A new theory of the relationship of mind and matter

DAVID BOHM

Department of Theoretical Physics, Birkbeck College, University of London, Malet St, London WC1E 7HX, United Kingdom

[Reprinted From: PHILOSOPHICAL PSYCHOLOGY, VOL. 3, NO. 2, 1990, pp. 271-286.]

ABSTRACT: The relationship of mind and matter is approached in a new way in this article. This approach is based on the causal interpretation of the quantum theory, in which an electron, for example, is regarded as an inseparable union of a particle and afield. This field has, however, some new properties that can be seen to be the main sources of the differences between the quantum theory and the classical (Newtonian) theory. These new properties suggest that the field may be regarded as containing objective and active information, and that the activity of this information is similar in certain key ways to the activity of information in our ordinary subjective experience. The analogy between mind and matter is thus fairly close. This analogy leads to the proposal of the general outlines of a new theory of mind, matter, and their relationship, in which the basic notion is participation rather than interaction. Although the theory, can be developed mathematically in more detail the main emphasis here is to show qualitatively how it provides a way of thinking that does not divide mind from matter, and thus leads to a more coherent understanding of such questions than is possible in the common dualistic and reductionistic approaches. These ideas may be relevant to connectionist theories and might perhaps suggest new directions for their development.

---

1 Introduction

This article discusses some ideas aimed at bringing together the physical and mental sides of reality. It is concerned mainly with giving the general outlines of a new way of thinking, consistent with modern physics, which does not divide mind from matter, the observer from the observed, the subject from the object. What is described here is, however, only the beginning of such a way of thinking which, it is hoped, can be developed a great deal further.

The problem of the relationship of mental and physical sides of reality has long been a key one, especially in Western philosophy. Descartes gave a particularly clear formulation of the essential difficulties when he considered matter as extended substance (i.e. as occupying space) while mind was regarded as thinking substance (which clearly does not occupy space). He pointed out that in mind, there can be clear and distinct thoughts that correspond in content to distinct objects that are separated in space. But these thoughts are not in themselves actually located in separate regions of space, nor do they seem to be anything like separate material objects in other ways. It appears that the natures of mind and matter are so different that one can see no basis for a relationship between them. This point was put very clearly by Descartes (see Cottingham, 1986) when he said that there is nothing included in the concept of body that belongs to mind, and nothing in that of mind that belongs to body. Yet, experience shows that they are closely related.

Descartes solved the problem by assuming that God, who created both mind and matter is able to relate them by putting into the minds of human beings the clear and distinct thoughts that are needed to deal with matter as extended substance. It was of course also implied by Descartes that the aims contained in thoughts had somehow to be carried out by the body, even though he asserted that thought and the body had no domain in common. It would seem (as was indeed suggested at the time by Malebranche) that nothing is left but to appeal to God to arrange the desired action somehow. However, since that time, such an appeal to the action of God has generally ceased to be accepted as a valid philosophical argument. But this leaves us with no explanation of how mind and matter are related.

This article aims at the development of a different approach to this question, which permits of an intelligible relationship between mind and matter without reducing one to nothing but a function or aspect of the other (such reduction commonly takes the forms of materialism which reduces mind, for example, to an 'epiphenomenon' having no real effect on matter, and of idealism, which reduces matter to some kind of thought, for example, in the mind of God).

The new approach described in this article is made possible from the side of matter by the quantum theory, which is currently the most basic theory of the nature of matter that we have. Certain philosophers of mind (see, e.g. Haugeland, 1981, ch. 1) would criticize bringing physics into the study of mind. In this way, because they assume mind to be of such a different (and perhaps emergent) quality that physics is not relevant to it (even though they also assume that mind has a material base in the brain). Such criticisms are inspired, in large part, by the belief that physics is restricted to a classical Newtonian form, which in essence ultimately reduces everything to a mechanism of some kind. However, as will be explained in more detail later, the quantum theory, which is now basic, implies that the particles of physics have certain primitive mind-like qualities which are not possible in terms of Newtonian concepts (though, of course, they do not have consciousness). This means that on the basis of modern physics even inanimate matter cannot be fully understood in terms of Descartes' notion that it is nothing but a substance occupying space and constituted of separate objects. Vice versa, It will be argued that mind can be seen to have always a physical aspect, though this may be very subtle. Thus, we are led to the possibility of a real relationship between the two, because they never have the absolute distinction of basic qualities, that was assumed by Descartes and by others, such as the emergent materialists.

The way is thus now opened to see the possible relevance of physics in this context. This is because the quantum theory denies the mechanistic (Newtonian) conceptual framework which has thus far implicitly justified the notion that mind is of such a nature that it can have absolutely nothing to do with the laws of matter. Moreover, though those new qualities of matter have been established at the fundamental level of particle physics, we shall indicate in a later section how it may be possible for them to become operative at higher levels of organization such as that of brain and nervous system.

2 The implicate order and the quantum theory

The question of the relationship of mind and matter has already been explored to some extent in some of my earlier work in physics (Bohm, 1980). In this work, which was originally aimed at understanding relativity and quantum theory on a basis common to both, I developed the notion of the enfolded or implicate order. The essential feature of this idea was that the whole universe is in some way enfolded in everything and that each thing is enfolded in the whole. From this it follows that in some way, and to some degree everything enfolds or implicates everything, but in such a manner that under typical conditions of ordinary experience, there is a great deal of relative independence of things. The basic proposal is then that this enfoldment relationship is not merely passive or superficial. Rather, it is active and essential to what each thing is. It follows that each thing, is internally related to the whole, and therefore, to everything else. The external relationships are then displayed in the unfolded or explicate order in which each thing is seen, as has already indeed been indicated, as relatively separate and extended, and related only externally to other things. The explicate order, which dominates ordinary experience as well as classical (Newtonian) physics, thus appears to stand by itself. But actually, it cannot be understood properly apart from its ground in the primary reality of the implicate order.

Because the implicate order is not static but basically dynamic in nature, in a constant process of change and development, I called its most general form the holomovement. All things found in the unfolded, explicate order emerge from the holomovement in which they are enfolded as potentialities and ultimately they fall back into it. They endure only for some time, and while they last, their existence is sustained in a constant process of unfoldment and re-enfoldment, which gives rise to their relatively stable and independent forms in the explicate order.

The above description then gives, as I have shown in more detail elsewhere (Bohm, 1980) a valid intuitively graspable account of the meaning of the properties of matter, as implied by the quantum theory. It takes only a little reflection to see that a similar sort of description will apply even more directly and obviously to mind, with its constant flow of evanescent thoughts, feelings, desires, and impulses, which flow into and out of each other, and which, in a certain sense, enfold each other (as, for example, we may say that one thought is implicit in another, noting that this word literally means 'enfolded'). Or to put it differently, the general implicate process of ordering is common both to mind and to matter. This means that ultimaltely mind and matter are at least closely analogous and not nearly so different as they appear on superficial examination. Therefore, it seems reasonable to go further and suggest that the implicate order may serve as a means of expressing consistently the actual relationship between mind and matter, without introducing something like the Cartesian duality between them.

At this stage, however, the implicate order is still largely a general framework of thought within which we may reasonably hope to develop a more detailed content that would make possible progress toward removing the gulf between mind and matter. Thus, even on the physical side, it lacks a well-defined set of general principles that would determine how the potentialities enfolded in the implicate order are actualized as relatively stable and independent forms in the explicate order. The absence of a similar set of principles is, of course, also evident on the mental side. But yet more important, what is missing is a clear understanding of just how mental and material sides are to be related.

Evidently what is needed is an extension of the implicate order, which develops the theory in the direction indicated above. In this paper, we shall go into another approach that in my opinion goes a long way toward fulfilling this requirement. This is based on what has been called the causal interpretation of the quantum theory (Bohm, 1952; Bohm & Hiley, 1975, 1987; Hiley & Peat, 1987). To show why this is being brought in, I shall first give a brief review or some of the main features of the quantum theory that called for a new interpretation along the proposed lines (see also Bohm, 1984; Zukav, 1979).

First, the quantum theory implies that all material systems have what is called a wave-particle duality in their properties. Thus, electrons that in Newtonian physics act like particles can, under suitable conditions, also act like waves (e.g. electrons can show statistical interference properties when a large number of them is passed through a system of slits). This dual nature of material systems is totally at variance with Newtonian physics, in which each system has its own nature independently of context.

Secondly, all action is in the form of definite and measurable units of energy, momentum and other properties called quanta which cannot be further divided. (For example, an atom is said to 'jump' from one state to another without passing through intermediate states and in doing this to emit an indivisible quantum of light energy.) When particle interact, it is as if they were all connected by indivisible links into a single whole. However, in the large scale limit, the number of links is so great that processes can be treated to a good degree of approximation as divisible (as one can treat the collective movement of a large mass of grains of sand as an approximately divisible flow). And this explains the indefinite divisibility of processes that we experience on the large scale level as a limiting case.

Thirdly, there is a strange new property of non-locality. That is to say, under certain conditions, particles that are at macroscopic orders of distance from each other appear to be able, in some sense, to affect each other, even though there is no known means by which they could be connected. Indeed if we were to assume any kind of force whatsoever (perhaps as yet unknown) to explain this connection, then the well-known Bell's theorem gives a precise and general criterion for deciding whether the connection is local, i.e. one brought about by forces that act when the systems are not in contact (Bell, 1966). It can be shown that the quantum theory implies that Bell's criterion is violated, and this implication is confirmed by the actual experiments. Therefore, it follows that if there are such forces, they must act non-locally. Such non-local interactions are basically foreign to the general conceptual scheme of classical

(Newtonian) physics, as it has been known over the past few centuries (which states that interactions are either in contact or carried by locally acting fields that propagate continuously through space).

All of this can be summed up in terms of a new notion of quantum wholeness, which implies that the world cannot be analyzed into independently and separately existent parts. This sort of analysis will have at most an approximate and limited kind of applicability; i.e. in a domain in which Newtonian physics is approximately valid. But fundamentally, quantum wholeness is what is primary.

In particular, such wholeness means that in an observation carried out to a quantum theoretical level of accuracy, the observing apparatus and the observed system cannot be regarding as separate. Rather, each participates in the other to such an extent that it is not possible to attribute the observed result of their interaction unambiguously to the observed system alone. Therefore, as shown by Heisenberg, there is a limit to the precision of the information that can be obtained about the latter. This contrasts with Newtonian physics, in which it is always possible in principle to refine observations to an unlimited degree of precision.

Niels Bohr (1934, 1958) has made a very subtle analysis of this whole question. For reasons similar to those outlined above, he treats the entire process of observation as a single phenomenon, which is a whole that is not further analyzable. For Bohr, this implies that the mathematics of the quantum theory is not capable of providing an unambiguous (i.e. precisely definable) description of an individual quantum process, but rather, that it is only an algorithm yielding statistical predictions concerning the possible results of an ensemble of experiments. Bohr further supposes that no new concepts are possible that could unambiguously describe the reality of the individual quantum process. Therefore, there is no way intuitively or otherwise to understand what is happening in such processes. Only in the Newtonian limit can we obtain an approximate picture of what is happening, and this will have to be in terms of the concepts of Newtonian physics.

Bohr's approach has the merit of giving a consistent account of the meaning of the quantum theory. Moreover, it focuses on something that is new in physics, i.e. the wholeness of the observing instrument and what is observed. The question is clearly also of key importance in discussing the relationship of mind and matter. But Bohr's insistence that this wholeness cannot be understood through any concepts whatsoever, however new they may be, implies that further progress in this field depends mainly on the development of new sets of mathematical equations without any real intuitive or physical insight as to what they mean apart from the experimental results that they may predict. On the other hand, I have always felt that mathematics and intuitive insight go hand in hand. To restrict oneself to only one of these is like tying one hand behind one's back and working only with the other. Of course, to do this is a significant restriction in physics, but evidently it is even more significant restriction in studying in mind, where intuitive insight must itself be a primary factor.

In view of the above, it seems very important to question Bohr's assumption that no conception of the individual quantum process is possible. Indeed, it was just in doing this that I was led to develop the causal interpretation of the quantum theory, that I have already mentioned earlier, which is able, as will be shown in this article, to provide a basis for a non- dualistic theory of the relationship of mind and matter.

3 The causal interpretation of the quantum theory

A brief account of the causal interpretation of the quantum theory win now be given (see Bohm, 1952; Bohm & Hiley, 1987). The first step in this interpretation is to assume that the electron, for example, actually is a particle, following a well defined trajectory (like a planet around the sun). But it is always accompanied by a new kind of quantum field. Now, a field is something that is spread out over space. We are already familiar, for example, with the magnetic field, shown to spread throughout space by means of iron filings around a magnet or a current carrying wire. Electric fields spreading out from a charged object are also well known. These fields combine to give electromagnetic waves, radiating out through space (e.g. radio waves).

The quantum field is, however, not simply a return to these older concepts, but it has certain qualitatively new features. These imply a radical departure from Newtonian physics. To see one of the key aspects of this departure, we begin by noting that fields can generally be represented mathematically by certain expressions that are called potentials. In physics, a potential describes a field in terms of a possibility or potentiality that is present at each point of space for giving rise to action on a particle which is at that point. What is crucial in classical (-Newtonian) physics is then that the effect of this potential on a particle is always proportional to the intensity of the field. One can picture this by thinking of the effect of water waves on a bobbing cork, which gets weaker and weaker as the waves spread out. As with electric and magnetic fields, the quantum field can also be represented in terms of a potential which I call the quantum potential. But unlike what happens with electric and magnetic potentials, the quantum potential depends only on the form, and not in the intensity of the quantum field. Therefore, even a very weak quantum field can strongly affect the particle. It is as if we had a water wave that could cause a cork to bob up with full energy, even far from the source of the wave. Such a notion is clearly fundamentally different from the older Newtonian ideas. For it implies that even distant features of the environment can strongly affect the particle.

As an example, we may consider the two slit interference experiment, shown in Fig. 1.

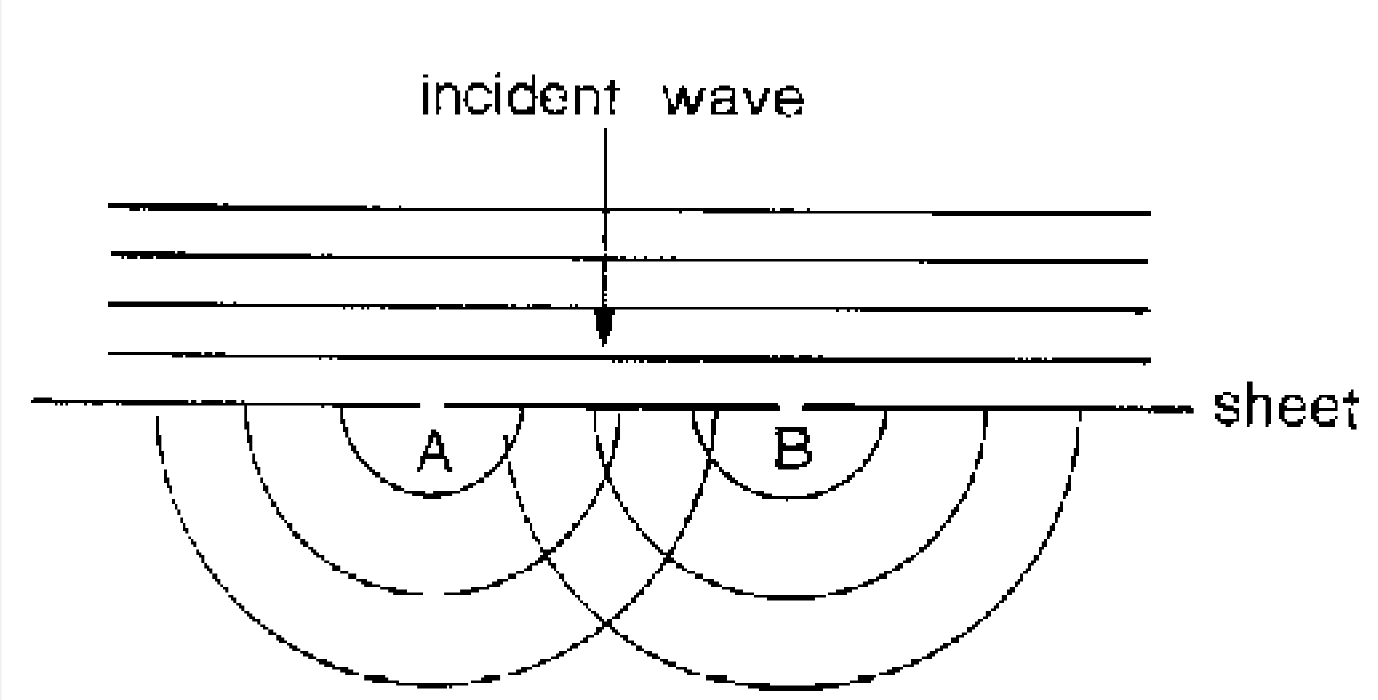

FIG. 1. The two slit interference experiment.

In this experiment, one may think of quantum waves that are incident on a sheet containing two slits, A and B. These waves pass through the two slits and then spread out as they propagate forward. Where the waves meet, they interfere, adding up to a stronger wave where their oscillations are in phase and canceling each other where they are out of phase. With classical fields, such as the electromagnetic, this gives rise to the well known interference pattern consisting of a set of fringe-like bands that are alternately strong and weak.

To see what happens with quantum systems, let us consider a very weak beam of electrons coming in to the slit system separately and independently, one after another. Each electron follows a well defined path, going through one slit or the other. Indeed, according to Newtonian ideas, after such an electron has passed through one of the slits, it should move through the empty space in front of it in a straight line at constant velocity. But quantum theoretically, this is not so. To see what happens here, let us consider the quantum potential, shown in Fig. 2., which results from the interference of the waves shown in Fig. 1.

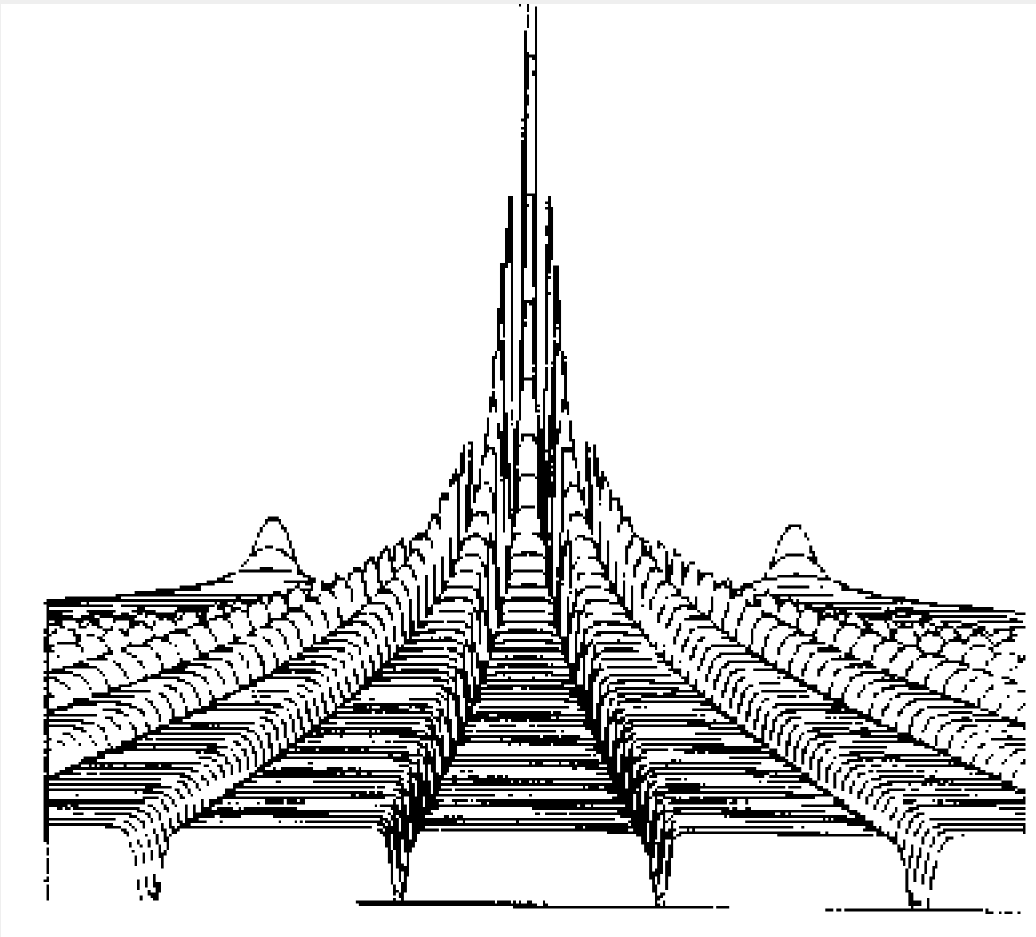

FIG. 2. The quantum potential for the two slit interference experiment.

The quantum potential is present in front of the slits. It consists of a series of plateaus' separated by deep 'valleys'. When an electron crosses one of these 'valleys', it is sharply accelerated. So the electrons are deflected even in the empty space in front of the slits by the quantum potential, and this deflection may still be large even far from the slits.

Now, in a typical experiment of this kind, the source of electrons is a hot filament, behind the slits, out of which they may be thought of as 'boiling' with a random statistical variation of initial positions (i.e. appearing here and there by chance). Each electron follows a particular path, going through one slit or the other, as it arrives at the detecting screen as an individual, particle, producing, for example, an individual spot in a photographic plate located at the screen. In its movement the electron is affected by the quantum potential, which, as we recall, is determined by the wave that in general precedes the particle. However, if we follow the whole set of trajectories, which represents an initially random distribution of particles, then, as shown in Fig. 3, these are 'bunched' systematically into a fringe-like pattern (which will become apparent after many electrons have arrived at the screen in front of the slits).

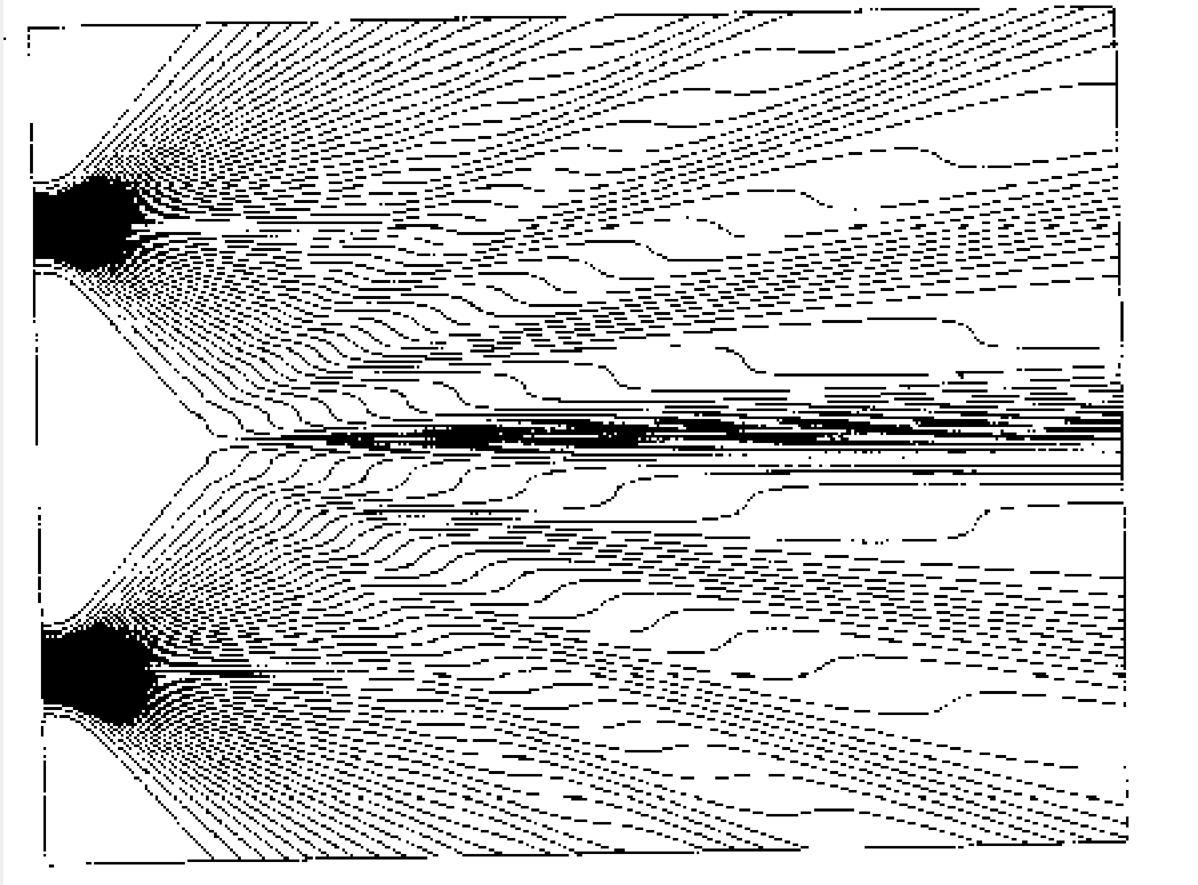

FIG. 3. Particle trajectories for the two slit interference expedient.

In this way, we explain how the electron can be a particle, and yet manifest characteristics wave-like properties statistically. It is essential for this explanation, however, that the quantum potential depends only on the form of the wave, so that it can be strong even when the wave intensity is weak. Or to put it differently, what is basically new here is the feature that we have called non-locality, i.e. the ability for distant parts of the environment (such as the slit system) to affect the motion of the particle in a significant way (in this case through its effect on the quantum field).

I would like to suggest that we can obtain a further understanding of this feature by proposing a new notion of active information that plays a key role in this context. The word in-form is here taken in its literal meaning, i.e. to put form into (rather than in it's technical meaning in information theory as negentropy). One may think of the electron as moving under its own energy. The quantum potential then acts to put form into its motion, and this form is related to the form of the wave from which the quantum potential is derived.

There are many analogies to the notion of active information in our general experience. Thus, consider a ship on automatic pilot guided by radar waves. The ship is not pushed and pulled mechanically by these waves. Rather, the form of the waves is picked up, and with the aid of the whole system, this gives a corresponding shape and form to the movement of the ship under its own power. Similarly, the form of radio waves as broadcast from a station can carry the form of music or speech. The energy of the sound that we hear comes from the relatively unformed energy in the power plug, but its form comes from the activity of the form of the radio wave; a similar process occurs with a computer which is guiding machinery. The 'information' is in the program, but its activity gives shape and form to the movement of the machinery. Likewise, in a living cell, current theories say that the form of the DNA molecule acts to give shape and form to the synthesis of proteins (by being transferred to molecules of RNA).

Our proposal is then to extend this notion of active information to matter at the quantum level. The information in the quantum level is potentially active everywhere, but actually active only where the particle is (as, for example, the radio wave is active where the receiver is). Such a notion suggests, however, that the electron may be much more complex than we thought (having a structure of a complexity that is perhaps comparable, for example, to that of a simple guidance mechanism such as an automatic pilot). This suggestion goes against the whole tradition of physics over the past few centuries which is committed to the assumption that as we analyze matter into smaller and smaller parts, their behaviour grows simpler and simpler. Yet, assumptions of this kind need not always be correct. Thus, for example, large crowds of human beings can often exhibit a much simpler behaviour than that of the individuals who make it up.

Does our knowledge of physics allow room for a structure of the kind suggested above? Actually, the smallest distances that have thus far been probed in physics are of the order of 10^{-16} cm. On the other hand, the shortest distance that could have meaning in present-day physics is of the order of 10^{-33} cm, the so-called Planck length, at which it is generally agreed that current concepts of space, time and matter would probably have to change radically. Between 10^{-16} and 10^{-33}, there is a factor of 10^{17}, which is about the same as that between 10^{-16} and ordinary macroscopic distances (of the order of 10 cm). Between 10 cm and 10^{-16} cm lies a tremendous possibility for structure. Why should there not be a similar possibility between 10^{-16} cm and 10^{-33} cm, and perhaps beyond even this? (It is interesting in this connection to note that even the current string theories of physics lead to the possibility of very complex structures at distances as short as 10^{-33} cm.)

The notion of active information implies, as we have seen, the possibility of a certain kind of wholeness of the electron with distant features of its environment. This is in certain ways similar to Bohr's notion of wholeness, but it is different ill that it can be understood in terms of the concept of a particle whose motion is guided by active information. On the other hand, in Bohr's approach, there is no corresponding way to make such wholeness intelligible.

The meaning of this wholeness is, however, much more fully brought out by considering not a simple electron as we have done thus far, but rather a system consisting of many such particles. Here several new concepts appear.

First, two or more particles can affect each other strongly through the quantum potential even when they are separated by long distances. This is similar to what happened with the slits, but it is more general. Such non-local action at long distances has been confirmed in experiments aimed at testing whether the Bell criterion that I mentioned earlier is satisfied.

Secondly, in a many particle system, the interaction of the particles may be thought of as depending on a common pool of information belonging to the system as a whole,, in a way that is not analyzable in terms of pre-assigned relationships between individual particles. This may be illustrated in terms of the phenomenon of superconductivity. Now, at ordinary temperatures, electrons moving inside a metal are scattered in a random way by various obstacles and irregularities in the metal. As a result, there is a resistance to the flow of electric current. At low temperatures, however, the electrons move together in an organized way, and can therefore go around such obstacles and irregularities to re-form their pattern of orderly movement together (see Fig. 4). Thus they are not scattered, and therefore the current can flow indefinitely without resistance.

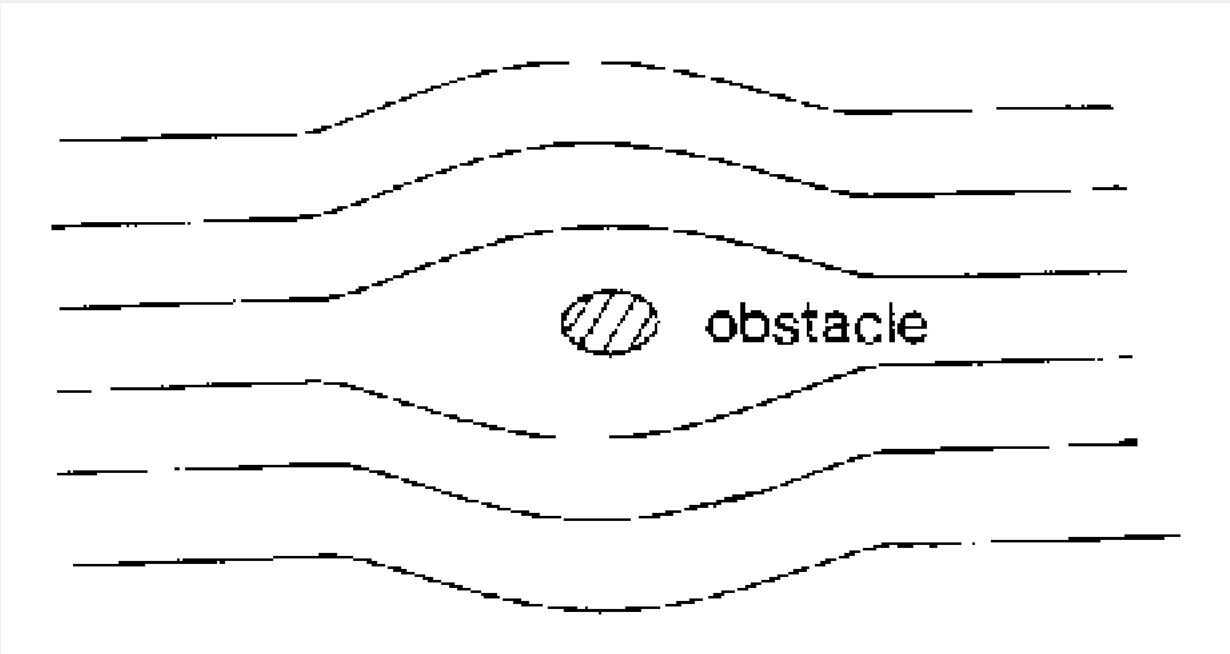

FIG. 4. Superconducting current flowing around an obstacles.

A more detailed analysis shows that the quantum potential for the whole system then constitutes a non-local connection that brings about the above described organized and orderly pattern of electrons moving together without scattering. We may here make an analogy to a ballet dance, in which all the dancers, guided by a common pool of information in the form of a score, are able to move together in a similar organized and orderly way, to go around an obstacle and re-form their pattern of movement.

If the basic behaviour of matter involves such features as wholeness, nonlocality and organization of movement through common pools of information, how then do we account for ordinary large scale experience, in which we find no such features? It can be shown (Bohm & Hiley, 1987) that at higher temperatures, the quantum potential tends to take the form of independent parts, which implies that the particles move with a corresponding independence. It is as if, instead of engaging in a ballet dance, people were moving independently, each with his own separate pool of information. They would then constitute a crowd, in which the organized movement of the ballet has broken up.

4 Implications for mind

It follows from the above that the possibilities for wholeness in the quantum theory have an objective significance. This is in. contrast to what happens in classical physics, which must treat a whole as merely a convenient way of thinking about what is considered to be in reality nothing but a collection of independent parts in a mechanical kind of interaction. On the other hand, in the quantum theory, the 'ballet-like' behaviour in superconductivity, for example, is clearly more like that of an organism than like that of mechanism. Indeed, going further, the whole notion of active information suggests a rudimentary mind-like behaviour of matter, for an essential quality of mind is just the activity of form, rather than of substance. Thus, for example, when we read a printed page, we do not assimilate the substance of the paper, but only the forms of the letters, and it is these forms which give rise to an information content in the reader which is manifested actively in his or her subsequent activities. A similar mind-like quality of matter reveals itself strongly at the quantum level, in the sense that the form of the wave function manifests itself in the movements of the particles. This quality does not, however, appear to a significant extent at the level at which classical physics is a valid approximation.

Let us now approach the question from the side of mind. We may begin by considering briefly some aspects of the nature of thought. Now, a major part of the significance of thought is just the activity to which a given structure of information may give rise. We may easily verify this in our subjective experience. For example, suppose that on a dark night, we encounter some shadows. If we have information that there may be assailants in the neighbourhood, this may give rise immediately to a sense of dancer, with a whole range of possible activities (fight, flight, etc.). This is not merely a mental process. But includes an involuntary and essentially unconscious process of hormones, heart-beat, and neurochemicals of various kinds, as well as physical tensions and movements. However, if we look again see that it is only a shadow that confronts us, this thought has a calming effect, and all the activity described above ceases. Such a response to information is extremely common (e.g. information that X is a friend or an enemy, good or bad, etc.). More generally, with mind, information is thus seen to be active in all these ways, physically, chemically, electrically, etc.

Such activity is evidently similar to that which was described in connection with automatic pilots, radios, computers, DNA, and quantum processes in elementary particles such as electrons. At first sight, however, there may still seem to be a significant difference between these two cases. Thus, in our subjective experience action can, in some cases at least, be mediated by reflection in conscious thought, whereas in the various examples of activity of objective information given here, this action is immediate. But actually, even if this happens, the difference is not as great as might appear. For such reflection follows on the suspension of physical action. This gives rise to a train of thought. However, both the suspension of physical action and the resulting train of thought follow immediately from a further kind of active information implying the need to do this.

It seems clear from all this that at least in the context of the processes of thought, there is a kind of active information that is simultaneously physical and mental in nature. Active information can thus serve as a kind of or 'bridge' between these two sides of reality as a whole. These two sides are inseparable, in the sense that information contained in thought, which we feel to be on the 'mental' side, is at the same time a related neurophysiological, chemical, and physical activity (which is clearly what is meant by the 'material' side of this thought).

We have however up to this point considered only a small part of the significance of thought. Thus, our thoughts may contain a whole range of information content of different kinds. This may in turn be surveyed by a higher level of mental activity, as if it were a material object at which one were 'looking'. Out of this may emerge a yet more subtle level of information, whose meaning is an activity that is able to organize the original set of information into a greater whole. But even more subtle information of this kind can, in turn, be surveyed by a yet more subtle level of mental activity, and at least in principle this can go on indefinitely. Each of these levels may then be seen from the material side. From the mental side, it is a potentially active information content. But from the material side, it is an actual activity that operates to organize the less subtle levels, and the latter serve as the material' on which such operation takes place. Thus, at each level, information is the link or bridge between the two sides.

The proposal is then that a similar relationship holds at indefinitely great levels of subtlety. I am suggesting that this possibility of going beyond any specifiable level of subtlety is the essential feature on which the possibility of intelligence is based.

It is interesting in this context to consider the meaning of subtle which is, according to the dictionary 'rarefied, highly refined, delicate, elusive, indefinable'. But it is even more interesting to consider its Latin root, sub-texere, which means 'finely woven'. This suggests metaphor for thought as a series of more and more closely woven nets. Each can 'catch' a certain content of a corresponding 'fineness'. The finer nets can not only show up the details of form and structure of what is 'caught' in the coarser nets; they can also hold within them a further content that is implied in the latter. We have thus been led to an extension of the notion of implicate order, in which we have a series of inter-related levels in which the more subtle-I.e. 'the more finely woven' levels including thought, feeling and physical reactions-both unfold and enfold those that are less subtle (i.e. 'more coarsely woven'). In this series, the mental side corresponds, of course, to what is more subtle and the physical side to what is less subtle. And each mental side in turn becomes a physical side as we move in the direction of greater subtlety.

5 An extension of the quantum theory

Let us now return to a consideration of the quantum theory. What is its relationship to the interweaving of the physical and the mental that has been discussed above? First, let us recall that because the quantum potential may be regarded as information whose activity is to guide the "dance" of the electrons, there is a basic similarity between the quantum behaviour of a system of electrons and the behaviour of mind. But if we wish to relate mental processes to the quantum theory, this similarity will have to be extended. The simplest way of doing this is to improve the analogy between mental processes and quantum processes by considering that the latter could also be capable of extension to indefinitely great levels of subtlety.

To bring this about, one could begin by supposing, for example, that as the quantum potential constitutes active information that can give form to the movements of the particles, so there is a superquantum potential that can give form to the unfoldment and development of this first order quantum potential. This latter would no longer satisfy the laws of the current quantum theory, which latter would then be an approximation, working only when the action of the superquantum potential can be neglected.

Of course, there is no reason to stop here. One could go on to suppose a series of orders of superquantum potentials, with each order constituting information that gives form to the activity of the next lower order (which is less subtle). In this way, we could arrive at a process that would be very similar to that to which we have been led in the consideration of the relationship of various levels of subtlety in mind.

One may then ask: what is the relationship of these two processes? The answer that I want to propose here is that there are not two processes. Rather, I 'Would suggest that both are essentially the same. This means that that which we experience as mind, in its movement through various levels of subtlety, will, in a natural way ultimately move the body by reaching the level of the quantum potential and of the 'dance' of the particles. There is no unbridgeable gap of barrier between any of these levels. Rather, at each stage some kind of information is the bridge. This implies, that the quantum potential acting on atomic particles, for example, represents only one stage in the process.

The content of our own consciousness is then some part of this over-all process. It is thus implied that in some sense a rudimentary mind-like quality is present even at the level of particle physics, and that as we go to subtler levels, this mind-like quality becomes stronger and more developed. Each kind and level of mind may have a relative autonomy and stability. One may then describe the essential mode of relationship of all these as participation, recalling that this word has two basic meanings, to partake of, and to take part in. Through enfoldment, each relatively autonomous kind and level of mind to one degree or another partakes of the whole. Through this it partakes of all the others in its 'gathering' of information. And through the activity of this information, it similarly takes part in the whole and in every part. It is in this sort of activity that the content of the more subtle and implicate levels is unfolded (e.g. as the movement of the particle unfolds the meaning of the information that is implicit in the quantum field and as the movement of the body unfolds what is implicit in subtler levels of thought, feeling, etc.).

For the human being, all of this implies a thoroughgoing wholeness, in which mental and physical sides participate very closely in each other. Likewise, intellect, emotion, and the whole state of the body are in a similar flux of fundamental participation. Thus, there is no real division between mind and matter, psyche and soma. The common term psychosomatic is in this way seen to be misleading, as it suggests the Cartesian notion of two distinct substances in some kind of interaction (if not through the action of God, then perhaps in some other way).

Extending this view, we see that each human being similarly participates in an inseparable way in society and in the planet as a whole. What may be suggested further is that such participation goes on to a greater collective mind, and perhaps ultimately to some yet more comprehensive mind in principle capable of going indefinitely beyond even the human species as a whole. (This may be compared to some of Jung's (1981) notions.)

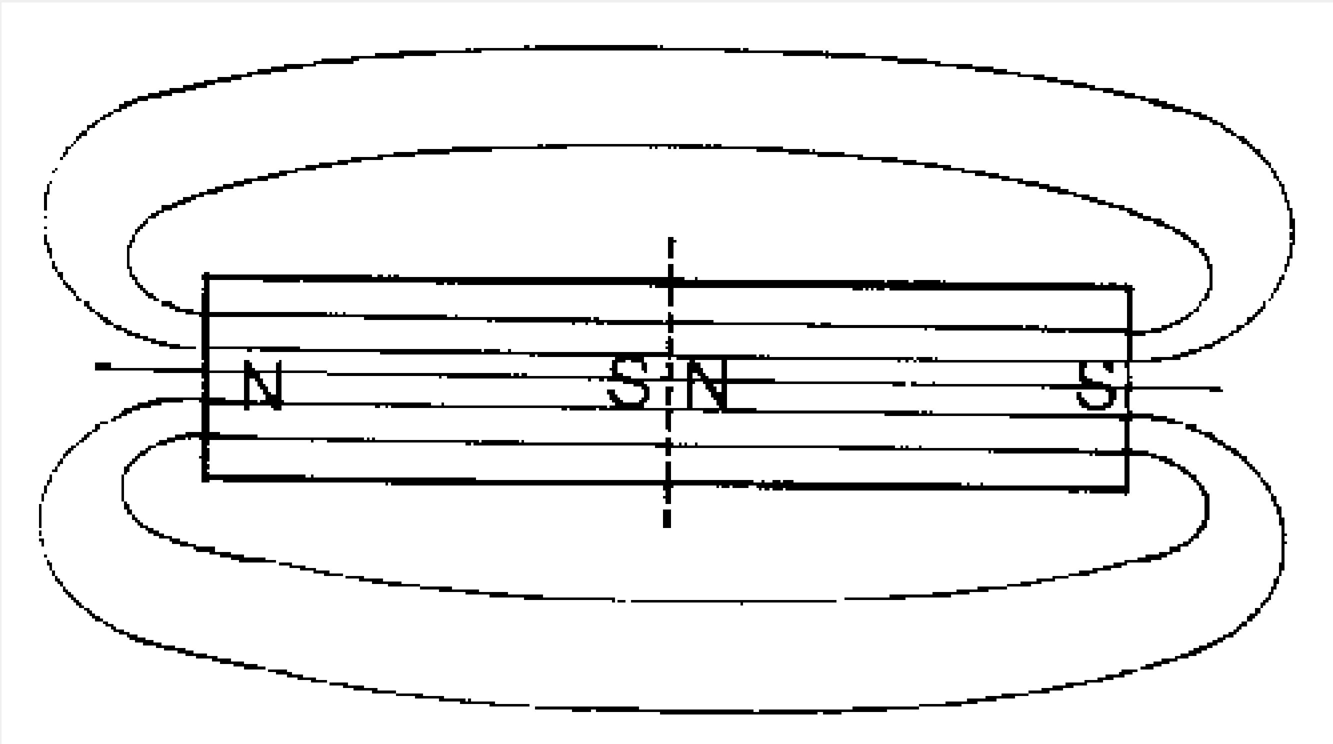

FIG. 5. Magnetic poles as abstractions from an overall magnetic field.

Finally, we may ask how we can understand this theory if the subtle levels are carried to infinity. Does the goal of comprehension constantly recede as we try to do this? I suggest that the appearance of such a recession is in essence just a feature of our language, which tends to give too much emphasis to the analytic side of our thought processes.

To explain what is meant here, one may consider the analogy of the poles of a magnet, which are likewise a feature of linguistic and intellectual analysis, and have no independent existence outside such analysis. As shown in Fig. 5, at every part of a magnet, there is a potential pair of north and south poles that overlap each other. But these magnetic poles are actually abstractions, introduced for convenience of thinking about what is going on, while the whole process is a deeper reality-an unbroken magnetic field that is present over all space.

Similarly, we may for the sake of thinking about the subject abstract any given level of subtely out of the unbroken whole of reality and focus our attention on it. At each such level, there will be a 'mental pole' and a 'physical pole'. Thus as we have already implied, even an electron has at least a rudimentary mental pole, represented mathematically by the quantum potential. Vice versa, as we have seen, even subtle mental processes have a physical pole. But the deeper reality is something beyond either mind or matter, both of which are only aspects that serve as terms for analysis [1]. These can contribute to our understanding of what is happening but are in no sense separate substances in interaction. Nor are we reducing one pole to a mere function or aspect of the other (e.g. as is done in materialism and in idealism). The key point is, however, that before the advent of the quantum theory, our knowledge of matter as gained from the study of physics would have led us to deny that it could have a mental pole, which would enable it to participate with mind in the relationship that have been described here. We can now say that this knowledge of matter (as well as of mind) has changed in such a way as to support the approach that has been described here. To pursue this approach further might perhaps enable us to extend our knowledge of both poles into new domains.

Note

[1] See Marshall (1989, p. 73) for an account of an idea having important similarities with what has been proposed here. He, too, uses the notion of a general quantum reality as a basis for the bodily and mental realms, considered as inseparable sides or aspects. But he proposes to explain this from the quantum theory as it now stands in its usual interpretation. However, in this paper we have used the causal interpretation of the quantum theory with its additional concepts of particle trajectories and active information, and have assumed that ultimately the relationship of mental and material sides can be understood only by extending the scheme beyond the domain in which the current quantum theory is valid.

For other recent attempts to consider the mind-matter relation in the light of the quantum theory, see Penrose (1989) and Lockwood (1989). For a discussion of the notions of active information and implicate order by a number of authors, see Pylkkanen (1989).

References

BELL, J.S. (1966) On the problem of hidden variables in quantum theory, Reviews of Modern Physics, 38, p. 447.

BOHM, D. (1952) A suggested interpretation of the quantum theory in terms of hidden variables, Physical Review, 85, pp. 166-189.

BOHM, D. (1980) Wholeness and the Implicate Order (London, Routledge & Kegan Paul).

BOHM, D. (1984) Causality, and Chance in Modern Physics, new edn with new preface (London, Routledge & Kegan Paul).

BOHM, D. & HILEY, B.J. (1975) On the intuitive understanding of Nonlocality as implied by the quantum theory, Foundations of Physics, 5, pp. 93-109.

BOHM, D. & HILEY, B.J. (1987) An ontological basis for the quantum theory, Physics Reports, 144, pp. 323-348.

BOHR, N. (1934) Atomic Theory and the Description of Nature (Cambridge, Cambridge University Press).

BOHR, N. (1958) Atomic Theory and Human Knowledge (New York, Wiley).

COTTINGHAM, J. (1986) Descartes (Oxford, Basil Blackwell).

HAUGELAND, J. (Ed.) (1981) Mind Design: philosophy, psychology, artificial intelligence (Mongtomery, VT, Bradford Books).

HILEY, B.J. & PEAT, F.D. (Eds) (1987) Quantum Implications (London, Routledge & Kegan Paul).

JUNG, C.G. (1981) Memories, Dreams and Reflections (London, Collins Fontana).

LOCKWOOD, M. (1989) Mind, Brain and the Quantum (Oxford, Basil Blackwell).

MARSHALL, I.N. (1989) Consciousness and Bose-Einstein Condensates, New Ideas in Psychology, 7, pp. 73-83.

PENROSE, R. (1989) The Emperor's New Mind: concerning minds, computers and the laws of physics (Oxford, Oxford University Press).

PYLKKANEN, P. (Ed.) (1989) The Search for Meaning (Wellingborough, Thorsons).

ZUKAV, G. (1979) The Dancing Wu Li Master: an overview of the new physics (New York, Morrow).
