800 warnings, 2300 cautions, and 6100 advisories. The majority of alarms indicate a failure of a redundant component, thereby posing no immediate threat (Dempsey 2017, 104).</p>

		<p>No ammonia was detected in the cabin of the Russian Segment. At the same time, flight control team members looked at multiple indications in their data and did not see the expected confirming cues of a real leak. In fact, it was starting to look as if an unusual computer problem was providing incorrect readings, resulting in a false alarm. After looking carefully at the various indications and starting up an internal thermal loop pump, the team verified that no ammonia had leaked into the space station (Dempsey 2017, 175).</p> <p>Just continue that iterative process, and that communication was key in making it successful, because not only did you have to have the small teams solving the specific details of the problem, but it was really important that the teams synced up again, multiple times in a day, or a couple of times in a day, to make sure that we're not making a decision that's going to impact some other aspect of the problem and make it worse for somebody else (Ross-Nazzal 2015, 14).</p>
	<p>NMC (Spacecrafts as relational objects)</p>	<p>The C&W [caution and warning] subsystem alerts the crew and ground of conditions that (1) endanger the safety of the crew or Station, (2) threaten mission success, or (3) indicate out of tolerance conditions. Events that trigger the C&W subsystem are grouped into four classes that are common across all partner segments. These classes range from class 1, which is a life-threatening condition, to class 4, which is an advisory regarding system information. The tone and color associated with each class are also depicted. Only three emergencies are defined on Station: fire, loss of pressure, and toxic atmosphere (Jorgensen 2000, 3–56).</p> <p>The ETCS ammonia is kept at a temperature of about 3.3°C (~37.9°F). If the temperature drops below that level, software in the system will automatically stop ammonia flow and configure these valves to bypass and isolate the ammonia side of the IFHX. When a heat exchanger is bypassed and isolated, it is hydraulically locked such that any sudden temperature increases within the ammonia will put the heat exchanger at risk of overpressurization (Dempsey 2017, 202).</p> <p>It is critical that the communication system works. It is the link between the spacecraft and its crew and the flight controllers on the ground. Without a good communication system, the crew will not have adequate insight into the condition of the International Space Station (ISS) and the ground may not be able to help during nominal events or, more importantly, during emergencies (Dempsey 2017, 222).</p>

<p>Science and technology studies</p>	<p>STSA (Spaceflights as fundamentally technology dependent)</p>	<p>The Environmental and Thermal Operating Systems (ETHOS) flight controller is responsible for monitoring these systems continuously; ETHOS carefully tracks O₂, CO₂, and every drop of water. Many of these same systems are found on the Russian Segment (RS); therefore, careful coordination is required between the two teams (Dempsey 2017, 334).</p> <p>One downside is that the system had an increased dependence on computers to safe hardware. This is especially evident when certain computers control their own power switches. If one of those computers malfunctions, it may be necessary to go farther upstream in the EPS to remove power from the faulty computer, thus impacting other user loads. In fact, a significant part of a module may need to be powered down to change out the faulty computer. Although remote-control capabilities have proven beneficial for freeing up crew time and potentially saving the ISS if a crew is not available to respond to off-nominal situations, having practically no manual overrides in the EPS also has its detriments (Dempsey 2017, 334).</p> <p>When the crew members' day was wrapping up, they helped by performing some of the power-down steps that required their intervention (Dempsey 2017, 358). We learned very quickly that, from a practical point of view, the ground is best to focus on that. There's a control team in the [Mission] Control Center made up of a variety of flight controllers, each one specializing in their system or systems. They have all the data in front of them, so it's more appropriate for them to respond to those failures or contingencies that might happen on Station, and if we have communication with Station, they'll do that as a matter of course. In fact, we'll have an alarm, even a warning, go off on the Space Station periodically. If it didn't take out the communication system, we'll very quickly get a call from the ground, from Houston, to say, "Disregard. We've got it." That allows us to go about our business, and that has been a natural evolution (Wright 2015, 25).</p> <p>Flight control is different for the ISS than it was for the shuttle and earlier spacecraft. In the case of the Space Shuttle, the astronauts were responsible for most operations, and the ground followed along. Almost all commands to the vehicle were "switch throws" or other similar operations by the crew. In contrast, the vast majority of the ISS commands are sent from the ground. This allows the crew to focus more on the science payloads and less on vehicle operations. A typical day during a shuttle mission saw the FCT uplink less than 500 commands. The collective station FCTs,</p>
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		<p>located all around the world, routinely send 50,000 commands per day to the ISS (Dempsey 2017, XXVII).</p>
	<p>STSB (Scientists as collaborative spacecrafts advocates)</p>	<p>To make the project work, Russia and the US would have to learn how to cooperate in order to merge two very different programs (Dempsey 2017, XIV). Finally, representatives from the international partners maintain some presence in the Mission Control Center-Houston, mainly to help with the integration of the operations from day to day. Most notable among the partners presence is that of the Russians, who maintain a small team of flight controllers, trainers, and a flight director as part of what is called the Moscow Support Group. Besides performing coordination tasks, the group can operate the Russian Segment in the event of a significant problem with the control center near Moscow. Likewise, NASA maintains a small team in Russia known as the Houston Support Group. NASA and the international partners also exchange support group personnel, though sometimes only during critical mission phases (Dempsey 2017, XXVII). The ISS has an elegant arrangement where the duties of attitude control are shared between the US Segment and the Russian Segment. Computers to manage the systems are divided between the segments and share data, and attitude control is handed over between the segments cooperatively, depending on operational demands (Dempsey 2017, 128). US EVA experts spent a number of years during early ISS construction temporarily living in Moscow to work with Russian EVA experts for the purpose of negotiating crew training, spacewalk techniques, and hardware use. Spacewalks have been conducted by Americans in Orlans and Russians in EMUs (plus other international partners in both suits), and training has been conducted in both countries in both spacesuits (Dempsey 2017, 283).</p>

7.2 Application of Symbiotic Realism to the ISS Emergency Protocols

7.2.1 *SRA: Interdependence and the Survival of Human Beings and the ISS Emergency Protocols*

The first pillar of symbiotic realism defends that the outer space environment is contributing to a situation of interdependence between human beings and spacecraft to ensure their survival. So far, this thesis has demonstrated on multiple occasions that a situation of interdependence between human beings on board a spacecraft and the latter is strongly present, and the analysis of the archives determined that it is no different for the ISS. However, since we are analyzing protocols and not a physical object, it is interesting to note the multiple relationships of interdependence that exist between the different actors within the ISS to ensure their mutual survival. Thus, we can certainly note a relationship of interdependence between humans and the station, but we can also notice situations of interdependence between the different modules of the station, between the station and other vessels being docked at the station and between the different individuals on board. The ISS therefore makes it possible to highlight a situation of multiple interdependences when it comes to operating a large international station.

One of the most relevant extracts for the SRA code are the words of Mike Fossum, Commander of Expedition 29, who explains in *The International Space Station: Operating an Outpost in the New Frontier* that the ISS is fundamentally dependent on the crew on board in order to ensure its survival: “Without a crew onboard, we were at risk of losing the ISS” (Dempsey 2017, 215). Fossum expressed this in 2011 in the context where problems with the Soyuz spacecraft's rocket risked leading to a cancellation of the crew rotation and thus leaving the ISS vacant for a certain period. This statement is relevant because although it is well established that humans are dependent on their spacecraft to ensure their survival, it turns out that the spacecraft that constitutes the ISS is indeed dependent on humans on board to ensure its own survival, particularly if an

emergency were to affect the ISS during the astronauts' absence. Thus, the analysis of the archives of the ISS' emergency protocols made it possible to identify these multiple cases of interdependence in the event of an emergency.

In the event of an emergency, the crew is dependent on the spacecraft docked at the station to ensure their safety. Indeed, the Soyuz spacecraft also acts as a “lifeboat” for the crew aboard the station and “as such, a Soyuz is always docked to the Station whenever the Station crew is onboard” (Jorgensen 2000, 2–6). While a crew has never had to leave the station on a Soyuz in an emergency, it has happened on multiple occasions that the crew has had to take refuge on board the Soyuz for safety and precautionary measures. In addition, the entire station is dependent on thrusters from the Russian segment in order to avoid a collision with space debris, if an imminent collision were expected. If the predicted collision is to take place in less than 5.5 hours, the crews must head to their Soyuz lifeboats (Dempsey 2017, 151).

We can also note times when the different American and Russian sections of the station have depended on each other to ensure the survival of their respective crews. This was particularly the case during the assembly of an American laboratory in the early 2000s where the water and oxygen supply for the American part of the Station had to be provided entirely by the Russian part (Jorgensen 2000, 3–43). Another notable moment was an ammonia leak in December 2013 which caused a general failure of the cooling systems of the American segment of the ISS and forced the Americans to rely on the Russian oxygen generation system for several days (Dempsey 2017, 361). Thus, we can easily conclude that the analysis of the ISS emergency protocols corroborates well with the SRA code.

7.2.2 SRB: The Neurobiological Nature of Human Beings Favours Symbiosis in the Microgravity Environment and the ISS Emergency Protocols

The second pillar of symbiotic realism defends that the neurobiological nature of humans favours a situation of symbiosis between astronauts, cosmonauts, and their spacecraft in outer space. We also know that two premises constitute this SRB code. First, it argues that moral behaviours among human beings are more likely to take place in situations where the basic needs of individuals are met and where there is a certain structural governance. Second, it proposes that that immoral situations arise when there is an excess of essential needs motivated by emotions such as envy and ego. However, as previously noted, the perception and expression of emotions in human beings are neurobiologically impacted by the micro-gravity environment in outer space.

The results of the coding of the ISS emergency protocols were similar to those of the Spektr module. Indeed, as was the case for Spektr, the coding of the archives was not able to identify a dynamic where the microgravity environment would have neurologically influenced the perception of the emotions of the humans on board the station. This dynamic could therefore not be identified within any of our objects of study. This will be addressed in further detail in the following chapter. That being said, as was briefly mentioned in the previous chapter, the absence of the observation of such dynamics within the archives does not necessarily mean that these dynamics are absent within human spaceflight. It is rather suspected that the fault of the absence of the observation of this dynamic rests on the methodological approach of this thesis. Indeed, we can doubt that analyzing archives whose object of study are spacecraft and emergency protocols is the best angle through which to identify a situation where microgravity environments would neurologically influence the perception of emotions of the crew. That being said, just as was the case for Spektr, it was possible to identify several dynamics corroborating the fact that moral behaviour in outer space occurs in a context of a certain structure and governance.

Indeed, the numerous emergency episodes that have taken place on board the ISS since its creation are a strong testimony to individuals having acted morally thanks to structure, governance and protocols. In 1997, at the dawn of the launch of the first modules of the ISS, NASA's Aerospace Safety Advisory Panel identified that programs that preceded the ISS such as Shuttle-Mir demonstrated great resilience during emergencies and that the ISS must take inspiration from it. This observation is notable given that the panel also identifies that this resilience is due to protocols, procedures and governance structure:

The ISS team should continue to examine the Shuttle-Mir program carefully for examples from which ISS operations can benefit and to provide policies and procedures to implement effective action should similar events occur on the ISS. The effort should be expanded beyond Mir to focus as well on possible weaknesses in the ISS design and operations. The ISS should assemble a special team, including persons with system-level perspectives as well as with design, operations, and human factors experience, to address these issues (Johnstone 1998, 16).

The December 2013 ammonia leak is an excellent example of the resilience and the moral behaviour adopted by the crew during a critical emergency. Indeed, Mike Fossum corroborates this dynamic by noting that “emotions on board ran the gamut”, but the protocols, structure and governance in place managed to resolve this complex problem. We can therefore cautiously assert that in the same way as was the case for Spektr, the SRB code is partially corroborated by the emergency protocols.

7.3 Application of New Materialism to the ISS Emergency Protocols

7.3.1 NMA: The ISS Emergency Protocols as Pedetic Actor

The main argument supported by the new materialism pillar of NSM argues that spacecraft must be considered as performative actors. The coding of the archives of the ISS' emergency protocols allows us to affirm that the ISS must certainly constitute one of the most performative objects ever built by humans. The first NMA code of new materialism is the one which considers objects as being pedetic actors (having a certain autonomy). Indeed, the coding has been able to

note this dynamic within the ISS' emergency procedures on multiple occasions. We already know that the ISS is almost entirely controlled by computers. However, it is important to emphasize that these and many other electronic and mechanical systems operate autonomously and automatically. In addition, these automatic systems are essential in emergencies. This is notably the case when a fire occurs on board the station. A fire is one of the most dangerous emergencies that can occur aboard a spacecraft since it is impossible to escape the fire by simply leaving the station as if leaving a burning house on Earth. In addition, the micro-gravity parameters in outer space being what they are, it is important to emphasize that there is no natural air circulation in a spacecraft. This detail is well explained in chapter 11 of *The International Space Station: Operating an Outpost in the New Frontier*:

In a gravity environment, a warmer, less-dense fluid rises through the cooler fluid above it because the less-dense fluid is “lighter” than the colder, denser fluid. This free convection is responsible for the weather patterns on Earth, the flight of hot air balloons, and the usefulness of old-fashioned radiators. Without gravity, however, air will get hot and expand but will stay exactly where it is. This occurs because things are not “light” or “heavy” when there is no gravity. Without gravity, hot air will not rise (Dempsey 2017, 193).

This is important because it means that the air must be circulated artificially to maintain a viable atmosphere on board the ISS. However, in the event of a fire, this air ventilation system would contribute to the fire spreading exponentially. It is therefore essential that any ventilation system be interrupted as quickly as possible in the event of a fire. Within the ISS this vital role rests in the hands of an automatic and autonomous system. As soon as the ventilation system is stopped, the danger linked to a fire decreases drastically. “This is based on the fact that there is no convection in microgravity. Without convection or forced ventilation, fires will consume the locally available oxygen and then extinguish due to a lack of additional oxygen” (Dempsey 2017, 217). The dynamic is the same in the event of an ammonia leak. Ammonia being a highly toxic gas, it is the role of the station to automatically close the ventilation in the event of a leak and this has happened on several

occasions (Dempsey 2017, 174). It would be possible to identify dozens, even hundreds of other examples of the pedetic aspect of the station, where it acted with autonomy, notably during emergencies.

7.3.2 NMB: The ISS Emergency Protocols as an Ongoing Iterative Indeterminate Process

For an object to be considered as performative, it also needs to be considered as involved in an ongoing iterative indeterminate process. This means, among other things, that the object must act in a relatively repeated manner which is not the result of a single action. Furthermore, the outcome of these actions should not be 100% predictable and fixed. It is this dynamic that makes it possible to detach the agency of the object from humans or any other external factors since the continuity of the action and the agency of the object essentially depend on the object itself. Analysis of the emergency procedures archives also supports the NMB code well. Indeed, the analysis of the archives allows us to note that although several automatic systems linked to emergency procedures are automatic and autonomous, it turns out that several of them do not necessarily act as expected. This is particularly the case for the ISS alarm systems. There are more than 10,000 different types of alarms in the ISS (80 alarms being emergency alarms) and the majority are in fact false alarms “indicating of a failure of a redundant component, thereby posing no immediate threat” (Dempsey 2017, 104). This is notable because it corroborates the indeterminate aspect of the ISS emergency protocols which cannot be 100% predictable and fixed. Such a situation happened in January 2015 when the ISS alarm systems identified an ammonia leak (and consequently closed the ventilation systems). The alarm had a definite effect on the crew: “At the sound of the alarm, crew members immediately began their memorized response of getting to the Russian Segment (considered a safe haven, since that segment does not have ammonia systems) and closed the hatch that connected to the United States On-orbit Segment” (Dempsey 2017, 175).

However, it turned out that no ammonia had leaked into the station, and that this alarm was caused by a computer problem.

Since protocols and emergency measures go beyond alarms and automated systems, Peggy Whitson (astronaut) explains in an Oral History Project interview that there is an ongoing and iterative nature for control teams on Earth when there is an emergency situation on the ISS. During an emergency, NASA sets up within the control center a special team called “Team 4” in order to work exclusively on an emergency situation. This team, independent from the rest of the control center, must therefore be in constant, continuous and repeated communication with the ISS flight director in order to successfully resolve the problem. Whitson explains that this is mostly an iterative process:

Just continue that iterative process, and that communication was key in making it successful, because not only did you have to have the small teams solving the specific details of the problem, but it was really important that the teams synced up again, multiple times in a day, or a couple of times in a day, to make sure that we’re not making a decision that’s going to impact some other aspect of the problem and make it worse for somebody else (Ross-Nazzal 2015, 14).

It goes without saying that just like NMA, the NMB code is well corroborated by the coding of the archives where we clearly see that the protocols and emergency measures of the ISS are carried out in an iterative, ongoing and indeterminate manner.

7.3.3 NMC: The ISS Emergency Protocols as Relational Objects

The last criterion used to identify an object as being performative is the relational one. Indeed, it would be difficult to recognize a certain agency in an object without being able to identify its ability to maintain a relational capacity with the world around it. The case of the ISS emergency protocols is very interesting because it was possible to identify, thanks to the coding, a triple relationship maintained by the emergency protocols. First, it is evident that the emergency protocols uphold a close connection with the personnel on board the station, notably through

alarms, codes and signals which provide and communicate essential information directly to the personnel on board:

The C&W [caution and warning] subsystem alerts the crew and ground of conditions that (1) endanger the safety of the crew or Station, (2) threaten mission success, or (3) indicate out of tolerance conditions. Events that trigger the C&W subsystem are grouped into four classes that are common across all partner segments. These classes range from class 1, which is a life-threatening condition, to class 4, which is an advisory regarding system information. The tone and color associated with each class are also depicted. Only three emergencies are defined on Station: fire, loss of pressure, and toxic atmosphere (Jorgensen 2000, 3–56).

The second type of relationship that emergency protocols have is with other systems on board. Emergency protocols interact with other automatic systems, such as the station's computer or mechanical systems. Thus, if an emergency measure occurs, emergency protocols can enter into relationships with other systems and act without the intervention of human beings. This is what happened during the ammonia leak of 2015 where emergency protocols intervened with the ammonia computer and mechanical ventilation and hydraulic systems:

The ETCS ammonia is kept at a temperature of about 3.3°C (~37.9°F). If the temperature drops below that level, software in the system will automatically stop ammonia flow and configure these valves to bypass and isolate the ammonia side of the IFHX. When a heat exchanger is bypassed and isolated, it is hydraulically locked such that any sudden temperature increases within the ammonia will put the heat exchanger at risk of overpressurization (Dempsey 2017, 202).

Finally, the third type of relationship to note is between emergency protocols and personnel outside the station, i.e. in the control centers. Indeed, it is essential that emergency protocols be in direct contact with control centers on Earth. The station was built to be controlled largely from the ground and without this communication and close relationship between emergency protocols and control centers, the ISS literally could not carry out its scientific mission given that personnel on board the station would have to spend the majority of their time maintaining the station and not performing scientific research:

It is critical that the communication system works. It is the link between the spacecraft and its crew and the flight controllers on the ground. Without a good communication system, the crew will not have adequate insight into the condition of the International Space Station (ISS) and the ground may not be able to help during nominal events or, more importantly, during emergencies (Dempsey 2017, 222).

7.4 Application of Science and Technology Studies to the ISS Emergency Protocols

7.4.1 *STSA: The ISS Emergency Protocols as Fundamentally Technology Dependent*

As has been demonstrated repeatedly within this thesis, it is clear that human spaceflight is technologically dependent. This dependence doesn't simply mean that a spacecraft or station is dependent on technology to survive. The important thing here is the impact that technology has on the very existence of our object of study and not only on its survival. Indeed, beyond the fact that outer space projects are technology dependent, what the STSA code seeks to determine is if there is a certain preponderance of the technological variable in the decision-making to carry out a project. This preponderance has been identified very easily for the ASTP docking module and less evidently for the Spektr module. Regarding the ISS emergency protocols, this preponderance of technology is just as evident as was the case for ASTP.

Indeed, the analysis of the coding of the archives made it possible to identify on multiple occasions that a project like the ISS and its emergency protocols would not have been possible without technology and especially without the coordination between the different technological capacities of different countries. For example, the air filtration system on board the station needed to be the subject of exhaustive technological coordination between the American and Russian segments. Without this coordination, effective management of air quality on board the station would not have been possible:

The Environmental and Thermal Operating Systems (ETHOS) flight controller is responsible for monitoring these systems continuously; ETHOS carefully tracks O₂, CO₂, and every drop of water. Many of these same systems are found on the Russian Segment (RS); therefore, careful coordination is required between the two teams (Dempsey 2017, 334).

Furthermore, the ISS emergency protocols are fundamentally technology dependent since, as presented in section 7.3.1., many station components and emergency systems must act autonomously. In fact, several computers on the ISS can control their own power switches, making the personnel on board dependent on the computers (Dempsey 2017, 334).

Probably one of the most significant aspects demonstrating the ISS emergency protocols' dependence on technology is the station and its crew's dependence on control centers on Earth. This dependence is notable because without this support –the dependence of the station on the personnel on Earth during an emergency situation–, the personnel on board the station and the station itself would not be able to carry out their scientific purposes. In fact, without this support, the staff on board the station would be preoccupied by managing and maintaining the station rather than in carrying out its scientific objectives. This significant dependence on control centers, their expertise, and their technology (thanks to communications technologies) is the basis of the existence of emergency protocols. These emergency procedures and protocols were basically constructed this way:

We learned very quickly that, from a practical point of view, the ground is best to focus on that. There's a control team in the [Mission] Control Center made up of a variety of flight controllers, each one specializing in their system or systems. They have all the data in front of them, so it's more appropriate for them to respond to those failures or contingencies that might happen on Station, and if we have communication with Station, they'll do that as a matter of course. In fact, we'll have an alarm, even a warning, go off on the Space Station periodically. If it didn't take out the communication system, we'll very quickly get a call from the ground, from Houston, to say, "Disregard. We've got it." That allows us to go about our business, and that has been a natural evolution (Wright 2015, 25).

7.4.2 *STSB: ISS Emergency Protocols and Scientists as Collaborative Spacecraft Advocates*

This last code of science and technology studies argues that scientists and engineers can have a certain capacity to influence politics or at least favour cooperation. This influence can be both direct and indirect. As was the case for the ASTP docking module and the Spektr module, it

was not possible to identify an archive passage presenting a direct influence of scientists and engineers on political decisions regarding emergency protocols. This issue will be addressed in the next chapter. However, as was the case for our two previous objects of study, it was possible to raise several passages where it is clear that the scientists and engineers acted as collaborative spacecraft advocates indirectly. The report *The International Space Station: Operating an Outpost in the New Frontier* mentions in its introduction that “to make the project work, Russia and the US would have to learn how to cooperate in order to merge two very different programs” (Dempsey 2017, XIV). Scientists and engineers have had an essential role to play in encouraging and implementing this cooperation.

Indeed, this dynamic is present in several central areas of the ISS, notably that of extra-vehicular activities (EVA) and spacesuits which are an essential aspect of the emergency protocols. An analysis of the archives clearly demonstrates that scientists did indeed have an important role to play in what is now a very cooperative use of American and Russian spacesuits where the two nations share their suits:

US EVA experts spent a number of years during early ISS construction temporarily living in Moscow to work with Russian EVA experts for the purpose of negotiating crew training, spacewalk techniques, and hardware use. Spacewalks have been conducted by Americans in Orlans and Russians in EMUs (plus other international partners in both suits), and training has been conducted in both countries in both spacesuits (Dempsey 2017, 283).

Moreover, it also turns out that crucial elements of the daily dynamics of emergency protocols are the result of collaboration between scientists from both countries. This is particularly the case of the ISS navigation system which was built by scientists and engineers so that it is fundamentally dependent on close and constant collaboration between the two countries:

The ISS has an elegant arrangement where the duties of attitude control are shared between the US Segment and the Russian Segment. Computers to manage the systems are divided between the segments and share data, and attitude control is handed over

between the segments cooperatively, depending on operational demands (Dempsey 2017, 128).

Finally, one of the most convincing elements testifying to the influence and the important collaboration between scientists is that of the daily dynamics in the control centers where the latter are not only operated by members of NASA in the United States but also by ROSCOSMOS personnel in Russia. In reality, there are experts, scientists and engineers from the respective countries who work permanently within their partner's control centers precisely to have a certain capacity and expertise to intervene in the event of an emergency situation:

Representatives from the international partners maintain some presence in the Mission Control Center-Houston, mainly to help with the integration of the operations from day to day. Most notable among the partners presence is that of the Russians, who maintain a small team of flight controllers, trainers, and a flight director as part of what is called the Moscow Support Group. Besides performing coordination tasks, the group can operate the Russian Segment in the event of a significant problem with the control center near Moscow. Likewise, NASA maintains a small team in Russia known as the Houston Support Group. NASA and the international partners also exchange support group personnel, though sometimes only during critical mission phases (Dempsey 2017, XXVII).

7.5 Summary of the ISS Emergency Protocols Archive Analysis

Just as it was done for the analysis of the ASTP docking module and the Spektr, we now must summarize the qualitative analysis of the Spektr module archives:

Table 8 – NSM Analysis of ISS Emergency Protocols - Summary Table

Pillars	Codes	Connection with ISS emergency protocols
Symbiotic realism	SRA (Interdependence and the survival of human beings in outer space)	Convincing connection
	SRB (The neurobiological nature of human beings favours symbiosis in microgravity environment)	Mixed connection
New materialism	NMA (Spacecrafts as pedetic actors)	Convincing connection
	NMB (Spacecrafts as ongoing iterative indeterminate process)	Convincing connection
	NMC (Spacecrafts as relational objects)	Convincing connection
Science and technology studies	STSA (Spaceflights as fundamentally technology dependent)	Convincing connection
	STSB (Scientists as collaborative spacecrafts advocates)	Convincing connection

This table collating the different results of the analysis of the archives allows us to conclude that there is a convincing connection between the analysis of the ISS emergency protocols archives and New Space Materialism. In more detail, as was the case for the ASTP docking module and the Spektr module, there is a strong connection between the pillar of new materialism and the ISS emergency protocols. These emergency protocols –even if they do not constitute a single concrete actor like a space module but rather a combination of procedures, machines and expecting behaviours– can very well be considered as a pedetic actor as well as a relational actor with an ongoing iterative indeterminate process. The documents analyzed within the archives are unequivocal and corroborate the dynamics of new materialism. Regarding the Science and Technology pillar, the latter is also supported by the emergency protocols. Indeed, relevant extracts were noted which allow us to convincingly corroborate that the ISS emergency protocols are fundamentally technology dependent. However, just like the ASTP docking module, no technical

document explicitly states that engineers and scientists influenced collaborative politics. However, the analysis of the archives made it possible to identify several relevant dynamics that indicated that they acted as collaborative agents. In connection with the pillar of Symbiotic Realism, the results of the coding were quite similar to those of the Spektr module. The links between the SRA code and the emergency protocols (interdependence and the survival of human beings in outer space) were abundant. For the SRB code (the neurobiological nature of human beings favours symbiosis in a microgravity environment), the analysis of the archives identified a mixed connection similar to the one of the Spektr module analysis where no archival documents noted the dynamic that the environmental conditions in outer space would alter the perception of emotions in individuals aboard spacecraft. However, concerning the dynamic that moral behaviours in outer space would occur in the context of a certain structure and governance, this dynamic has been coded and identified in the analysis of the emergency protocols archives. It is interesting to note the partial absence of the SRB code given that we know (as presented in Chapter 3 of this thesis) that several studies have been carried out on board the ISS studying the impact of the micro-gravity environment on the brain and the perception of emotions. This absence could be explained by a methodological bias where this subject was not covered by the archives of the emergency protocols but rather studied within the framework of this thesis, but rather by other types of sources such as scholarly articles or interviews. This gap in the SRB code will be discussed in more detail in the next chapter.

Thus, just like the two previous objects of study, we can conclude that there is a strong correspondence between the ISS emergency protocols and New Space Materialism. By maintaining our qualitative methodological approach analyzing the different variables as a whole

and not as separate entities, it is possible to affirm that there is a convincing connection between NSM and the ISS emergency protocols.

It is now time to give a heuristic meaning to the analysis of our three objects of study which are the ASTP docking module, the Spektr module and the ISS emergency protocols. Thus, the next and final chapter of this thesis presents a large synthesis of the analysis collating the coding results into a coherent whole which allows us to determine to what extent NSM was able to answer our research question. It will also present how this theoretical construction that constitutes New Space Materialism fits within the broader field of the study of international relations.

8. Chapter 8 – Conclusion: New Space Materialism and its Contribution to International Relations Studies

American-Russian cooperation in human spaceflight constitutes a very interesting geopolitical puzzle to solve. This thesis was able to demonstrate that there is an important contrast between the situation which prevails on Earth between the two countries and that which has prevailed in outer space within human spaceflight for the past 50 years. Thus, the research question that animated this reflection asked: *how can we explain the US-Russia cooperation in human spaceflights?* It has also been established that this situation of cooperation cannot be explained with a pragmatic argument which would simply assert that this cooperation was in the selfish interest of the states. The same goes for more nuanced approaches in relation to the role of the state such as the theory of international regimes or even securitization theory. It turns out that these approaches share a common challenge: they still use a state-centric approach which is not suitable for understanding the situation of human spaceflight. The state-centric approach, as explained in Chapter 2, presents several problems in the analysis of outer space issues, notably that it is not capable of capturing the multiplicity of actors involved in human spaceflight. This thesis therefore proposed to answer the research question by going beyond the state-centric approach, by making an important change in terms of the object of study and by adopting spacecrafts as the main object of examination. This change in the object of study is also explained by the fact that political studies in outer space are confronted with a very particular reality: the end of territoriality. The fact of existing beyond state boundaries in space means that state-centric approaches in outer space are obsolete given that outer space constitutes a unique environment within IR where notions of sovereignty cannot apply. This also has the consequence that spacecraft must be considered non-territorial, non-sovereign, and borderless objects. Faced with these unique parameters, it was necessary to build a new theoretical framework which both is adapted to the situation in outer

space, beyond the state, and can use spacecraft as its object of study. This new theoretical framework is also a necessary adaptation to the unique situation that prevails in outer space. Indeed, the outer space environment poses unique challenges for human beings and their social interactions on a level not otherwise encountered, even in the most hostile environments on Earth such as the high seas and Antarctica. To achieve this, it was agreed that this new theoretical framework should adopt a critical and multidisciplinary approach. Indeed, it is a vision of IR which uses different theories as tools –but above all which considers that such a theoretical construction must be done in a plural, eclectic way, considering theory as part of the daily practice of all actors– that was used to build a political theoretical framework that can analyze spacecraft. It is this approach that led us to build this new theoretical toolbox called New Space Materialism. Constituting the heart and soul of this thesis, New Space Materialism was used to suggest the main hypothesis of this research which argues that: *we can understand cooperation between the United States and Russia in human spaceflight through the framework of New Space Materialism which emphasizes the role of precarity, objects and technology*. The three case studies that were analyzed to demonstrate this hypothesis are the Apollo-Soyuz Test Project (ASTP), the Shuttle-Mir program and the International Space Station (ISS). More precisely, the objects under analysis were the docking module in the case of ASTP, the Spektr module in the case of Shuttle-Mir and the emergency protocols in the case of the ISS. Finally, it was through archival analysis and coding that the research was carried out to verify our hypothesis.

This concluding chapter is divided into four parts. Firstly, considering the results and analyses of the coding from chapters 5, 6 and 7, the hypothesis will be verified. As noted several times in the previous chapters and particularly in Chapter 4, to be able to adequately judge whether New Space Materialism is able to explain US-Russian cooperation in human spaceflight, it is

essential to analyze and consider all the results obtained coherently. Indeed, to fully understand the complexity of human spaceflight, a complete analysis of the three cases study is necessary to obtain a holistic portrait of the situation. This dynamic will be explained in more detail in the following paragraphs. In the second part of this concluding chapter, a global analysis of the results will be done. The third section will present the place of this thesis in the analysis of the international in outer space and the last but not least section will look at how the results of this thesis invite us to rethink an important issue in the field of international relations (IR): cooperation under scarce resources.

8.1 From Liftoff to Landing: Global Analysis of the ASTP, Mir-Shuttle and ISS Archives Using New Space Materialism

In synthesizing our results, it is important to reiterate New Space Materialism's principal objectives as well as its three main pillars. It was argued in Chapter 2 that to answer our research question it was necessary to use an approach which was post-state-centric, critical and which was post-state-centric and critical, and which could analyze material objects (in this case spacecraft) as objects of study. Three approaches which explain cooperation in outer space were retained in order to construct the theoretical framework of New Space Materialism (NSM): (1) Symbiotic Realism, (2) new materialism and (3) science and technology studies (STS). The Symbiotic Realism aspect of NSM argues that the outer space environment is contributing to a situation of interdependence between human beings and spacecrafts in order to ensure human survival. It also posits that the neurobiological nature of humans favours a situation of symbiosis in a microgravity environment. The new materialism approach within NSM argues that spacecrafts must be considered as performative actors and that the latter therefore have a certain political agency. Three criteria can be identified to recognize a spacecraft as being a performative actor: the spacecraft must be a pedetic actor, it must be involved in an ongoing iterative indeterminate process as well as be

recognized as a relational object. Finally, regarding the approach of Science and Technology Studies, it argues within NSM that spaceflights are fundamentally technology dependant, and that scientists and engineers are acting as collaborative spacecrafts advocates.

It is very important to reiterate that although NSM is divided into 3 pillars and 7 codes, all these components share equal importance. NSM is a holistic theoretical framework which relies upon its different elements and components when analyzed into a coherent whole. Indeed, we cannot focus on a single pillar of NSM to judge its explanatory power, for example by only focusing on the pedetic aspect of a spacecraft. This is because the theoretical dynamics of NSM must work in the same way as a spaceflight. Just as it would be unreasonable to assess the complexity of a spaceflight by focusing on singular aspects such as the rocket or spacecraft, NSM functions in the same fashion: the different pillars and criteria, although crucial in their role within the theoretical toolbox, must be seen as parts of a coherent whole.

Following the construction of the NSM theoretical framework, it was agreed that the analysis of the three case studies would be done via archival analysis and coding. Furthermore, the choice of archives and their analysis was carried out in a way which reflects the dynamic of cooperation in human spaceflight. This was important because to be consistent with NSM's holistic approach, it was necessary to be able to capture the broadest possible picture of what constitutes human spaceflight. Thus, the first step which has been identified to successfully carry out a collaborative human spaceflight mission is to successfully connect multiple spacecraft in orbit. The ASTP mission was chosen to study this stage, focusing on the precise object of the ASTP docking module. The second step identified is to build a collaborative spacecraft or module. For this purpose, the archives of the Shuttle-Mir program were analyzed, with a specific focus on the Spektr module. Finally, the third stage necessary in carrying out a concerted mission in outer space is to

operate a collaborative spacecraft and especially to establish operating protocols and specifically joint emergency measures. In this case, it was the ISS archives which were analyzed, specifically those related to emergency protocols and measures. The table below presents the final portrait of the results of the analysis of the archives using the NSM coding framework:

Table 9 – Global Portrait of the NSM Coding Analysis

Pillars	Codes	Connection with ASTP docking module	Connection with Spektr module	Connection with ISS emergency protocols	Overall connection of NSM with US-Russia cooperation in human spaceflights
Symbiotic realism	SRA (Interdependence and the survival of human beings in outer space)	Convincing connection	Convincing connection	Convincing connection	Convincing
	SRB (The neurobiological nature of human beings favours symbiosis in microgravity environment)	No connection	Mixed connection	Mixed connection	Mixed
New materialism	NMA (Spacecrafts as pedetic actors)	Convincing connection	Convincing connection	Convincing connection	Convincing
	NMB (Spacecrafts as ongoing iterative indeterminate process)	Convincing connection	Convincing connection	Convincing connection	Convincing
	NMC (Spacecrafts as relational objects)	Convincing connection	Convincing connection	Convincing connection	Convincing
Science and technology studies	STSA (Spaceflights as fundamentally technology dependent)	Convincing connection	Convincing connection	Convincing connection	Convincing
	STSB (Scientists as collaborative spacecrafts advocates)	Mixed connection	Convincing connection	Convincing connection	Mixed/convincing

8.1.1 *Global analysis of symbiotic realism*

As Table 9 demonstrates, the Symbiotic Realism pillar had both convincing and mixed results with archival analysis. Regarding the SRA code, the first portion of Symbiotic Realism which posits that the outer space environment is contributing to a situation of interdependence between human beings and spacecrafts to ensure their survival, the correspondence with the archives has been convincing. Indeed, all the objects of study coded using archival analysis have clearly demonstrated the presence of this dynamic. With regard to the ASTP mission and its docking module, whether by the need to set up a rescue capability or by the steps put in place to ensure that the docking module was built in a collaborative manner to ensure the safety and survival of humans on board, it is clear that the ASTP docking module constitutes a reflection of the interdependence between human beings and spacecraft to ensure their survival. It is also the case of our second object of study, the Spektr module of the Mir station, which demonstrated not only by its intrinsic functions, but also with the incident of the collision with the Progress spacecraft, that the Americans using the Spektr module were dependent on the Mir station to ensure their survival. Conversely, this was also the case for the Russians who needed the Spektr module to ensure their own survival. Regarding the last case of the emergency protocols of the ISS, the analysis made it possible to highlight a situation of multiple interdependencies between humans and the station, between the different modules of the station, between the station and the multiple spacecraft docked to it and between the individuals on board in order to ensure their mutual survival.

Concerning the second portion of symbiotic realism (code SRB) affirming that the neurobiological nature of humans favors a situation of symbiosis between astronauts, cosmonauts, and their spacecraft in outer space, its correspondence with the analysis of the archives is more mixed. Indeed, regarding the ASTP docking module, it was simply not possible to corroborate the

SRB code. As mentioned in Chapter 5, there are several reasons for this. Notably, there is the fact that the ASTP mission was very little, if at all, interested in studying the relationship between humans and the spacecraft. ASTP was essentially a mission with one technical goal: the connection of two spacecraft in orbit. The archive addresses primarily this dynamic, rather than focusing on the impact that the outer space environment had or may have on the humans aboard the docking module. Regarding Spektr, it was also not possible to identify in the archives a dynamic demonstrating that the outer space environment affected the perception of the emotions of the individuals on board. It is clear that the technique of archival analysis presented limits on the capacity to explore this portion of the SRB code. Indeed, it is evident that the sources that would have shed light on a dynamic where the emotions of astronauts in outer space are influenced by the environment were not located in spacecraft archives. In particular, it would have been more useful to use a guided interview technique with astronauts that would have allowed us to more precisely raise this dynamic. However, the approach of this thesis, which wanted to give voice to our material objects of study and not replace it with individuals' interpretation, led us to use archival analysis at the expense of interviews. Exploring this dynamic via interviews would be a very interesting complementary asset for our thesis. On the other hand, regarding the second portion of SRB which defends that moral behaviors in outer space occur in a context of a certain structure and governance, this dynamic was evidenced by the coding of the archives. Indeed, it was the collision of the Progress spacecraft with the Spektr module which made it possible to highlight that the individuals on board Mir acted in a moral manner thanks to the structure put in place on board the station. The dynamic is essentially the same when it comes to the ISS. The coding of the archives was not able to identify a dynamic where the microgravity environment would have neurologically influenced the perception of human emotions on board the station. However, the numerous emergency

episodes that have taken place on board the ISS since its creation are a strong testimony to individuals having acted morally thanks to structure, governance, and protocols.

Considering these results, we can affirm that the pillar of Symbiotic Realism of NSM is corroborated by the analysis of the archives, despite additional research still being in order. Indeed, we can assess that Symbiotic Realism is corroborated in a satisfying manner given that the SRA code has been convincingly corroborated and the SRB is corroborated at least in part. The archives were able to clearly demonstrate that there is a strong relationship of multiple interdependencies between spacecraft and the humans on board to ensure their mutual survival. Moreover, what is most striking is that this interdependence is not exceptional nor is it occurring in certain very specific circumstances. On the contrary, this situation of interdependence is always present, at all the stages of the process leading to the completion of a space mission from liftoff to landing. This situation diverges significantly from what prevails on Earth. Although there may be situations where humans and objects are temporarily in a situation of mutual interdependence to survive (we can think of the cases of airplanes, submarines, etc.), this cannot be compared to the situation which prevails in outer space. In space, this interdependence between spacecraft and humans is constantly present, and several examples from the archives have demonstrated that a multitude of scenarios (air leaks, space debris, drastic changes in atmospheric pressure, etc.) can occur at any time and put the life of both the humans and spacecraft in immediate danger. It is obvious that this intrinsic interdependence specific to the situation in outer space promotes a cooperative relationship between the different humans and spacecraft within a space mission, regardless of the origin and home port of the machines or humans involved. Thus, if we take for example the case of the ASTP docking module, cooperation between the United States and the USSR in the development of this device was not only essential, but also obligatory given the parameters of interdependence existing

in outer space. In other words, without this cooperation, the ASTP docking module and the entire mission would have been impossible. We see that this situation diverges greatly from what prevails on Earth where, for example, two planes, boats or other vehicles can end up carrying out collaborative missions without the actual construction of their machine having been achieved through collaboration. When it comes to cooperation between humans and spacecraft in outer space, this cooperation is necessary. To put it differently, it would be impossible for a Soyuz spacecraft and an American spacecraft like Orion or the SpaceX Dragon to carry out a collaborative mission in outer space without having made prior collaborative preparation (for example if a Soyuz would like to go and save the crew members of a Dragon spacecraft whose crew is in danger). The parameters of the outer space environment and the mutual interdependence that exists between spacecrafts and their crews simply do not allow this.

That being said, further research is required to examine the portion of symbiotic realism which posits that a microgravity environment can neurologically influence the perception of the emotions on board a spacecraft. As mentioned earlier, this dynamic has not been identified within the archives. However, this is not sufficient to reject the entire pillar of symbiotic realism for two reasons. First, it seems obvious a posteriori that the methodology used in this thesis was not appropriate to shed light on this dynamic. Indeed, the archives analyzed, whether the ASTP docking module, the Spektr module or the emergency protocols of the ISS, proved to be excellent sources to study the origins, the conceptualization, the operationalization as well as the relationships of these objects with their environments. On the other hand, the archives have proven to be particularly ineffective in extensively evaluating human behavior inside these spacecrafts. This facet has simply not been addressed within the archives. It now seems obvious that new research using the neurobiology of emotions in outer space as specific object of study would be

best suited to explore this dynamic of symbiotic realism. Moreover, other methodological approaches would be more appropriate to explore this issue such as interviews. The second reason explaining why the absence of any observations of the influence of microgravity on the perception of emotions is not sufficient to reject the entire pillar of symbiotic realism is because it in no way discredits the other dynamics of symbiotic realism. Indeed, as with all the codes and pillars of New Space Materialism, the impact of microgravity on emotions is essentially complementary to the other arguments of symbiotic realism. This therefore does not fundamentally call into question the idea that the outer space environment is contributing to a situation of interdependence between human beings and spacecrafts to ensure their survival or that the neurobiological nature of humans favors a situation of symbiosis in a situation of microgravity. Furthermore, as demonstrated in Chapter 3, it is well established scientifically that this dynamic where the microgravity environment influences the perception of emotions indeed exists. The only flaw here is that this dynamic has not been proven within the political analysis of this thesis. This does not mean that this dynamic is not in fact present. Indeed, increasing amounts of research are being carried out for this purpose in anticipation of long-term exploration missions to the Moon and Mars and it is obvious that this dynamic is indeed present:

These findings suggest that participants not only needed significantly more time with increasing time spent in HDBR [head-down tilt bed rest] to identify the correct emotion, but they also developed a response bias from responses of neutral or positive valence to responses of negative valence. The spaceflight relevance of a deterioration of emotional processing with increasing time in mission cannot be overstated, especially for exploration space missions (Basner et al. 2021, 10).

8.1.2 Global analysis of New Materialism

As Table 9 demonstrates, the new materialism pillar has been convincingly corroborated by the archival analysis. It is in fact the pillar with the best match within the entire NSM analysis. Faced with these results, we can affirm without hesitation that the spacecraft involved in human

spaceflight can be considered as performative actors. Here, we can again recognize the three criteria (codes) allowing us to identify an object as being performative. First, we have the NMA code which considers spacecraft to be pedetic actors which means that they have a certain autonomy. They are not fundamentally dependent on human action, and we cannot predict all their effects, movements, and actions. In regards to the ASTP docking module, the archive analysis demonstrated that the essential elements to the success of the docking mission depended on the autonomy of the docking module. This autonomy is important for the success of the mission given that it was also responsible for ensuring the survival of the crews of the Apollo and Soyuz spacecrafts giving it an even more important role and agency. The case of the Spektr module of the Mir station made it possible to highlight with even more depth the pedetic aspect of spacecraft. Despite the fact that this module is an automatic and autonomous object –as was the case for the ASTP docking module–, the latter did not act in a 100% predictable and repeated manner on several occasions. This was particularly the case during the docking of Spektr at Mir station where the latter failed, causing anxiety and unpredictability for the station crew and ground teams. The case of the ISS certainly constitutes one of the most convincing examples of a pedetic actor with its thousands of emergency measures and protocols which act autonomously and automatically. Indeed, whether for the suppression of fires or the toxic gas management, the pedetic character of the ISS is at the heart of its operation and its reason for being.

Regarding the NMB code which stipulates that spacecraft must be considered as participating in an iterative, ongoing, and indeterminate processes, this has also been well corroborated by the analysis of archives. Indeed, each object of study made it possible to corroborate one or more facets of this code. The ASTP docking module highlighted the fact that the latter had an ongoing impact over time by essentially acting as the blueprint for the docking

module which is still in use today. The Spektr module allowed us to highlight the indeterminate aspect of the object given the numerous reversals and unforeseen events that affected Spektr throughout its existence. Finally, the ISS emergency protocols made it possible to highlight all aspects of the NMB code, but it highlighted in particular its iterative aspect. Indeed, as astronaut Peggy Whitson pointed out, when a major emergency arises on board the ISS, a special team is formed within the ground team which is responsible for reviewing all the issues of the problem in a very repeated, iterative manner which also necessitates constant communication with the station teams.

The third and final code within the new materialism (NMC) framework identifies that spacecraft are relational objects. This code is crucial given that it would be difficult to recognize a certain agency in an object without being able to identify its ability to maintain a relational capacity with the world around it. Once again, the three objects of study were found to be highly relational objects. The ASTP docking module made it possible to demonstrate the important relationship that it maintained with other spacecrafts. Indeed, once the connection has been established between the docking module and the Apollo and Soyuz spacecrafts, we had a situation of relationships that were both intrinsic and multiple and which included sharing electrical power, communications and environmental control at the same time. In a rather dramatic way, the archives demonstrated that the Spektr module maintained important relationships. This was particularly illustrated with the loss of Spektr following the collision with the Progress spacecraft. Indeed, it was this complete loss of Spektr's relationships with the rest of the Mir station and its personnel on board that demonstrated just how important the module's relationships are. Finally, the emergency protocols of the ISS made it possible to demonstrate a triple relationship maintained by the station. Indeed, via its alarms, codes and signals the ISS maintains relationships with the personnel on

board the station. Via automated systems, the emergency protocols maintain relationships with other systems on board the station, notably to prevent the spread of a fire or gas leak. Finally, emergency protocols maintain close relationships with personnel on Earth as the ISS was built to be almost entirely controlled from the ground.

It goes without saying that the results of the coding linked to new materialism corroborate our research hypothesis. Still, the results of this analysis also help to strengthen the general materialist argument in international relations which argues that certain objects have real political agency. Indeed, in the same way as Dittmer (2017) identified that the sheet of paper was able to influence British foreign policy through its design and its materiality within the British Foreign Office and as Piché (2015) notes that refugee boats played a significant role in making possible the “international” by creating refugee flows, our thesis defends that we can consider spacecraft as performative actors having a founding role making possible the cooperation within human spaceflight between the United States and Russia. Furthermore, this observation invites us to push further research on the subject beyond the cases of ASTP, Mir-Shuttle and ISS to determine if there are other cases of spacecraft that had a performative role. Notably, we can think of the Canadarm. Could the success surrounding the Canadian robotic arm, or even its agency, help us explain the place that Canada occupies today within human spaceflight both within the ISS program and for upcoming programs like Artemis? It also invites us to evaluate the role of the next spacecraft with a multinational vocation like Orion, Gateway, and future private space stations to know if these will also present such a performative character or if they will essentially be machines simply serving the humans.

8.1.3 *Global analysis of Science and Technology Studies*

As Table 9 demonstrates, the science and technology studies (STS) pillar had both convincing and mixed results with archival analysis. On the other hand, we can immediately assess that this connection is stronger than that of Symbiotic Realism. Let's see in more detail how the analysis of the archives of our three objects of study corroborated the two different codes of STS. The STSA code states that spaceflights are fundamentally technology dependent, and this code has been largely corroborated by the archival analysis. Indeed, regarding ASTP, the archives have clearly demonstrated that the entire enterprise which led from the conceptualization to the creation of the ASTP docking module was dependent on technology. The same goes for the Spektr module where the final report of the Shuttle-Mir program noted that it was technology and particularly technical collaboration that made the Spektr project possible. Certainly, one of the most convincing examples of technology dependence is that of the emergency protocols of the ISS. Indeed, the analysis of the coding of the archives made it possible to identify on multiple occasions that the emergency protocols of the ISS would not have been possible without technology and especially without the coordination between the different technological capacities of different countries.

The second code (STSB) of Science and Technology Studies stipulates that within human spaceflight missions, scientists and engineers are acting as collaborative spacecrafts advocates. In other words, this implies that they would have some capacity to influence policy in favor of the option of cooperation and collaboration. The results of the archival analysis are mixed, but still rather favorable. The issue is that we have not been able to identify any archival documents, particularly documents written by engineers, clearly presenting a dynamic where the latter would have sought to influence policy. This observation was, in a way, predictable given that it was expected that the archives would contain mainly technical documents and not opinion articles. This is furthered by the logic that we do not expect scientists and engineers to keep logs indicating their

political actions. Faced with this issue, it was therefore necessary to analyze the influence of scientists and engineers within the archives in an indirect way. It turned out that for all our subjects of study, it has been possible to identify several dynamics demonstrating that scientists and engineers played a fundamental pioneering role leading to a collaborative mission. As for ASTP, the archives were able to demonstrate how easy collaboration was between engineers and scientists from two different countries, speaking a different language and using equally different space technologies. It was also possible to identify that the very use of Apollo components to carry out a collaborative mission was an idea stemming from the engineers and scientists of the Apollo program. The analysis of the archives of the Spektr module made it possible to highlight that it was easy for scientists to put aside personnel and political differences in favour of greater cooperation, as Bill Reeves, flight director of the Shuttle-Mir program explains: “if you take a technical problem and you lay it on the table with a bunch of engineers, I don't care what part of the world they come from, sooner or later you're going to get to pretty much the right answer, and the right answer always kind of looks the same, no matter where you're coming at it” (Wright, Davison, and Butler 1998, 19). Regarding the emergency protocols of the ISS, it was possible to demonstrate that several essential elements of the ISS program such as the design of the space suits were negotiated in a collaborative manner between engineers and scientists from the two countries. Additionally, it also appears that engineers from NASA and ROSCOSMOS are permanently based in the other country's control centers to be able to collaborate effectively in an emergency. Here again, it is evident that we are faced with a clear dynamic that demonstrates the limits of archival analysis. Certainly, the analysis of archives allowed us to explore our material objects of study in detail, but it proved to be of little use in exploring certain human behaviors towards these objects as was the case for the perception of emotions in outer space. It is clear that here too, the use of directed interviews with space engineers and scientists would have allowed us to more directly identify

whether they attempted to influence political decisions. However, that being said, this would have been done at the expense of our approach which sought to give voice to our objects of study and not through the interpretation of individuals. Such interviews are therefore subject to future studies complementary to the results of this thesis.

Ultimately, even though the STSB code has been identified in a rather indirect way, we can affirm that Science and Technology Studies corroborates our thesis. Indeed, it has been possible to identify on multiple occasions that not only is the entire enterprise leading to the completion of a collaborative human spaceflight technology dependent, but this collaboration is made possible in large part thanks to the work and especially at the initiative of scientists and engineers. Obviously, without discrediting the value of our results, it is certain that further research on this subject would further strengthen this observation, particularly with the help of targeted interviews with scientists and engineers who have worked in a collaborative human spaceflight mission. The results of our research help to strengthen and reiterate the materialism argument, namely that in certain circumstances such as those of human spaceflight, technology and scientists can have political influence. This corroborates Kaufman's argument which defends that technology must be perceived as an actor in its own right within IR (Kaufman 2019, 141). Thus, in the same way that French scientists in the 1970s influenced the diffusion of public policies regarding the electrification of transport (Callon 2012), space scientists had a certain influence on the nature of collaboration in human spaceflight.

8.2 Global Analysis of New Space Materialism and Validation of the Hypothesis

We must now validate the main research hypothesis of this thesis, which posited that *we can understand cooperation between the United States and Russia in human spaceflights through the framework of New Space Materialism which emphasizes the role of precarity, objects and*

technology. In concluding this thesis, we can validate the hypothesis, but some nuances must be clarified.

First, we can validate the hypothesis because, in the same methodological logic that guided this thesis, New Space Materialism constitutes an interesting tool for understanding cooperation within human spaceflight. This thesis does not claim to propose a formal IR theory that can explain the entirety of phenomena linked to human spaceflight. Rather, it constitutes more of a toolbox, a theoretical approach allowing us to grasp the most important parameters of cooperation in human spaceflight. Thus, New Space Materialism first allows us to understand that the precarious situation present in an outer space environment constitutes part of the answer explaining why cooperation within human spaceflight seems so easy, especially considering the disconnect that exists at the international relations level between the United States and Russia on Earth. Indeed, the outer space environment presents unique parameters, as demonstrated throughout this thesis with symbiotic realism, which ensure that there exists a situation of strong multiple interdependencies between spacecrafts and humans to ensure their survival, regardless of their home port. Furthermore, one of the great explanatory powers of NSM lies in its emphasis on the importance of objects when it comes to cooperation within human spaceflight. Indeed, whether spacecraft, modules or emergency protocols, these objects have demonstrated throughout this thesis to have an essentially performative character in addition to influencing social behaviors and interactions. These objects, which are at once autonomous, indeterminate, and relational, have strongly contributed to shaping cooperation within human spaceflight between the United States and Russia. Finally, New Space Materialism allows us to understand the importance and influence that science, technology, and scientists can have on human spaceflight. Not only are they essential in building and putting into orbit the machines allowing this cooperation to be achieved, but they are also at the origin of

collaborative initiatives at the very basis of this cooperation. Ultimately, this thesis demonstrated that it is necessary to go beyond the interests of States, political leaders or geopolitical and geostrategic considerations in order to understand why and how the United States and Russia came to achieve one of the largest scientific collaborations in history in ASTP, Shuttle-Mir and ISS. To fully understand this impressive collaboration, we must adopt a non-state-centric approach that is aware of the unique influence of the outer space environment, the performative and collaborative role of spacecraft and the eminently collaborative nature of the science, technology and space scientists.

However, this theoretical toolbox has some limits. These limits do not put into question the nature and value of the arguments presented by NSM but invite us to explore and further specify certain aspects of NSM to strengthen its explanatory and exploratory potential. In fact, the analysis of the archives made it possible to demonstrate that the materialist character of this research, with its emphasis on spacecrafts as the main objects of study, made it possible to prove many interesting dynamics, but this approach also had the consequence of eclipsing an aspect which remains very important within human spaceflight and that is individuals, human beings. Indeed, the partial correspondences of the SRB code (The neurobiological nature of human beings favors symbiosis in microgravity environment) and STSB code (Scientists as collaborative spacecrafts advocates) highlight this research's blind spot, which is methodological in nature. As highlighted above, although this does not necessarily denigrate the pillar of Symbiotic Realism, more research needs to be conducted to fully understand the impact of microgravity environments on the perception of emotions in human beings. It is important to conduct such research to understand the extent to which this phenomenon (which is corroborated by scientific literature) influences social interactions and ultimately politics in outer space. The same goes for the impact of scientists and

engineers on outer space policies. Research more focused on individuals as objects of study would be able to identify whether patterns where scientists have sought to shape collaborative policies exist. Such research could notably use a methodological approach focused on guided interviews with astronauts and engineers.² Such research could essentially be complementary to NSM since not only would the objects of study be completely different (humans instead of machines and protocols), but it would also use a method much better adapted to this new object of study. Indeed, it was not possible to interview spacecraft or emergency protocols. We do not see this observation as calling into question NSM, but rather as a call to build another theoretical toolbox complementary to NSM.

Certainly, NSM constitutes a very interesting theoretical toolbox. That being said, this theoretical contribution should not also overshadow the important empirical contributions of this thesis. Indeed, this is the first time to our knowledge that the archives of ASTP, Shuttle-Mir and ISS have been studied through a political-materialist lens. Moreover, it is important to emphasize that access to the abundant archives of ASTP in digital format (hundreds of digitized documents for thousands of pages) is a first. The collection of the majority of these archives on DVD by NASA's Johnson Space Center National Archives in Fort Worth, Texas has been done especially for our thesis. Moreover, it is also the first time to our knowledge that a case of collaboration in human spaceflight has been studied in such an exhaustive manner by taking into consideration the entire space enterprise that constitutes collaborative manned spaceflight. Indeed, the empirical contribution of this thesis has also made it possible to highlight the importance of studying human

² It should be noted that the original plans for the thesis project in 2020 included conducting interviews with astronauts and engineers. A preliminary list of 164 individuals had been established. However, the COVID-19 pandemic disrupted these plans, and the focus of the thesis was concentrated on the archives for reasons of much greater accessibility and safety.

spaceflight as a whole, that is to say by studying not a specific facet of the collaboration, but rather its entirety by focusing on the connection between two vessels, the construction of a collaborative spacecraft as well as its operationalization.

8.3 The Place of this Thesis in the Analysis of International Relations in Outer Space: The Importance of Materiality

As mentioned in the introductory chapter, although a variety of social science approaches have been mobilized in this work (political science, international relations, history, geography, science and technology, sociology, etc.), this thesis is essentially inserted within the field of the politics of outer space and is directly addressed to this audience. Within this field, the arguments of the thesis are particularly addressed to the IR approach of *Astropolitik* which defends that relations between states in outer space constitute essentially a reflection of the situation of power struggle which prevails on Earth. This thesis aimed not to discredit such an approach, but rather to provide explanatory avenues that are both different and complementary in order to understand cooperation in outer space by using tools from other fields of study such as sociology and science and technology.

It is now possible to situate the place of this thesis within recent IR studies relating to international relations in outer space. As demonstrated in Chapter 2, the existing literature related to human spaceflight is very interesting and full of useful analyses. It also invites us to go beyond the state actor and to study the more marginal actors that are rarely taken into account in analyses such as spaceships and scientists. This thesis is therefore part of a new materialist movement inspired by authors such as Gamble, Hanan and Nail who seeks to understand a political phenomenon by looking at the performativity of objects. The thesis is also part of a movement inspired by STS with authors such as Latour and Barkawi who seek to understand both the impact

of technology on politics as well as the influence of scientists on politics and how they come to cooperate.

Moreover, recent studies have raised a puzzle quite similar to that identified in this thesis, namely that there is in reality a notable difference between IR on Earth and IR in outer space. We can think in particular of the recent book by Davis Cross *International Cooperation Against All Odds: The Ultrasocial World* where the author notes this dichotomy well (Davis Cross 2024). There is also the more recent paper by van Wingerden and Vigneswaran which calls for the IR field to leave the “terrestrial trap” and to consider IR in outer space as being anchored in a reality quite different from what prevails on Earth (van Wingerden and Vigneswaran 2024). It turns out that our thesis is both a complement and a contribution to these recent additions to the literature.

As for Davis Cross's book, she acknowledges that outer space has been and continue to be “a highly cooperative realm for human interaction, and this dimension deserves more attention” (Davis Cross 2024, 127). She explains that outer space is an arena in which the ultrasocial predisposition of human beings “has been particularly resonant because the idea of human space exploration inherently allows us to fulfill our ultrasocial drive. This is because, on a grand scale, space is a constant reminder of our common fragility as a single species traveling on a small planet in a vast universe” (Davis Cross 2024, 127). She gives the example of the ISS which in her opinion must constitute one of the greatest expressions of the ultrasociability of humans who have carried out this immense project of unparalleled scientific collaboration (Davis Cross 2024, 163). She also notes that outer space exploration, even during the exploration of the Moon by the United States from 1969 to 1972, has essentially taken on an ultrasocial character and not fundamentally national one: “The idea of exploring and understanding space has clearly been a fundamentally human, rather than purely nationalistic, endeavor. Public enthusiasm for the adventure of space, and the

celebration of any milestone as a human accomplishment, has always been evident” (Davis Cross 2024, 173). After all, it is true that the first words spoken by humanity on the Moon were “It’s one small step for man, one giant leap for mankind” and not for the United States. Davis Cross justifies this analysis by arguing that international cooperation against all odds in outer space can be explained by the fact that “space has been about the common identity of humans as a species and the fact that we are all traveling through space on planet Earth together, a “pale blue dot” in a vast universe” and that “it is precisely because of the idealism, aspiration, and optimism—the ability to fulfill our ultrasocial drive—that the Spaceflight Idea has been consistently championed all over the world” (Davis Cross 2024, 173).

We agree with Davis Cross's thesis since it helps to understand why IR in outer space are different from what prevails on Earth. However, it seems obvious to us that in order to have a complete picture of the situation, particular attention to the materiality specific to outer space is necessary. This is where one of the most important contributions of our thesis lies. New Space Materialism allows us to grasp the political reality within human spaceflight while being aware of the importance of space objects and the unique outer space environment. We therefore see our thesis, the theoretical toolbox that constitutes New Space Materialism, as being able to very well complement that of Davis Cross, without necessarily denying it.

This emphasis that our thesis brings on the importance of materiality in order to understand IR in space corresponds exactly to the call of Wingerden and Vigneswaran in their paper “*The Terrestrial Trap: International Relations Beyond Earth*” (van Wingerden and Vigneswaran 2024). In our opinion, our thesis even constitutes a contribution to their paper, enriching the vision according to which one must consider materiality in outer space as being different and this has certain consequences on politics in this unique environment. Indeed, not only do Wingerden and

Vigneswaran agree that IR in outer space are not simply a reflection of that on Earth (van Wingerden and Vigneswaran 2024, 600), but they argue that “space politics beyond zones of human habitation is more than an extension of terrestrial politics, as it is shaped through the intersection of the specific material conditions” (van Wingerden and Vigneswaran 2024, 603). They also contradict the view that the unique environment of space and its inherent materiality is merely an engineering challenge and has no real impact on politics (van Wingerden and Vigneswaran 2024, 610). On the contrary, in a manner similar to what we have argued in our thesis, they argue that:

The extreme material conditions of space influence how human endeavours in space are planned and regulated, as scientists, lawyers, and politicians transform Earthly frameworks to these specific circumstances. These material circumstances are also expected to influence the feasibility and methods of emergent space initiatives – for example, space resource extraction – as the specific composition of different celestial bodies such as asteroids and the Moon shapes how geopolitical tensions and conflicts over resource ownership and utilization may play out. [...] Therefore, material conditions are key to studying politics beyond Earth. Understanding how the politics of outer space is influenced by its material conditions fits within longer trends of materialist theorizing (van Wingerden and Vigneswaran 2024, 612).

They also add in a way that could not have been said better that:

The further we move away from Earth’s most densely populated zones of human habitation, the more challenging it becomes to sustain dominant political forms, and the more urgent the grappling with different material conditions. These material conditions challenge and transform the conduct of politics as developed on Earth. This raises new questions that cannot be answered by bringing extraterrestrial environments into the fold of IR’s theoretical apparatuses, but by provincializing the terrestrial grounds of political practices and ideas (van Wingerden and Vigneswaran 2024, 615).

Now, where our thesis literally contributes to van Wingerden and Vigneswaran's paper is that they specify that their contribution is essentially theoretical. Indeed, their argument constitutes a call for IR researchers to explore space politics through the lenses of a heightened sensitivity to materiality. This is exactly what we have done both theoretically with New Space Materialism, but

also in a very empirical way where we have studied the phenomenon of American-Russian cooperation within human spaceflight with an essentially materialist approach by studying the ASTP connector, the Spektr module and the emergency protocols of the ISS. The results of our empirical research support that we can understand cooperation between the United States and Russia in human spaceflights through the framework of New Space Materialism which emphasizes the role of precarity, objects and technology.

Finally, our thesis well supports a recent text by Stewart and Dittmer (*More-than-Human Space Diplomacy: Assembling Internationalism in Orbit*) which could not better complement what is put forward in our thesis. Indeed, Stewart and Dittmer argue that in order to understand the peaceful relationship in human spaceflight between the United States and Russia, a materialist and technological approach must be adopted. “Understanding this space diplomacy as purely the product of agreements and commissions is to understate the role of materials as diplomatic actors in the wider inter-state assemblage” (Stewart and Dittmer 2023, 26). The authors argue that the diplomacy of orbital docking should be understood as having been marked by a process where essentially technological and material solutions have made it possible to resolve a political problem (Stewart and Dittmer 2023, 26). We could not agree more with this observation by Stewart and Dittmer and our thesis constitutes a conceptualization of this dynamic in a pragmatic and concrete way using the theoretical toolbox of New Space Materialism.

8.4 The Place of this Thesis within IR: Cooperation under Scarce Resources and Human Beings in Outer Space

The results of our thesis also make a contribution to the field of IR as a whole. Beyond New Space Materialism which can be used as an IR toolbox to analyze other cases of human spaceflight, this thesis also makes it possible to contribute to a particular aspect of IR studies which concerns

the issue of cooperation and conflicts in situations of scarce resources. As mentioned in the introduction of this thesis, a literature exists in the discipline of international relations looking at the relationship between resource scarcity and conflict and cooperation. The majority of studies tend to demonstrate that in situations of scarce resources, actors will be more likely to enter into conflict (Dawson, Rosin, and Wald 2017, 1). Dawson, Rosin and Wald add that a situation of scarce resources can also lead to the aggravation of tensions between two actors that already have a difficult relationship. We could list several studies supporting this observation. Kistruck et al. (2016, 1174) defend that it is not a collaborative structure, but rather a competitive one that “lead[s] to higher levels of motivation within a resource scarce environment”. In their experimental field research in Ethiopia, Gatiso, Vollan and Nuppenau (2015) demonstrated that individuals tend to be much less cooperative in situations of scarce resources. However, our thesis has highlighted an opposite dynamic, focusing on when human beings are in outer space which probably constitutes one of the scarcest environments for humans. Indeed, we see that cooperation between the United States and Russia is quite exemplary and much more important in the resourceless environment of outer space compared to a multitude of examples on Earth where resources are abundant, and cooperation is deficient or absent. When humans are in outer space, scarce resources contribute to greater cooperation between the spacecrafts and individuals who venture there, regardless of their country of origin.

In order to fully understand this dynamic, it is important to recall the extent of the lack of resources, the scarcity and especially the extreme precariousness that exist in outer space for human beings. Indeed, despite the fact that human spaceflight missions are supported by some of the most technologically advanced objects ever designed by mankind, as well as a myriad of redundant systems and thousands of people on Earth in control centers, the fact remains that outer space is

the most hostile environment for humans and a deadly catastrophe can occur at any time in a few seconds despite the presence of all this technology. As presented in detail in Chapter 3, the parameters specific to the outer space environment ensure that despite all the technology and support that are present to support human spaceflight, the scarcity equation does not change. Quite the contrary. This dynamic can be illustrated by very concrete physical realities and notions. We can think in particular of the notion of kinetic energy. Indeed, a small piece of debris of barely 1 centimeter can cause an explosion as powerful as a hand grenade and destroy any spacecraft in its path. The same goes for the notion of the Kessler syndrome which stipulates that in a zero-gravity environment, such an impact causing space debris can lead to a multiplication an exponential multiplication of debris and theoretically mappable to an infinite scale. Finally, we can also think of the notion of escape velocity which explains that if an object in outer space collides with a spacecraft, it will go at a relative minimum speed of 7.8 km/s, with not only an astronomical kinetic energy compared to what the same object would have on Earth, but also with the capacity to make its orbit inaccessible (or rather unusable) for the next several hundred thousand years because of the consequences of the Kessler syndrome. Such parameters that make the situation in outer space so precarious have no comparison on Earth. Not only does this make any direct armed conflict in outer space virtually impossible, but it also explains why collaboration between two countries exploring outer space together must be impeccable. Indeed, a simple mistake due to a lack of collaboration, coordination, communication or even negligence could result in “denying the use of Earth orbit to all spacecraft virtually forever” (Steer and Hersch 2021, 8).

In fact, the three pillars of NSM supports this direction. Regarding symbiotic realism, as Al-Rodhan stated: “outer space will either be safe for everyone or for no one” (Al-Rodhan 2012, 215). Indeed, the parameters of the outer space environment, demonstrated throughout this thesis, tend

to favour a situation of interdependence between spacecrafts and the individuals on board to ensure their survival, and contributes to cooperation despite the situation of extreme scarce resources. There must be very few environments where the scarcity of resources is as important as in outer space, where all possible resources are extremely rare and limited. However, given the environmental parameters that prevail in outer space, the interdependence between humans and their spacecraft pushes the latter to collaborate instead of causing conflict to preserve the integrity of these rare resources. We can take for example the case of oxygen which constitutes a rare resource in human spaceflight. The analysis of our three objects of study demonstrated that during ASTP, Shuttle-Mir and ISS, the United States and Russia collaborated extensively to manage this rare resource in the most efficient manner possible. The same goes for access to drinking water. Our analysis demonstrates that the two countries collaborated and not competed to effectively manage these scarce resources. The other two pillars of NSM also favor cooperation over competition in resource management. New Materialism has demonstrated that the automatic and relational nature of spacecraft works, among other things, to preserve resources such as oxygen and drinking water in a collaborative manner. The ASTP docking module, the Spektr module and the ISS are objects where the management of these rare resources is done in an intrinsic collaborative way. Regarding the pillar of STS, this only reinforces this dynamic given that it has been demonstrated that technology, engineers, and scientists have worked on mutual and collaborative management of resources and not on a competition over them.

The results of our thesis therefore contribute to strengthening this marginalized facet of the literature which argues that situations of scarce resources can be beneficial for cooperation. In their book *Global Resource Scarcity: Catalyst for Conflict or Cooperation?* Dawson, Rosin and Wald (2017) posit that a situation of scarce resources can lead to increased cooperation when there is

“shared interest in the current and future benefits of access to resources” (Dawson, Rosin, and Wald 2017, 6). They note that currently “the most common areas for such peacebuilding involve transboundary management of water, nature conservation parks and international or global governance agreements” (Dawson, Rosin, and Wald 2017, 6). It therefore seems necessary that we add the area of human spaceflight to this list of examples being most likely to witness cooperation in a situation of scarce resources.

9. Bibliography

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