PHILOSOPHY AND THE PRINCIPLE OF THE CONSERVATION OF ENERGY

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CURRICULUM STUDIORUM

Robert A. Larmer was born March 21, 1954, in Millbrook, Ontario. He received the Bachelor of Arts degree in Philosophy from Carleton University, Ottawa, Ontario, in 1979. He received the Master of Arts degree in Philosophy from the University of Ottawa, Ottawa, Ontario, in 1981. The title of his thesis was The Question of Miracle.

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INTRODUCTION

My aim in this thesis is to explore the philosophical significance of the Principle of the Conservation of Energy. I argue that this Principle is linked, both historically and logically, to the Principle of Sufficient Reason and the Principle of Universal Causality. As I shall show, it is relevant to discussions concerning the possibility and plausibility of uncaused events, mind-body interaction and miracles. It provides, therefore, an important subject for philosophical investigation.

To achieve my aim, I have undertaken three related tasks. The first is to explore the historical and logical roots of this Principle. I have undertaken to show that, in addition to its basis in experimental science, this Principle is linked to the Principle of Sufficient Reason and the Principle of Universal Causality. Demonstrating the existence of these links makes clear that, although they have hitherto been melded together and gone unnoticed, there exist two distinct forms of the Principle. One of these is the claim that energy is conserved in an isolated system;

the other is the claim that energy can neither be created nor destroyed. The relation between these two claims is that the latter implies the former, but not vice-versa.

My second task is to explore the relevance and significance of this distinction. Considerable attention needs to be devoted to the question of why these two forms of the Principle have not hitherto been distinguished.

My third task is to assess the relevance of the Principle to three philosophical issues of importance and debate. These are: (i) the implications of the claim that uncaused events occur, (ii) the claim that mind-body interaction, if it occurs, violates the Principle of the Conservation of Energy, and (iii) the claim that miracles, if they occur, violate the laws of nature.

My method of conducting this investigation largely parallels these three tasks. I begin by placing the Principle of the Conservation of Energy into its historical context. I then consider some logical issues pertaining to the nature of energy, the relation of this Principle to two other important Principles, namely the Principle of Sufficient Reason and the Principle of Universal Causality. I also note that we must distinguish between what may be called the strong form of the Principle, i.e., the claim that energy can neither be created nor destroyed, and what may be called the weak form of the Principle, i.e., the claim that energy is conserved in a causally isolated system.

Next, I discuss how the Principle of the Conservation of Energy enters into discussions of three important issues, namely issues of causality, mind-body interaction and miracles. I argue that many of the problems associated with these issues must be reassessed and viewed in a new light. These problems may not be so intractable as they seem.

Finally, I further discuss the distinction which must be drawn between the strong and the weak form of the Principle. I consider the relation of these forms to one another and their relation to the experimental evidence which is usually taken to confirm the Principle of the Conservation of Energy.

CHAPTER ONE: SOME HISTORICAL CONSIDERATIONS

My aim in this thesis is to examine the philosophical significance of the Principle of the Conservation of Energy. This examination is largely independent of historical considerations, but not wholly so. Unlike Minerva, important ideas and concepts rarely emerge fully developed. If we are to understand them it is important to have some knowledge of the historical process by which they developed.

This being the case, it is appropriate to begin with some historical considerations. Examination of these should accomplish two things. First, it will make clear the importance of a fact frequently overlooked in the attempt to explain the ready acceptance of the Principle of the Conservation of Energy in the mid-nineteenth century, namely that there already existed a well-established tradition of searching for conservation principles, and that the history of conservation principles is largely one of revising and clarifying earlier guesses concerning the nature of that which remains invariant. Second, it will serve to lay bare some of the roots of the Principle, thus setting the stage for the logical considerations discussed in chapter two.

SOME HISTORICAL CONSIDERATIONS

Any historical account of the Principle of the Conservation of Energy must come to grips with the fact that in the mid-nineteenth century "the idea was 'in the air' and just ripe for acceptance by the world of science."[1] It provides a remarkable example of a phenomenon known as simultaneous discovery. Between the years 1842 and 1847, this Principle was announced by no fewer than four widely scattered European scientists - Mayer (1814-1878), Joule (1818-1889), Colding (1815-1888), and Helmholtz (1821-1894) - all of whom, except for Helmholtz, were working in complete ignorance of the others.[2] This fact takes on even more significance when it is realized that the announcements of these men were unique only insofar as they combined concrete quantitative applications with generality of formulation. A large number of other scientists of the time independently recorded views that bore remarkable similarities to the Principle of the Conservation of Energy.[3] Although they studied only one special case of energy conservation, Sadi Carnot (1796-1832), Seguin[4] (1786-1875), Holtzmann (1811-1865), and Hirn (1815-1890) were convinced that heat and work are quantitatively interchangeable and attempted to compute a value for the conversion coefficient.[3] In a more general vein, others such as Mohr (1806-1879), Grove (1811-1896), Faraday (1791-1867), and Liebig (1803-1873) postulated that there exists but a single 'force' in nature. This 'force', they hypothesized, could appear in thermal, dynamical, electrical, or other guises, but it could never be created or destroyed.[4]

Such a remarkable convergence of opinion including the views of a large number of independent investigators working in different areas of scientific research needs to be explained. Attempts to do this usually concentrate on a concatenation of factors operating in the late eighteenth and early nineteenth centuries. Important as the interplay of such factors was, it is nevertheless a mistake to emphasize their role too heavily. To do so leads to an explanation that is essentially incomplete in that it ignores a very old and influential tradition of searching for conservation principles. This tradition is evident in even the earliest stages of science and philosophy and was a crucial precondition for the discovery of the Principle of the Conservation of Energy. It must, therefore, figure in any adequate explanation of the discovery and ready acceptance of the Principle.

That this tradition must be taken into account can be demonstrated by examining an essay by Thomas Kuhn entitled,

Some Historical Considerations

"Energy Conservation As An Example Of Simultaneous Discovery." In this essay Kuhn attempts to explain the discovery and ready acceptance of the Principle in terms of three factors operative in the late eighteenth century and the beginning of the nineteenth century. In the following paragraphs I shall briefly examine these factors. I shall argue that they do not wholly explain the discovery and acceptance of the Principle of the Conservation of Energy. I wish to emphasize that my point is not that these factors were unimportant. On the contrary, they were extremely important and go a long way towards explaining why the Principle was accepted at the particular time that it was. Rather, my point is that important as the factors were, they do not in themselves constitute a sufficient explanation of the predisposition of scientists to accept this Principle.

The first factor which Kuhn suggests was very important was the discovery and availability of a large number of conversion processes. Scientists in the early part of the nineteenth century were beginning to realize, and perhaps more importantly were beginning to be able to demonstrate experimentally, the interconnectedness of phenomena hitherto viewed as disparate. Experiments early in the century by scientists such as Oersted (1777-1851) and Faraday (1791-1867) showed that electricity, magnetism and motion are inter-convertible. Somewhat later, but still early in the century, the development and progress of photography[5] provided yet another conversion process to ponder.

Another significant factor was the development of the steam engine in the eighteenth century by men like Newcomen (1663-1729) and Watt (1736-1819). This provided scientists with a conversion process connecting heat and motion and focussed their attention on how to make these engines more efficient. The result of this practical concern was twofold. First, it made scientists examine the quantitative aspects of conversion processes and encouraged them to conceive of cause and effect as mathematically equivalent.[6] Second, it made them develop practical engineering concepts and encouraged them to apply these concepts in their attempts to derive conservation laws.

Finally, Kuhn suggests, the German school of philosophy known as _Naturphilosophie_ played a significant role in the ready acceptance of the Principle of the Conservation of Energy. He notes "that many of the discoverers of energy conservation were deeply predisposed to see a single indestructible force at the root of all natural phenomena."[7] "Put bluntly, these pioneers seem to have held an idea capable of becoming conservation of energy for some time before they found evidence for it."[8] He further notes that, although Germany had not at this time the scientific eminence it was to achieve later in the century, a large number of the pioneers of energy conservation were German scientists who had, in one way or another, been influenced by *Naturphilosophie*.[9] He also feels that it is significant that it is possible in a number of cases of non-German pioneers of energy conservation to trace some link to *Naturphilosophie*.[10] For this reason, although he is careful to indicate that further research is needed, Kuhn thinks it is very likely that the influence of *Naturphilosophie* was a major factor in the discovery and easy acceptance of the Principle in the mid-nineteenth century.[11]

All these factors were significant and must figure in any explanation of the discovery of the Principle of the Conservation of Energy. Equally significant - but not adequately explained by Kuhn - was the predisposition of scientists to adopt the Principle. Kuhn attempts to explain this predisposition as the result of the influence of *Naturphilosophie*, but it is clear that such an attempt must fail in that it ignores the fact that there was a well-established tradition of searching for conservation principles long before the rise of *Naturphilosophie*.

From the historical point of view, the Principle of the Conservation of Energy is merely the latest, albeit the most inclusive and well-supported, in a long series of conservation principles which stretch back to the pre-Socratic philosophers.[12] Insofar as these earlier conservation principles were formulated and readily accepted long before Naturphilosophie came into existence - indeed long before the existence of a large number of conversion processes became known or quantified, and certainly before the development of the steam engine - the predisposition of scientists to accept the Principle of the Conservation of Energy cannot be explained in terms of any of the factors Kuhn mentions. It is clear there are factors other than those suggested by Kuhn which largely explain this predisposition. We must, therefore, examine earlier conservation principles with an eye to laying bare what these factors were.

THE DEVELOPMENT OF CONSERVATION PRINCIPLES

Examination of the history of conservation principles reveals is that in their first formulation they were almost invariably enunciated as philosophical ideas.[13] Although the differences between these early conservation principles and the Principle of the Conservation of Energy should not be underestimated, neither should their similarities be ignored. It would be wrong to read the early Greek philosophers as if they possessed our modern concept of energy, but equally it would be wrong to deny that there are conceptual and historical links between early conservation principles and our modern Principle of the Conservation of Energy. It would be surprising if such links were not relevant to explaining its discovery and acceptance.

Although they are not always traced so far back, conservation principles were formulated in the earliest stages of philosophy. We have little direct knowledge of the writings of the Milesian philosophers, but it is evident they formulated conservation principles. Aristotle, commenting upon the thought of the Milesian philosophers, wrote that,

> the early philosophers were content to seek a material first principle as the cause of all things. For that of which all things consist, from which they arise, into which they pass away, the substance remaining the same through all its changing states - that, I say, is what they mean by the element, or the first principle, of the things that are. And this is why they hold that, strictly speaking, nothing comes into being or perishes, since the primal nature remains ever the same. ... There must be some natural body, one or many, from which all things arise, but which itself remains the same.[14]

Conservation principles were also formulated by the Eleatic philosophers. Heraclitus, writing sometime between 500 B.C. and 460 B.C., although he emphasized change and flux, enunciated a conservation principle when he wrote, "This universe, the same for all, no one, either god or man, has made; but it always was, and is, and ever shall be an everlasting fire, fixed measures kindling and fixed measures dying out",[15] and "All things are exchanged for fire and fire for all things, just as wares are exchanged for gold and gold for wares."[16] It seems clear that Heraclitus postulated a hidden harmony, something which he called 'fire', which remains constant in the midst of process. He thought that this 'fire' constitutes the true reality underlying all visible changes. As Bruce Lindsay notes,

> in spite of his emphasis on the primacy of change, he also held that there is something invariant in the universe as a whole. This something he apparently took for fire, though he obviously did not mean fire in a modern sense, nor even in the ancient Greek practical sense. It was some ethereal essence which could be transformed into the common objects of our experience without net loss.[17]

Conservation principles are also found in the writings of the atomists and the Stoics. Consider, for example, the remark of Lucretius (95 B.C.-55 B.C.). "I have taught that things cannot be created from nothing."[18] Consider also the description given by Aphrodisiensis of Stoic thought:

> prior events are causes of those following them, and in this manner all things are bound together with one another, and thus nothing can happen in the cosmos which is not a cause to something else following it and linked with it. Nor can any one of those events happening later be separated from what happened earlier and not be tied up with one of those earlier happenings. ... there exists nor happens anything uncaused in the cosmos, because there is nothing in it which is separated and divorced from all that happened before.

> The cosmos would break up and be scattered and could no longer remain a unity ... if some uncaused movement were to be introduced into it. ... a causeless event is equal in essence to and equally impossible as a creation out of nothing.
>
> ... wherever the same circumstances prevail with regard to the cause and the things affected by the cause, it is impossible that sometimes the result should be this and sometimes that; otherwise there would exist some uncaused motion.[19]

There is not, however, much emphasis placed upon conservation principles in either the writings of Plato (427 B.C.-348/347 B.C.) or Aristotle (384 B.C.-322 B.C.).[20] One reason for this may be that they gave different answers to the question of what is the nature of the immutable principle which underlies changing phenomena than did many of their predecessors and successors. Many of the pre-Socratics sought reality in matter. They slowly developed a theory of a primary element, a theory which after many modifications culminated in the atomism of Leucippus (fifth century B.C.) and Democritus (late fifth century B.C.). In contrast, Plato and Aristotle seem to have been influenced by another tradition in pre-Socratic philosophy, i.e. the Pythagorean tradition, which held that it is not matter, but ideas or forms which possess full reality.[21] The result of this influence was that in their philosophies phenomena were explained by reference to certain essential unchanging qualities, rather than by reference to conserved quantities.

Neither is there in Medieval philosophy, influenced as it was by the idea of substantial forms, much emphasis upon conservation principles. Medieval thinkers certainly believed that there was something essential in matter, some underlying substratum which persisted through modifications, but they made little attempt at quantitative analysis of this postulated substratum.[22] They were concerned primarily with questions of qualities, not quantities. In general, conservation principles do not play a large role in their philosophy.

It is important, however, to note the influence upon Medieval philosophy of a tradition stemming from the study of mechanics. Early writers on mechanics were aware of a principle of compensation by which a gain in some vital effect is always balanced by a corresponding loss in an associated phenomenon. For example, Hero of Alexandria, writing around 60 A.D., was aware of some sort of invariance and consequent conservation principle when he noted that, "In machines in which great force is developed there is a retardation since we must use more time in proportion as the moving force is smaller than the weight to be moved. Force is to force as time is to time inversely."[23] Even earlier, it seems clear that the Pseudo-Aristotle of the Mechanica, in using the law of the lever as an explanatory concept, was impressed that something must stay the same at both ends of a lever in spite of different weights.[24]

This tradition is important. Translations into Arabic of authors such as Johannes Philoponus (A.D. late fifth century to mid sixth century) had a considerable impact on physical doctrine in the Islamic world.[25] Under the influence of such authors, Arabic philosophers questioned the Aristotelian account of motion and offered in its place, a complex theory of 'violent inclination', this being their term for something very close to our modern concept of impetus. This theorizing on the nature of motion influenced the thinking of the Latin scholastics on the subject and was an important factor in the criticism of Aristotelian doctrines made by Oresme, Buridan, Albert of Saxony, and many others in the fourteenth century.

Unfortunately, it proved difficult to integrate the insights obtained from the practical science of mechanics with Medieval and Renaissance philosophy. The dominant philosophies of the period, with their emphasis upon qualities and substantial forms, did not provide a theoretical framework into which mechanics with its emphasis upon questions of quantities could be easily fitted. It is true that the rediscovery of Aristotle provided a great thrust to Western thought and stimulated a desire for scientific knowledge, but it was not until the teleological categories into which Scholasticism analyzed change and movement had been rejected in favour of definite mathematical concepts of time and space that the insights obtained from the study of mechanics began to be readily assimilated into natural philosophy.

The work of Galileo (1564-1642) is usually taken to mark the beginning of this process. It is possible to discern in Galileo two emphases which occur again and again in later writers. The first is that there exists in nature rigorous mathematical necessity;[26] the second is that nature must be investigated and understood by means of scientific experiment.

Although he formulated no general explicit conservation principles, Galileo worked with assumptions which imply conservation principles of some sort. We find, for example, the following comment on the working of machines,

> It has seemed well worthwhile to me, before we descend to the theory of mechanical instruments, to consider in general and to place before our eyes, as it were, just what the advantages are that are drawn from those instruments. This I have judged the more necessary to be done, the more I have seen (unless I am much mistaken) the general run of mechanicians deceived in trying to apply machines to many operations impossible by their nature ... These deceptions appear to me to have their principal cause in the belief which these craftsmen have and continue to hold, in being able to raise very great weights with a small force, as if with their machines they could cheat nature, whose

> instinct - nay, whose most firm constitution - is that no resistance may be overcome by a force that is not more powerful than it.[27]

Although Lindsay oversimplifies when he says Galileo's famous pendulum experiment was "devised in order to provide an experimental basis for his fundamental assumption that when a ball falls from rest at a given height from the ground, the velocity on arriving at the ground depends only on the height and is independent of fall."[28], it is nevertheless clear that Galileo was persuaded there exists some fundamental invariance within a closed system.[29]

We find in Descartes (1596-1650), a younger contemporary of Galileo, many of the same elements of thought, albeit stated more philosophically. Descartes was interested in mechanics and, like Galileo, recognized a principle of invariance in the functioning of machines. In a letter dated Oct 5, 1637, written in reply to Huygens who had suggested that Descartes write a short treatise on mechanics, Descartes appended an Explication which he entitled "Des engins par l'ayde desqvels on pevt avec vne petite force lever vn fardeav fort pesant" from which the following interesting comment is taken,

> L'inuention de tous ces engins n'est fondée que sur vn seul principe, qui est que la mesme force qui peut leuer vn poids, par exemple, de cent liures a la hauteur de deux pieds, en peut aussy leuer vn de 200 liures, a la hauteur d'vn pied, ou vn de 400 a la hauteur

> d'vn demi pied & ainsy des autres si tant est qu'elle luy soit appliquee. Et ce principe ne peut manquer d'estre receu, si on considere que l'effect doit estre tousiours proportionne a l'action qui est necessaire pour le produire: de facon que s'il est necessaire d'employer l'action par laquelle on peut leuer vn poids de 100 liures a la hauteur de deux pieds, pour en leuer vn a la hauteur d'vn pied seulement, cetuy cy doit peser 200 liures. Car c'est le mesme de leuer 100 liures a la hauteur d'vn pied, & derechef encore cent a la hauteur d'vn pied, que d'en leuer deux cent a la hauteur d'vn pied, & le mesme aussy que d'en leuer cent a la hauteur de deux pieds.[30]

Descartes went further than Galileo in that he explicitly stated general conservation principles. Descartes felt that both the amount of matter and motion in the universe remains constant and that this constancy is a consequence of the immutability of God. He wrote,

> "... qui de sa Toute-puissance a creé la matiere auec le mouuement & le repos, & qui conserue maintenant en l'vniuers, par son concours ordinaire, autant de mouuement & de repos qu'il y en a mis en le creant. Car, bien que le mouuement ne soit qu'vne façon en la matiere qui est meue, elle en a pourtant vne certaine quantité ... qui n'augmente & ne diminue jamais ..., encore qu'il y en ait tantost plus & tantost moins en quelques vnes de ses parties. ... Nous connoissons aussi que c'est vne perfection en Dieu, non seulement de ce qu'il est immuable en sa nature, mais encore de ce qu'il agit d'vne façon qu'il est immuable en sa nature, mais encore de ce qu'il agit d'une façon qu'il ne change jamais: ... D'où il suit que ..., puis qu'il a meu en plusieurs facons differentes les parties

> de la matiere, lors qu'il les creées, & qu'il les maintient toutes en la mesme facon & auec les mesmes loix qu'il leur a fait obseruer en leur creation, il conserue incessamment en cette matiere vne égale quantité de mouument.[31]

The importance of this insistence by Descartes that the quantity of motion in the universe remains constant should not be underestimated. His work on the quantity of motion provided the starting point for the seventeenth and eighteenth century discussions on this subject which proved extremely fruitful. Nevertheless, it must be emphasized that for Descartes the conservation of motion was more a metaphysical law to be deduced _a priori_ than a scientific hypothesis to be devised and tested. As Hiebert notes, Descartes did not carefully define what he meant by conservation of motion nor did he consider the question of the units by which quantities of motion were to be measured.[32]

Like Descartes, Leibniz (1646-1716) assumed "that a heavy body, falling from any height, will have exactly or precisely the power necessary for it to rise back to the same height if it is understood to have lost no force on its way by friction or resistance by the medium or some other body."[33] Leibniz held that the same sum of motive force ... [is] conserved in nature."[34] Unlike Descartes, he felt that we must distinguish between motive force, which he termed _vis viva_, and quantity of motion. He believed that

Descartes had erred in equating the two. In an essay entitled "A Brief Demonstration of a Notable Error of Descartes and Others Concerning a Natural Law", he attempted to demonstrate this.

> In order to show what a great difference there is between these concepts [motive force and quantity of motion] I begin by assuming ... that a body falling from a certain altitude acquires the same force which is necessary to lift it back to its original altitude if its direction were to carry it back and if nothing external interfered with it. For example, a pendulum would return to exactly the height from which it falls except for the air resistance and other similar obstacles which absorb something of its force and which we will now refrain from considering. I assume also, in the second place that the same force is necessary to raise [a] body ... of 1 pound to the height ... of 4 yards as is necessary to raise ... [a] body of 4 pounds to the height ... of 1 yard. Cartesians as well as other philosophers and mathematicians of our times admit both of these assumptions. ...
>
> Now let us see whether the quantities of motion are the same in both cases. ... Galileo has proved that the velocity acquired in the fall [of 4 yards] is twice the velocity acquired in the fall [of 1 yard]. So, if we multiply the mass of A [the body weighing 1 pound] ... by its velocity (which is 2), the product, or the quantity of motion is 2; on the other hand, if we multiply the body B [the body weighing 4 pound] ... by its velocity (which is 1) the product, or quantity of motion is 4. [Leibniz then comments that although the quantities of motion of these two bodies are not equal, their motive forces are. He proposed the term <u>vis viva</u> be used to

> describe such motive force] ... There is thus a big difference between motive force and quantity of motion, and the one cannot be calculated by the other ... It seems from this that force is rather to be estimated from the quantity of the effect which it can produce; ...[35]

Leibniz' criticism of Descartes on this point sparked a lively criticism that extended well into the eighteenth century. Followers of Descartes insisted that the only genuine measure of the force of a moving body was quantity of motion and that the vis viva (mv^2) of Leibniz was not really a force at all, but merely a mathematical device. On the other hand, followers of Leibniz such as Johann Bernoulli (1667-1745) insisted that Leibniz' version of living force (vis viva) was the genuine force associated with a body in motion. Both parties agreed that 'force' was conserved, but they had not yet worked out a clear conception of what was meant by force. Eventually, the controversy came to an end when it was realized that the efficacy of a force may be measured either by its effect over time (Descartes) or its effect over space (Leibniz) and that both measures of force are legitimate.[36]

By 1750 natural philosophers were making consistent use of a restricted ideal principle of the conservation of mechanical energy.[37] Widely used though it was, it was seen to be essentially incomplete in that it only applied to the interaction of perfectly inelastic bodies. Early investigators were quite aware that there exist in nature no completely rigid, frictionless, mechanical systems and that in the case of collisions between elastic bodies, i.e., deformable bodies, there is at least apparently neither conservation of Descartes' quantity of motion (momentum), nor of Leibniz' vis viva (kinetic energy). They refused to accept that conservation principles apply only to the interaction of perfectly inelastic bodies and hence only to ideal systems, however. They sought to demonstrate that conservation principles also apply to the interaction of elastic bodies.

Two main arguments were invoked to establish that conservation principles could be applied to the interaction of elastic bodies. One was to argue that momentum and vis viva could be stored "in the form of constraint or of unreleased compression - an internal tension of some kind which is nevertheless stored by the body in a manner similar to the way in which virtual work [vis viva] is stored in a raised weight."[38] Thus the loss in momentum or vis viva is only apparent, in reality it is not lost, only stored.

The second and more common argument was that the quantity of motion or vis viva apparently lost in the interaction of macroscopic bodies was not really lost, but merely transferred from the macroscopic bodies, where it could be observed, to the internal invisible components which make up the macroscopic bodies, where it could not be observed. This hypothesis allowed investigators to adhere to a conservation principle while at the the same time admitting that at the phenomenal level there is no apparent conservation of motion or _vis viva_.

This latter argument is quite old. It was at least partially a concern with the problem of inelastic collisions, i.e. collisions between deformable bodies, which led Gassendi (1592-1655) to revive the atomic physics of Epicurus (341 B.C.-270 B.C.) and develop the notion that a constant amount of impetus resides in atoms.[39] Atomism provided Gassendi with a powerful theoretical framework with which to deal with the problem of inelastic collisions. He argued that atoms have an inherent force (_vis_) which is not destroyed when complex substances come to rest; it is merely impeded or held in check. Similarly, when complex substances begin to move, force is not created; the force inherent in atoms merely acquires its freedom.

These arguments, however, remained speculative in the absence of a means to quantify the force which is presumably stored or transferred to the internal particles making up the macroscopic bodies in question. If they were to be made scientific it was necessary that in cases of apparent loss of motion or _vis viva_ some experimental method of measuring this force be found. Given that in inelastic collisions momentum and kinetic energy is transformed predominantly into heat, it was important that some method be found of quantifying heat. Without some experimental means of measuring its intensity and capacity, investigators could not establish a mathematical equivalence between apparent losses of mechanical work and the heat gained by bodies during inelastic collisions.

The task of demonstrating this equivalence was accomplished in the early and mid-nineteenth century. Early in the nineteenth century scientists such as Rumford (1753-1814) demonstrated that the hypothesis that heat is a substance is untenable. This finding opened the way for the rival conception of heat derived from early theories of atomism, namely that heat is a consequence of the movements of the ultimate particles of matter. This theory implied that there should exist some numerical equivalence between quantities of heat and quantities of work and focussed the attention of scientists upon the problem of demonstrating this equivalence.

That there is an exact relationship between heat and mechanical work was established in the main by the researches of Joule (1818-1889), Mayer (1814-1878), Colding (1815-1888), and Helmholtz (1821-1894). Through their experiments it became clear that the idea that force or energy is conserved not only in elastic collisions but also in inelastic collisions could be experimentally confirmed.

From this demonstration of an exact equivalence between work and heat it was but a short step to the conclusion that heat, like mechanical work, is merely one form of energy. It comes as no surprise, therefore, to learn that by the mid-nineteenth century the notion of force or energy had been broadened so as to include many phenomena formerly not thought to be related, e.g. motion and heat.

The tendency of this period was to broaden the concept of energy in order to claim a greater degree of inclusiveness for the Principle of the Conservation of Energy. This tendency reached its culmination in the work of Einstein (1879-1955). Einstein, following in the the steps of these nineteenth century scientists, further broadened the concept of energy and vividly demonstrated the inclusiveness of the Principle of the Conservation of Energy when he showed that mass itself may be considered a form of energy.

CONCLUSION

Even such a brief historical excursus as this demonstrates the importance of the notion of invariance. Historically, it is easy to demonstrate that the Principle of the Conservation of Energy is but one, albeit the latest and empirically best grounded, in a long line of conservation principles. Like the Principle of the Conservation of Energy, all these preceding conservation principles were closely connected with the conviction that there exists in nature something which remains invariant in the midst of change. It is this conviction which underlies not only the predisposition of the scientists of the mid-nineteenth century to accept the Principle of the Conservation of Energy, but the willingness of earlier investigators to postulate and accept conservation principles far in advance of the empirical data needed to establish them.

The notion of invariance is, therefore, an important one. If we are to understand the readiness of scientists to believe in conservation principles it is essential that we examine this notion further. Only if this is done, only if the conceptual roots of this notion are laid bare, will it be possible to explain the predisposition to believe in conservation principles. It is to this task that I turn in my next chapter.

CHAPTER TWO: SOME LOGICAL CONSIDERATIONS

THREE CONCEPTUAL ELEMENTS OF CONSERVATION PRINCIPLES

I suggest that the emphasis that is placed upon the notion of invariance and consequently upon the notion of conservation arises because of the interplay and synthesis of three factors. These are: (i) a deep-seated conviction that that which changes must ultimately be explained by reference to that which does not change, (ii) an adherence to the Principle of Sufficient Reason, and (iii) experience of the empirical world. Concerning (i) it is our conviction that if what changes is to be explained then it must be explained in terms of something that does not change which leads us to search for something which remains invariant in the midst of process. Concerning (ii) it is our adherence to the Principle of Sufficient Reason which persuades us, even in advance of positive experience, that that which changes may be explained. Concerning (iii) it is our experience of the empirical world which confirms our expectation that there is something which remains invariant and which teaches us what this something is. In the following paragraphs I will describe these factors more fully and say something more about how they interact to produce in us belief in the Principle of the Conservation of Energy.

Conservation principles arise out of the need to explain a world which sense experience reveals, at least apparently, to be constantly changing. In attempting to explain this world of changing phenomena, we typically seek something which remains constant in the midst of change. This search is the expression of a very deep and fundamental conviction. It is that that which changes is less ultimate than that which does not change and can only be explained by reference to it. Put somewhat differently, it is the conviction that the only sufficient reason for that which is conditioned in time is something which is not conditioned in time.

We are, however, not only convinced that if the changing world which sense-experience reveals is to be explained then there must exist something which remains itself unchanged. We are also convinced that there is something which persists unchanged and which serves to explain the world of changing phenomena. We believe this by virtue of another very deep and fundamental conviction. It is the conviction that changes can indeed be explained; that for every event which occurs there is an explanation. Put somewhat differently, our belief that the world of changing phenomena can be explained is an expression of our belief in the Principle of Sufficient Reason which states that for everything which happens there is a sufficient or determining reason why it should happen.

Conjoined, these two beliefs that (i) if change is to be explained it must ultimately be explained by reference to that which does not change and (ii) the conviction that change may indeed be explained, produce an allegiance to the idea of invariance. It is this allegiance which explains the fact that conservation principles have always played an important role in science and have typically been accepted far in advance of the empirical evidence needed to establish them. We feel not only that if the sensible world is to be explained there must be something which remains invariant, but that the sensible world may indeed be explained. We have, therefore, proved extremely ready to postulate conservation principles of one sort or another.

The actual process of revision and broadening of conservation principles which is so evident a feature of the progress of science is due to the influence of the third factor which has been mentioned, namely the influence of empirical data. We are, because of our conviction concerning the nature of explanation, and our loyalty to the

Principle of Sufficient Reason, firmly convinced that something remains constant and invariant in the midst of change. Applied indiscriminately, this idea of invariance would imply that everything persists, a conclusion immediately denied by experience. The conviction thus held is not that everything persists, but that certain essential things persist. What we find, though, is that this conviction, taken by itself, gives no clue concerning the nature of that which remains invariant. We have a fundamental conviction that something persists unchanged, but the question of what this is must be answered by an appeal to experience. Mach made essentially this point when he wrote of the role the Principle of Sufficient Reason plays in physics.

> The law of sufficient reason is an excellent instrument in the hands of an experienced investigator, but is an empty formula in the hands of even the most talented people in whom special knowledge is lacking. ... On this account - and history teaches this - it [i.e. the theorem of excluded perpetual motion which Mach regards as a consequence of the Principle of Sufficient Reason] has found more and more application in physics as positive knowledge progressed.[1]

We must, therefore, if we are to say what remains invariant, be able to refer to some body of experience. It should be noted that this experience needs to be of the disciplined and cumulative sort characteristic of scientific investigation. As we have seen, the history of conservation principles is largely one of revising and clarifying earlier guesses concerning the nature of that which remains invariant.

THE NATURE OF ENERGY

The interplay of our commitment to the Principle of Sufficient Reason and our need to give empirical content to it explains why conservation principles are postulated even before the concepts involved are precisely articulated, and why these concepts are typically revised, modified, and broadened in the face of experience and accumulating empirical data. Emile Meyerson described this process well when he wrote,

> conservation is postulated even before the concept is precisely stated. We want something to be conserved. Descartes and his contemporaries affirm it, though completely deceived as to the nature of what is conserved. ... it is clear that the discovery of Mayer and Joule only substituted one concept of constancy for others, already pre-existing, which it destroyed by that very fact. Leibniz supposed mechanical energy to be indestructible and, on the other hand, Deluc, Black, and Wilke admitted the indestructibility of heat-matter. What we call the principle of the conservation of energy consists in the opposite proof, namely that heat as well as mechanical energy, taken separately, can be created and destroyed, the disappearance of mechanical energy being accompanied by the appearance of a certain quantity of

heat energy and vice versa.[2]

Unfortunately, this broadening of scope makes it very difficult to discuss the nature of energy. When the concept of energy was associated primarily with the realm of mechanical phenomena it seemed clear that there were only two forms of energy; potential energy (U) which depended upon position, and kinetic energy (T) which depended upon velocity. It was thought that the claim that energy is conserved amounted only to the claim that the sum of T + U remains constant.

Clearly, if this were true, energy could be defined unambiguously. As Poincaré noted:

> In this simple case the enunciation of the principle of the conservation of energy is of extreme simplicity. A certain quantity, accessible to experiment, must remain constant. This quantity is the sum of two terms; the first depends only on the position of the material points and is independent of their velocities; the second is proportional to the square of these velocities. This resolution [of the function of forces which must exist by virtue of the Principle of the Conservation of Energy] can take place only in a single way. ...
>
> It is true that if T+U is a constant, so is any function of T+U, i.e. F(U+T). But this function F(T+U) will not be the sum of two terms the one independent of the velocities, the other proportional to the square of these velocities. Among the functions which remain constant there is only one which enjoys this property, that is T+U (or a linear function of T+U, which comes to the same thing, since this linear

> function may always be reduced to T+U by change of unit and of origin). This then is what we shall call energy; the first term [U] we shall call potential energy and the second [T] kinetic energy. The definition of the two sorts of energy can therefore be carried through without any ambiguity.

Once, however, we begin to consider the realm of non-mechanical phenomena, e.g., chemical, thermal, or electrical processes; it becomes clear that a third term must be introduced in order to represent the internal energy of bodies involved in non-mechanical processes. The reason for this is that, contrary to the case of bodies involved in mechanical interaction, the internal energy of bodies involved in non-mechanical interaction has a great influence on the course and nature of such interaction. Thus, if we let Q represent the internal energy of the bodies involved, the Principle of the Conservation of Energy amounts to the claim that, in an isolated system T+U+Q=constant. Insofar as no actual physical system is purely mechanical this formulation holds even for systems which, for practical reasons, we are inclined to term mechanical.

This raises a problem. If T, U, and Q are to be considered distinct it ought to be possible to define them independently of one another. Thus T needs to be defined solely by reference to quantity of motion, U needs to be defined solely by reference to position, and Q needs to be defined solely by reference to the internal state of the bodies involved. Unfortunately, in the case of Q the internal energy of the bodies involved, there proves to be no independent means of defining it.[4] Electrostatic energy, for example, depends not only upon the internal state of the bodies involved, i.e., their charge, but also upon their position and their velocities.[5]

What this means is that it will prove impossible to separate these three forms of energy in the final analysis. In the absence of any means to distinguish in any ultimate sense between T, U, and Q, we cannot describe the nature of energy. As Poincare noted:

> All would go well if these three terms were absolutely distinct, if T were proportional to the square of the velocities, U independent of these velocities and of the state of the bodies, Q independent of the velocities and of the positions of the bodies and dependent only on their internal state.
>
> The expression for the energy could be resolved only in one single way into three terms of this form.
>
> But this is not the case; consider electrified bodies; the electrostatic energy due to their mutual action will evidently depend upon their charge, that is to say, on their state; but it will equally depend upon their position. If these bodies are in motion, they will act one upon another electrodynamically and the electrodynamic energy will depend not only upon their state and their position, but upon their velocities.
>
> We therefore no longer have any means of making the separation of the terms which should make part of T, of U and of Q, and of separating the three parts of energy.

Some Logical Considerations

> If (T+U+Q) is constant so is any function F(T+U+Q).
>
> If T+U+Q were of the particular form I have above considered, no ambiguity would result; among the functions F(T+U+Q) which remain constant, there would only be one of this particular form, and that I should convene to call energy.
>
> But as I have said, this is not rigorously the case; among the functions which remain constant, there is none which can be put rigorously under this particular form; hence, how choose among them the one which should be called energy? We no longer have anything to guide us in our choice.
>
> There only remains for us one enunciation of the principle of the conservation of energy: There is something which remains constant.[6]

All that can be said is that T, U and Q are all manifestations or forms of energy and that in a causally isolated system their sum remains constant.

Two attempts have been made to sidestep the difficulty we experience in trying to say what energy is. The first is to offer an operational definition of it. Given the impossibility of defining energy by reference to any essential property it possesses, we must, it is urged, define it in terms of the particular experimental procedures used in measuring it.

Attractive as this alternative might seem, it is unsatisfactory in that it does not take into account the flexibility of the concept and the unifying effect it has had on different areas of science. If energy is to be defined by reference to particular experimental procedures it is difficult to understand how the concept can function in the way it does. As Theobald notes, "If operationalism were valid, we should not be able to do something which we clearly can and do do, namely use the concept of energy beyond its original mechanical context, since the methods of measuring mechanical energy are not those for measuring thermal energy and so on."[7]

The second attempt to sidestep the difficulty we experience in trying to define energy is to suggest that the Principle of the Conservation of Energy is merely a convention and that there is no need to define energy. According to this line of thought it is merely a well-established convention that whenever we observe a +E we should seek a corresponding -E. If such a -E is not immediately obvious we invent a new form of energy. Thus in a system which is not adiabatically isolated the Principle of the Conservation of Energy is stated as $\Delta Q=\Delta W+\Delta H$ [where Q is the change in the internal energy of the system, W is the work done on the system, and ΔH is the heat absorbed by the system] even though no independent means of measuring the quantity ΔQ exists.[8] Given the fact that there is no independent means of estimating ΔQ, it seems we may regard the Principle of the Conservation of Energy as merely a convention, albeit a very well-established one. As such it makes no attempt to describe any real feature of the world and enjoys complete immunity to empirical testing.

This suggestion overlooks an important fact. It ignores the fact that, although the application of the Principle may in some cases be a matter of convention, it is not so in all cases. In the face of an apparent exception to the Principle of the Conservation of Energy, a scientist may postulate a new form of energy, but, if his hypothesis is not to be considered purely ad hoc and consequently rejected, it must be shown that this hitherto unnoticed form of energy is a function of a new set of variables of state and that it manifests itself in at least one independent set of circumstances. Thus, "to postulate a new type of energy transfer in order to comply with the requirements of the conservation of energy ... would be quite rightly deemed insufficient, unless we could show the generality of this new type of energetic transaction and arrive at a universal exchange-rate for it."[9] It is clear that the Principle is not merely a convention. It describes - or at least claims to describe - some real feature of physical processes.

Energy, then, is not to be defined operationally and the Principle of the Conservation of Energy is not merely a convention. But neither can we say what energy is like; we cannot define it by reference to any essential property it possesses. This seems somewhat strange. Normally, when we consider something to be real we expect to be able to describe it in at least some respects. Why, then, in the absence of any such description, do we consider energy to be real?

The answer, I think, is this. The first two conceptual elements of conservation principles, i.e. the belief that that which changes can only be explained by reference to that which does not change, and the belief that that which changes can in fact be explained, produce in us the expectation that there exists something which remains invariant and which serves to explain the sensible world. When faced with a large body of experimental evidence which demonstrates a mathematical invariance within a causally isolated system, we regard this as confirmation of our expectation that there exists something invariant. This we call energy.

Unfortunately, what is actually found is not the persistence of some fundamental property or quality which may be identified as energy, but a quantitative invariance which characterizes the relations between changes which take place within a causally isolated system. What is really measured by scientists is the capacity of such a system for change. The claim that energy is conserved amounts - at a purely experimental level - to the claim that a causally isolated system has only a fixed capacity for change. Thus any change in one aspect of such a system will be accompanied by some equivalent change in another aspect of the system.

Scientific inquiry produces evidence of mathematical invariance. This evidence, interpreted in the light of our conviction that there exists something invariant, gives rise to the notion of energy. Ironically, although this evidence encourages our conviction that something exists which remains invariant, it also makes its expression very difficult. It encourages this conviction by confirming our expectation that an invariance may be found in the midst of constantly changing phenomena which at first glance seem to bear little relation to one another. It makes the expression of this conviction very difficult, however, in that, while it confirms the existence of a mathematical invariance, it precludes us from identifying this invariance with any observable property or quality. We find ourselves in a paradoxical situation. The very evidence which supports our conviction that something remains invariant renders the expression of that conviction very difficult.

One attempt to escape the difficulty would be to argue that the quantitative invariance we observe does not imply the existence of something which remains invariant. It might be argued that it is just a fact that a quantitative invariance characterizes the relation between changes in a causally isolated system and that there is no need to explain this fact by reference to some mysterious substance thought to underlie these changes. All attempts to identify any property or quality of this presumed something have come to naught. Surely, therefore, it is better to cease postulating the existence of some mysterious substance and merely note the existence of a mathematical invariance. There is no need to infer the existence of energy. The invariance characteristic of such systems is merely a brute fact and points to nothing beyond itself.

This abandonment of any attempt to explain this invariance is unjustified. Faced with the fact that there always exists a precise correlation between the changes which take place in a causally isolated system, the scientist inevitably searches for some explanation of why this should be so. He does so precisely because he is convinced that this exact correlation between changes is not just a brute fact, forever opaque to our understanding, but reflects an order and structure which may be understood.[10] He postulates, therefore, the existence of something (energy) underlying this invariance and in terms of which the phenomena may be understood. His success in explaining and manipulating the phenomena and the integral part that the concept of energy plays in his ability to do this suggest that he is correct in his conviction.

Some Logical Considerations

Nevertheless, it must be admitted that there exists a certain ambiguity in the way in which energy is spoken of. Sometimes it seems to be conceived as something substantive, as the basic stuff of which the world is made, e.g., the matter which makes up the desk at which I write and the chair at which I sit is, presumably, just a form of energy. Other times energy seems to be thought of merely as a measure of change or the capacity to change.

This ambiguity arises due to the fact that energy is never directly observed. We infer the existence of energy as the best explanation of the mathematical invariance characterizing phenomena in a causally isolated system. Unfortunately, the fact that such an inference is necessary if one is to arrive at the concept of energy is not always realized. Consequently, there is often confusion between the inferred concept of energy and the evidence which is taken to support the inference. The result is a certain ambiguity in the way in which energy is talked about.

Once it is realized that the concept of energy rests upon an inference from the existence of mathematical invariance in causally isolated systems, it becomes clear that energy is conceived as something substantive. We infer the existence of energy because we are convinced that some reality must underlie such quantitative invariance. Energy is conceived as that which underlies and explains the phenomena of nature. Given this, it is scarcely surprising that we conceive of energy as something substantive: the external world revealed by the senses is conceived as something real and substantive and cannot be explained in terms of something non-substantive. As Meyerson noted,

> The physicist ... begins by believing blindly, as does every man, in the conceptions of common sense. He modifies them afterward, but how does he modify them? Solely by proceeding from reality to reality. When he has decomposed the stick into a nebula of atoms, or even, if you prefer, of electric ions, these atoms or these ions are as real to him as the stick was; he has never, indeed, 'reduced' anything but substantive to substantive, object to object.[11]

It is no accident, therefore, that, despite a certain ambiguity and looseness in the way in which the term is used, energy is conceived as something substantive. Indeed, in the thought of many there seems an identification of the concept of energy and the concept of substance. Robert Cohen notes that "all the early discoverers of the conservation of energy, Carnot, Mayer and Joule, argued that [energy] ... was too important to be destroyed, quite like advocates in earlier centuries had argued about material substance",[12] and D.W. Theobald notes that "energy is justifiably called the 'substance' of nineteenth-century physics, just as matter was the 'substance' of the physics of Newton and Locke in the seventeenth century."[13]

Some Logical Considerations

The critic may object that there is a problem with this line of argument. The concept of substance is a notoriously difficult one. Many philosophers, despairing of attempts to ascribe any properties to substance or show that it has empirical reference, would like to dispense with the idea of substance altogether. Surely this ought to make us very wary of linking the concept of energy to the concept of substance.

In reply to this objection, it must be admitted that we cannot say what energy is like; we cannot define it by reference to any essential properties it possesses. However, it does not follow from this that the concept is devoid of empirical reference. Clearly, energy considerations influence physical behaviour. Equally, there are constraints on the way in which we talk about energy. As was shown when we discussed whether the Principle of the Conservation of Energy is merely a convention, we are not at liberty to invent some new form of energy and consequently some new type of energy transfer unless we can also show the generality of this new type of energy transfer and demonstrate some sort of universal exchange rate between it and other forms of energy. It is not the case, therefore, that the concept of energy is devoid of empirical reference.

I suggest that the relation between the idea of substance and the concept of energy is analogous to the relation between the Principle of Sufficient Reason and specific conservation principles. Unlike specific conservation principles, the Principle of Sufficient Reason is held *a priori*. This is not to say that we conceive of the Principle of Sufficient Reason as a necessary truth; that there is no state of affairs in the world which would lead us to abandon it. It is to say that we are predisposed to believe the Principle of Sufficient Reason and that we do not willingly abandon it. It is through the Principle of Sufficient Reason that we are convinced that all events have causes, i.e., a sufficient or determining reason why they should occur. We are convinced that events do not just happen and that we cannot get more out of a system than we put in. We postulate, therefore, the existence of conservation principles.

The problem with the Principle of Sufficient Reason is that, taken by itself, it is powerless to do more than suggest the existence of conservation principles. In the absence of positive experience of the disciplined and cumulative sort characteristic of science, it is possible to postulate that something is conserved, but it is impossible to either test this hypothesis or be precise concerning the nature of that which is conserved. As Mach noted,

> In general, a lower stage of knowledge may perhaps be distinguished from a higher one not so much by the difference of the conception of

> causality as by the manner of application of this conception.
>
> He who has no experience will, because of the complication of the phenomena surrounding him, easily suppose a connexion between things which have no perceptible influence on one another. Thus, for example, an alchemist or wizard may easily think that, if he cooks quicksilver with a Jew's beard and a Turk's nose at midnight at a place where roads cross, while nobody coughs within the radius of a mile, he will get gold from it. The man of science of today knows from experience that such circumstances do not alter the chemical nature of things and accordingly he has a smoother path to traverse. Science has grown almost more by what it has learned to ignore than by what it has had to take into account.[14]

The problem which arises when we consider the notion of substance is very similar. It is that the notion of substance - like the Principle of Sufficient Reason - is, at a purely *a priori* level, empty. We postulate the existence of substance in order to explain the realm of changing phenomena. Unfortunately, in the absence of *a posteriori* elements of knowledge it is impossible to show that the concept has any content. Hence the suspicion arises that the notion of substance is at best a barren concept devoid of any possible reference to the empirical world and at worst a metaphysical chimera.

What saves the concept of energy from such a fate is that, unlike the purely *a priori* notion of substance, it constitutes a synthesis of *a priori* and *a posteriori* elements. The conviction that something exists unchanged, by reference to which change may be explained, is a priori and arises from our adherence to the notion of substance. It is this conviction which motivates our search for something which remains unchanged in the midst of change. The empirical evidence which supports our conviction that, although we cannot know any of its essential properties, there is something which remains invariant in the midst of change is known a posteriori, however. It is the synthesis of this empirical evidence and our a priori conviction that something exists unchanged which produces the concept of energy and guarantees the importance of this concept in our thinking.

TWO FORMS OF THE PRINCIPLE OF THE CONSERVATION OF ENERGY

I noted in the preceding section that our belief that there exists something invariant by which we may explain changing phenomena is produced by our commitment to the idea that that which is conditioned in time can only be explained by that which is invariant in time, and our commitment to the Principle of Sufficient Reason which leads us to think that phenomena may indeed be explained. We have, therefore, the idea that that which does not change is somehow more fundamental than that which does. Thus, for example, we tend to think of a flower as being less fundamental than the matter of which the flower is composed.

Another related, but nevertheless distinct, idea we have is that that which is most fundamental not only does not change, it cannot come into nor go out of existence. The fact that we have this idea is a natural consequence of the Principle of Sufficient Reason. We are, by virtue of our belief in the Principle of Sufficient Reason, convinced that something cannot come into existence without a cause nor go out of existence without a cause, i.e., a determining or sufficient reason. In the case of that which is most fundamental, however, no such cause can exist, since any such cause would be more fundamental than that which it causes to come into existence or go out of existence.

It is important to recognize that these two ideas - the idea that that which does not change is more fundamental than that which does, and the idea that that which is most fundamental not only does not change but cannot come into nor go out of existence - although related, are logically distinct. To say that something does not change does not entail that it did not come into existence nor that it may not go out of existence; it is only to assert that during the time it does exist it does not change. Thus, to say that something which does not change is more fundamental than something which does, does not entail that that thing is fundamental in an absolute sense, that there is nothing which brought it into existence or might cause it to cease to exist.

Unfortunately, these two ideas are not always clearly distinguished. The Principle of the Conservation of Energy is commonly stated as 'Energy can neither be created nor destroyed although its form may change.',[15] or as 'In an isolated system [i.e. a system not causally influenced by something other than itself] the total amount of energy remains constant although its form may change.'[16] Usually these two formulations are used interchangeably, the unspoken assumption being that they are logically equivalent. I suspect that the reason these two statements are taken to be logically equivalent is that when we fail to distinguish between something not changing and its existence being uncaused, we are led very quickly to conclude from the fact that energy remains constant in an isolated system, i.e., its quantity does not change, that it can neither be created nor destroyed.

It is essential to realize, however, that these two statements are not logically equivalent. We can deduce from the statement 'Energy can neither be created nor destroyed.', the statement 'In an isolated system the total amount of energy remains constant.' We cannot from the statement, 'In an isolated system the total amount of energy remains constant.', deduce the statement 'Energy can neither be created nor destroyed.'

What this reveals is that the statement, 'Energy can neither be created nor destroyed.', is considerably stronger than the statement 'In an isolated system the total amount of energy remains constant.' The former statement could not, for example, be held by a theist since such a statement, by definition, rules out the possibility of creation ex nihilo of energy. By contrast, a theist could hold that in an isolated system, i.e., a system not subject to the causal influence of something other than itself, energy remains constant since such a statement implies nothing concerning the possibility of creation ex nihilo, just as it implies nothing concerning whether in fact the physical universe is an isolated system, i.e. open to re-ordering by a transcendent agent.

It is appropriate at this point to discuss very briefly an issue that will be more fully dealt with in later chapters. This is the issue of the relation of these two statements - 'Energy can neither be created nor destroyed' and 'In an isolated system the total amount of energy remains constant' - to experimental evidence. Again it is important to note that these two statements are quite distinct. A large body of evidence supports the conclusion that if a system is isolated then its energy remains constant. It is a further inference, however, to conclude that energy can neither be created nor destroyed.

What this suggests is that we could consistently accept well-evidenced scientific claims that the amount of energy in an isolated system remains constant and yet deny the further claim that energy can neither be created nor destroyed. It might be argued, of course, via Occam's Razor, that the inference from the constancy of energy in an isolated system to the claim that energy can neither be created nor destroyed is justified; that there exists no reason to postulate anything more fundamental than energy. Whether or not there exists reason, or there could exist reason, to postulate something more fundamental than energy is a matter of considerable philosophical debate; a debate which will concern us in later chapters. The point which must be stressed at present is that while scientific evidence supports the claim, 'In an isolated system the total amount of energy remains constant.', the claim 'Energy can neither be created nor destroyed.' requires a further inference. Prima facie at least, we are not being unscientific if we accept the claim that 'In an isolated system the total amount of energy remains constant.', but deny the further inference that 'Energy can neither be created nor destroyed.'

CONCLUSIONS

Two conclusions may be drawn concerning the issues discussed in this chapter. The first is that the Principle of the Conservation of Energy is a powerful synthesis of *a priori* and *a posteriori* elements of thought. The conviction that something is conserved has its conceptual roots both in our conviction that something invariant must exist if we are to explain that which changes, and in our loyalty to the Principle of Sufficient Reason which leads us to insist that events may in fact be explained. It is this *a priori* loyalty to the notion of invariance which largely motivates our search for conservation principles and which explains our ready acceptance of them. However, what is conserved is known *a posteriori*, as indeed is the empirical evidence which supports our conviction that there is something which is conserved. It is this empirical element which is able to give content to our *a priori* notion of invariance; a notion which would otherwise remain empty and barren.

The second is that there are two forms of the Principle of the Conservation of Energy. These are:

> (1) Energy can neither be created nor destroyed.
>
> (2) In an isolated system energy will remain constant.

Although these two forms are used interchangeably, the unspoken assumption being that they are logically equivalent, it is important to realize this is incorrect. The first statement is much stronger than the second and less directly supported by experimental evidence. It will be important in considering the philosophical implications of the Principle to keep this distinction firmly in mind.

CHAPTER THREE: UNCAUSED EVENTS AND THE CONSERVATION OF ENERGY

In the previous chapter I noted that there is a link between the Principle of Sufficient Reason and the Principle of the Conservation of Energy. The conviction that something is conserved has its roots not only in the observation of empirical data, but also in adherence to the Principle of Sufficient Reason. I noted that loyalty to the Principle of Sufficient Reason largely motivated the search for conservation principles and accounts for a great deal of the firmness and confidence with which the Principle of the Conservation of Energy is held.

In this chapter I discuss two related issues. First, I explore the link between the Principle of Sufficient Reason and the Principle of Universal Causality, and the link between the Principle of Universal Causality and specific conservation principles. Second, I discuss whether, in light of these links, the occurrence of an uncaused event would imply the falsity of the Principle of the Conservation of Energy.

Concerning this second issue, it should be noted that it is relevant to discussions of acausal interpretations of quantum mechanics. Since exploration of the different proposals concerning the interpretation of quantum mechanics lies beyond the scope of this thesis, I propose only to note this point. Nevertheless it is an important issue.[1] Acausal interpretations of quantum mechanics are not usually thought to entail the falsity of the Principle of the Conservation of Energy. Should it emerge that the occurrence of uncaused events implies the falsity of the Principle of the Conservation of Energy, these interpretations may not seem nearly as attractive or compelling. At the very least, they would stand in need of re-examination, since most scientists agree that the Principle of the Conservation of Energy is not to be lightly abandoned.

CAUSALITY AND THE CONSERVATION OF ENERGY

The Principle of Universal Causality may be stated as the claim that every event has a cause. Both the status and truth of this claim are matters of considerable debate. Questions of what constitutes a cause and whether every event is caused are difficult and, despite an enormous amount of analysis and debate, philosophers have reached no firm consensus on these issues. In what follows, I shall explore these questions in light of the links that exist between the Principle of Universal Causality and the Principle of Sufficient Reason, on the one hand, and between the Principle of Universal Causality and the Principle of the Conservation of Energy, on the other.

Viewed historically, the claim that every event has a cause seems far more than an inductive generalization based on the results of previous experience. Even the most cursory study of the history of scientific thought reveals not only the attempt to discover the causes of events, but also the insistence that events have causes. We find in the history of science an _a priori_ loyalty to the idea that every event has a cause. This is not to suggest that we are inevitably committed to regarding the Principle of Universal Causality as a necessary truth. It seems quite possible that empirical evidence might lead us to question the truth of this Principle. Indeed, in the case of quantum mechanics, this seems to have actually happened. It is nevertheless true that this Principle has played a large role in the development of science and that the loyalty accorded to it goes beyond that accorded to a mere 'working hypothesis.' Any treatment of it which does not recognize this historical fact and adequately account for the important place that the Principle has had in our thinking must be deemed inadequate.

The conviction which seems to underlie the Principle of Universal Causality is that every event has an explanation. One reason that this Principle has been held so strongly is that it is implied by the beliefs that all events may be explained and that an event is explained only when one gives the cause of its occurrence. What this reveals is that loyalty to the Principle of Universal Causality is, at least in large part, an expression of belief in the Principle of Sufficient Reason.

Indeed, there is a strong tradition which insists that these two Principles may be identified one with the other. Schopenhauer, for example, expressed the view that the Principle of Universal Causality is but an an expression of the more general Principle of Sufficient Reason. He wrote:

> the principle of sufficient reason appears as the law of causality and I call it as such the principle of sufficient reason or ground of becoming, principium rationis sufficientis fiendi. ... The principle is that, if a new state of one or several real objects appears, another state must have preceded it upon which the new state follows regularly, in other words, as often as the first state exists. Such a following is called ensuing or resulting; the first state is called the cause, the second the effect.[2]

Meyerson also thought that there is a connection between the Principle of Sufficient Reason and the Principle of Universal Causality. He wrote:

Uncaused Events and the Conservation of Energy

> What is the origin of the causal postulate? ... To discover the real source of the principle it is enough to recall the name which Leibniz and many others after him have given it. It is the principle of the determining reason or sufficient reason. Wherever we establish it the phenomenon becomes rational, adequate to our reason: we understand it and we can explain it.[3]

Lest it be thought that this linking of the two Principles is confined to thinkers of the idealist tradition, it is worth mentioning that even so positivistic a philosopher as Mach identified these two Principles, although he preferred to 'reduce' the Principle of Sufficient Reason to the Principle of Universal Causality, rather than vice-versa. The important point is not the name he chose, but the fact that he concurred in identifying them. He commented that "The law of sufficient reason is not essentially different from the law of causality or from the theorem 'The effect is determined by the cause'."[4]

This consensus by thinkers of widely differing philosophical temperaments indicates that there can be little doubt that there exists a link between the Principle of Sufficient Reason and the Principle of Universal Causality. Given this link, and given the link that exists between the Principle of Sufficient Reason and the Principle of the Conservation of Energy, it comes as no surprise to learn that there also exists a close connection between the Principle of Universal Causality and the Principle of the

Conservation of Energy. As we have seen, the Principle of Universal Causality is an expression of the beliefs that every event can be explained and that an event is explained only when one gives the cause of its occurrence. It is, therefore, basically the expression of a fundamental conviction that nothing happens by chance, i.e. without a determining cause. According to this Principle, events do not just happen and we cannot get more out of a system than we put in. Consequently, we must postulate some principle of conservation.

This argument that the Principle of Universal Causality implies the conservation of some basic 'force' or 'stuff' is a very old one. It recurs again and again in the development of the Principle of the Conservation of Energy. Early Greek thinkers, although they had no precise knowledge of particular causes and effects such as we associate with modern science, were nevertheless convinced of the existence of conservation principles.[5] Later, as scientific thought developed and scientists began to be more precise in their attempts to describe what is conserved, we find the same argument. Johann Bernoulli (1667-1745), for example, argues that vis viva must be conserved on the basis that,

> Everyone regards as an incontrovertible axiom that no efficient cause may be destroyed either in whole or in part, but that it produces an effect equal to its (apparent) loss. ... It is ... clear that, if the vis viva of a body

> decreases or increases on collision with another body, the *vis viva* of the other body will increase or decrease by the same amount, the increase in the one being the immediate effect of the decrease in the other. This necessarily implies the conservation of the total quantity of *vis viva*, or that the total quantity remains constant during the collision.[6]

Still later, we find Helmholtz (1821-1894), one of the discoverers of the Principle of the Conservation of Energy, using this argument. He argued in his famous paper "The Conservation of Force" that the attempt to discover invariable laws and ultimately principles of conservation is made necessary and justified

> by the fundamental principle that every change in nature must have a sufficient cause. The proximate causes, to which we refer natural phenomena, are themselves either invariable or variable; in the latter case, the same fundamental principle compels us to seek still further for the causes of the variation, and so on, until we arrive finally at causes which operate according to invariable law and which consequently produce under the same external conditions the same effect every time.[7]

Like the Principle of Sufficient Reason, however, the Principle of Universal Causality cannot by itself give rise to any positive knowledge. It produces in us a predisposition to believe that all events have causes, but, in the absence of *a posteriori* elements of knowledge, it remains an empty claim. Unless there exist these *a* *posteriori* elements of knowledge we have no way of deciding what constitutes a cause and no way of testing the claim that all events have causes. The relation between the Principle of Universal Causality and the Principle of the Conservation of Energy is, therefore, similar to the relation which holds between the Principle of Sufficient Reason and the Principle of the Conservation of Energy.

The relation between the Principle of Universal Causality and the Principle of the Conservation of Energy is this. The Principle of the Conservation of Energy, although closely linked to the Principle of Universal Causality, is not identical to it. The Principle of the Conservation of Energy is the result of our attempt to give empirical content to the *a priori* conviction that there exists some fundamental principle of conservation and that every event has a determining cause. It constitutes a "filling in" of the Principle of Universal Causality and gives content to what would otherwise remain an empty claim.

Indeed, as the early Greeks were keenly aware,[8] if the physical universe is all that exists and is, *ex hypothesi*, an isolated system, then the implications of conservation and causality merge.[9] In such a case, the "relationship between causation and energy-momentum flows ... [would have] the logical status of an empirically discovered identity, namely that the causal relation is identical with a certain physically specifiable relation."[10] It comes as no surprise, then, to find a physicalist such as David Fair claiming that "the plausibility of physicalism as a thesis about physical phenomena and their interrelations gives reason to suspect that the causal relation would have a redescription in the language of physics."[11] Fair, commenting on what he feels is the relation between the idea of cause and the idea of energy, writes,

> I suggest taking seriously what physical science has discovered in answering the traditional philosophical questions about the nature of causation. For a large class of cases, physics has discovered that there has been a transference of the physical quantities, energy and momentum, from the cause to the effect. These are physical quantities conserved through time. Their behaviour in physical systems can be described in terms of derivatives with respect to position and momentum of a closed system's total energy when that energy is specified as a function of the positions and momenta of the elements of the system.
>
> ... causes ... as described by physics ... are the sources of physical quantities, energy and momentum, that flow from the objects comprising cause to those comprising effect. The causal relation is a physical relation of energy-momentum transference.
>
> ... Just when and only when there is a flow of energy between objects (or events or whatever) do they seem to be causally connected.[12]

An objection which might be raised even from within the physicalist camp against the identification of causality and energy transfer is that whereas the notion of energy occupies a prominent place in scientific thought the notion of cause does not. For example, Quine, following Russell, argues that "a notion of cause is out of place in modern physics"[13]. In Quine's view, it is an

> ironical but familiar fact that though the business of science is describable in unscientific language as the discovery of causes, the notion of cause itself has no firm place in science. The disappearance of causal terminology from the jargon of one branch of science and another has seemed to mark the progress in understanding of the branches concerned.[14]

Surely this could not be the case if the proposed identification of causality and energy transfer is correct.

Fair's reply to this objection is that

> if physics has in fact reduced the causal relation to one having to do with energy-momentum transfers, it is hardly a surprise that physical science has little use for that ordinary language concept in its statement of theory. Physics can be more precise and general with the concepts of energy and momentum.[15]

According to Fair, it is a confirmation of the correctness of his theory that science can dispense with the notion of cause and use instead the notion of energy transfer. He notes that "a physicalistic analysis of causation [i.e. his analysis of causation in terms of energy-momentum transfer], if correct does not show that the causal relation lacks instances, but rather it shows what the relation is when described in the language of physics."[16] The disappearance of the notion of causality indicates not that causality cannot be identified with energy transfer, but that the attempt to do so has been successful.

We might well question Fair's thesis that physics is descriptively and explanatorily complete and his consequent claim that all cases of causality may be correctly viewed as cases of energy transfer. Nevertheless, there seems little doubt that, at a practical level, the Principle of the Conservation of Energy is – as were the conservation principles which preceded it – essentially an attempt on the part of scientists to circumvent conceptual difficulties associated with the causal relation and yet apply the Principle of Universal Causality to physics. True, the causal relation can only be contingently identified with the idea of energy transfer and the Principle of Universal Causality can only be contingently identified with the Principle of the Conservation of Energy. It is, indeed, logically possible that the Principle of Universal Causality could be instantiated in a number of different ways, but this does not in the least show that the Principle of Universal Causality and the Principle of the Conservation of Energy are not closely linked.

THE CONSERVATION OF ENERGY AND UNCAUSED EVENTS

This link between the Principle of Universal Causality and the Principle of the Conservation of Energy raises an interesting question. Is it possible to abandon belief in the Principle of Universal Causality yet retain belief in the Principle of the Conservation of Energy?

The question is an important one. Contrary to earlier thinking, the Principle of Universal Causality is presently viewed with suspicion and is widely questioned. The Principle of the Conservation of Energy, on the other hand, is well-established and widely accepted. There are thus a number of philosophers who reject the Principle of Universal Causality, while accepting the Principle of the Conservation of Energy. Given the close link between these two Principles, the question arises whether these philosophers are consistent in their thinking. It is essential to inquire whether we may reject the Principle of Universal Causality and still justify belief in the Principle of the Conservation of Energy.

Before approaching this issue, I wish to make two preliminary points. The first is that I am not suggesting that talk about causes can be eliminated in favour of talk about energy transfer. I think it very likely that our language about causes is too deep and rich to permit this.[17]

What I am suggesting is that the link between the Principle of Universal Causality and the Principle of the Conservation of Energy raises the question of whether we may deny the former, but affirm the latter. The question is not whether a cause can be *defined* in terms of energy transfer, but whether uncaused events *involve* the non-conservation of energy.

The second point I wish to make is that I am not contending that if the Principle of Universal Causality is false then it is logically necessary that the Principle of the Conservation of Energy must also be false. I have said that the Principle of Universal Causality entails a fundamental principle of conservation and that this principle, fleshed out by empirical investigations, is known to us as the Principle of the Conservation of Energy. However, the fact that the Principle of Universal Causality, if true, provides grounds for believing the Principle of the Conservation of Energy does not guarantee that if the Principle of Universal Causality is false then the Principle of the Conservation of Energy must also be false. To argue that it does would be to commit the fallacy of denying the antecedent. It would be analogous to arguing that since it is true that if I have a Saint Bernard I have a big dog, then it must also be true that if I do not have a Saint Bernard I cannot have a big dog. My concern is not to argue that it is inconceivable that the Principle of the Conservation of Energy could be true if the Principle of Universal Causality is false, but to evaluate whether belief in the Principle of the Conservation of Energy can be justified if the Principle of Universal Causality is abandoned.

The question, then, is whether we may abandon the Principle of Universal Causality, yet justify belief in the Principle of the Conservation of Energy. My view is that we cannot. By way of arguing for this, I propose to develop and defend the following three claims:

1. The occurrence of a single uncaused event would imply the falsity of the Principle of the Conservation of Energy.

2. It is nevertheless conceivable, i.e. logically possible, that energy might be conserved if a number of uncaused events occur simultaneously.

3. However, it is highly improbable that energy would be conserved in such cases. It follows, therefore, that if we abandon belief in the Principle of Universal Causality we ought to abandon belief in the Principle of Universal Causality as well.

My first claim is that a single uncaused event implies the falsity of the Principle of the Conservation of Energy. The reason I say this is that the occurrence of such an event entails that a certain amount of work is performed upon the system in which it occurs. Inasmuch as this work does not involve, and is not to be explained in terms of any previous transfer of energy, this implies that energy is not conserved if an uncaused event occurs.

By way of illustrating this general claim, let us conduct a simple thought-experiment. Let us postulate an isolated system in which a single uncaused event occurs. Let us examine whether the energy the system possesses before the occurrence of the uncaused event is equal to the energy it possesses after the occurrence of the uncaused event.

Let us take as our system a single spherical object in a box. We will define the box as an adiabatic enclosure and the object as a special kind of object which moves now and again without being caused to move. We will observe the system at t_1, a time prior to the uncaused movement of the object, and at t_2, a time after its uncaused movement.

It is clear that prior to the movement of the object the system will have a certain amount of energy. It is also clear that, inasmuch as the object moves without being caused to move, there is no transfer of energy which causes it to move. Also evident is the fact that its movement results in the system[18] having more energy than it did. Its movement introduces kinetic energy into the system, but this kinetic energy is not the result of any transfer of energy.

We must conclude, therefore, that the system possesses more energy at t_2 than it did at t_1.

The critic is liable to reply that my asserting the general claim that if x is an uncaused event then the occurrence of x implies the falsity of the Principle of the Conservation of Energy is premature. Granted that an uncaused event might involve the non-conservation of energy, does it follow that it must involve the non-conservation of energy. Surely, the critic will urge, we can conceive of uncaused events which result only in the conversion of one form of energy into another and hence do not imply the falsity of the Principle of the Conservation of Energy.

I think the critic is wrong if he attempts to argue in this manner. It is quite true that we can conceive of uncaused events which result in the conversion of one form of energy into another. I do not think it is true, however, that we can conceive of uncaused events which result only in the conversion of one form of energy into another. The reason I think this is that, in cases where an uncaused event would result in a conversion of one form of energy into another, we must conceive the uncaused event as acting as a 'trigger' whereby the process of conversion of one form of energy into another is begun. There will be a certain amount of energy associated with the triggering event, however. If this energy is the result of an uncaused event;

and not some previous transfer of energy, then energy cannot be conserved. The critic is right to point out that uncaused events could act as 'trigger' events. He is wrong if he attempts to maintain that such events are consistent with the conservation of energy.

Again, by way of illustrating my general claim, let us conduct a thought-experiment. Let us imagine a perfectly round ball sitting on top of a pyramid whose top has been slightly flattened. The ball is so delicately balanced that any movement on its part will cause it to roll down the slope of the pyramid. Now let us suppose that the ball uncausedly moves ever so slightly. It begins to roll down the slope of the pyramid, its speed increasing the further it rolls.

The question, of course, is whether this occurrence is consistent with energy being conserved within the system? The critic will be eager to answer that it is. He will argue that, although the ball acquires kinetic energy in moving down the slope of the pyramid, this kinetic energy is gained by transforming its potential energy. As the ball rolls down the slope its kinetic energy increases, but its potential energy decreases by a corresponding amount. There is, the critic will contend, no net gain or loss of energy even though an uncaused event has occurred.

This is certainly a tempting view. Its flaw is that it does not take into account the uncaused movement which starts the whole process. The problem the critic faces is not to account for the kinetic energy the ball acquires once it begins moving, but the energy introduced into the system by its initial movement. His suggestion is that once the ball has started moving towards A the potential energy it possesses accounts for the kinetic energy it acquires. This is quite true, but it ignores the crucial fact that prior to its initial movement the potential energy of the ball is unavailable. Before its potential energy can become available, the ball must be slightly off-balance. However slight, there must be some lateral movement of the ball before the process by which potential energy is tranformed into kinetic energy can begin. What the critic does not account for is the energy involved in the initial uncaused movement which triggers the process. Obviously, it cannot be accounted for in terms of potential energy, since prior to this movement the potential energy of the ball is unavailable.

Perhaps a further illustration of my general view is in order. We have considered an example in which the transformation of potential energy plays a role. Let us now consider an example in which the transformation of internal energy plays a role. Let us make our thought-experiment a very simple one. Let us suppose that a combustible material begins, uncausedly, to burn.

Again, the question is whether this occurrence implies the falsity of the Principle of the Conservation of Energy. Again, the critic will be inclined to answer that it does not. He will argue that the heat given off by the burning material is merely the transformation of some of the internal energy it gives up in the process of burning. There is, he will contend, no net gain or loss of energy, only its transformation.

The problem with this view is that once again the critic errs in considering only the process once it has begun and not what is required if it is to start in the first place. By way of showing this, let us briefly consider what is involved in the burning of the material.

The internal energy of the material may be defined as "the kinetic energy of its constituent particles plus the energy involved in the intermolecular attractions."[19] This energy is stored in the form of atomic and chemical bonds that exist between the components of the ball. Roughly speaking, what happens when the ball burns is that some of the chemical bonds are broken, releasing energy which in turn breaks more of these bonds. New and different kinds of chemical bonds are formed, but these store less energy. The excess energy, formerly stored in the old bonds, is transformed into heat and light.

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What the critic ignores is that a certain amount of work must be done in order to start the combustion process. It takes work to break the chemical bonds which, once broken, release enough energy to break further bonds and continue the combustion process. It is quite permissible to postulate that one or more of the components of the ball uncausedly breaks a chemical bond and initiates this process. What must be understood, however, is that this uncaused action results in a certain amount of work being performed and that this work cannot be explained in terms of any previous energy-transfer. Certainly the work performed cannot be explained in terms of the internal energy of the ball, since until this work has been performed that internal energy is unavailable. The critic, in concentrating upon the fact that energy is conserved once the process of combustion has begun, tends to miss the essential point that energy is required to trigger the process. If this triggering results from an uncaused event then the quantity of energy within the system will not be conserved. At t_1, a point prior to the triggering event, it will be different than at t_2, a point after the triggering event.

I think these thought-experiments illustrate my general claim that the occurrence of an uncaused event implies the falsity of the Principle of the Conservation of Energy. Before leaving the discussion, however, let us consider another somewhat different example. Since all the events we have considered have been uncaused in a pretty immediate sense, let us consider an event which is uncaused in a more remote sense.

Consider, within an adiabatic enclosure, a picture hanging on the wall and assume that there is a loaded gun within the enclosure. The gun is placed opposite the picture and mounted in such a way that if it fires it will cause the picture to fall. Now let us suppose that the trigger of the gun uncausedly moves, the gun fires, and the picture falls.

Faced with the question of what caused the picture to fall, we will say something along the following lines. The picture fell because its support was broken by the bullet fired from the gun. The bullet broke the picture's support because when it hit the support it had a certain momentum. The bullet had this momentum because it was moving at a certain speed. The bullet was moving at this speed because of the explosion which took place in the firing-chamber of the gun. The explosion took place because the firing-pin of the gun struck the shell in such a way as to cause the gun-powder in the shell to explode. The firing-pin of the gun struck the shell because the trigger moved. The trigger moved, but it was not caused to move.

The movement of the trigger, although certainly not the immediate cause of the event of the picture falling, was the event we feel was most significant in explaining why the picture fell. Thus, even though it was a remote rather than proximate cause, we speak of it as the cause of the picture's fall. However, the movement of the trigger was itself uncaused. We are, therefore, prepared to say that, in a certain readily understood sense, the event of the picture's falling was uncaused.

This example seems to raise a problem for the view that an uncaused event implies the falsity of the Principle of the Conservation of Energy. It is clear that we want, at least in some sense, to call the fall of the picture an uncaused event, yet it seems that this event does not violate the Principle of the Conservation of Energy. Whatever potential energy the picture loses by falling will be balanced by the kinetic energy it acquires in its fall. It seems that we may conclude that energy is conserved within the adiabatic structure, even though an uncaused event has occurred.

Granted that we call the fall of the picture an uncaused event, and granted that this event does not introduce or withdraw any energy, it is nevertheless true that the occurrence of such an event implies the falsity of the Principle of the Conservation of Energy. The reason this is so lies in the fact that we are prepared to call the fall of the picture an uncaused event only by virtue of the fact that one of the events which produced it was uncaused. Strictly speaking, the event of the picture falling was caused: it was caused by the breaking of its support which in turn was caused by the impact of the bullet and so on. We are only prepared to call the fall of the picture an uncaused event by virtue of the fact that the event which initiated the sequence of events leading to its fall, namely the movement of the trigger, was uncaused. However, once we consider the system which includes the movement of the trigger - the event which initiated the sequence of events, i.e., the uncaused event which justifies us in terming the fall of the picture an uncaused event - it becomes clear that the amount of energy within our adiabatic enclosure has not remained constant. The trigger when it uncausedly moves acquires kinetic energy, but it does not acquire this energy by virtue of any transfer of energy within the adiabatic enclosure. It is clear that the uncaused movement of the trigger - the event which justifies us in calling the fall of the picture an uncaused event - implies that the amount of energy within the system does not remain constant. It is therefore true that the uncaused event of the picture falling entails that energy was not conserved within our adiabatic enclosure. Hence, the occurrence of such an event would imply the falsity of the Principle of the Conservation of Energy.

In summary, we may distinguish between two types of uncaused events. There might be events which are uncaused in an immediate sense, e.g. the jumping of the spherical object in our first example, and there might be events which are uncaused in a remote sense, e.g. the falling of the picture in our last example. Both types of event, if they occur, imply the falsity of the Principle of the Conservation of Energy.

In the case of events which are uncaused in an immediate sense this is fairly obvious. In the case of events which are uncaused in a remote sense, it is not always so obvious that they imply the falsity of the Principle. Such events might be the result of uncaused events which serve as delicate triggers and the energy these uncaused trigger events would add or subtract to the processes they set in motion would be minimal. Nevertheless, the occurrence of such events would entail the non-conservation of energy. This can be seen if we reflect on the fact that events which are uncaused in a remote sense presuppose events which are uncaused in an immediate sense. Once we note this, and consider the system which includes the original immediate uncaused event, it becomes clear that remote uncaused events, no less than immediate uncaused events, imply the falsity of the Principle of the

Conservation of Energy.

My second claim is that, although the Principle of the Conservation of Energy implies there cannot occur a solitary uncaused event in either a remote or an immediate sense, it does not imply that a number of uncaused events cannot occur simultaneously. The reasoning behind this somewhat paradoxical claim is that in the case of uncaused events which take place simultaneously there might be a cancelling effect such that there is no net gain or loss of energy by the system in which they occur.[20]

This possibility can be illustrated by means of a simple experiment. Take a thousand packs of cards from which the Jacks, Queens and Kings have been removed. Let the red cards have a positive value, e.g. the three of diamonds will be worth plus three, the seven of hearts will be worth plus seven. Let the black cards have a negative value, e.g. the four of spades will be worth minus four, the nine of clubs will be worth minus nine. Aces will have a value of either plus one or minus one depending upon whether they red or blac Thoroughly shuffle each of the thousand packs of cards and draw one card from each of the decks. Add the value of all these cards and then return each card to the deck from which it was drawn. Reshuffle the cards and repeat the procedure.

This experiment provides a good analogy of a system in which a number of uncaused events occur simultaneously. Quite clearly, the event of drawing a card from any one of the decks does not influence which card is drawn from any of the other decks. The drawing of cards is, therefore, analogous to the occurrence of uncaused events, in that in neither case does the occurrence of one event have any influence upon the occurrence of other events of the same type. The two sets of events are analogous in another way in that each event has a certain quantitative value. In the case of the cards we assign each event either a positive or negative value based on the face value of the card; in the case of the uncaused events we assign each event a certain value based on energy considerations. Finally, the two sets of events are analogous in that in each set one event may cancel another, e.g. the effect of one uncaused event might cancel the effect of another uncaused event just as the effect of drawing one card, say a red seven, might be cancelled by drawing another card, say a black seven.

This example illustrates the possibility of unrelated events occurring in a manner such that their net effect is nil. It is quite possible that the sum of the thousand cards on any given trial might be zero. Similarly, we may imagine that a number of uncaused events might occur in such a manner that the energy of the system in which they occur remains constant. Strictly speaking, therefore, the occurrence of uncaused events does not imply the falsity of the Principle of the Conservation of Energy. It is conceivable that the Principle of the Conservation of Energy might be true even if the Principle of Universal Causality is false.

This brings us to my third claim, namely that, although it is conceivable that energy might be conserved if a number of uncaused events occur simultaneously, the probability that it would be is so low that we are justified in concluding that if we abandon belief in the Principle of Universal Causality we ought also abandon belief in the Principle of the Conservation of Energy. By way of considering this claim, let us once again examine our card experiment.

I propose that we take the sum of the thousand cards drawn on a trial to be analogous to the amount of energy possessed by an isolated system in which a thousand simultaneous uncaused events occur. I further propose that we examine now the various sums obtained on various trials vary.

What we find is that there is an averaging effect; the probability of any given sum being zero or some number close to zero is greater than the probability of it being either an extremely large positive or negative number.[21] If our analogy holds, this indicates that there would be some tendency for uncaused events to cancel the effects of one another.

The existence of such an averaging effect might seem to bolster the case of those who wish to deny the Principle of Universal Causality and yet affirm the Principle of the Conservation of Energy. The problem, as even the most cursory mathematical treatment will reveal,[22] is that, although an averaging effect may exist, it is nevertheless quite remarkably improbable that energy will be conserved in even an approximate, never mind absolute, sense. In our card experiment we find that the probability of getting zero on any given trial is very low and that it decreases the more cards we introduce into the experiment, e.g. the probability of getting zero as a sum will be lower when we use ten thousand decks than we we use a thousand decks. We will also find that the probability of obtaining zero as a sum not just occasionally, but invariably, is so small as to be infinitesimal. Similarly, the probability that energy will be conserved at any moment is very low and gets lower, the more simultaneous uncaused events we postulate as taking place, and the probability that energy that will invariably be conserved at all moments of time approaches zero. Of course, the fact that such a result is very improbable does not mean that it is inconceivable. It will not do, though, merely to assert that, because it is conceivable that the

Principle of the Conservation of Energy might be true even if the Principle of Universal Causality is false, there is no problem in abandoning the Principle of Universal Causality yet retaining the Principle of the Conservation of Energy. To say that something is logically possible is not to say that it is plausible or probable.

The critic, if he is to demonstrate that we may abandon the Principle of Universal Causality yet retain the Principle of the Conservation of Energy, must show two things. First, he must show that it is _conceivable_ that the Principle of the Conservation of Energy could be true even if the Principle of the Conservation of Energy is false. Second, he must show that we can _justify_ belief in the Principle of the Conservation of Energy once we have abandoned the Principle of Universal Causality.

It is this second task at which the critic fails. In order to hold that energy is conserved even though uncaused events occur we must maintain that such events, at every moment in time, always exactly balance one another so that there is no net gain or loss of energy. The difficulty with maintaining that energy just happens to be conserved in this manner is that, although conceivable, it is always far more probable that energy will not be conserved than that it will. The probability of events occurring in this manner is so low that it virtually guarantees that if uncaused events occur then energy will not be conserved. The critic must admit, therefore, that once we abandon belief in the Principle of Universal Causality, we cannot justify belief in the Principle of the Conservation of Energy.

An objection the critic might raise against my argument is that considerations of probability miss the point entirely. He might argue that, because the Principle of the Conservation of Energy has been established experimentally, questions of probability are irrelevant. Given that the conservation of energy has already been established, and given good reason to believe that uncaused events occur, we must conclude not that the Principle of the Conservation of Energy is false, but that the improbable has happened.

This response is inadequate, however. It makes the truth of this Principle the result of a coincidence. On such a view it must be understood not as a basic and fundamental law of nature, but as a wild and improbable accident. Even worse, such a view implies there is no reason to believe that energy will continue to be conserved and considerable reason to think it will not. As I have noted, it is improbable that energy is conserved if uncaused events occur, and even if by some wildly improbable coincidence it has been conserved in the past, it is very unlikely that it will continue to be conserved in the future. It is scarcely wise to believe that a happy accident' will inevitably or even likely repeat itself.

Finally, the critic may protest that I have moved too quickly. He may attempt to draw a distinction between uncaused and loose events. I have maintained that uncaused events are not causally linked and are, therefore, loose, i.e. the occurrence of one does not necessitate the occurrence of another. The critic may protest that I have no right to equate uncaused events and loose events. He may maintain that to postulate uncaused events is not necessarily to postulate loose events. If this is true then it is possible that uncaused events may be connected in some non-causal way so that they necessarily cancel one another in such a manner that the total energy of an isolated system is invariably and absolutely conserved.

The argument the critic wishes to develop cannot be made coherent. To postulate an essential connecting principle of this sort is to postulate a causal connection. Either the events in question are related in such a manner that the occurrence of one necessitates the occurrence of another, in which case we are forced to postulate some kind of causal connection - and hence deny that they are really uncaused - or they are not related in such a manner that the occurrence of one necessitates the occurrence of another, in which case they are loose.

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CONCLUSIONS

There are two conclusions that may be drawn from our discussion of causality and the Principle of the Conservation of Energy. The first is that the Principle of the Conservation of Energy is a synthesis of the *a priori* Principle of Universal Causality with *a posteriori* elements of experience. It is closely linked to the Principle of Universal Causality and can plausibly be viewed as an instantiation of this Principle.

The second is that we cannot jettison belief in the Principle of Universal Causality yet be justified in believing the Principle of the Conservation of Energy. Although it is conceivable that the Principle of the Conservation of Energy might be true even if the Principle of Universal Causality is false, the possibility is so remote that we can have no justification for thinking that if uncaused events occur energy will be conserved.

CHAPTER FOUR: MIND-BODY INTERACTION AND THE CONSERVATION OF ENERGY

In the preceding chapter the link between the Principle of Universal Causality and the Principle of the Conservation of Energy was explored. I argued that, although they are not to be identified with one another, these two Principles are so closely linked that we cannot deny the Principle of Universal Causality and still be warranted in affirming the Principle of the Conservation of Energy.

In the present chapter and in the one which follows I wish to explore some further implications of this close link between the Principle of Universal Causality and the Principle of the Conservation of Energy. Specifically, I wish to discuss two issues. I wish to discuss whether we may believe the Principle of the Conservation of Energy and yet affirm that the mind, considered as a substantial immaterial entity, acts upon the body. Also I wish to discuss whether we may believe the Principle of the Conservation of Energy and yet affirm the occurrence of miracles. Both issues are important ones. Both the belief that the mind acts upon the body and the belief that miracles occur commit one to the view that physical events occur which, although caused, do not have a physical cause.[1] Given the close link between the Principle of Universal Causality and the Principle of the Conservation of Energy, the question arises whether the occurrence of such events is consistent with the truth of the Principle of the Conservation of Energy. In the present chapter I shall consider the issue of the action of an immaterial mind upon the body. In the following chapter I shall consider the issue of miracles.

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Few philosophers are inclined to deny the fact that the body influences the mind, however the mind is to be conceived. A great number, though, deny that an immaterial mind could act upon the body. The result has been a widespread rejection of any dualist theory which suggests that the mind acts upon the body.

One of the major reasons underlying this rejection is the feeling that such a theory commits one to denying the Principle of the Conservation of Energy. It is felt that to deny this Principle is to deny one of the most fundamental scientific laws (The First Law of Thermodynamics) and to place in question the whole scientific enterprise. Mario Bunge, for example, argues that if an immaterial mind were to act upon the body then

> energy - a property of all - and only concrete things would fail to be conserved. And so physics, chemistry, biology, and economics would collapse. Faced with a choice between these 'hard' sciences and primitive superstition, [the hypothesis of a substantial immaterial mind which may act upon the body] we opt for the former.[2]

The claim that the action of an immaterial mind upon the body would violate the Principle of the Conservation of Energy arises from the fact that such action implies that, in the case of a mental event causing a physical event, there will exist "a gap between the state of the brain before the mental event has had its effect and the state of the brain after the mental event has had its effect."[3] This claim that we will find ourselves unable to explain the physical state of the brain at that particular time, unless we make reference to the action of a non-physical mind upon the brain, implies that the mind, in acting upon the brain, changes the position or velocity of some of the material particles making up the brain..

It thus seems that if we hold that a non-physical mind acts upon the brain we are committed to denying the Principle of the Conservation of Energy which is taken to state that the amount of energy in the universe is fixed.

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The reason this conclusion seems implied is that the mind, in changing the position or velocity of some of the material particles making up the brain, changes the amount of energy possessed by the brain. If this new amount of energy does not arise by virtue of energy being transferred to or from some physical source, but through the action of the mind upon the brain then it follows that the amount of energy in the universe is not fixed.[4]

This conclusion, it is urged, is a <u>reductio ad absurdum</u> of the idea that an immaterial mind could act upon the body. To hold that energy may be created by the action of the mind upon the body, to hold that the First Law of Thermodynamics - a law presumably a foundation of the whole scientific enterprise - is false, is ridiculous.

Various attempts have been made to counter this objection. They fall into three basic categories. These are:

1. Attempts to argue that, although the action of the mind upon the body involves the creation or destruction of energy, energy could still be conserved by virtue of the fact that a corresponding amount of energy may appear or disappear somewhere else.

2. Attempts to argue that the Principle of the Conservation of Energy is only statistically valid and hence that, so long as it does not create a great deal of energy, the action of the mind upon the body need not be taken to violate the Principle of the Conservation of Energy.

3. Attempts to argue that the Principle of the Conservation of Energy is merely the defining-postulate of physicalism and that any attempt to rule out the theory that an immaterial mind acts upon the body on the grounds that such a theory is not consistent with the Principle of the Conservation of Energy is only to assume the truth of physicalism.

It is worth noting that we have met the first two arguments, albeit in a slightly different guise, in the preceding chapter. These two arguments parallel arguments put forward by those who wish to reject the Principle of Universal Causality yet accept the Principle of the Conservation of Energy. The argument (2) that mind-body interaction is consistent with the Principle of the Conservation of Energy conceived statistically, i.e. mind-body interaction is consistent with the approximate conservation of energy, parallels the argument that uncaused events are consistent with the approximate conservation of energy, and the argument (1) that mind-body interaction is consistent with the Principle of the Conservation of Energy conceived absolutely parallels the argument that uncaused events may be linked in such a way that energy is absolutely conserved. At a purely _ad hominem_ level, therefore, the interactionist is in no worse straits than the person who rejects the Principle of Universal Causality yet accepts the Principle of the Conservation of Energy.

This observation is worth making, but it does not deal with the central issue. To say that the interactionist – when it comes to dealing with the objection that his position implies the falsity of the Principle of the Conservation of Energy – is in no worse straits than the person who rejects the Principle of Universal Causality, may well be to say nothing more than that the interactionist has company in his misery. Indeed, the fact that the first two arguments of the interactionist parallel the arguments discussed in the preceding chapter suggests that, at least as far as these two arguments are concerned, the interactionist has no adequate rebuttal to the charge that his position implies the falsity of the Principle of the Conservation of Energy.

In fact, none of the three attempts deals adequately with the objection which they are supposed to counter, i.e. the claim that if one believes in mind-body interaction then one is not warranted in accepting the Principle of the Conservation of Energy. In the following paragraphs I shall briefly say why each is less than satisfactory. I shall then suggest an alternative approach which, although it raises other issues, disposes of this particular objection to interactionism.

The first suggestion I have listed is the weakest of the three. It is so weak that it appears very infrequently in the literature and even then has little weight placed upon it by its proponents.[5] Its basic defect is that it conflates what is logically possible with what is plausible or probable. It will not do to argue that, because some state of affairs is logically possible, it is therefore likely to be realized. Thus, although it is certainly logically possible that whenever the action of mind creates a certain amount of energy an equal amount of energy invariably vanishes from the world at some other place even though the two events are not causally connected, the probability of such a state of affairs being actually realized is vanishingly small.[6] Even supposing we could satisfy ourselves that such a remarkably improbable coincidence had up to the present time continually occurred, we could scarcely justify the belief that it would continue to occur: the odds against such a remarkably improbable coincidence continually occurring are so great as virtually to guarantee that, at some point, energy would not be conserved. Indeed, the probability of such a coincidence and its continual occurrence are so low that faced with the seeming occurrence of such a situation we would probably question whether the mind was indeed non-physical; preferring, instead, to postulate the presence of some strange hitherto undiscovered form of energy which acts upon the brain and must be taken into account in formulating the Principle of the Conservation of Energy.

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The second suggestion is somewhat more plausible. Karl Popper, in The Self and Its Brain, a book he co-authored with John Eccles, suggests that "the law of the conservation of energy ...[may] turn out to be valid only statistically."[7] Presumably, if this were the case then the action of the mind upon the body could be viewed as relatively minor fluctuations which do not really violate the Principle of the Conservation of Energy, provided we remember that this principle is really a statistical one, not absolute.

This response is not entirely adequate. There are at least two problems. The first is that, unless we suppose that only a relatively small number of interactions take place between minds and bodies, it is very improbable that energy will be even approximately conserved. In our discussion in the preceding chapter of an argument which basically parallels this one, i.e. the claim that a number of uncaused events occurring simultaneously are consistent with a statistical form of the Principle of the Conservation of Energy by virtue of the fact that there will be some kind of averaging tendency, we found that the greater the number of events involved the less chance there is of energy being conserved in even an approximate sense. Given the large number of events which the interactionist claims are instances of mind-body interaction, there is little hope of salvaging the Principle along statistical lines.

The second problem is that, even supposing we can get around the difficulty that there seem to be too many events involved for it to be likely that energy is even approximately conserved, it is far from clear that the First Law of Thermodynamics could (1) be reformulated in a statistical manner, and (2) that it would be desirable to reformulate it in such a manner. Concerning (1) I wish only to note that it is a matter of debate whether the First Law of Thermodynamics could be reformulated along statistical lines. A number of writers such as D.W. Theobald, J.J.C. Smart and Eugene Wigner argue that conservation or invariance laws must be conceived as absolute, not statistical.[8] Whether or not they are right in arguing this is a debate into which I do not propose to enter. It is sufficient for my purposes to note that it is not clear that the First Law of Thermodynamics can, in fact, be reformulated along statistical lines. Concerning (2) it is fair to say that, whatever the outcome of the debate concerning (1), the First Law of Thermodynamics is not viewed by the scientific community as a statistical law. We may conclude that at least at the present time, it has not been shown that it is possible or desirable to reformulate the First Law of Thermodynamics along statistical lines. Popper's suggestion, although interesting, constitutes no real solution to the problem of how to reconcile interactionism and the Principle of the Conservation of Energy.

The third suggestion, namely that the critic begs the possible truth of interaction in rejecting it on the grounds that it implies the falsity of the Principle of the Conservation of Energy, is by far the strongest and most direct of the three replies generally made by interactionists. It merits closer scrutiny than the first two.

C.J. Ducasse, one of its most eloquent proponents, formulated this argument in the following way:

> the conservation of energy is simply a postulate, and more particularly a defining postulate, of the notion of 'an isolated physical system' (irrespective of whether or not anything short of the whole physical universe could be an isolated system). That is, conservation of energy is something one has to have, if (as the materialistic ontology of physics and more generally of naturalism demands) one is to be able to conceive the physical world as wholly self-contained, independent, 'isolated'. Accordingly, when what observation reveals seems to be dissipation of energy instead of conservation, conservation is saved by postulations ad hoc; for example, by postulating that something else, which appears when energy one observed disappears - but which was not until then conceived as energy - is energy too, in 'another form'; ...
>
> Conservation of energy, thus, would be an obstacle to the possibility of psychophysical ... causation only if it

> were known to be a universal fact; ...
> But this is not known - only postulated, and postulated only to save the universality of the conservation of energy. And what need, other than a doctrinaire one, have we to postulate a physical cause, when observation reveals a psychical one?[9]

Ducasse was correct when he asserted that we cannot simply define away the question whether an immaterial mind acts upon the body. Although he was correct in this, the problem with the reply he actually made is that it largely misses the point. He seriously underestimated the force of the critic's objection.

The point, as the critic will be quick to note, is not that we begin by rejecting the claim that an immaterial mind acts upon the body, but that there exists an initial presumption in favour of the truth of the Principle of the Conservation of Energy. The reason this presumption exists is that the Principle has an enormous body of experimental evidence in its favour. Given that interactionism implies the falsity of the Principle, it would take an enormous amount of evidence in favour of interactionism to persuade us to abandon the idea that energy is conserved.

The critic will go on to claim that we do not have a great deal of evidence in favour of mind-body interaction. He will claim that, when faced with two claims which cannot both be true, it is only rational to believe the one for which there exists the most evidence, namely the Principle of the Conservation of Energy. He does not on that account beg the issue in favour of physicalism and Ducasse erred in thinking that he does.

The basic problem with Ducasse's suggestion is that it does not take into account the possibility that the critic may justify his rejection of mind-body interactionism by means of a balance of probabilities argument. The critic is quite willing to acquiesce to the demand that we do not beg the question of the truth of interactionism, but he will quite properly insist that we must decide between interactionism and the Principle of the Conservation of Energy by looking to see which is supported by the larger body of evidence. The suggestion that this objection simply begs the question of the truth of interactionism fails to take into account the fact that there is a legitimate presumption in favour of the truth of the Principle of the Conservation of Energy which cannot be overcome except on the basis of some stronger body of evidence in favour of interactionism. Inasmuch as Ducasse's argument does not not take this into account, it does not constitute an adequate reply to the objection it is supposed to counter.

Our examination of the standard interactionist attempts to deal with the objection that interactionism is not consistent with the truth of the Principle of the Conservation of Energy reveals that none of these attempts constitutes an adequate rebuttal. I propose, therefore, to develop an alternative approach which does adequately deal with this objection.

AN ALTERNATIVE APPROACH

I suggest that the answer to this difficulty lies in the distinction which must be made between two forms of the Principle of the Conservation of Energy. Earlier, I distinguished between what I termed the strong form of the Principle, i.e. the claim that energy can neither be created nor destroyed, and what I termed the weak form of the Principle, i.e. the claim that in a causally isolated system the total amount of energy remains constant. I noted that these two forms are not logically equivalent: the claim that energy can neither be created nor destroyed is considerably stronger than the claim that the total amount of energy in a causally isolated system remains constant. It is possible to deduce the weaker claim from the stronger, i.e. it is possible to deduce the statement 'In a causally isolated system the total amount of energy remains constant' from the statement 'Energy can neither be created nor destroyed', but it is not possible to deduce the stronger claim from the weaker claim, i.e. it is impossible to deduce the statement 'Energy can neither be created nor destroyed' from the statement 'In a causally isolated system energy remains constant. I also noted that the experimental evidence which is taken to support the Principle of the Conservation of Energy more directly supports what I have called the 'weak' form of the Principle. Our actual experimental evidence only demonstrates that in a causally isolated system the total amount of energy will remain constant. It does not, by itself, demonstrate that energy can neither be created nor destroyed. If we wish to arrive at this stronger claim some further inference, some additional premise, is required. To say this is not to rule on the question of whether such a further inference can be justified: that is an issue which we shall have occasion to discuss in later chapters. It is merely to raise the possibility that we might accept, on the basis of the large body of experimental evidence in its favour, the claim that in a causally isolated system the total amount of energy remains constant, yet deny the further claim that energy can neither be created nor destroyed.

The relevance of the distinction is this. The person who believes that the mind, considered as an immaterial entity, acts upon the body is under no compulsion to deny the weak form of the Principle, i.e. the claim that in a causally isolated system energy will remain constant. The interactionist denies not that in an isolated system energy will remain constant, but that the human body is an isolated system. He rejects not the well-evidenced claim that in an isolated system energy remains constant, but the considerably weaker claim that the human body is an isolated system in the sense that it is uninfluenced by an immaterial mind.

The interactionist must deny the strong form of the Principle, i.e. the claim that energy can neither be created nor destroyed. The point that must be emphasized is that in doing this he is under no compulsion to deny any of the experimental evidence usually taken to support belief in the Principle of the Conservation of Energy. No less than his opponent, the interactionist accepts the large body of experimental evidence which suggests that in an isolated system energy is conserved. He denies only the further claim that there is no reason to postulate something more fundamental than energy whereby energy may be created or destroyed.

Unfortunately, this distinction between the strong and weak form of the Principle has not been previously noted. What usually happens is that the critic, having in mind the strong form of the Principle, realizes that the action of an immaterial mind upon the body implies that energy may be created or destroyed and concludes that such a view is in conflict with the large body of experimental evidence which supports belief in the weak form of the Principle. The critic then constructs a balance of probabilities argument designed to show that it is extremely improbable that the mind could act upon the body, since this would imply the falsity of the Principle of the Conservation of Energy.

What must be stressed is that the possibility of drawing this distinction changes the picture. The enormous body of experimental evidence the critic has in mind most directly supports the weaker claim that in an isolated system energy remains constant; a claim with which the interactionist wholeheartedly agrees. The real issue is not whether mind-body interaction is consistent with the experimental evidence taken to justify belief in the Principle of the Conservation of Energy, but whether the inference required to move from the weak to the strong form of the Principle is justified.

My point, put somewhat differently, is that the actual experimental evidence usually taken to justify belief in the Principle of the Conservation of Energy cannot automatically be taken to justify belief in the claim that energy can neither be created nor destroyed. _Prima facie_, this evidence only demonstrates that in a causally isolated system energy is conserved. The critic, if he is to justify the inference required to move from the weak to the strong form of the Principle, must show that this evidence 'flows upward' in such a manner as to provide inductive support for the strong form of the Principle. Unless he can do this, he is in no position to rule against interactionism on the ground that it is not consistent with the truth of the strong form of the Principle, since to do so would be merely to assume the truth of the strong form.

The real issue, therefore, is not whether interactionism is consistent with the experimental evidence supporting the Principle of the Conservation of Energy - clearly it is - but whether the interactionist is in a position to resist the further inference that energy can neither be created nor destroyed. If he is not then his theory of mind-body interaction, even though it does not conflict with any actual experimental evidence, is bound to seem extremely implausible. However, if he is in a position to resist the further inference that energy can neither be created nor destroyed then he will be able to lay to rest any objection based upon the Principle of the Conservation of Energy.

CONCLUSIONS

There are two conclusions to be drawn from our discussion in this chapter. The first is that the standard interactionist replies to the objection that interactionism is not consistent with the Principle of the Conservation of Energy are inadequate. All three of these replies are, in one way or another, unconvincing.

The first fails in that it conflates what is conceivable with what is plausible. To say that something is conceivable is not to advance any grounds for thinking it is actually the case. It might conceivably be that whenever energy appears or disappears because of the action of an immaterial mind that somewhere else in the universe a corresponding amount of energy disappears or appears, but such a state of affairs is hardly probable. Until some grounds for believing this to be actually the case are advanced, this suggestion cannot be accepted as a solution to the problem of reconciling mind-body interaction and the conservation of energy.

The second suggestion that mind-body interaction is consistent with the Principle of the Conservation of Energy conceived statistically also fails. It fails in that, unless we suppose an unrealistically small number of mind-body interactions, energy will not even be approximately conserved. It also fails in that the First Law of Thermodynamics is conceived by scientists as an absolute, not a statistical, law.

The third suggestion that the Principle of the Conservation of Energy proves to be a defining-postulate of physicalism and that the critic in objecting to mind-body interaction on this basis is merely assuming the truth of physicalism, is an interesting one. The problem with it is that it fails to take into account the fact that the physicalist can utilize a balance of probabilities argument based on a presumed conflict between the evidence which supports belief in the Principle of the Conservation of Energy and the evidence which supports belief in mind-body interaction.

My second conclusion is that the objection that mind-body interaction is not consistent with the truth of the Principle of the Conservation of Energy must be assessed in light of the distinction between the strong and the weak form of that Principle. This distinction may provide a way for the interactionist to escape the balance of probabilities argument which would otherwise prove a problem. What vitiates approaches such as that of Ducasse is that they can provide no reply to the critic who asserts that mind-body interaction is antecedently improbable because it conflicts with the enormous amount of scientific evidence which supports belief in the Principle of the Conservation Of Energy. The necessity of drawing a distinction between the two forms of the Principle reveals that the interactionist is not in such dire straits as might be thought. Mind-body interaction conflicts not with the weak form of the Principle and the experimental evidence which supports it, but with the strong form of the

Principle. Provided he can resist the inference required to move from the weak to the strong form of the Principle, the interactionist is in a position to block any attempt by the critic to frame a balance of probability argument based on a presumed conflict between the evidence which supports belief in the Principle of the Conservation of Energy and the evidence which supports belief in mind-body interaction. If he can block this inference he is in a position to resist any objection based on the Principle of the Conservation of Energy.

Miracles and the Conservation of Energy

CHAPTER FIVE: MIRACLES AND THE CONSERVATION OF ENERGY

In the present chapter I shall consider some of the philosophical issues surrounding the notion of a miracle. I hope to show that these issues are related to questions which have concerned us in earlier chapters and that new light can be cast on them by considering them in this manner. In particular, I hope to show that the distinction which has been drawn between the weak and strong form of the Principle of the Conservation of Energy must be taken into account when evaluating the 'conflict of evidence' argument employed by Hume and his successors.

HUME'S 'OF MIRACLES'

Hume's famous essay 'Of Miracles' provides a logical and convenient starting point from which to launch our discussion. The essay is divided into two parts. Part I consists of an *a priori* argument. Here, Hume argued that because of the way in which belief in the laws of nature is established and the way in which belief in miracles must be established, testimonial evidence could never justify belief in a miracle. Part II consists of four a posteriori arguments. Here, Hume argued that, as a matter of fact, the testimonial evidence in favour of miracles is extremely poor.

Philosophers generally agree that Hume's _a posteriori_ arguments are not of the same high calibre as his _a priori_ argument given in Part I. Hume was almost certainly aware of this. For example, we notice in examining his first _a posteriori_ argument that he ultimately falls back on the argument found in Part I of the essay. [1] Since it is not only the most important of Hume's arguments against belief in miracles, but also the argument to which the distinction between the weak and strong form is most relevant, I shall confine myself to discussing the _a priori_ argument of Part I.

Hume's argument is this:[2]

1. Experience is our "only guide in reasoning concerning matters of fact."[115]

2. "It must be acknowledged that this guide [experience] is not altogether infallible but in some cases is apt to lead us into errors."[115]

3. Therefore, " a wise man ... proportions his belief to the evidence. In such conclusions as are founded on an infallible experience, he expects the event with the last degree of assurance and regards his past experience as a full proof of the future existence of that event. In other cases he proceeds with more caution; he weighs the

opposite experiments; he considers which side is supported by the greater number of experiments - to that side he inclines with doubt and hesitation; and when at last he fixes his judgment the evidence exceeds not what we properly call 'probability.'"[116]

4. "We ought not to make an exception to this principle in favour of human testimony."[117]

5. "We do not have a firm and unalterable experience that human testimony is always trustworthy."[123]

6. "A firm and unalterable experience has established the laws of nature."[119]

7. "A miracle is a violation of the laws of nature."[119]

8. Therefore, since "a uniform experience amounts to a proof, there is ... a direct and full proof from the nature of the fact, against the existence of any miracle, nor can such a proof be destroyed or the miracle rendered credible but by an opposite proof which is superior."[120]

9. "The proof against a miracle from the very nature of the fact, is as entire as any argument from experience can possibly be imagined."[119]

10. Therefore, "no testimony is sufficient to establish a miracle unless the testimony be of such a kind that its falsehood would be more miraculous than the fact which it endeavours to establish."[120] [This together with 9., the claim "the proof against a miracle ... is as entire as any argument from experience can possibly be imagined", implies that no testimony could ever be sufficiently strong to establish belief in a miracle.]

There are a number of criticisms that can be made of this argument. First, at a purely *ad hominem* level, it is noteworthy that Hume's treatment of miracles is inconsistent with his treatment of induction. In his treatment of induction Hume says that the move from regular experience of event A followed by event B to the belief that event A will invariably be followed by event B is logically unjustified. Presumably, this belief is merely the result of a strong psychological tendency to believe in uniformity. We may speak, therefore, of two psychological tendencies: the tendency of certain people to believe in absolute uniformity and the tendency of others to believe in miracles. As psychological states these two beliefs are on equal footing and Hume does not give, and on his own theory is unable to give, any reason for preferring one belief to the other.

Further, if Hume's analysis of causation be accepted, namely that there exist no necessary connections between events, his discussion of whether or not it is rational to believe a report of a miracle, begs the question. As Anthony Flew admits, "to dismiss out of hand all testimony to the occurrence beyond the range of our observations of a counter example, on the sole ground that such an occurrence would falsify the universal generalization based upon our observations to date would be arbitrary and bigotted."[3]

Hume should have either repudiated his explicitly stated position concerning induction and causality or else admitted that his conception of what is meant by a law of nature prohibited him from pressing his objection to miracles. If a law of nature is nothing more than a strong psychological tendency to believe in uniformity it can hardly act as a legitimate reason for rejecting reports of non-uniform events such as miracles.

Another criticism which can be made of Hume's argument is that it commits us to maintaining that no event is a miracle unless it is absolutely unique. The claim that a miracle must contradict the whole course of experience is a strange and untenable one. Surely, despite the fact that Elijah is reported to have multiplied food, Christ's multiplication of the loaves and fishes is to be judged 'miraculous'.[4] As Broad commented, "It seems arbitrary to suppose that two or three exceptions to a regularity necessarily prove that it is not a law of nature and consequently that none of the exceptions are miraculous."[5] Hume, if he is to be consistent, is forced to say just this. Clearly he overemphasized the fact that a miracle is a non-uniform event to the neglect of the fact that it is an event caused by a rational agent who transcends nature.

A much more serious objection than either of these is the objection that the argument proves too much. It not only prohibits belief in reports of miracles, but also progress in science. The reason this is so is that belief in the laws of nature, no less than belief in miracles, rests mainly on testimonial evidence. Moreover, there have been many statements held to express natural laws because of an invariable experience in their favour which, upon later observation of exceptions, were subsequently abandoned. If Hume's *a priori* argument is accepted this procedure must be judged irrational, since the first reported exception, to anyone who has not observed it, occupies the same logical status as the report of a miracle. Thus,

> those, ... to whom the first exception was reported ought to have rejected it, and gone on believing in the alleged law of nature. Yet, if the report of the first exception makes no difference to their belief in the law, their state of belief will be precisely the same when a second exception is reported as it was on the first occasion. Hence if the first report ought to make no difference to their belief in the law, neither ought the second. So that it would seem on Hume's theory that if, up to a certain time, I and every one else have always observed A to be followed by B then no amount of testimony from the most trustworthy persons that they have observed A not followed by B ought to have the least effect on my belief in the law.[6]

That Hume was not unaware of this objection can, perhaps, be inferred from his discussion of people in a warm climate who, having never directly observed that water freezes, are told that water freezes. He commented

> it must be confessed that, in the present case of freezing, the event follows contrary to the rules of analogy

> and is such as a rational Indian would not look for. The operations of cold upon water are not gradual, according to the degrees of cold; but whenever it comes to the freezing point the water passes in a moment from the utmost liquidity to perfect hardness. Such an event, therefore, may be denominated 'extraordinary' and requires a pretty strong testimony to render it credible to people in a warm climate: but still it is not miraculous, nor contrary to uniform experience of the course of nature in cases where all the circumstances are the same.[7]

His reply, judging from this passage, is that strong testimony is sufficient grounds to establish belief in 'unusual' events beyond the ken of one's experience so long as the reports of such events also indicate that the circumstances under which the events took place were somewhat foreign to one's experience.

This reply is inadequate. It ignores the fact that the "people who discover exceptions to alleged general laws are seldom the same people who explain them."[8] It often happens, for example, that a researcher reports an exception to an alleged general law even though he cannot identify any relevant background circumstance that is even subtly different from those under which more usual results are obtained. Unless suitably strong testimony establishes at least a provisional belief in the occurrence of the event, the theoretician has no reason to think there is anything that needs explanation or investigation.

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It might be replied that the belief of the theoretician is only provisional; that if only one researcher reports an exception, and if the theoretician upon careful inspection of the report of the conditions under which the reported exception occurred can find no relevant background condition that could serve to explain or make plausible the unusual results then he would be justified in concluding that the apparent exception never occurred.

Suppose, though, that a significant minority of reputable independent researchers report that they on occasion obtain similar results. Surely it is possible to imagine conditions under which it would be irrational to dismiss the reports of exceptions, even though it is impossible to point to any relevant differing background condition that is different from those under which more usual results are obtained. If it is to progress, science must admit the possibility of such exceptions to alleged general laws; otherwise there is no need to think there is anything that needs explanation and consequently there is no need to revise scientific theory. Hume's argument, in that it precludes this typical activity on the part of scientists, is not only an argument that precludes belief in reported miracles, but an argument that precludes the possibility of progress in science.

All these are important criticisms and go a long way toward showing there is something wrong with Hume's famous argument. Nevertheless, to leave the matter at this would be a mistake. The argument may be summarized as follows:

1. The testimonial evidence in favour of a miracle inevitably conflicts with the evidence in favour of laws of nature.

2. The testimonial evidence in favour of a miracle cannot exceed, even in principle, the evidence in favour of laws of nature.

3. Therefore, belief in the occurrence of a miracle can never be justified on the grounds of testimonial evidence.

Critics of this argument have focussed their entire attention upon the second premise. Unreflectively accepting Hume's claim that the testimonial evidence in favour of miracles inevitably conflicts with the evidence in favour of laws of nature, they have left the first premise unexamined. This is a mistake, since, as I intend to show, this claim can be shown to be false.

MIRACLES AND THE LAWS OF NATURE

In discussing Hume's claim that the testimonial evidence for a miracle inevitably conflicts with the evidence supporting belief in the laws of nature, it is essential to make clear what we mean by the terms 'miracle' and 'law of nature.' I shall, therefore, briefly indicate how I shall use these terms. I shall then be in a position to discuss Hume's claim that the testimonial evidence in favour of a miracle inevitably conflicts with the evidence in favour of the laws of nature.

I shall use the term 'miracle' to designate a physical event which is specially caused by God. As such, it constitutes an overriding of the order of nature. In short, a miracle is an event which nature would not have produced had not God intervened and acted in such a way as to bring it about. Thus, although this sense of the term 'miracle' "includes the idea that wonder is called for as at least part of the appropriate response, the crux as well as the ground for the wonder is that a miracle should consist in an overriding of the order of nature."[9]

The term 'law of nature' I shall take as logically equivalent to a scientific law which is, in fact, true. I hasten to add that by scientific law I do not mean 'inductive generalization' or 'experimental law.' Rather, I am referring to theoretical laws or principles which serve to explain the experimental laws discovered by scientists. What this means is that, while the term 'law of nature' refers to a universal conditional that may in principle be either confirmed or disconfirmed by empirical evidence, the conditional will contain terms which refer not directly to observed regularities, but to unobservable entities and properties, e.g. electrons, which serve to explain observed regularities. Laws of nature, therefore, cannot be directly confirmed or disconfirmed by observation; they must be indirectly confirmed or disconfirmed through predictions made on the basis of these laws.

Having indicated how I am using the terms 'miracle' and 'law of nature', I am now in a position to discuss Hume's claim that there is an inevitable conflict between the testimonial evidence supporting belief in miracles and the evidence supporting belief in particular laws of nature.[10] My view is that Hume was wrong to claim this. Considered as objective physical events specially caused by God, miracles can conceivably occur in a world which behaves, always and everywhere, completely in accordance with the laws of nature.

This view is a controversial one. It is usually thought that if we define the terms 'miracle' and 'law of nature' in the way I have defined them then we are committed to the proposition 'If a miracle occurs then some law of nature has been violated.'. The reasoning behind this is that a miracle must constitute an overriding of nature, but that such an overriding can take place only if one or more laws of nature are violated. This reasoning, however, is fallacious. I shall show that it is quite conceivable that an overriding of nature could take place without any law of nature being violated.

In order to demonstrate this claim, I will begin by examining some commonplace features of the 'Covering Law Theory of Explanation.' In this theory the typical form an explanation takes is:

$(C_1, \ldots, C_n)$,
$(L_1, \ldots, L_m)$,

Therefore E,

where $(C_1, \ldots, C_n)$, is a set of singular statements describing relevant initial conditions, and where $(L_1, \ldots, L_m)$ is a set of general laws, and where E, the event to be explained, is a logical consequence of the C's and L's, but not of the C's alone.[11] As is well known, this same schema can be used to predict the occurrence of E if $(C_1, \ldots C_n)$ were to occur.

The point I wish to emphasize is this. Although we may often speak as though the laws of nature are, by themselves, sufficient to explain the occurrence of an event this is not really true. Inasmuch as they are merely conditionals, the laws cannot, by themselves, explain the occurrence of an event. What this means is that a scientific explanation must not only make reference to the laws of nature, but also to the actual 'stuff' of nature, i.e. the matter or, more accurately, mass/energy, whose behaviour is described by the laws of nature.

If we keep in mind this basic distinction between the laws of nature and the 'stuff' of nature, i.e. mass/energy, whose behaviour they describe, it can be seen that, although a miracle is an event which never would have occurred had not nature been overridden, and although the notion of a miracle is logically dependent upon the notion of a known order to which it constitutes an exception, this in no way entails that a miracle must violate, suspend, or be an exception to the laws of nature. If God creates or annihilates a unit or units of mass/energy, He breaks no law of nature, but He does, by the creation of new mass/energy, or by the annihilation of previously existing mass/energy, change the material conditions to which the laws of nature apply. He thereby produces an event which nature on its own would not have produced.

It is important to emphasize that such an event in no way implies that the laws of nature are violated, suspended, or even have exceptions. We do not, for example, violate, suspend, or even produce an exception to the laws of motion if we toss an extra billiard ball into a group of billiard balls in motion on a billiard table. There is no moment of time at which the laws of motion are violated, suspended, or suffer an exception. What one does by introducing the extra billiard ball is change the material conditions to which the laws of motion apply, and hence change the result which would otherwise be expected. Similarly God, by creating or annihilating a unit or units of mass/energy, might produce in nature an event which would not otherwise have been expected without violating, suspending, or creating exceptions to the laws of nature.

To anticipate an objection, it will not do to argue that if a miracle occurs then some instance of the implication of the complete set of the laws of nature is contravened, and, therefore, by modus tollens, at least one of the laws in the set is contravened. Put somewhat differently, it will not do to argue that if a miracle is an exception to the regular course of nature, then it is *ipso facto* an exception to some law, since the complete set of laws entails a complete description of the course of nature.[12] What this argument fails to take into account is the fact that the complete set of laws entails the complete description of the course of nature only if the material conditions to which the laws apply are not changed. To revert to our billiard table example, the laws of motion entail the description of the actions of the billiard balls only so long as no extra billiard balls are introduced into the system. Similarly, the complete set of the laws of nature entails a complete description of the course of nature only so long as God does not create or annihilate mass/energy, thus changing the material conditions to which the laws apply.

There are two major objections that might be raised against my argument. The first is that my conclusion can only be reached by offering an arbitrary, unrealistic definition of the term 'law of nature.' The second is that, even if it be granted that the definition of 'law of nature' put forward is adequate, the argument still implies that at least one law of nature must be violated if a miracle occurs, since the creation or annihilation of mass/energy implies that the First Law of Thermodynamics has been violated.

Considering the first objection, it might, I suppose, be urged by a critic that the term 'law of nature' is best understood as meaning merely a well-established regularity of nature. For example, the critic might maintain that it is a law of nature that virgins do not give birth. Presumably, if the miracle of the Virgin Birth actually occurred then the law of nature that virgins do not give birth must have been violated.

If we grant the critic this definition then it seems to follow that a miracle is indeed a violation of the laws of nature. Unfortunately for the critic, it also follows that a number of non-miraculous events which we are not normally inclined to view as being violations of the laws of nature must be classed as violations of the laws of nature. Consider, for example, the possible case of a virgin who, through surgical procedures, has a fertilized egg implanted in her uterus. After a period of nine months this woman gives birth. My point is that, although we might find such an event unusual and newsworthy, we would scarcely be inclined to view it as violating the laws of nature. Regularities in nature, such as the fact that virgins do not usually give birth, may constitute evidence for the laws of nature or, given that we know the relevant set of conditions, be explicable by reference to laws of nature, but it does not seem plausible to view them as being themselves laws of nature.

The critic might argue that this distinction does not fully resolve the difficulty. Granted that we must distinguish between laws of nature and well-established regularities of nature, we are nevertheless firmly convinced that there are a great number of well-established regularities of nature which, in the absence of extraordinary circumstances, admit of no exceptions. Surely the regularity of nature that, in the normal course of events, virgins do not give birth, admits of no exceptions.

The claim that we are firmly and justifiably convinced that, all other things being equal, some regularities of nature admit of no exceptions must be granted. It must also be granted that our conviction that virgins do not, in the usual course of events, give birth falls into this category. However, it is precisely the contention of the believer that all other things were not equal. Thus, for example, the believer in the miracle of the Virgin Birth would hold that this miracle is, in some respects, analogous to the hypothetical case of the virgin who through surgical procedures had a fertilized egg implanted in her uterus. They are analogous not in the means by which the result of a virgin birth is achieved, but in that in neither case are 'all other things equal.' In our hypothetical case a human agent, i.e. the surgeon, intervenes so as to change the material situation to which the laws of nature apply. In the case of the Virgin Birth, a divine agent, i.e. The Holy Ghost, intervenes so as to change the material situation to which the laws of nature apply. Both produce in nature an event which would not otherwise occur and which constitutes an exception to a well-established regularity of nature.' In neither case are 'all other things equal' and in neither case is there any reason to suppose that the laws of nature were violated, suspended, or suffered an exception.[13]

My argument is that miracles are, in an important sense, analogous to acts of human agents. Thus, if a human agent may act in such a way as to produce an exception to a regularity of nature which, in the absence of action on the part of some agent, would admit of no exception, it seems reasonable to suppose that a divine agent might act similarly. It follows that if a human agent need not violate any natural laws in producing an event which is an exception to a well-established regularity of nature then neither need a divine agent violate any natural laws in producing such an event.

The critic might reply that I have not made miracles easier to conceive so much as raised problems concerning the notion of agency. If the notion of agency implies that agents in some significant way stand outside physical processes, yet act in such a way as to influence physical processes, this suggests that some form of interactionism is a correct theory of the mind/body relation. Surely such a theory of the mind/body relation is difficult to defend.

This criticism suggests, correctly I think, that, in the final analysis, the question of miracle cannot be considered in isolation from a number of other important philosophic issues. I wish merely to note this. I do not, in this thesis, propose to develop a theory of agency and show its relation to the question of miracle and the mind/body problem. Nevertheless, it is appropriate to note that even if the notion of agency I have employed implies the truth of some version of interactionism, it is not usually objected that the interaction of mind and body implies that natural laws are violated.[14]

Prima facie, the second objection seems much harder to deal with than the first. There seems no way around the conclusion that if a miracle involves either the creation or annihilation of mass/energy then the occurrence of a miracle implies that the law known as the First Law of Thermodynamics (The Principle of the Conservation of Energy) has been violated. I shall show that this difficulty is apparent rather than real.

The answer to this objection is essentially the same as when it was raised against the possibility of mind-body interaction. It is this. We must distinguish between two forms of the Principle of the Conservation of Energy; one of which states that 'Energy can neither be created nor destroyed', the other that 'The total energy of an isolated system remains constant.' It must be realized that these two statements are not logically equivalent. It is possible to deduce from the statement 'Energy can neither be created nor destroyed', the statement, 'The total energy of an isolated system remains constant', but it is not possible to deduce from the statement 'The total energy of an isolated system remains constant', the statement, 'Energy can neither be created nor destroyed.'

Further, it must be realized that the scientific evidence usually taken to ground belief in the Principle of the Conservation of Energy directly supports the weaker claim that energy is conserved in an isolated system, but a further inference that there exists no sufficient reason to postulate anything more fundamental than energy whereby it may be created or destroyed is necessary if we wish to arrive at the strong form of the Principle. Strictly speaking, the scientific evidence only demonstrates that in an isolated system energy remains constant. In itself, it does not imply that energy can neither be created nor destroyed.

The relevance of the distinction is this. The person who believes in the occurrence of miracles is under no compulsion to deny the weak form of the Principle, namely the claim that in a causally isolated system energy remains constant. He denies not that in a causally isolated system energy will remain constant, but that nature is a causally isolated system. He rejects not the well-evidenced claim that in an isolated system energy remains constant, but the much weaker claim that nature is an isolated system in the sense that it is not open to the causal influence of God. He is in a position to accept all the scientific evidence. In short, he is in a position to accept the Principle of the Conservation of Energy, when it is formulated as a scientific law and not as a defining-postulate of physicalism.

He must, of course, deny the strong form of the Principle of the Conservation of Energy, namely the claim that energy can neither be created nor destroyed. The point which must be stressed is that in doing this he does not deny that it is a law of nature that in an isolated system energy is conserved. Neither, it must be emphasized, does he maintain that this law of nature is in any way violated, suspended, or suffers an exception in the case of a miracle. He denies only that energy can neither be created nor destroyed. He denies only the assertion that there exists nothing other than nature by which energy could be created or destroyed.

Now it certainly must be admitted that the statement 'Energy can neither be created or destroyed' is one which seems to many people to be obviously true; so much so that it is often confused with the well-evidenced but much weaker claim that 'The total energy of an isolated system remains constant.' The source of this confusion lies in the fact that it is usually at least an implicit assumption on the part of those who assert this that nature exists and functions, so to speak, 'on its own'. Once the assumption is made that nature is all that exists and cannot be subject to addition or subtraction by something external to it, the claim that 'Energy cannot be created or destroyed' is one which is bound to seem very plausible.[15] However, in the case of reports of miracles it is precisely this assumption which is being questioned, and to object to such reports on the basis that the occurrence of miracles would not be consistent with the truth of the claim that 'Energy can neither be created nor destroyed' is only to beg the question of whether nature exists and functions entirely 'on its own'.

The conclusion is clear. Insofar as the Principle of the Conservation of Energy is formulated as a scientific law, a miracle constitutes no violation of it. One may agree that 'If a system is isolated then its total energy remains constant' without thereby agreeing that nature is in fact an isolated system. However, insofar as the Principle of the Conservation of Energy is formulated as a defining-postulate of physicalism, it, by definition, rules out the possibility of miracles. This should come as no surprise, since so formulated it also rules out theism and any possibility of creation _ex nihilo_.

The claim that a miracle occurred conflicts not with the well-evidenced scientific claim that 'The total energy of an isolated system remains constant', but with the metaphysical assertion that nature is an isolated system not open to the action of God. I conclude that insofar as the Principle of the Conservation of Energy is asserted as a law of nature and not as a somewhat disguised metaphysical assertion, a miracle need not be conceived as in conflict with it. Thus, the idea that a miracle must be an event which nature would not produce on its own and which constitutes an exception to the regular course of nature does not entail the conclusion that a miracle must violate, suspend, or be an exception to the laws of nature.

It should be noted that this conclusion only follows if it is appropriate to view a miracle as an event which is at least partially caused by an act of creation or annihilation of mass/energy by a rational agent who transcends nature. I use the phrase 'at least partially' because it is clear that an event which is termed a miracle may be a product of both the already functioning processes of nature and an act of creation or annihilation. For example, the miracle of the Virgin Birth can be seen as an event in which an act of creation by God, i.e., the creation of a spermatozoon in the body of Mary, combined with existent natural processes, i.e. the normal growth and development of a fetus during pregnancy, to produce the miraculous event we call the Virgin Birth. Or, to develop a different example in which the annihilation of mass/energy may have played a part, certain acts of healing on Christ's part may have involved the annihilation of the material making up harmful tumors or infections. Or, to take this line of thought a step further, it is entirely possible that a miracle may involve both acts of creation and acts of annihilation. Christ's healing of lepers might, for example, have involved both the annihilation of diseased cells and the creation of new tissue to replace tissue previously lost to the disease. In all of these, it seems quite clear that an act of creation or annihilation may combine with already functioning natural processes to produce an event we would term a miracle. On the other hand, it should be emphasized, a miracle need not have any natural processes linked to it, e.g. the miracle of the multiplication of the loaves and fishes appears to have been a direct act of creation in which already functioning natural processes played little part.

Miracles, therefore, need not be conceived as conflicting with the laws of nature. Rather, they involve acts of creation or annihilation of that to which the laws apply. It is clear that God, by annihilating or creating mass/energy and so changing the material conditions to which the laws of nature apply, could produce within nature events which nature would not otherwise produce without thereby violating, suspending, or creating exceptions to any of the laws of nature.

This conclusion is a significant one. Since Hume, a major objection to the claim that there could be a rationally justified belief in the occurrence of miracles has been that the historical evidence seeming to favour such events must be judged to be in conflict with the scientific evidence which supports belief in the laws of nature. However, if a miracle need not be considered a violation of the laws of nature there is no reason to believe that the two bodies of evidence conflict. Miracles cannot, therefore, be judged antecedently improbable. Hume's famous balance of probabilities argument based on a presumed conflict between the evidence which supports belief in the laws of nature and the evidence which supports belief in miracles cannot be sustained.

CONCLUSIONS

Our examination of the relation between miracles and the Principle of the Conservation of Energy has brought to light an important fact. It is that a miracle, considered as an objective event specially caused by God, need violate no laws of nature. There is no necessary conflict between the evidence supporting belief in laws of nature and evidence in favour of miracles. Miracles do not imply the falsity of the laws of nature and therefore cannot be considered antecedently improbable.

This reveals that the question of justifying belief in the occurrence of miracles is remarkably similar to the question of justifying belief in interactionism.[16] In both cases we find the use of a balance of probabilities argument based ultimately on the strong form of the Principle of the Conservation of Energy, namely the claim that energy can neither be created nor destroyed. In both cases, provided the inference required to move from the weak to the strong form of the Principle of the Conservation of Energy can be blocked, it can be shown that this argument is illegitimate. Unless the critic can demonstrate that the experimental evidence which confirms belief in the weak form of the Principle also confirms belief in its strong form, he is not at liberty merely to assume the truth of the strong form.

CHAPTER 6: PHYSICALISM AND THE CONSERVATION OF ENERGY

In the previous two chapters I discussed objections to mind-body interaction and miracles based on the Principle of the Conservation of Energy. My strategy in dealing with these objections was to distinguish between two forms of the Principle. I distinguished between what I termed the weak form of the Principle, namely the claim that in a causally isolated system energy will be conserved, and what I termed the strong form of the Principle, namely the claim that energy can neither be created nor destroyed. I noted that it is the weak form which is directly supported by actual experimental evidence and that if we wish to reach the strong form of the Principle an additional premise and further inference is required. I argued that mind-body interaction and miracles are consistent with the truth of the weak form of the Principle and that they are only inconsistent with the strong form of the Principle. I concluded that, provided the inference required to move from the weak form of the Principle to the strong form of the

Principle can be blocked, the proponent of mind-body interaction or miracles is in a position to deny that such events are inconsistent with the Principle of the Conservation of Energy.

This strategy is bound to raise questions. Granted that we can distinguish between the two forms of the Principle, why do we so often overlook this distinction? Can the weak form of the Principle be taken as providing evidence for the truth of the strong form of the Principle and hence for the truth of physicalism? These are important questions. Therefore, by way of taking the discussion further, I propose to examine the connection between physicalism and the Principle of the Conservation of Energy and whether the evidence we take to confirm the weak form of the Principle also confirms the strong form of the Principle.

PHYSICALISM AND THE CONSERVATION OF ENERGY

In the course of this thesis I have explored certain links between, on the one hand, the Principle of Sufficient Reason and the notion of substance and, on the other hand, conservation principles and the idea of energy. That these links exist proves initially surprising. At first glance the contrast is vivid: the Principle of Sufficient Reason and the notion of substance are suspiciously metaphysical;

conservation principles and the idea of energy are refreshingly empirical. Closer scrutiny, though, reveals important historical and logical connections between these two sets of ideas.

What emerges from consideration of these historical and logical links is that the idea of energy constitutes a 'filling in', a giving of content to the notion of substance, and the idea that energy is conserved constitutes a 'filling in', a giving of content to the Principle of Sufficient Reason. In the case of the latter, the immediate link is between the Principle of the Conservation of Energy and the Principle of Universal Causality. However, the Principle of Universal Causality is itself an expression of the Principle of Sufficient Reason; hence it is true to say that the idea that energy is conserved constitutes an attempt to give content to the Principle of Sufficient Reason.[1]

Given these links, it is easy to see why physicalism is an attractive world-view. By virtue of our loyalty to the notion of substance and the Principle of Sufficient Reason, we hold the very basic and fundamental beliefs that phenomena must ultimately be explained in terms of something which does not change and that all phenomena may be explained. The problem we face, though, is that at a purely a priori level these beliefs are empty of content. Our commitment to the notion of substance persuades us there is something which does not change, but it cannot give us any idea of what this is. Similarly, our commitment to the Principle of Sufficient Reason persuades us that events are caused, but it cannot give us any idea of what constitutes a cause. What we attempt to do, therefore, is to give some content to these beliefs: we wish to know what it is which does not change and what constitutes a cause. In the course of doing this we begin, whether consciously or unconsciously, to associate the notion of substance with the idea of energy and the notion of causality with the idea of energy transfer. This leads to the view - whether it be implicit or explicit - that the relation between substance and energy has the logical status of an empirically discovered identity, as does the relation between causation and energy transfer. Physicalism, it is concluded, is implied by our attempts to give content to the most basic categories of thought.[2]

The problem with concluding this is that it ignores the possibility that there may be more than one way of giving content to the notion of substance and more than one way of giving content to the idea of causality.[3] In other words, there may exist more than one kind of substance, e.g. the human mind might constitute another type of substance besides energy, and more than one kind of causality, e.g.

agent causality might constitute another type of causality besides energy transfer. We must be careful not to rule out this possibility prematurely.

My point in distinguishing between the two forms of the Principle of the Conservation of Energy is that arguments against mind-body interaction and miracles which are based on the Principle of the Conservation of Energy are much weaker than generally thought. Both mind-body interaction and miracles are rejected on the basis of a balance of probabilities argument involving a presumed conflict between the evidence which supports belief in the Principle and the evidence which supports belief in mind-body interaction and miracles. The argument is basically this:

> 1. There exists a conflict between the evidence supporting belief in the Principle of the Conservation of Energy and the evidence supporting belief in mind-body interaction and miracles. [A conflict is presumed to be inevitable by virtue of the fact that both mind-body interaction and miracles imply the falsity of the Principle of the Conservation of Energy.]
>
> 2. The evidence supporting belief in the Principle of the Conservation of Energy far exceeds the evidence supporting belief in mind-body interaction and miracles.
>
> 3. Therefore, we are justified in believing the Principle of the Conservation of Energy and rejecting the view that mind-body interaction or miracles occur.

It is important to realize that this seemingly strong argument must be reevaluated in light of the distinction which must be drawn between the strong and the weak forms of the Principle. Given this distinction, it is not clear that the first premise of this argument can be defended

The reason this premise comes under fire is that the occurrence of mind-body interaction and miracles is consistent with the body of evidence which is taken to justify belief in the Principle of the Conservation of Energy, namely the vast amount of experimental data which supports the conclusion that energy is conserved in a causally isolated system. It is to be emphasized that the claim that mind-body interaction or miracles occur does not conflict with the claim that in a causally isolated system energy is conserved. To say that energy is conserved in an isolated system is not to address the question of whether the human body is isolated in the sense that it is not influenced by the action of an immaterial mind, or whether the physical universe is isolated in the sense that it is not influenced by the action of God. The person who believes that mind-body interaction takes place or that miracles occur does not deny that in a causally isolated system energy is conserved. That person denies only that the human body or the physical universe is causally isolated.[4] He is not forced, therefore, to deny any of the evidence usually cited as confirming belief in the Principle of the Conservation of Energy.

If this argument against mind-body interaction and miracles is to be pressed, it must be pressed on the basis of what I have called the strong form of the Principle, namely the claim that energy can neither be created nor destroyed. The problem the critic faces is that the claim that energy can neither be created nor destroyed is a defining postulate of physicalism and stands in need of justification. If the critic - now revealed to be a physicalist - is to press this argument against mind-body interaction and miracles then he must provide this justification.

EVIDENCE AND THE TWO FORMS OF THE PRINCIPLE OF THE CONSERVATION OF ENERGY

The question which arises is how is he to do this. His most plausible course of action seems to be to argue that the experimental evidence which confirms belief in the weak form of the Principle also confirms belief in the strong form of the Principle. Thus, he will claim that to the degree that belief in the weak form of the Principle is justified so belief in the strong form of the Principle is justified.

Against this, his opponent will argue that he cannot merely appeal to the large body of experimental evidence which supports the conclusion that in a causally isolated system energy remains constant. The claim that energy is conserved in a causally isolated system is consistent with the claim that energy can neither be created nor destroyed, but it does not imply this claim and the evidence which supports it does not, in itself, warrant us in drawing the far stronger conclusion that energy can neither be created nor destroyed. The body of evidence supporting the claim that in a causally isolated system energy will be conserved is neutral as regards the further question of whether or not there exists something capable of creating or destroying energy, since that evidence implies nothing as concerns the further question of whether or not in fact the human body or the physical universe is causally isolated in the relevant sense of not being subject to non-physical influences. Thus, although the strong form of the Principle is consistent with the experimental evidence which supports belief in the weak form of the Principle, it is not confirmed by it.

The physicalist may protest that this objection ignores what is known in confirmation theory as the converse consequence condition. The converse consequence condition states that if a body of evidence, e, confirms a hypothesis, h_1, and if there exists another hypothesis, h_2, which implies h_1, then e also confirms h_2. For example, "those experimental findings which confirm Galileo's law, or Kepler's laws are considered also as confirming Newton's law of gravitation."[5] Thus, in the present instance, the physicalist may argue that, since the weak form of the Principle of the Conservation of Energy may be deduced from the strong form of the Principle, the empirical evidence which confirms belief in the weak form of the Principle also confirms belief in the strong form of the Principle.

It must be pointed out, though, that the converse consequence condition is not generally satisfiable and cannot be accepted as a general rule of the logic of confirmation. Consider the following counterexample: for any a and c put $b \equiv a \vee c$. Then $a \rightarrow b$, and by the entailment condition, i.e., if $a \rightarrow b$ then a confirms b, a confirms b. Hence by the converse consequence condition a confirms c, since c entails b. It is impossible, on pain of everything confirming everything, that a non-trivial relation of confirmation subsist between every pair of statements and thus if entailment is retained the converse consequence condition must be rejected.[6]

To be fair, it must be admitted that often a body of data which confirms a particular hypothesis H is considered to confirm also a stronger hypothesis from which H may be deduced. We do regard the body of data which confirms Galileo's and Kepler's laws as also confirming Newton's law of gravitation and feel that we are justified in so doing. However, as Carl Hempel observes, such examples do not justify accepting the converse consequence condition as a general rule, for in such examples the weaker hypothesis is invariably connected with the stronger one by a logical bond of a particular kind. In such instances the weaker hypothesis is essentially a substitution instance of the stronger hypothesis.[7] Thus, although neither Galileo in developing his terrestrial physics nor Kepler in developing his celestial physics talked of forces, their laws can, in the clear vision of hindsight, be seen to be approximations to Newton's general law of gravitation which refers to the force between any two bodies. Even if as approximations these laws need some revision and correction in the light of Newton's law, they are viewed as being essentially instances of Newton's more general law of gravitation. In instances where this special logical relation exists, it does seem permissible to view the evidence as confirming both hypotheses; the reason being that the stronger hypothesis is just a more general form of the weaker more specific hypothesis and hence cannot contain any extraneous elements which the evidence does not confirm.[8]

The problem the physicalist faces in the present instance is that in cases such as the strong and the weak forms of the Principle of the Conservation of Energy where this special relation does not exist the converse consequence condition becomes "entirely absurd."[9] The strong form of the Principle, although it implies the weaker hypothesis that energy is conserved in a causally isolated system, contains the extraneous assumption that energy is uncreated and indestructible. This assumption, it is clear, need not be confirmed by the evidence which confirms the weaker hypothesis that in a causally isolated system energy is conserved. Thus the evidence which confirms belief in the weak form of the Principle cannot be taken to confirm belief in its strong form. The physicalist cannot appeal to the converse consequence condition. The body of evidence which supports belief in the weak form of the Principle is neutral as regards the further question of whether energy may be created or destroyed.

Faced with this, the most promising course of action for the physicalist seems to be to revise the converse consequent principle somewhat and argue that if e, e.g., a body of experimental evidence, confirms h_1, e.g., the weak form of the Principle, and h_2, e.g., the strong form of the Principle, <u>explains</u> h_1 then e confirms h_2. His strategy will be to argue that the weak form of the Principle is a lower-level law which needs to be explained on the basis of some deep structural assumption. The strong form of the Principle, with its deep structural assumption that energy can neither be created nor destroyed, provides an explanation of the weak form and hence all the inductive support of the weak form can be regarded as 'flowing upward' so as to support the strong form of the Principle.

Without denying the legitimacy of demanding an explanation of the weak form of the Principle, it must nevertheless be noted that the physicalist is on shaky ground if he attempts to argue in this manner. The history of science is replete with deep structural assumptions which were made in order to explain certain lower-level laws, but which were later abandoned. Theories of the aether, of phlogiston, and of spontaneous generation, to name only a few, have all, at one time or another, been proposed as deep structural assumptions necessary to explain well-evidenced lower-level laws.

Lest the physicalist be tempted to reply that there are good deep structural assumptions and bad deep structural assumptions, and that the strong form of the Principle constitutes a good deep structural assumption, I wish to draw a distinction between a belief being confirmed and a belief being justified. At this point in the discussion what is at issue is whether the belief that energy can neither be created nor destroyed is confirmed, not whether it is a belief which is justified. At this point I am not arguing that belief in the strong form of the Principle is unjustified - that is a further question - only that it is unconfirmed.

This distinction is a necessary one. A belief may be justified even though it is not confirmed. To say that a belief is justified is to say that it is a reasonable belief to hold on the basis of available evidence; to say that a belief is confirmed is to say that the evidence in some way guarantees that the belief is true. To say that a belief is justified is not to deny the very real possibility that as more evidence becomes available this belief must be discarded because the additional evidence disconfirms it, but to say that a belief is confirmed is to deny that there is further evidence which will disconfirm it.

The critic is likely to respond that it is impossible to talk of evidence 'guaranteeing' belief. Surely all beliefs concerning matters of fact are corrigible. Surely it is conceivable that even the best confirmed scientific beliefs might be false. What then does this distinction amount to?

It amounts to this. Without denying that even the best-confirmed beliefs are corrigible, we must nevertheless distinguish between beliefs which we have reason to think will never be disconfirmed and beliefs about which we must suspend judgement concerning whether they will be disconfirmed. Those beliefs which we have good reason to think will never be disconfirmed we regard as confirmed, those about which we must suspend judgement we regard as justified, but not confirmed.

It is the various ways in which evidence may be linked to belief which permits us to draw this distinction. In the case of a confirmed belief a wide variety of evidence is linked to that belief in a number of different ways by a number of independent hypotheses. In other words, we have a network of converging hypotheses, each of which finds it necessary to postulate the truth of that belief. It is this convergence which provides us with good reason to think that the belief is actually true. Of course it is not logically impossible that the belief might be false, but this convergence gives good reason to believe that this is not in fact the case. For example, although it is conceivable that the claim that the blood circulates in a normal living human body might be false, the wide variety of evidence and the large number of independent hypotheses which support this claim make its falsity very improbable.

In the case of a belief which is justified but not confirmed we do not find this. We do not find such a wide variety of evidence nor do we find that the evidence is linked to the belief in a number of different ways by a number of independent hypotheses. In such a case the connection between evidence and belief is more like a chain than a network. It is this fact which teaches us that, although the belief may be justified, it is nevertheless unconfirmed. The belief may be an attractive one, but, in the absence of a wide variety of evidence and a convergence of independent hypotheses, it remains only a possible interpretation of the evidence felt to support it.

To revert to our examples of aether, phlogiston and spontaneous generation, these are all cases of beliefs which, at the time they were proposed, were justified beliefs. They were justified inasmuch as they provided explanations of the lower-level laws they were invoked to explain and were consistent with the available evidence. Nevertheless, it was a mistake to think that these beliefs were confirmed - a mistake made amply clear by the subsequent course of science.

My point is not that explanations of lower-level laws should not be sought. Nor is it that deep structural explanations are illegitimate. Rather, it is that we cannot conclude that the evidence which supports lower-level laws confirms the deep structural assumptions said to be necessary to explain them. The problem in assuming that the evidence which confirms a lower-level law also confirms our deep structural assumption is that it may be possible to offer some other deep structural assumption which equally well explains the lower-level law. Thus, the problem in assuming that the evidence which confirms belief in the weak form of the Principle also confirms belief in the strong form is that it may be possible to offer some deep structural assumption other than the assumption that energy can neither be created nor destroyed, which can equally well explain the weak form of the Principle.

The physicalist is quite correct to demand an explanation of the truth of the weak form of the Principle. He is also on firm ground in proposing a hypothesis which explains the weak form of the Principle, i.e. his hypothesis that energy can neither be created nor destroyed. He errs, though, if he thinks the evidence for the weak form of the Principle also confirms its strong form. It is true that the hypothesis that energy can neither be created nor destroyed is consistent with the experimental results confirming belief in the weak form of the Principle. It may even be that in the absence of a rival hypothesis capable of explaining the weak form we are justified in accepting it as the best explantion of the weak form of the Principle. Nevertheless, the evidence which confirms belief in the weak form of the Principle does not confirm belief in its strong form. The experimental evidence which confirms the belief that in a causally isolated system energy is conserved no more confirms the belief that energy can neither be created nor destroyed than the results of seventeenth, eighteenth and nineteenth century physics confirm the existence of aether.

Before going any further, let us pause for a moment to consider the result of our investigation of whether the evidence which confirms the weak form of the Principle also confirms its strong form. What has emerged is this. Inasmuch as it is a deep structural assumption made in order to explain the weak form of the Principle, the strong form of the Principle can never be confirmed by empirical evidence. Its utility and attractiveness stem from the fact that it is consistent with the experimental evidence which confirms belief in the weak form of the Principle and from the fact that it provides some explanation of why the weak form is true. However, these two facts in no way confirm the truth of the strong form. Theories of spontaneous generation, phlogiston and the aether were all at one time or another of great utility and consistent with the evidence which supported the lower-level laws they were invoked to explain.

It is important to realize that this does not imply that the strong form of the Principle cannot be disconfirmed. To say that it cannot be confirmed is not to suggest that it cannot be disconfirmed. Additional evidence may serve to disconfirm a deep structural assumption, yet leave untouched the lower-level law the deep structural assumption was invoked to explain. For example, Pasteur was able to offer some new evidence and an alternative explanation of why maggots often appear in dead meat. He was thus able to dispense with the deep structural assumption of spontaneous generation. In the present case the occurrence of either mind-body interaction or miracles would serve to disconfirm the strong form of the Principle. Both are consistent with the weak form of the Principle, but both are inconsistent with the strong form inasmuch as they imply that energy may be created or destroyed

We have been led to an interesting conclusion. It is that the strong form of the Principle of the Conservation of Energy cannot ever be confirmed, but that it could conceivably be disconfirmed. Confirming evidence cannot 'flow upward' so as to confirm the strong form, but additional evidence, e.g. the occurrence of a miracle, might serve to disconfirm it. In so doing it would leave untouched the weak form of the Principle.

Pictured in a diagram the situation looks something like this.

(See Figure 1 on the following page.)

Physicalism and the Conservation of Energy

Figure 1: Evidence and the Principle of the Conservation of Energy

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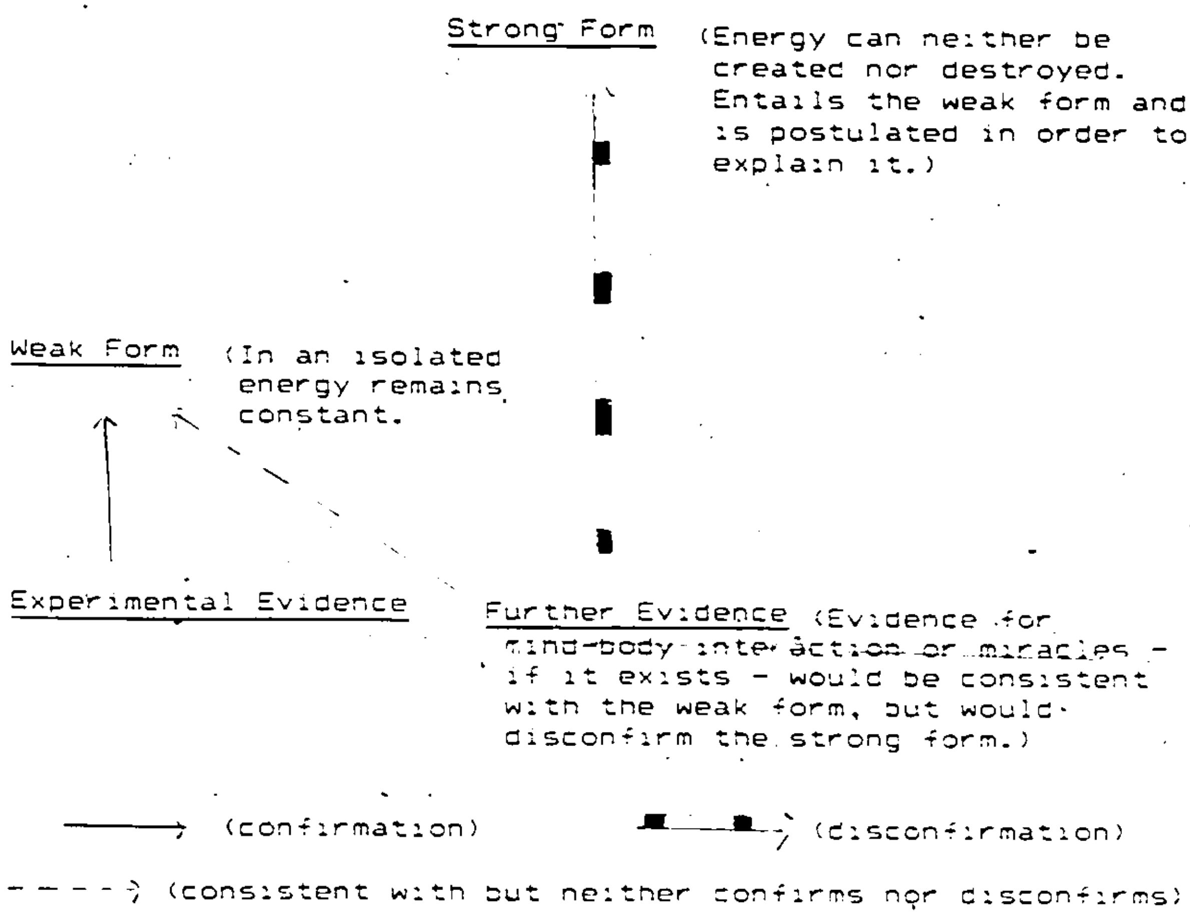

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We have seen that the physicalist cannot argue that the evidence which confirms belief in the weak form of the Principle of the Conservation of Energy also confirms belief in the strong form of the Principle. The question which now arises is whether the physicalist, abandoning his attempt to argue that the evidence which confirms the weak form of the Principle also confirms the strong form of the Principle, is in a position to claim that belief in the strong form of the Principle is nevertheless justified.

There are two arguments by which the physicalist may attempt to support such a view. The first argument that he may attempt is to argue that the strong form of the Principle may be justified on the basis of Occam's Razor. Thus, he may argue that there exists no positive evidence that energy is ever created or destroyed. Given the basic principle that we ought not to multiply entities needlessly, we ought not to postulate the existence of something capable of creating or destroying energy. We are justified, therefore, in believing that energy can neither be created nor destroyed.

Unfortunately for the physicalist, this is a very weak argument. He is proposing that since there exists no evidence that energy is ever created or destroyed we ought to accept the strong form of the Principle on the basis of Occam's Razor. The problem he faces is that the existence of such evidence is precisely what is at issue. The occurrence of mind-body interaction or miracles would constitute evidence that energy is sometimes created or destroyed. It will not do, therefore, when faced with alleged instances of such events, to dismiss them on the ground that such events are antecedently improbable by virtue of the fact that they imply the falsity of the strong form of the Principle.

This point concerning antecedent improbability deserves to be stressed. Earlier in the chapter, I noted that the physicalist rejects mind-body interaction and miracles on the basis of a balance of probabilities argument involving a presumed conflict between the evidence which supports belief in the Principle of the Conservation of Energy and the evidence which supports belief in mind-body interaction and miracles. Examination of this argument reveals, however, that mind-body interaction and miracles are only inconsistent with the strong form of the Principle and that the physicalist can point to no positive body of evidence in favour of the strong form. For this reason, he is in no position to frame a balance of probabilities argument designed to show that mind-body interaction and miracles are antecedently improbable by virtue of the fact that the evidence in their favour conflicts with a stronger body of evidence in favour of the strong form of the Principle.

Appealing to Occam's Razor does not help the cause of the physicalist in this regard. On such an argument the sole justification for accepting the strong form of the Principle lies in a presumed lack of evidence that energy is ever created or destroyed. Faced with positive evidence that mind-body interaction or miracles occur, the physicalist is in no position to appeal to a conflict of evidence. He is, therefore, in no position to develop his balance of probabilities argument.

The second argument the physicalist may attempt is to argue that there are no hypotheses capable of explaining the truth of the weak form of the Principle, other than the hypothesis that energy can neither be created nor destroyed. Granted that this hypothesis is not confirmed by the evidence, it is nevertheless the only explanation available and we are therefore justified in believing it. Should another hypothesis be put forward which better explains the weak form of the Principle then the hypothesis that energy can neither be created nor destroyed must be abandoned, but in the absence of such an alternative hypothesis we are fully justified in believing that energy can neither be created nor destroyed. A variant of this argument would be for the physicalist to admit the existence of other hypotheses capable of explaining the weak form of the Principle, but to argue that the hypothesis that energy can neither be created nor destroyed is superior to any of its rivals.

I do not wish to say much concerning this argument at the present time. I propose to deal more fully with this issue in chapters seven and eight where I discuss the nature of world-views and questions concerning evidence. However, I think it fair to comment that even if his argument is entirely successful, the physicalist cannot utilize the balance of probabilities argument discussed earlier. It is clear that the evidence which supports belief in mind-body interaction or miracles conflicts not with any of the evidence which supports belief in the Principle of the Conservation of Energy, but with what the physicalist believes to be the best explanation of the fact that in a causally isolated system energy is conserved. Assuming his opponent can point to some positive body of evidence, the physicalist has no grounds upon which he can dismiss such evidence. He can point to no evidence which confirms his view that energy can neither be created nor destroyed. It will not do, therefore, when faced with alleged instances of mind-body interaction or miracles, to argue that such events are antecedently improbable by virtue of the fact that they imply the falsity of the strong form of the Principle. Once again it emerges that no balance of probabilities argument based on a conflict of evidence is possible, since the way in which belief in the strong form of the Principle must be justified precludes there being any body of evidence which could conflict with the evidence supporting belief in mind-body interaction and miracles.

Physicalism and the Conservation of Energy

CONCLUSIONS

There are two conclusions which may be drawn from our discussion in this chapter. The first is that physicalism owes much of its attractiveness to the fact that that it allows us to give content to the notion of substance and the Principle of Sufficient Reason expressed as the Principle of Universal Causality. As we have seen, the notion of substance becomes identified with the idea of energy and the idea of a cause is identified with the idea of energy transfer. Unfortunately, the question of whether there might be more than one type of substance and more than one type of causality is easily forgotten. Ignoring this question permits an easy shift from the weak form of the Principle of the Conservation of Energy, i.e., the claim that energy is conserved in a causally isolated system, to the strong form of the Principle of the Conservation of Energy, i.e., the claim that energy can neither be created nor destroyed. This is understandable, but it is essential if the question of the truth of physicalism is not to be begged that this question not be ignored.

The second conclusion that may be drawn from our discussion in this chapter is that the physicalist cannot legitimately object to mind-body interaction or miracles on the basis of the Principle of the Conservation of Energy.

Physicalism and the Conservation of Energy

If he is to object to mind-body interaction or miracles he must do so on the basis of the strong form of the Principle, since the claim that mind-body interaction takes place or that miracles occur is consistent with the truth of the weak form of the Principle. However, for him to object to such events on the basis of the strong form he would have to be in a position to argue that belief in the strong form is confirmed by the evidence which confirms belief in its weak form. As we have seen, he is in no position to claim this. The evidence which confirms belief in the weak form of the Principle is consistent with the truth of the strong form of the Principle, but it cannot be taken as confirming its truth. The physicalist is, therefore, in no position to argue that events such as mind-body interaction and miracles are antecedently improbable by virtue of the fact that they imply the falsity of the strong form of the Principle of the Conservation of Energy. To attempt to do so would only be to beg the question of whether the inference required to move from the weak to the strong form of the Principle is justified.

CHAPTER SEVEN: WORLD-VIEWS, EVIDENCE AND FALSIFICATION

In the previous chapter I argued that the physicalist cannot object to mind-body interaction or miracles on the basis of the Principle of the Conservation of Energy, since to do so is only to beg the question of whether they really occur. It must be emphasized, however, that to remove objections is not the same thing as to establish grounds for belief. It is true that the physicalist cannot object to mind-body interaction or miracles on the ground that they violate the Principle of the Conservation of Energy and are, therefore, improbable. Nevertheless, he can quite justifiably demand that his opponent provide grounds for believing in mind-body interaction or miracles. He can also quite justifiably demand that the non-physicalist provide some alternative explanation of the truth of the weak form of the Principle.

I do not propose to enter the debate concerning whether in fact belief in mind-body interaction or miracles is justified. Neither do I intend to put forward an alternative hypothesis capable of accounting for the truth of the weak form of the Principle. What I do propose is to address the issue of what must be shown if belief in mind-body interaction or miracles is to be justified. I also propose to discuss what is involved in putting forward an alternative explanation of the truth of the weak form of the Principle.

What is involved in both these enterprises is the elaboration and defense of a world-view other than physicalism. To claim that miracles occur or that mind-body interaction takes place is not to claim merely that the strong form of the Principle, and hence physicalism, is false. The reason this is so is that to call an event a miracle or an instance of mind-body interaction is to offer not just a description, but an interpretation of the event. To call an event a miracle or an instance of mind-body interaction presupposes the truth of some alternative world-view in which these concepts can be embedded and seen to make sense.

It is important, therefore, to say something about world-views in general and physicalism in particular. It is also important to say something about the issue of whether a world-view may be falsified. I have said that there could exist evidence which would falsify physicalism, but this is an assumption that will not go unchallenged. Many philosophers hold the holistic view that evidence can only bear on the entire body of our beliefs and, although I have already given some reasons in the previous chapter for thinking this view is mistaken, more deserves to be said.

WORLD-VIEWS AND FALSIFICATION

Put simply, a world-view constitutes a coherent, or at least apparently coherent, set of basic beliefs about the fundamental character of reality.[1] As such, it provides its adherents with a framework or system of beliefs within which to theorize. It thus plays a large role in their treatment of specific philosophical issues. The problems that they are inclined to regard as genuine rather than as pseudo-problems, the possible solutions they are inclined to investigate as being viable - as opposed to those they feel they are wasting their time and effort in investigating - all these are in a large and important part influenced by their commitment to a particular world-view. Of course, this is not to say that what a philosopher committed to the truth of a particular world-view will say concerning a specific philosophical issue is completely determined. There may be, indeed there usually is, a number of possible views consistent with the truth of a particular world-view. However, it is clear that a world-view does set parameters within which those committed to its truth are constrained to theorize.[2]

World-views, because of their comprehensiveness, are very difficult to falsify. Many philosophers have noted that falsification becomes progressively more difficult as we move from the level of simple experimental laws and limited theories to the level of comprehensive theories and paradigms and finally to the level of metaphysical assumptions and world-views. Indeed some, having noted the fact that it seems impossible to specify in advance any 'crucial experiment' which decides with finality between even low level theories,[3] have concluded that world-views cannot be falsified. Evidence, they contend, is only evidence in the framework of some theory in which it is seen to be significant. It cannot, therefore, serve to overthrow a rival theory, since the rival theory will always either cease to regard it as significant data, and hence cease to regard it as evidence, or else reinterpret it and account for it in some other way. On this view, world-views in general, and physicalism in particular, are impossible to falsify.

Although many thinkers, especially those concerned to defend a religious viewpoint, have endorsed this holistic view, it is nevertheless premature to hold that a world-view is impossible to falsify. It is certainly true that a theory may always be 'saved' by a certain amount of tinkering, but if such tinkering must be done on a purely ad hoc basis it is bound to appear unjustified and implausible. To conclude that a world-view is immune to falsification because such tinkering is always possible is to miss the point that there is a sense in which we may speak of discordant data or counter-evidence, namely data which cannot be explained or reinterpreted within the confines of the world-view, except on the basis of purely ad hoc assumptions. If the amount of such tinkering required to save a world-view becomes too great then this counts as a legitimate reason for abandoning it.[4]

Neither will it do to argue, as have some holists, that, since there are no privileged analytic truths connecting the language of evidence with the language of theory, there can be no empirical data which can serve as evidence for an alternative world-view, unless the truth of that world-view is already presupposed. It is quite right to think that there must exist links between the language of evidence and the language of theory if evidence is to be used to confirm theoretical claims. What is not required, though, is that these links consist of analytic truths. These links may be provided by the theory to be tested - in this case some alternative world-view - so long as they are not used in such a way as to guarantee that the theory to be tested will be positively instantiated whatever the evidence might be.

Of course it is necessary to take certain precautions in evaluating evidence. It is important to test a claim by using a variety of different hypotheses to link evidence and theory. It is also important to test the hypotheses used in this linking. The holist is right to think that our faith in any particular claim depends upon our faith in the hypotheses we have used to link observation and theory and that our faith in these hypotheses depends in turn upon further linking hypotheses.

But this does not entail that a piece of evidence cannot bear on one part of a world-view without bearing on all of it. Neither does it entail that we cannot accept one claim a world-view makes without accepting all the claims it makes. Which claims are confirmed or disconfirmed, and to what degree, will depend both on the evidence and the structure of the world-view.[5]

Consider an example. A theistic world-view, in contrast to an idealist world-view, maintains the reality of the material world. The physicalist will certainly side with the theist in regarding the material world as real. However, he will scarcely agree that his believing this commits him to the truth of theism as a whole. The reason he will cite is that the theist, although he agrees with the physicalist in regarding the world as real, goes on to make some claims with which the physicalist does not agree, namely that the world, although real, was created by God and is subject to His influence. The physicalist will quite correctly point out that the claim that the world is real does not entail the claim that it was created by God and that the evidence which confirms the former claim does not confirm the latter.

My point is that it is quite legitimate to accept well-tested portions of a world-view and yet reject other more speculative portions of it. Thus the non-physicalist is under no obligation to falsify all the claims of physicalism. He is at liberty to accept the better-tested portions of physicalism, yet reject the unconfirmed claim that energy can neither be created nor destroyed. It is possible, therefore, to conceive of an accumulation of evidence, e.g., evidence that mind-body interaction takes place or that miracles occur, which would count not against the better-tested portions of physicalism, e.g., the weak form of the Principle which states that in a causally isolated system energy is conserved, but against the unconfirmed strong form of the Principle, i.e., the claim that energy can neither be created nor destroyed, which serves as the defining-postulate of physicalism.

We must conclude that empirical evidence is relevant to the issue of the truth of physicalism. It is relevant not in the sense that it could ever confirm physicalism, but in the sense that it could disconfirm it. The reason this is so is that the defining-postulate of physicalism, i.e. the claim that energy can neither be created nor destroyed, is a deep structural assumption which can never be confirmed, but which could be disconfirmed.

Important as such evidence may be, it must nevertheless be emphasized that falsifying a world-view is not merely a matter of producing discordant evidence. In theory, physicalism would be disconfirmed if we could falsify the claim that energy can neither be created nor destroyed. Theoretically, it seems entirely conceivable that we might show that physicalism is an inadequate world-view even if we have no alternate world-view to put in its place. In actual practice, the task is liable to prove considerably more difficult. Practically speaking, if we wish to falsify a world-view we must be prepared not only to make reference to a body of discordant data, but also to develop an alternative world-view capable of explaining the discordant data.

The reason for this is that world-views have immense explanatory power, otherwise they could scarcely be termed world-views. This fact that world-views explain large areas of experience means that a world-view is rarely, if ever, abandoned merely because there exist some discordant data.

World-Views Evidence and Falsification

Difficulties in a world-view do not generally persuade us to abandon it, unless there exists a rival world-view which seems better able to resolve those difficulties. A world-view which accounts for a great deal of our experience is obviously better than no theory at all. As Ian Barbour notes:

> we should picture not a two-way confrontation of theory with falsifying data, but a three-way confrontation of rival theories with a body of data of varying degrees of susceptibility to reinterpretation. ... Abandoning one set of fundamental beliefs ... involves at least implicit acknowledgment of possible alternatives even if one reserves judgment about them.[6]

In actual practice, therefore, the evaluation of a particular world-view such as physicalism involves not merely examining its 'fit' with the empirical data, but its 'fit' as it compares to the 'fit' of rival world-views.

What this means is that the person who wishes to defend mind-body interaction or the occurrence of miracles must develop an alternative world-view. Otherwise, his claim that the strong form of the Principle of the Conservation of Energy is unconfirmed will be accorded little weight. The reason it will be accorded little weight is that the physicalist will exploit the distinction between a belief which is confirmed and a belief which is justified. He will argue that, even if it is not confirmed, the belief that energy can neither be created nor destroyed is justified in the absence of any rival hypothesis capable of explaining the truth of the weak form of the Principle.

The strategy of the non-physicalist must be to develop an alternative world-view which accounts not only for the large body of truth contained in physicalism, but also for that body of data which casts doubt on physicalism, namely the body of data which the non-physicalist takes to suggest the occurrence of mind-body interaction or miracles. He must show that it is possible to retain the best-tested parts of physicalism, yet reject physicalism as an adequate account of reality. In particular, he must show that it makes sense to accept the weak form of the Principle, yet reject its strong form. If he can do this he will be in a position to claim not only that belief in physicalism is unconfirmed, but unjustified.

THE TASK OF THE NON-PHYSICALIST

If the non-physicalist is to develop an alternative world-view he must show three things. First, he must show that it is possible to give content to the notions of substance and causality in more than one way. Specifically, he must clarify and develop the notions of agent and agent causality, since implicit in any defence of mind-body interaction or miracles is the notion of an immaterial agent with the ability to produce or influence events in the material world. Second, the non-physicalist must show that there is a body of evidence which supports him in postulating the existence of immaterial substances and causes. To refuse this challenge is to fall foul of the principle that we must not multiply entities needlessly. Unless the requirements of Occam's Razor can be met, the defender of mind-body interaction or miracles must cede the day to the physicalist. Third, the non-physicalist must show that his views concerning immaterial agents and agent causality are part of a larger system of thought which not only explains the body of data which physicalism does not explain, but also that body of data which physicalism explains extremely well. The non-physicalist must develop a world-view which 'corrects' physicalism, i.e., a world-view which accepts and explains all that is true in physicalism, yet provides a theoretical framework in which sense is made of the immaterial realities which physicalism refuses to countenance.

It is beyond the scope of this thesis to pronounce on whether, in fact, these three things can be shown. Some brief remarks concerning what is involved in attempting to demonstrate them are in order, however.

First, with regard to the task of clarifying and developing the notions of agent and agent causality, two very general comments need to be made. The first is that it is important that the person who defends mind-body interaction or miracles show not only that we make reference to agents and agent causality in our everyday speech, but also that such notions are 'primitive' in the sense that they cannot be shown to be merely a convenient way of talking about energy and energy transfers. The second is that an analysis of other selves is of great relevance to this issue. Questions of whether we ascribe to other persons non-observable characteristics which transcend our direct experience of their bodies, and what it means to do this if we indeed do, will cast light on the notions of agent and agent causality.

With regard to the second task, I have said that it is crucial that the non-physicalist produce positive evidence in favour of mind-body interaction or miracles. Crucial to note, however, is the fact that it would not be fair for the physicalist to demand that such evidence be experimentally reproducible. The reason this is so is that the non-physicalist is committed to a non-regularity view of agent causality.[7] The strategy of the non-physicalist must be not to attempt to discover experimentally reproducible evidence, but rather to point to explanatory hiatuses which cannot be satisfactorily explained except on the supposition of the operation of an immaterial agent. It must be emphasized that this does not prevent the non-physicalist from appealing to physical evidence, e.g., the regeneration of a lost limb might constitute evidence for a miracle, but it does mean that it would be unfair to demand that such a result be duplicated before it be accepted as evidence.

Finally, as regards the third task of the non-physicalist, namely that of showing that his views concerning agents and agent causality fit into a larger system of thought, it to be stressed that this larger system must exhibit the twin virtues of consilience and simplicity. It must be consilient in that it needs to unify and systematize the facts it purports to explain. To say that a theory is consilient is to say more than that it 'fits the facts' in the sense that it is formally consistent with their truth; "it is to say first that the theory explains the facts, and second that the facts it explains are taken from more than one domain."[8] Second, the world-view the non-physicalist proposes must be simple in the sense that it explains the facts without making a lot of _ad hoc_ assumptions. It deserves emphasis that to say that a world-view needs to be simple in this sense is not to forbid in any way ontological complexity. As Paul Thagard comments,

> [we are] not to multiply entities beyond necessity. Necessity is a function of the range of facts to be explained without the use of a lot of auxiliary assumptions. Ontological complexity does not detract from the explanatory

> value or acceptability of a theory so long as the complexity contributes towards consilience and simplicity.[9]

It is to be noted that the development of such a world-view would permit the non-physicalist not only to urge that there exists evidence which falsifies the claim that energy cannot be created or destroyed, but would also provide him with the resources to develop a hypothesis which explains why the weak form of the Principle of the Conservation of Energy is true. He would be in a position to fulfill the demand of the physicalist that he provide some alternative explanation of the truth of the weak form of the Principle.

Although they may be separated in theory, these three tasks are inextricably entwined in practice. It is tempting to think that the non-physicalist must proceed by first developing an alternative concept of substance and causality, then inquiring whether there is any evidence to suggest the existence of such a type of substance and causality, and finally, having concluded such evidence exists, constructing a non-physicalist world-view. In practice, though, his concept of what an agent is and how agent causality functions cannot be arrived at independently of interacting with the evidence he takes to support him in postulating another type of substance and causality. Equally, his assessment of evidence does not take place in a vacuum, but is influenced by his world-view. This, I wish to emphasize, in no way implies that the views of the non-physicalist are unfalsifiable. We have already seen in our discussion of world-views and the possibility of falsifying a world-view that the fact that concepts, evidence and theory are linked together does not imply a holistic view of theorizing.

Demonstrating these three things is a large undertaking. So great that, strictly speaking, it is inaccurate to speak of the task of the person who wishes to defend mind-body interaction or miracles. Rather, we should speak of the collective task of people who wish to defend mind-body interaction or miracles. Similarly, we should speak not of the task of the person who wishes to defend physicalism, but of the collective task of people who wish to defend physicalism. The elaboration and defense of a world-view presupposes a community of scholars: a community in which various members, sharing a common faith that their world-view may indeed be elaborated and defended, undertake different projects directed towards this goal.

What this makes clear is that world-views are, at least in some senses, research traditions.[10] A world-view presupposes a community of scholars who have a commitment to a certain traditional body of thought. Quite legitimately, such a community adheres very tenaciously to its world-view, preferring to explore its potentialities rather than prematurely abandoning it in the face of difficulties which may be apparent, not real.

Except in extreme cases, this tenacity does not deserve to be censured. It is hard to see how knowledge could advance if it did not exist. As Imre Lakatos notes,

> the idea of instant rationality ... [is] utopian. ... [all] theories of instant rationality - and instant learning - fail. ... rationality works much slower than most people tend to think.[11]

The existence of this tenacity makes clear an important fact. It is that there inevitably exist what may be termed metaphysical predilections which influence our assessment of data. Great care must be taken that such predilections do not lead to a premature rejection of alternative interpretations suggested by rival world-views. If care is not taken a quite legitimate tenacity in attempting to defend a certain viewpoint may degenerate into an unreasoning dogmatism.

For example, consider the treatment of historical documents containing accounts of miracles, e.g. the gospels of the New Testament. By virtue of his world-view, the physicalist is inclined to reject the claim that miracles occur. Thus, he questions the historical accuracy of any document which contains an account of miracles. There is nothing wrong in his insistence that we assess the accuracy of such documents. Indeed, such insistence is necessary if we are to guard against an easy credulity. What deserves emphasis, though, is that his assessment of these documents must be based on features other than the fact that they contain accounts of miracles. Simply put, the fundamental principle in assessing evidence concerning past events is to accept as much evidence as is possible and yet develop a coherent account that is consistent with the evidence. *Prima facie*, these documents constitute evidence that miracles have occurred. Given that Hume's argument that accounts of miracles are antecedently improbable is fallacious, it is up to the physicalist to provide some independent grounds upon which the historical worth of these documents may be questioned. It will not do for him to assume that any account of a miracle must be unhistorical. Such an assessment, unless it can be buttressed with independent arguments, amounts to mere dogmatism.

CONCLUSIONS

Two conclusions may be drawn from our discussion in this chapter. The first is that world-views are in some sense falsifiable. Neither the fact that there are no privileged analytic truths connecting the language of evidence with the language of theory nor the fact that a theory may be made consistent with any body of evidence provided one indulges in enough ad hoc tinkering implies that a world-view cannot be falsified. Although it is difficult to specify an event or set of events which would falsify a given world-view conclusively, it is nevertheless true that empirical data are relevant to the question of the truth of a world-view and serve to render it more or less plausible. Proponents of different world-views do not dwell in intellectual 'ghettos' which do not permit them to understand or assess systems of thought other than their own.

The second conclusion is that, given the fact that a world-view is not abandoned solely in the face of discordant evidence, but rather in the face of discordant evidence better dealt with by a rival world view, the person who defends mind-body interaction or miracles must be prepared to develop and defend a world view other than physicalism. If this is to be accomplished three things must be shown. First, it must be shown that the notions of an immaterial agent and agent causality are coherent and not mere pseudo-concepts. Second, it must be shown that there is a positive body of evidence which supports us in postulating the existence of immaterial agents and agent causality. Finally, it must be shown that it is possible to integrate the view that mind-body interaction takes place or that miracles occur with a larger body of beliefs so as to arrive at a world-view other than physicalism. If the non-physicalist can accomplish these three things he will be in a position not only to claim that belief in the strong form of the Principle of the Conservation of Energy is unconfirmed, but that it is disconfirmed.

CHAPTER EIGHT: THE POSSIBILITY OF EVIDENCE

The admission on the part of the physicalist that the defining-postulate of his world-view is neither confirmed nor capable of confirmation by any positive body of data can scarcely be comforting to him. Still, he may attempt to argue that this admission is not all that damaging to his cause. He may attempt to argue that, although physicalism is unconfirmed by any positive evidence, it is nevertheless, in the absence of any disconfirming body of evidence, worthy of belief. He may argue that if some non-physicalist world-view is true then we would expect to find evidence which disconfirms the claim that energy can neither be created nor destroyed. If this evidence is lacking, this justifies belief in physicalism, since we would expect such disconfirming evidence if physicalism were false. Put somewhat more paradoxically, the only evidence the physicalist can have against the immaterial entities postulated by the non-physicalist is a lack of evidence in their favour. His argument, therefore, is an argument from silence, although arguably a legitimate one.

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Unfortunately for the physicalist, he will not find this an easy argument to press. The non-physicalist will insist not only that the claim that energy can neither be created nor destroyed is unconfirmed by any positive body of evidence, but that there is evidence which disconfirms it, namely the evidence which justifies belief in mind-body interaction or miracles. The physicalist will find himself not only in a position of defending a world-view which cannot be confirmed, but one which seems disconfirmed.

Nevertheless, the best strategy for the physicalist to pursue is to admit that his world-view cannot be confirmed by any positive body of evidence, but to argue that neither is there any evidence which disconfirms physicalism. If he can do this, it may be possible for him to justify belief in physicalism on the grounds I have just mentioned. In order to do this, though, he must first argue that there exists no evidence which confirms belief in mind-body interaction or miracles.

Once again, it is worth emphasizing that the physicalist can have no recourse to a balance of probabilities argument designed to show that the evidence in favour of the strong form of the Principle, i.e. the claim that energy can neither be created nor destroyed, outweighs the evidence in favour of mind-body interaction or miracles. There is no body of evidence which supports belief in the strong form of the Principle and hence there is no possibility of constructing such an argument. Rather, the physicalist must deny that the evidence the defender of mind-body interaction or miracles makes reference to actually exists. If he can do this the physicalist will be in a position not to claim that physicalism is confirmed, but that it is not disconfirmed.

Although such a balance of probabilities argument is not possible, the physicalist does have recourse to a number of other arguments designed to show that evidence in favour of mind-body interaction or miracles is either impossible or antecedently improbable. I propose by way of concluding this thesis to consider these objections. I shall examine two arguments that it is improbable that there is evidence for mind-body interaction and three arguments that it is impossible that there be evidence for miracles. I wish to emphasize that my discussion in this final chapter is not aimed at establishing whether or not there is actually evidence which disconfirms the claim that energy can neither be created nor destroyed, but whether such evidence is impossible or antecedently improbable.

MIND-BODY INTERACTION AND THE NATURE OF THE BRAIN

One way in which the physicalist challenges the idea that there may exist evidence for mind-body interaction is to argue that our increasing understanding of the brain reveals no reason to believe that it is influenced by an immaterial mind. The problem, he insists, is simple and straightforward. What is called for is scientific observation of the brain. If there exist explanatory hiatuses in any physicalist explanation of the functioning of the brain - hiatuses which can plausibly be explained on the supposition of the influence of an immaterial mind - then this will count strongly in favour of interactionism, since the presence of such explanatory gaps resulting from the effect of the mind upon the brain is precisely what the interactionist would predict on the basis of his theory. If, on the other hand, no such gaps are to be found then this will count heavily against interactionism, since the theory of the interactionist commits him to postulating such gaps.

The physicalist will go on to argue that it is not clear that such gaps exist. Earlier thinkers, ignorant of the workings of the brain, could plausibly argue that the mind influences the brain and thus controls the body. Scientific-investigation has not revealed any obvious gaps in the working of the brain, however. Surely this fact must count heavily against any theory of mind-body interaction.

There is a problem in taking such an approach. It is quite true that scientific investigation of the brain does not reveal any obvious gaps in the functioning of the brain. It reveals, however, that the brain is exceedingly delicate and difficult to observe. Sir John Eccles comments that the synaptic knob of the neurone, which influences whether or not a neurone fires, is of such a small size as to be an object to which Heisenberg's uncertainty principle is applicable and that "it is conceivable that the excitatory efficacy of a synaptic knob would be appreciably affected by an uncertainty of this order."[1] Given that in the active cerebral cortex, within the space of twenty milliseconds, "the pattern of discharge of even hundreds of thousands of neurones would be modified as a result of an 'influence' that initially caused the discharge of one neurone",[2] it is clear that the influence of the mind upon the brain need not be obvious to be effective.

To say, therefore, that there are no obvious gaps in the functioning of the brain is not to say that the mind does not influence the brain or that such influence is somehow improbable by virtue of the fact that its effects cannot at the present time be observed. Neither is it to say that the mind does not create or destroy energy in influencing the brain. It is merely to say that neither the physicalist nor the interactionist is in a position to confirm or disconfirm these effects by direct observation. The exceeding delicacy of the brain neither confirms nor disconfirms interactionism, but it does render suspect any attempt to discredit interactionism on the grounds that there are no obvious gaps in the functioning of the brain.

MIND-BODY INTERACTION AND THE UNITY OF SCIENCE

Another physicalist objection to the possibility of there being evidence for mind-body interaction is based on the unity of science. Consider, for example, the following argument taken from D.M. Armstrong's book A Materialist Theory of the Mind. Armstrong writes:

> It seems increasingly likely that biology is completely reducible to chemistry which is, in its turn, completely reducible to physics. That is to say it seems increasingly likely that all chemical and biological happenings are explicable in principle as particular applications of the laws of physics that govern non-chemical and non-biological phenomena.
>
> Consider what this means for a non-Materialist theory of the mind. It means that the whole world studied by science contains nothing but physical things operating according to the laws of physics with the exceptions of the mind. If all the sciences except psychology are, in theory, very complex particular cases of the fundamental sciences of physics, it seems very unlikely that psychology is an exception. It would follow that some Materialist theory of the mind is the true one.[3]

Two points need to be made concerning this argument. The first is that Occam's Razor merely states that we must not multiply entities needlessly. It implies nothing concerning the possibility of evidence. Thus, even if it were to be the case that all reality, with the possible exception of human actions, operates and is fully explicable in terms of the laws of physics operating on a closed system, we should not automatically conclude that a physicalist theory of the mind is correct. The physicalist must admit the possibility that evidence in favour of mind-body interaction may exist. He must also admit that if it does exist he has no grounds upon which to reject it.

The second point that needs to be made is that the interactionist is under no great compulsion to defend the claim that the human mind is a solitary island in a reductionist sea. The claim of the physicalist that the interactionist is committed to such a position is premature. It ignores the possibility that the interactionist may develop a world-view in which the idea of immaterial minds is viewed as something more than an improbable and ad hoc hypothesis. Given that the basic and fundamental belief of the physicalist, i.e. the claim that energy can neither be created nor destroyed, is unconfirmable, he is scarcely in a position to object that an alternative world-view which postulates immaterial entities and accords them a fundamental place in its conception of reality is antecedently improbable.

The Possibility of Evidence

MIRACLES AND THE COURSE OF NATURE

The physicalist also challenges the possibility of there being evidence which justifies belief in miracles. He often argues that belief in miracles can be ruled out on logical and methodological grounds. One of the most ambitious of these arguments is found in an article by Alastair McKinnon entitled "Miracle and Paradox". In this article McKinnon attempts to demonstrate that the occurrence of a miracle could never be demonstrated because of the simple reason that the term 'miracle' "cannot consistently name or describe any real or alleged event."[4]

McKinnon begins by noting that that "the concept of natural law, ... if it is to be allowed at all, is and must be universal in its application."[5] He further comments that a miracle must be conceived as either: (1) "an event involving the suspension of natural law", or (2) "an event conflicting with our understanding of nature."[6]

He then argues that our understanding of natural law and the first sense of the term 'miracle' involves a contradiction. According to McKinnon, our concept of natural law implies that natural laws "are simply highly generalized shorthand descriptions of how things do in fact happen."[7] This involves a contradiction, though, in that a miracle must then be defined as an exception to what actually happened. As McKinnon puts it,

> Miracle would then be defined as 'an event involving the suspension of the actual course of events.' And someone who insisted upon describing an event as a miracle would be in the rather odd position of claiming that its occurrence was contrary to the actual course of events.[8]

Unfortunately, the second sense of miracle as 'an event conflicting with our understanding of nature' also involves us in a contradiction. It involves a contradiction in that we

> cannot believe both that the event happened and that the conception of nature with which it conflicts is adequate. In attempting to do so ... [one] necessarily contradicts oneself. ... [One] is like the man who says 'Yes this cat is white' then blandly adds ' ... but I hold that all cats are black.[9]

As McKinnon comments, "such a person may reasonably be asked to surrender the historicity of the event or the conception of nature with which it conflicts."[10]

McKinnon insists that neither alternative is acceptable. Neither alternative makes it possible to employ the term 'miracle' to describe any real or alleged event. To surrender the historicity of the event or events in question is to admit there is no need to employ the term 'miracle' in describing events in the real world. To revise our conception of nature, though, is to repudiate the grounds upon which it was originally urged that the event be regarded as a miracle. We appear forced to conclude that the notion of miracle is a mere pseudo-concept.

Impressive as it seems, this argument is nevertheless unsound. Both McKinnon's understanding of the laws of nature and his understanding of miracle are incorrect. His first premise, that we may substitute the expression 'the actual course of events' for the term 'natural law', is false. I noted earlier that science typically assumes that an event E is explained when it is shown to be a logical consequence of relevant initial conditions and a set of general laws. Unless we have knowledge of the relevant initial conditions, we cannot predict the actual course of events. It is thus a mistake to think that the terms 'actual course of events' and 'natural law' are interchangable.

His second premise is also false. I demonstrated earlier that the notion of miracle does not entail the idea that a law of nature is violated if a miracle occurs. The occurrence of a miracle does not indicate that the laws of nature no longer apply or are temporarily suspended. Rather it indicates that God, or possibly some other transcendent agent, has changed the material conditions to which the laws apply and so introduced into nature an event which nature would not otherwise produce.

The difficulty with McKinnon's argument is that, having noted that a miracle is an event that is contrary to the natural course of events, he interprets this to mean that a miracle is an event contrary to the actual course of events. Unless he is also prepared to argue that no actual event could have a non-physical, non-natural cause, such a conclusion is illegitimate. A miracle is contrary to the natural course of events not in the sense that it is an event which cannot actually occur, but in the sense that it is an event which cannot be explained except by reference to the action of an agent who transcends nature. Granted that such events are at least logically conceivable, it appears, contra McKinnon, that the term 'miracle' could consistently name or describe a real or allegedly real event.

MIRACLES AND EXPLANATION

Another challenge to the possibility of there being evidence which justifies belief in miracles is put forward by Patrick Nowell-Smith, in an article entitled "Miracles - The Philosophical Approach." He begins by noting that to call an event a miracle is to offer not just a description of a particular event, but also an explanation of its occurrence, since to call an event a miracle is to engage not only in observation, but also in explanation. Given that "evidence must be kept distinct from explanatory theory",[11] this means that all that even the best evidence can establish is that certain extraordinary phenomena sometimes occur. The question, though, of whether these phenomena occur must be kept distinct from the question of whether these phenomena are to be termed miraculous. "It will not do, having established the occurrence of an extraordinary event, automatically to term it a miracle.

The next step in Nowell-Smith's argument is to observe that "science is committed, not to definite theories or concepts, but to a certain method of explanation."[12] This means that, even though it might involve new terms and unfamiliar concepts, it may be possible at some future point in time to frame a strictly scientific explanation of the extraordinary events we are tempted to call miracles. Thus, "the problem is not whether science can explain everything in current terms but whether the explanation of 'miracles' requires a method quite different from that of science."[13]

Finally, Nowell-Smith comments that a genuine explanation must always have predictive power and involve "a law or hypothesis capable of predictive expansion."[14] Further, in explaining a miracle, it makes no sense to make reference to presumed 'supernatural' laws, since it is impossible to distinguish a 'supernatural' law from a 'natural' law.

This leads to the conclusion that an event is either scientifically explicable or no explanation at all is possible. As Nowell-Smith puts it, "the supernatural seems to dissolve on the one hand into the natural and on the other into the inexplicable."[15]

The biggest problem with this argument is that it assumes the very thing it needs to demonstrate. The premise that a true explanation must always have predictive power and involve 'a law or hypothesis capable of predictive expansion' is crucial to the success of the argument. This is a questionable claim, however. Scientific explanation does indeed involve citing 'a law or hypothesis capable of predictive expansion', but it is far from clear that scientific explanation is the only legitimate type of explanation.

In this regard it is noteworthy that one of the necessary conditions for an event being a miracle is that it be an event brought about by a rational agent who in some way transcends nature. It is therefore significant that we must distinguish between explanations which involve agents' purposes or intentions and explanations which do not. _Prima facie_ at least, these two types of explanation are radically different.[16]

In a scientific explanation an event E is the consequence of a certain set of relevant initial conditions and a certain set of relevant general laws. However, in what is sometimes termed a 'personal' explanation [17] an event E is explained by reference to an agent's intention or purpose to accomplish E or a further event F. Further, this type of explanation differs from scientific explanation in that it need have no close connection to the notion of prediction and yet may still serve as an adequate explanation of an event. As Richard Swinburne comments, "You could not discover my purpose and therefore my consequent action in going out the door now by noting what I always or normally did before going out the door."[18] Usually, if we wish to explain the actions of an agent, we must make reference to the agent's public utterances concerning his intentions and purposes. There appears to be no parallel to this requirement in the case of scientific explanation.

Lest my foregoing remarks be misconstrued, I wish to emphasize that I have already indicated that one of the tasks of the non-physicalist is to make clear the notion of agent causality and elaborate a world-view in which it acquires credibility. This is a large and complex task and one which I am not going to address in this thesis. The only point I want to make is that, prima facie at least, there exist two different types of explanation. One of these, it is true, always involves 'a law or hypothesis capable of predictive expansion', but the other does not. It will not do for Nowell-Smith merely to assume there is only one legitimate type of explanation. It is, therefore, far from clear that the concept of miracle dissolves into either the natural or the inexplicable.

Miracles and Criteria

A further challenge the physicalist sometimes raises is that, although the concept of miracle may be logically coherent, and there may exist extraordinary occurrences which we might be tempted to call miracles, we must never call an event a miracle, since this would be to impose arbitrary limits on what is scientifically explicable. Guy Robinson, in developing this objection, writes:

> notice what would happen to the scientist if he allowed himself to employ the concept of an irregularity in nature or of a miracle in relation to his work. He would be finished as a scientist. ...To do this would be simply to resign, to opt out, as a scientist. ... Scientific development would either be stopped or else made completely capricious, because it would necessarily be a matter of whim whether one invoked the concept of miracle or irregularity to explain an awkward result, or on the other hand accepted the result as evidence of the need to modify the theory one was investigating.[19]

In essence, this is an objection that, because there exist no criteria by which we may determine whether 'anomalies' are properly regarded as miracles or as events which indicate an inadequate understanding of natural processes, it is impossible to justify the use of the term 'miracle.' To invoke the term, therefore, is to set artificial and arbitrary limits on scientific explanation.

It may be agreed that not every way of postulating a miracle deserves consideration and that a superstitious mentality in which miracles proliferate is to be avoided. It must be questioned, however, whether it is impossible to develop criteria which would distinguish events properly termed 'miracles' from events which are properly understood as indices of an inadequate understanding of natural processes.

Suppose, in the case of a reported event, the following criteria are met:

1. There is strong evidence that the event in question actually occurred.

2. The event took place in a moral and religious context and has moral and religious significance.[20]

3. Although it is carefully scrutinized, the event cannot be identified as being of some repeatable type. (The event need not be absolutely unique, but merely of such a nature that it is not consistently repeatable.)

4. The regularity to which the event constitutes an exception is strongly confirmed, and is known to apply to the same type of physical circumstances in which the event happened.

Surely these criteria would serve to differentiate events which might legitimately be interpreted as miracles and events which would best be interpreted as indices of an inadequate understanding of natural processes. Whether we view an extraordinary event as a miracle or as the result of some unknown natural process need not be a matter of whim.

A possible objection to this line of argument is that, although it may not be a matter of caprice or whim whether we call an event a 'miracle', miracle claims, no less than scientific claims, are corrigible. To term an event a 'miracle', though, is to hold that the event is explained and to rule out the possibility of any future scientific explanation.

This objection fails, however. Two of the criteria for an event being considered a miracle are that it cannot be identified as an event of some repeatable type and that the regularity of nature to which it constitutes an exception is strongly confirmed and known to apply to the type of physical circumstances in which the event happened. Clearly, there could be new scientific evidence which would suggest either that the event can be identified as being of some repeatable type or that the regularity of nature to which the event constitutes an exception is not as strongly established as was previously thought. We do not, therefore, in terming an event a 'miracle', prematurely rule out the possibility of a future scientific explanation of the event.

There is another related objection based on the fact that miracle claims are corrigible. This may be expressed as the claim that it is always more rational to believe that an event could be explained naturalistically if only we had the requisite scientific knowledge, than to believe that a miracle has occurred.

The answer to this objection is found in the distinction which must be drawn between pragmatic working assumptions and metaphysical presuppositions. We may endorse the principle of first seeking a natural explanation of an event without thereby committing ourselves to the position that a supernatural explanation of an event can never be legitimately postulated. N.L. Geisler is correct when he writes:

> Simply to assume ... that there must be a naturalistic explanation for every event begs the question in favour of naturalism. ... adopting the working procedure of always looking for a natural explanation need not be extended into a rigid naturalistic position that there are no nonnatural explanations. The scientific mind should not legislate what kind of explanations there can be.[21]

Of course there is always the logical possibility that a revision of scientific law may lead to a natural explanation of what was hitherto considered a miracle. This fact, though, does not in itself justify the claim that it is always the more rational course to believe that all events have natural explanations. The fact that a claim is corrigible does not entail the conclusion that other logically possible claims are more probably true.

For example, given the fact that all scientific claims are corrigible, there is always the logical possibility that we are wrong in supposing that, in the normal course of events, the blood circulates in a living human body. However, it will hardly do, merely on the grounds that this claim is corrigible, to claim that some other logically possible alternative, such as the claim that we are mistaken in believing the blood to circulate, is equally probable or as well-established.[22]

It is logically possible that some revision of scientific law might enable one to offer a natural explanation of those events we are tempted to term 'miraculous', but it is also true that it is logically possible that no revision would enable us to offer a natural explanation of such events. Our decision as to which of these hypotheses is most probably true must be based on an assessment of how well they 'fit' the evidence. Both alternatives may be logically possible but they are not necessarily equally probable.

Let us consider an example. Suppose we hear of a man who claims to perform miracles of healing through the power of God. Upon investigating, we learn that this person has not only an exemplary character, but also the apparent ability to perform remarkable cures. We are able to document occasions when, immediately following the prayers of this man, limbs lost to disease or accident were regrown within a matter of minutes, eyes severely damaged were restored to sight, and supposedly terminal diseases were reversed. Further, we find not only that this man appears to have the power to heal any kind of disease or injury, but also that no interposition of lead screens or strong electromagnetic fields or the like has any effect on his apparent ability to heal. Indeed, we observe that his power is apparently independent of distance, since people in distant countries have experienced dramatic healing after this man prayed for their cure.

Such an example raises at least two major problems for the person who holds that it is always more reasonable to postulate a natural explanation rather than accept the occurrence of a miracle. The first is that this procedure leads to an apparently unwarranted scepticism concerning our knowledge of the laws of nature. If we had good reason to accept that these extraordinary events had occurred, and if we insist that all explanations of physical events must be natural, then we would have to be prepared to reject or revise the laws which led us to expect different results.

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This would place us in the position of questioning what were hitherto thought to be basic, well-evidenced, and accurate statements of the laws of nature. In short, we would be forced to adopt a position of radical scepticism concerning the claims of science. This, it should be noted, would be in sharp contrast to the person who accepts that the event was a miracle and who is able to offer an account of how one may accept the occurrence of such extraordinary events and yet retain faith in our knowledge of natural laws.

This is neither to deny that revolutions occur in scientific theory nor that science often progresses by rejecting previously accepted statements of natural law. To insist, however, that the phenomena described in our hypothetical case be interpreted naturalistically, merely on the basis of some general remarks about falsifiability and revolution in science, would be at least as great an act of faith as any religious interpretation of such events.

Indeed, it may require a greater act of faith to interpret such events naturalistically. The person who believes such events to be miracles - taking his cue from Hume - may ask which is more likely: that a multitude of unknown processes requiring us to revise radically or even reject well-established statements of the laws of nature fortuitously combined to produce an extraordinary and religiously significant event, or that an extraordinary and religiously significant event occurred which, although it does not force us to revise or reject any well-established statements of natural law, seems to indicate that a transcendent rational agent acted to produce in nature an event which nature would not, of itself, have produced.[23] Surely only a dogmatic and uncritical metaphysical assumption that energy can neither be created nor destroyed, and that physical reality being all that exists is immune to any influence by something other than itself, can explain the insistence of some thinkers that, no matter what the event might be and no matter what the context in which it might occur, it would always be more rational to live in the faith that surn an event has a natural explanation than to believe it to be a miracle.

The second major difficulty which the defender of naturalistic interpretation must overcome is that his claim that extraordinary phenomena must have a natural explanation tends to lose its meaning. I wonder, in the case of our hypothetical example, what it could mean to term the power to heal a 'natural' power if it were shown that this capacity was not affected by distance, by any kind of physical screening, nor by the specific disease or injury of the person in need of healing. Could we legitimately use the word 'natural' to describe a capacity that appears to be independent of other natural forces and capacities? The physicalist cannot hold that physicalism is compatible with any logically possible state of affairs in the world without leaving himself vulnerable to the charge that he makes his world-view invulnerable by making it untestable and hence unfalsifiable.

The defender of naturalistic explanation may reply that, even in such a hypothetical case as has been described, it would be difficult to demonstrate that a certain ability is truly independent of physical limitations. There would always be the logical possibility that our healer was bounded by conditions which we had not yet discovered. Thus, it could never be entirely clear that the healer's capacity to heal was not affected by distance or truly independent of other natural forces and capacities.

This response evades rather than resolves the issue. To invoke it leaves the physicalist in the awkward position of justifying his rejection of evidence to the contrary. The fact that evidence concerning matters of fact can never be conclusive does not entail the conclusion that we must suspend judgement concerning their nature - otherwise science would be an impossibility. We must reach provisional conclusions on the basis of the evidence available. Provisional conclusions, though, may be strongly established and, in the absence of contrary evidence, deserve one's rational assent. There could, conceivably, as in the case of our hypothetical example, be instances where an abundance of evidence indicates the exercise of capacities which are independent of physical limitations.

The claim that we must always postulate a natural explanation of an event - however improbable that explanation may be - is, at best, false, at worst, meaningless. At best such a claim begs the question of whether nature may be considered an isolated system suffering no intrusions from something other than itself. At worst, it is vulnerable to the charge that it is meaningless by virtue of the fact that it is compatible with any state of affairs in the world.

CONCLUSION

The conclusion to be drawn from our discussion in this chapter is that the physicalist is in no position to argue that evidence in favour of mind-body interaction is improbable and that evidence in favour of miracles is impossible. Arguments based on the structure of the brain or the unity of science do not demonstrate that it is improbable that any evidence in favour of mind-body interaction exists. Neither do arguments based on logical and methodological considerations demonstrate that it is impossible that there exist evidence for miracles. The physicalist must admit two things, therefore. He must admit not only that his claim that energy can neither be created nor destroyed is unconfirmed, but also that it is not antecedently improbable that there may exist evidence which disconfirms this claim.

Footnotes

Footnotes Chapter 1

1. Milton A. Rothman, The Laws of Physics, (New York, Fawcett Publications, 1963) p. 48.

2. Thomas Kuhn, "Energy Conservation As An Example of Simultaneous Discovery" in his The Essential Tension, (Chicago, The University of Chicago Press, 1977) pp. 66-104.

3. Kuhn, pp. 67,68. Also see Energy: Historical Development of the Concept, ed. R. Bruce Lindsay, (Stroudsburg, Pennsylvania, Halsted Press) 1975.

4. Kuhn, pp. 68,69

5. Kuhn, p. 73

6. E.A. Burtt, The Metaphysical Foundations of Modern Science, Garden City (New York, Doubleday, 1954) p. 101.

7. Kuhn, p. 96

8. Kuhn, p. 94

9. Kuhn, p. 100

10. Kuhn is correct in his assertion that Naturphilosophie was a factor in the development and ready acceptance of the Principle of the Conservation of Energy. One must not overestimate its benign influence, however. Some critics feel that it hindered the development and acceptance of the Principle. Note Sambursky's comment in Physical Thought: From the Presocratics to the Quantum Physicists: An Anthology ed. S. Samburksy (London, Hutchinson, 1974) on ". . . the reluctant and almost hostile attitude of many leading men of science to the first publications dealing with the law of conservation of energy. After the observations of Rumford and the quantitative experiments of Joule had demolished the conception of heat as another kind of 'tenuous matter', physicists returned to the idea, already suggested by Daniel Bernoulli one hundred years earlier, that heat consisted in the kinetic energy of the ultimate particles of matter. This paved the way for the first general formulations of the law of conservation of energy or, as it is also called, the first law of thermodynamics. However, scientists were deeply suspicious of the kind of universal law of nature exemplified by this and regarded it as a relapse into the comprehensive conception of nature of ancient Greece, akin to Naturphilosophie, and as an attempt to discover a 'world

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formula' of a clearly metaphysical kind. The opposition to Robert Mayer's paper can easily by explained by his philosophical arguments in favour of the principle, but even Helmholtz's publication 'On the Conservation of Force' (1847), with its careful exposition based on purely scientific considerations, aroused misgivings among many of his colleagues.", p. 27.

11. For a good discussion of the role of Naturphilosophie in the discovery and acceptance of the Principle of the Conservation of Energy see Barry Gower's "Speculation in Physics: The History and Practice of Naturphilosophie" in Studies in History and Philosophy of Science, Vol. 3, No. 4, 1973. pp. 301-356

12. See, for example, E.N. Hiebert, Historical Roots of the Principle of Conservation of Energy (New York, Book Craftsmen Associates, 1962). Also see Lindsay's Energy: Historical Development of the Concept.

13. D.W. Theobald, The Concept of Energy (London, E.&F.N. Spon Ltd., 1966) p. 146.

14. Aristotle, Met. I. 3, 983 b 6 (R.P. 9A) I take this passage from Source Book in Ancient Philosophy, Charles M. Bakewell (revised ed. 1939; rpt. New York, Gordian Press, 1973) pp. 1,2.

15. Heraclitus, Fragment 30. See Source Book in Ancient Philosophy, p. 30. (Bakewell follows Diels' numbering of the fragments.)

16. Heraclitus, Fragment 90. See Source Book in Ancient Philosophy, p. 33.

17. R. Bruce Lindsay, "The Concept of Energy and Its Early Historical Development" in Energy: Historical Development of the Concept, (Stroudsburg, Pennsylvania, Halsted Press, 1975) p. 16.

18. Lucretius, De Rerum Natura, translated W.H.D. Rouse, (London, Loeb Classical Library, Heinemann Press, 1924) I 265-328.

19. Alexander, Aphrodisiensis, De Fato, 192, 14. I use Samuel Sambursky's translation which appears in his Physical Thought From the Presocratics to the Quantum Physicists: An Anthology. (London, Hutchinson, 1974) p. 97, No. 106.

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20. Hiebert notes, however, two passages in Aristotle which are related to the Principle of Virtual Velocities. These are De caelo 3,2, 301b 4-13, and Physica 7,5, 249b 30-250, a 4. The Principle of Virtual Velocities, which states that in any system of any number of interrelated points, if each point is acted upon by any force so that an infinitesimal displacement is given to each point, then the work performed by all the forces taken together will be zero if the system is in equilibrium, significantly influenced the development of mechanics which in turn influenced the the development of the concept of energy. See Historical Roots of the Principle of Conservation of Energy, p. 10.

21. W.C. Dampier, A History of Science (4th ed. 1948; rpt. Cambridge, At the University Press, 1966) p. xiv.

22. Emile Meyerson, Identity and Reality, translated Kate Loewenberg, (London, 1930; rpt. New York, Dover, 1962) p. 162.

23. A Source Book in Greek Science, edited, M.R. Cohen, I.E. Drabkin (New York, McGraw-Hill, 1948) pp. 231,232

24. Lindsay, p. 17. Also see Hiebert, p. 13

25. S. Pines, INTRODUCTION (Section II) in Sambursky's Physical Thought: From the Presocratics to the Quantum Physicists: An Anthology, (London, Hutchinson, 1974) pp. 123-127, p. 126

26. Drake, however, cautions that Galileo's "famous dictum that 'the book of nature is written in mathematical characters, without a knowledge of which men cannot understand it' probably represents a methodological canon rather than a metaphysical position." See S. Drake, "Galileo Galilei" in The Encyclopedia of Philosophy, chief editor, Paul Edwards (New York, Macmillan, 1967, Vol. 3, pp. 262-267) p. 264.

27. Galileo Galilei, On Motion and On Mechanics, translated by S. Drake, edited by I.E. Drabkin and S. Drake (Madison, Wisconsin, University of Wisconsin Press, 1960) p. 147.

28. Lindsay, p. 19

29. Consider, for example Max Von Laue's comment that "from the historical standpoint, the energy principle stems from mechanics. Even Galilei [Galileo] used it, less as a

result of experiment than as an intuition, in the form that the velocity reached by a falling object was capable of raising it again to the original height but no higher." History of Physics, translated, Ralph Oesper (New York, Academic Press, 1950) p. 83.

30. Rene Descartes, "Des engins par l'ayde desquels on peut avec une petite force lever un fardeau fort pesant." in Oeuvres de Descartes, edited, Adam and Paul Tannery, (Paris, 1897; rpt. Paris, Librairie Philosophique J. Vrin, 1969) Vol. 1, pp. 435-448. pp. 435,436.

31. Rene Descartes, Principles of Philosophy, Part II, Sec. 36 in Oeuvres de Descartes, edited, Adam and Paul Tannery, (Paris, 1897; rpt. Paris, Librairie Philosophique J. Vrin, 1964) pp. 83,84.

32. Hiebert, pp. 65,66

33. Leibniz, "A Brief Demonstration of a Notable Error of Descartes and Others Concerning a Natural Law" (Acta eruditorum, March 1686) in Gottfried Wilhelm Leibniz: Philosophical Papers and Letters, translated and edited, Leroy E. Loemker (Chicago, The University of Chicago Press, 1956) Vol. 1, pp. 455-463. p. 456.

34. Leibniz, p. 456.

35. Leibniz, p. 456.

36. D'Alembert is usually credited with definitely settling the momentum versus vis viva controversy in 1743. This seems incorrect. As Lindsay notes, [Energy: Historical Development of the Concept (p. 21)] "there is now some doubt whether D'Alembert should be considered to have definitely settled the momentum vs. vis viva controversy. ... historical evidence shows that the arguments over the 'true' measure of force continued long after 1743, and that many well-known writers on the subject made no mention of D'Alembert in their discussions." Also see Carolyn Iltis, "D'Alembert and the Vis Viva Controversy" in Studies in History and Philosophy of Science, Vol. 1, No. 2, 1970, pp. 135-144.

37. Hiebert, p.60.

38. Hiebert, p. 87.

39. Hiebert, p. 67

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Footnotes Chapter 2

1. Ernst Mach, History and Root of the Principle of the Conservation of Energy, translated and annotated by Philip E.B. Jourdain, 2nd ed. (Chicago, Open Court Publishing Co., 1911) pp. 69-71

2. Meyerson, pp. 206-207.

3. H. Poincare, The Foundations of Science, translated by George Bruce Halsted (1913; rpt. Washington, University Press of America Inc., 1982) p. 116.

4. Theobald, p. 59. Also see Meyerson, p. 209

5. Poincare, pp. 117,118.

6. Poincare, pp. 117,118.

7. Theobald, p. 23

8. Theobald, p. 59

9. Theobald, p. 153

10. It is, in fact, the confidence in order and structure which motivates the scientist's search for precise correlations between changes.

11. Meyerson, pp. 366,367

12. Robert S. Cohen, "Alternative Interpretations of the History of Science", in The Validation of Scientific Theories, ed. Philipp G. Frank (New York, Collier Books, 1961) p. 204.

13. Theobald, p. 152

14. Mach, p. 64

15. Duane E. Roller, Leo Nedelsky, "Conservation of Energy", in McGraw-Hill Encyclopedia of Science and Technology (New York, McGraw-Hill, 1960) Vol. 3, pp. 456,457, p.456

16. Sidney Borowitz, "Conservation of Energy" in The Harper Encyclopedia of Science (New York, Harper, 1963) Vol. 1, p.276

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Footnotes Chapter 3

1. See, for example Mary Hesse, Forces and Fields (London, Thomas Nelson and Sons Ltd., 1961) She writes,

> An interesting result of the general field theory is that it enables not only radiation to be described in terms of particle emission and absorption, but also the interactions of source particles, for example the Coulomb, Lorentz, and Yukawa forces for Maxwell and nuclear fields respectively. Such a description introduces the notion of *virtual* exchanges of field particles, in which there is apparent short-term violation of conservation of energy by spontaneous emission and subsequent absorption of, for example, a photon, by the same or another source-particle, thus restoring the energy-balance. If this exchange takes place in a short enough time, it will be impossible to detect a small energy unbalance, since energy and time are complementary variables in the sense of the uncertainty principle. Hence these exchanges are called *virtual* as opposed to *real* emissions of radiation, in conformity with the quantum mechanical convention that 'reality' is ascribed only to what is detectable in a classical sense, that is, to radiation which can produce observable effects on photographic plates, and so on. Also, no doubt, the word 'virtual' is meant to entail that these exchanges cannot 'really' take place because they violate conservation of energy, and this is 'impossible'. But it does not seem necessary to insist on this. If the uncertainty principle is correct and ultimate, we cannot know that energy is conserved in detail because in order to measure it accurately we need a correspondingly long time, and in a dynamic process this may not be available. Its apparent conservation may be connected with the value of the constant h which sets a lower limit to observability. If, on the other hand, a

> theory of the sub-quantum level proves to be possible, the missing energy may be found to be connected with motion at that level, and there would then be no need for an ontological distinction between virtual and real emissions. (pp. 276,277)

2. Arthur Schopenhauer, On the Fourfold Root of the Principle of Sufficient Reason, translated from the German by E.F.J. Payne, introduction by Richard Taylor (Illinois, Open Court Publishing Co., 1974) pp. 52,53

3. Meyerson, p. 41.

4. Mach, p. 66. Interestingly, this view also appears in Wittgenstein. In Tractatus Logico-Philosophicus we read that "the law of causality is not a law but the form of a law" [6.32], that "people ... surmised that there must be a 'law of least action' [conservation law] before they knew exactly how it went" [6.3211], that "we do not have an a priori belief in a law of conservation, but rather a priori knowledge of the possibility of a logical form" [6.33] and that "all such propositions, including the principle of sufficient reason, the laws of continuity in nature and of least effort in nature, etc. etc. - all these are a priori insights about the forms in which the propositions of science can be cast." [6.34] Translated D.F. Pears and B.F. McGuinness. (London, Routledge & Kegan Paul, 1974)

5. Theobald notes that,

> Causality to the Greeks was the general feeling that nothing in the physical world happened quite by chance. Nature, they held, displayed some order, even if in the event it proved very difficult to discover. The principle of causality in antiquity was, however, more a philosophical suspicion than a precise knowledge of particular causes and effects, such as we associate with functional variation in the mathematical and mechanistic sciences for example. For our purposes it is important to note that causality to the scientists and philosophers of antiquity was closely connected with conservation. To the Stoics and the Atomists the denial of all conservation principles was equivalent . . . the denial that every

event has a cause. Conservation was thus closely allied to the idea that the physical world is in some way orderly. (p. 147) Also note S. Sambursky, The Physical World of the Greeks, translated, Merton Dagut (New York, Macmillan, 1956) pp. 170-71

6. Johann Bernoulli, Discours sur les lois de la communication du mouvement, Chap x, Paris, 1724. The translation I have quoted was done by R. Bruce Lindsay. See Energy: Historical Development of the Concept, p. 129.

7. Hermann von Helmholtz, "The Conservation of Force: A Physical Memoir" in Selected Writings of Hermann von Helmholtz, edited, with Introduction by Russel Kahl (Middleton, Connecticut, Wesleyan University Press, 1971) p. 4.

8. Sambursky, The Physical World of the Greeks, pp. 170-71.

9. Theobald, p. 148.

10. David Fair, "Causation and the Flow of Energy" in Erkenntnis, Vol. 14, No. 3, Nov. 1979, pp. 219-250. p. 224. Hereafter cited as "Causation and the Flow of Energy"

11. Fair, p. 231.

12. Fair, p. 228

13. W.V. Quine, The Roots of Reference (La Salle Illinois. Open Court, 1973) p. 6

14. W.V. Quine, "The Scope and Language of Science" in The Ways of Paradox (Cambridge Massachusetts, Harvard University Press, 1976) pp. 228-245, p. 242.

15. Fair, p. 232

16. Fair, p. 233

17. I would be reluctant to try to reduce language about causality to language about energy transfer for two reasons. My primary reason is that such a reduction assumes the truth of physicalism, since unless physicalism is true it would be very rash to assume that the notion of energy transfer exhausts the notion of causality, i.e. there may be more than one kind of causality. Second, even if it is

possible invariably to identify the causal relation with transfer of energy, this is not to say that we should discard our language about causes and try only to speak about energy transfers. A contingent identity between mental and physical events is postulated by those who hold the mind-body identity theory, but very few identity theorists would say that we can dispense with language about the mental. Similarly, even if it should turn out to be true that causality can be identified as energy transfer, this is not to say that we can or should cease employing language about causes.

18. It is tempting to talk of the energy of the object; indeed we often do. Properly speaking, however, if energy is to be conceived as a property then it must be conceived as the property of a system and not that of an object. See, for example, Meyerson, p. 207.

19. Issac Asimov, Understanding Physics (New York, Walker and Company, 1966) Vol. 1, p. 213.

20. It might be, for example that sometimes a particle uncausedly pops into existence, but at precisely the same moment another uncausedly pops out of existence. The events are not connected, but they occur in such a manner that energy is conserved.

21. Mathematicians would say that the 'expected value' is 0. This does not mean that it is more probable than not that the sum will be 0. It means only that getting 0 as a sum is somewhat more probable than getting any other sum. In this case, although the expected value is 0 the actual probability of getting 0 as a sum is very low.

22. The simplest way to treat this experiment mathematically is to treat it as a box model. Our experiment with the cards is like the sum of a thousand draws at random with replacement from a box in which we have forty numbered tokens - two sets of which are numbered from 1 to 10 and two sets of which are numbered from -1 to -10.

The expected value for the sum of the draws = μ.

$\mu = 1000 \times 0$

$\mu = 0$

The standard error for the sums of the draws = σ.

σ = (the square root of the number of draws) x (the standard deviation of the box)

$\sigma = (1000)^{1/2} \times [(4 \times (10^2 + 9^2 + 8^2 + 7^2 + 6^2 + 5^2 + 4^2 + 3^2 + 2^2 + 1^2))/40]^{1/2}$

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(The standard deviation for a population is given by $[(x_i - u)^2/N]^{1/2}$ where u = the arithmetical mean and N = population.

σ = 196.2142

This means that in 1000 draws you can expect to have a sum of 0 give or take 196.2142 approximately 66% of the time.

To apply the normal approximation we use u = 0 and σ = 1.96.2142. To compute our standard values we let
$z = (x-u)/\sigma = (x - 0)/1.96.2142$

Thus when x = 2, z = .0102 and the probability of obtaining a sum which falls between -2 and +2 is .0080 (by the table for normal curve area)

When x = 10, z = .0510 and the probability of obtaining a sum which falls between -10 and +10 is .0398.

When x = 50, z = .2548 and the probability of obtaining a sum which falls between -50 and +50 is .1974.

When x = 100, z = .5096 and the probability of obtaining a sum which falls between -100 and +100 is .3900.

It can be readily appreciated, therefore, that the probability of getting even approximately 0 is very low. It should be noted that this probability gets even lower as the number of events increases. For example, the standard error when we use 100,000 decks of cards instead of 1000 becomes 1962.1416. This means that 66% of the time we expect a sum of 0 give or take 1962.1416. In such an instance the chance of obtaining a sum between -100 to +100 decreases to .0199, the chance of obtaining a sum between -50 and +50 decreases to .0120, and the chances of obtaining a sum between -10 and +10 or -2 and +2 become so low that the table does not give them.

Postulating a large number of simultaneous uncaused events does not, therefore, seem a promising approach to the problem of how if one abandons belief in the Principle of Universal Caus~~ality~~ one may yet retain belief in the Principle of the Conservation of Energy.

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Footnotes Chapter 4

1. It would be more precise to say there exists no determining physical cause.

2. Mario Bunge, The Mind-Body Problem (Toronto, Pergamon Press, 1980) p. 17.

3. D.M. Armstrong, A Materialist Theory of the Mind (New York, Humanities Press, 1968) p. 32.

4. Indeed, given the fact that matter is conceived as being essentially a form of energy, it follows that the mind is at least potentially capable of creating or destroying matter.

5. C.J. Ducasse, in his article "In Defense of Dualism," Dimensions of Mind, ed. Sidney Hook (New York, New York University Press, 1960) p. 89, attributes to C.D. Broad the argument that "it might be the case that whenever a given amount of energy vanishes from, or emerges in, the physical world at one place, then an equal amount of energy respectively emerges in, or vanishes from, that world at another place."

I am unable to find this argument in Broad's work. Certainly it is not present in Broad's The Mind and its Place in Nature (London, Kegan Paul, 1937). Whether or not this argument is to be found somewhere else in Broad's writings, its absence from his major book on the mind indicates that he did not place much emphasis upon the argument.

Broad does consider the problem we are speaking of, however. He suggests that mind-body interaction is analogous to systems whose parts are causally related but which, allegedly, exchange no energy. The analogy he uses is that of a pendulum. He writes,

> Take the case of a weight swinging at the end of a string hung from a fixed point. The total energy of the weight is the same at all positions in its course. It is thus a conservative system. But at every moment the direction and velocity of the weight's motion are different, and the proportion between its kinetic and its potential energy is constantly changing. These changes are caused by the pull of the string, which acts in a different direction at each different moment. The

string makes no difference to the total weight; but it makes all the difference in the world to the particular way in which the weight moves and the particular way in which the energy is distributed between the potential and the kinetic forms. This is evident when we remember that the weight would begin to move in an utterly different course if at any moment the string were cut.

Here, then, we have a clear case even in the physical realm where a system is conservative but is continually acted on by something which affects its movement and the distribution of its total energy. (pp. 107,108)

Broad's analogy is not very helpful, however. As Michael Levin comments,

This analogy is misguided ... energy is actually being exchanged in the pendulum case. The shaft is exerting centripetal force on the bob, and the bob is exerting centrifugal force on the shaft; and at different positions the bob is exerting and bearing different amounts of both. The potential and kinetic energy of the bob are constantly changing.

Metaphysics and the Mind-Body Problem (Oxford, Clarendon Press, 1979) p. 85)

6. In discussing the parallel argument in chapter 3, I have already shown that an appeal to some presumed non-causal essential connecting principle is incoherent.

7. Karl, R. Popper; John, C. Eccles, The Self and Its Brain (New York, Springer International, 1977) p. 541

8. There is a great deal of doubt that such a reformulation is actually possible, let alone desirable. Note, for example, Theobald's comment that, "In any physical system it is of the utmost importance to ascertain what it is that is conserved absolutely during physical processes, for something conserved there must be ..." (The Concept of Energy, p. 49), J.J.C. Smart's comment that "there is at least considerable doubt as to whether a successful theory can be developed which rejects the conservation laws" Between Science and Philosophy (New York, Random House,

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1968) p. 162, and Eugene P. Wigner's remark that "It is now natural for us to try to derive the laws of nature and to test their validity by means of the laws of invariance, rather than to derive the laws of invariance from what we believe to be the laws of nature." ("Invariance in Physical Theory", in Proceedings of the American Philosophical Society, Vol. 93, No. 7, 1949, pp. 521-526, p. 522)

9. C.J. Ducasse, Nature, Mind, and Death (La Salle, Illinois, The Open Court Publishing Company, 1951) p. 241.

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Footnotes · Chapter Five

1. David Hume, "Of Miracles," On Human Nature and the Understanding, ed. Anthony Flew (New York, Collier Books, 1962) p. 123, where he writes concerning the well-attested Jansenist miracles,

> There surely never was a greater number of miracles ascribed to one person than those which were lately said to have been wrought in France upon the tomb of Abbe' Paris, the famous Jansenist with whose sanctity the people were so long deluded. ... what is extraordinary is that many of the miracles were immediately proved upon the spot, before judges of unquestioned integrity, attested by witnesses of credit and distinction, in a learned age and on the most eminent theatre that is now in the world. ... And what have we to oppose to such a cloud of witnesses but the absolute impossibility or miraculous nature of the events which they relate. And this, surely, in the eyes of all reasonable people will alone be regarded as a sufficient refutation. (emphasis added)

2. Hume, "Of Miracles", pp. 115-120.

3. Anthony Flew, Hume's Philosophy of Belief (London, Routledge & Kegan Paul, 1961) p. 205

4. 1 Kings 17:14-16, Luke 9:16-17

5. C.D. Broad, "Hume's Theory of the Credibility of Miracles", Proceedings of the Aristotelian Society, Vol. 17, 1916-1917, p. 86.

6. Broad, p. 87

7. Hume, p. 119.

8. Broad, p. 87

9. Anthony Flew, "Miracles", The Encyclopedia of Philosophy, chief editor, Paul Edwards (New York, Macmillan, 1967) Vol. 5, p. 346.

10. We have already seen that Hume's use of the term

'laws of nature' is not entirely consistent with his views expressed elsewhere on induction and causation. I think in "Of Miracles" he uses the term 'law of nature' in much the sense I propose. I do, however, consider other views of what is meant by the term in examining possible objections to my argument. It is hard to see how Hume could formulate his argument if he does not hold some such view of the laws of nature as I have described.

11. Jaegwon Kim, "Explanation in Science," The Encyclopedia of Philosophy, chief editor, Paul Edwards (New York, Macmillan, 1967) Vol. 3, p. 159.

12. I am assuming for the sake of the argument that the laws of nature are absolute not statistical and that the working of physical processes is deterministic. My point is that even granting this assumption miracles need not be conceived as violating or implying the falsity of the laws of nature.

13. See, for example, C.S. Lewis, Miracles, A Preliminary Study (Glasgow, Fontana Books, 1960) pp. 62-63.

14. It is sometimes objected that the interaction of mind and body would imply the falsity of the law of nature known as the First Law of Thermodynamics (Principle of the Conservation of Energy). We have seen in chapter four that this is not so. The First Law of Thermodynamics, considered as a scientific law, i.e. the claim that in a causally isolated system energy is conserved, and not as the defining-postulate of physicalism, i.e. the claim that energy cannot be created or destroyed, is consistent with a theory of mind-body interaction.

15. The reason it becomes plausible is that, on such a view, there exists nothing more ultimate than nature which could either create or destroy the basic 'stuff', i.e. energy, of nature.

16. This is hardly surprising since both interactionism and miracles involve the action of spirit upon matter.

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Footnotes Chapter Six

1. See chapter 3 where I discuss the link between the Principle of Sufficient Reason and the Principle of Universal Causality. Also see Schopenhaurer, (On the Fourfold Root of the Principle of Sufficient Reason)

2: See, for example, David Fair, "Causation and the Flow of Energy".

3. See, for example, Identity and Reality, p. 47, where Meyerson distinguishes between what he terms 'scientific' and 'theological' causality.

4. Scientists agree that no physical system is ever truly isolated except, perhaps, the universe. In the case of the universe ~~we~~ might speak of it as being isolated in the sense that there is no other physical system for it to interact with. Whether or not it is causally isolated in the sense that it is never affected by something other than itself is, however, precisely the question at issue between the physicalist and non-physicalist.

5. Carl G. Hempel, "Studies in the Logic of Confirmation", Aspects of Scientific Explanation and Other Essays in the Philosophy of Science (New York, The Free Press, 1965) p. 32.

6. Mary Hesse, The Structure of Scientific Inference, London, Macmillan, 1974, p. 146.

7. Hempel, p. 32.

8. Lest the physicalist, noting that strictly speaking the laws of Galileo and Kepler are not mere substition instances of the laws of Newton, insist that the relation between the strong and the weak forms of the Principle is analogous, it should be emphasized that in cases where the converse consequent condition is legitimately applied it is always possible to bring some additional independent evidence which helps confirm the stronger hypothesis and ensures that any additional elements introduced by it are not gratuitous. Thus Newton did not offer his hypothesis simply as an explanation of the laws of Galileo and Kepler, but could claim additional support. In the case of the strong form of the Principle this cannot be done, since there exists no additional body of evidence which would tend to confirm the otherwise gratuitous view that energy can neither be created nor destroyed.

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9. Hempel, p. 32

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Footnotes: Chapter Seven

1. Ian Barbour, Issues in Science and Religion (Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1966), says this concerning world-views, "We may use the term 'world-view' to designate ... a set of basic beliefs about the fundamental charcter of reality. World-views are realistic (they purport to reality) and inclusive (they include all of reality), but they represent only the features deemed significant as a framework for life-orientation. A metaphysical system, on the other hand, tries to represent exhaustively the most general characteristics of all events, and it arises from a more theoretical interest. But the distinction is never a sharp one, since world-views use metaphysical categories, and metaphysical systems reflect ultimate commitments which provide life-orientations. (pp. 261,262)

2. For example, a philosopher who adheres to a physicalist world-view, when called upon to give an account of the 'religious sentiment', may consistently give a Freudian explanation or a Marxist explanation, or any one of a large number of explanations whose truth would be compatible with the truth of physicalism. What he is not at liberty to do is to accept an explanation whose truth would be incompatible with the truth of physicalism. He cannot, for instance, offer as a possible explanation of 'religious sentiment' the theory that God, a spiritual being, exists and instills this 'religious sentiment' in certain of His creatures.

3. Imre Lakatos cautions that,

> There are no such things as crucial experiments, at least not if these are meant to be experiments which can instantly overthrow a research programme. In fact, when one research programme suffers defeat and is superseded by another one, we may - with long hindsight - call an experiment crucial if it turns out to have provided a spectacular corroborating instance for the victorious programme and a failure for the defeated one ... But scientists, of course, do not always judge heuristic situations correctly. A rash scientist may claim that his experiment defeated a programme, and parts of the scientific community may even, rashly, accept his claim. But if a scientist in the

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> 'defeated' camp puts forward a few years later a scientific explanation of the allegedly 'crucial experiment' within (or consistent with) the allegedly defeated programme, the honorific title may be withdrawn and the 'crucial experiment' may turn from a defeat into a new victory for the programme.

Imre Lakatos, "Falsification and the Methodology of Scientific Research Programmes," Criticism and the Growth of Knowledge, ed. Imre Lakatos, Alan Musgrave (London, Cambridge University Press, 1970) p. 173

4. Lakatos, although he is not talking explicitly of world-views suggests that one objective, as opposed to socio-psychological, reason to prefer one research programme over another is that it explains the previous success of its rival and supersedes it by a further display of heuristic [explanatory] power. I take him to be making essentially the same point as I wish to make. See p. 155 of "Falsification and the Methodology of Scientific Research"

5. Clark Glymour, Theory and Practice (Princeton, New Jersey, Princeton University Press, 1980) pp. 150-152.

6. Ian Barbour, Myths, Models and Paradigms (London, SCM Press, 1974) p. 130

7. John Thorp writes,

> One thing which is clear is that there can be no such thing as agent causality - at least the radical kind of agent causality that the libertarian [and interactionist] wants - if one adheres to a mere regularity view of causation. Agent causality is, precisely, irregular. So that if there can be any content at all to the libertarian notion of agent causality it must be something other than regularity; it must be the idea of 'power' or one of its congeners.

Free Will (London, Routledge & Kegan Paul, 1980) p. 101

8. Paul R. Thagard, "The Best Explanation: Criteria for Theory Choice," The Journal of Philosophy, 75, February 1978, p. 82.

9. Thagard, p. 89.

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10 Ian Barbour, Myths, Models and Paradigms, p. 134.

11. Lakatos comments that "the idea of instant rationality ... [is] utopian. ....all ... theories of instant rationality - and instant learning - fail. ...rationallity works much slower than most people tend to think ... (Lakatos, p. 174)

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Footnotes Chapter Eight

1. Sir John C. Eccles, The Neurophysiological Basis of Mind: The Principles of Neurophysiology, (Oxford, At The Clarendon Press, 1958), p. 278.

2. Eccles, p. 276.

3. D.M. Armstrong, A Materialist Theory of the Mind, (New York, Humanities Press, 1968), pp. 49,50.

4. Alastair McKinnon, "Miracle and Paradox," American Philosophical Quarterly, Vol. 4, (1967) p. 308.

5. McKinnon, p. 309.

6. McKinnon, p. 309.

7. McKinnon, p. 309.

8. McKinnon, p. 309.

9. McKinnon, p. 310.

10. McKinnon, p. 310.

11. Patrick Nowell-Smith, "Miracles - The Philosophical Approach", in Philosophy of Religion: Selected Reading, ed. William L. Rowe, William J. Wainwright (New York, Harcourt Brace Jovanovich, Inc., 1973) p. 395

12. Nowell-Smith, p. 396.

13. Nowell-Smith, p. 396.

14. Nowell-Smith, p. 399.

15. Nowell-Smith, p. 397.

16. I am aware that it is a controversial issue whether explanations involving references to agents' purposes may be reduced to scientific explanations. Unless, however, there is, at least initially, some reason to distinguish between the two types of explanation there would hardly exist a controversy.

17. See, for example, Richard Swinburne, The Concept of Miracle, (London, Macmillan, 1970) pp. 53,54.

18. Swinburne, p. 54.

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19. Guy Robinson, "Miracles" in Ratio, Vol. 9, (Dec. 1967), p. 159

20. I am aware that phrases like 'moral and religious significance' tend to be somewhat vague. The point I am trying to make in introducing this criterion is put very well by Bernard Ramm, who writes:

> It may be safely asserted that a hypothesis does not receive fair treatment if viewed disconnected from its system, and further, that any hypothesis proposed must make peace with the system that it is associated with - even to revolutionizing the system, e.g. Copernicus and Einstein. It is therefore impossible to see miracles in the Christian [religious] perspective if viewed only as problems of science and history, i.e. to use only historical and scientific categories for interpretation. It is not asked that miracles be accepted blindly simply because they are associated with the Christian system; nor do we argue in a circle asking one to view miracles from the Christian position to see them as true when the Christian system is the point at issue. No hypothesis in science is confirmed until tentatively accepted as true. The tentative acceptation does not prove the hypothesis but it is absolutely necessary to test the hypothesis. (Protestant Christian Evidences, Chicago, Moody Press, 1953, p. 129.)

21. N.L. Geisler, Christian Apologetics (Grand Rapids, Baker Books, 1976) p. 272.

22. See Margaret Boden, "Miracles and Scientific Explanation", Ratio, Vol. 11, (Dec. 1969), pp. 137-144, for a good discussion of this issue.

23. John Henry Newman, in Two Essays on Biblical and on Ecclesiastical Miracles (London, Longmans, Green & Co., 1890,) pp. 53-54, makes the point that the theist may also make use of a balance of probability argument. He writes,

> A ... subtle question remains, respecting the possible existence of causes in nature, to us unknown, by the

supposed operation of which the apparent anomalies may be reconciled to the ordinary laws of the system. ... it is impossible, from the nature of the case, absolutely to disprove any, even the wildest, hypothesis which may be framed. ... It becomes, then, a balance of opposite probabilities, whether gratuitously to suppose a multitude of perfectly unknown causes, and these, moreover, meeting in one and the same history, or to have recourse to one, and that a known power, then miraculously exerted for an extraordinary and worthy object.

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