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A New Theory of the Relationship of Mind and Matter¹

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ABSTRACT: The relationship of mind and matter is approached in a new way in this, the first Gardner Murphy Memorial Lecture. 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 a field. 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 corresponds in many ways to what is signified by "meaning" 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. Within this theory, there is room for a natural explanation of parapsychological phenomena, as well as for exploring new domains, both in the study of mind and in that of matter. However, although the theory can be developed mathematically in more detail, the main emphasis here is to show how it provides a way of thinking that does not divide observer and observed, and, thus, that may be helpful both in the setting up of parapsychological experiments and their interpretation.

It is a great honor to have been chosen to receive the first Gardner Murphy Award, and it gives me much pleasure to have been invited to give this lecture to mark the occasion. The great contribution that Gardner Murphy made to the entire field of parapsychological research is well known. He had an especially strong interest in extending and deepening our theoretical understanding of the whole subject. What I would like to do this evening is to indicate some ways, based on my own work, in which such understanding may be developed further. In particular, what I shall discuss are some ideas aimed at bringing together the physical and

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mental sides of reality, and I shall then go on to show how these two sides may be related in such a way as to suggest the beginnings of a theory of parapsychological phenomena. But I wish to stress here that my main concern at this point is to bring out a new way of thinking, consistent with modern physics, which does not divide mind from matter or the subject from the object. I hope that others will sooner or later be able to develop this way of thinking by embodying it in their work.

The problem of relating the mental and physical sides of reality has long been a key one, especially in Western philosophy. Descartes gave a very clear formulation of the essential difficulties when he considered matter to be *extended substance* and mind to be *thinking substance*. Within mind, there may be clear and distinct thoughts that correspond in content to separate and extended objects. But these thoughts are in themselves actually neither separate nor extended. The natures of mind as thinking substance and matter as extended substance are indeed so different that one can see neither in mind nor in the world of extended substance any basis for a relationship between them. Descartes assumed, however, that this basis is supplied from beyond both mind and the world by God, who put into man's mind the possibility of clear and distinct thoughts that are able to correspond in the way that I have indicated to separate and extended objects. But since the time of Descartes, such an appeal to the action of God has generally ceased to be accepted as a valid philosophical argument. This leaves us, however, with no explanation of how mind and matter are to be related.

In my work in physics, which was originally aimed at understanding relativity and the quantum theory on a deeper basis common to both, I developed the notion of the enfolded or *implicate order* (Bohm, 1980). The essential feature of this idea was that the whole of the universe is in some way enfolded in everything and that each thing is enfolded in the whole. From this it follows that in some ways, and to a certain degree, everything enfolds or implicates everything. The basic proposal is that this enfoldment relationship is not merely passive or superficial. Rather, it is active and essential to what each 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 separate and extended and related only externally to other things. The explicate order, which dominates ordinary experience as well as classical physics, is secondary, however, in the sense that ultimately it flows out of the primary reality of the implicate order.

Because the implicate order is basically dynamic in nature, I

called it 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 reenfoldment, which gives rise to the relatively stable and independent forms in which they appear in the explicate order.

The above description, then, gives 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, and this word literally means "enfolded"). Or to put it differently, the implicate order is common both to mind and to matter. This means that ultimately, mind and matter are not nearly so different as they may appear to be under superficial examination. Therefore, it seems reasonable to suggest that the implicate order may serve as a means of expressing consistently the relationship between mind and matter.

At this stage, however, the implicate order is still largely a general framework of thought within which we may reasonably hope to make progress toward removing the gulf between mind and matter. Even on the physical side, however, 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 even more important, what is missing is a clear understanding of just how mental and material sides are to be related. Evidently, this is relevant not only as a matter of general principle, but also if we are to obtain a real understanding of parapsychological phenomena.

In this talk, I shall go into another aspect of my work over the past 35 years, which I think goes a considerable way towards fulfilling the requirements described above. This I have called the causal interpretation of the quantum theory (Bohm, 1952a, 1952b, 1957/1971; Bohm & Hiley, 1975). In order to show why I am bringing in this aspect of my work, I shall first review briefly some of the main features of the quantum theory that I feel call for a new interpretation of the general sort that I have proposed. (For a general account of the main features of the quantum theory, see, e.g., Zukav, 1979.)

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

Secondly, there is a strange new property of nonlocality. That is to say, under certain conditions, particles that are even at macroscopic orders of distance 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 (1966) theorem gives a precise and general criterion for deciding whether the connection is local, that is, one brought about by the forces that act only when systems are in contact, or nonlocal, that is, one brought about by forces that may act when systems are not in contact. The actual experiments show that Bell's criterion is violated, which means that if there are such forces, they must act nonlocally. Such nonlocal interactions are basically foreign to classical physics as it has been known over the past few centuries.

Thirdly, the laws of the quantum theory are essentially statistical in nature, and they do not determine in precise detail how an individual system will behave. Statistical laws are, of course, common in both ordinary experience and in classical physics. But in the quantum theory, the statistics seem to have a different kind of significance. This is brought out especially clearly by considering Heisenberg's uncertainty principle.

Heisenberg made an analysis of how a typical process of physical observation or measurement may take place when one goes to a quantum mechanical level of refinement of detail and accuracy. He considered as his prime example the observation of the position of a particle with the aid of a microscope. Now, some kind of intermediary link is needed between the observed particle and the microscope to allow the two to interact, or else no observation will be possible. To make the disturbance of the observed system as small as possible, one may suppose that we use as a link a single quantum of light. Heisenberg then showed that the laws of quantum mechanics imply that there is a minimum uncertainty in our knowledge of the properties of the observed particle that can be obtained from such an interaction. Thus, the statistical laws of the quantum theory lead to the conclusion that there is no way to use

measurements to obtain information accurate enough to go beyond these statistical laws and to make completely accurate and detailed predictions of the behavior of individual systems. This contrasts with classical physics, in which it is always possible, in principle, to refine observations without limit, so that one can, without any intrinsic restrictions, go from a statistical law applying to an aggregate of systems to a relatively precise description of the motion of individual systems.

Niels Bohr (1934, 1958) has made a very subtle analysis of this whole question. He treats the entire process of observation, including the overall experimental conditions and the meaning of the observable experimental results (e.g., spots on the photographic plate) as a single *phenomenon*, which is a whole that is not further analyzable. This means that the mathematics of the quantum theory is not capable of providing an unambiguous reflection of reality, but rather, as Bohr himself says, that it is only an algorithm yielding statistical predictions concerning the various possible phenomena. Bohr further supposes that no new concepts are possible that could unambiguously reflect the reality of the individual quantum process. Therefore, there is no way intuitively or otherwise to understand what is happening in such quantum processes. Only at the level of a statistical aggregate of these processes can we obtain an approximate picture of what is happening, and this will have to be in terms of the concepts of classical 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, that is, the wholeness of the observer and what is observed. This question is surely relevant also 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 the mathematical formalism without any real intuitive or physical insight. 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. This is important in physics, but it is evidently even more important in studying the mind, where intuitive insight must itself be a primary factor in all exploration (as well as for further reasons that I shall explore later).

THE CAUSAL INTERPRETATION OF THE QUANTUM THEORY

In view of the above, I felt that it was very important to question Bohr's assumption that no analysis of the individual quantum pro-

cess is possible, even in thought. It was in doing this that I developed the causal interpretation of the quantum theory during the 1950s.

I began by assuming that an electron, for example, is a particle following a well-defined trajectory. This particle is, however, always accompanied by a new kind of field described by the ordinary Schrödinger wavefunction, Ψ , the motions of which are determined by Schrödinger's equation (rather as the motions of the electrodynamic field are determined by Maxwell's equations). The electron as we actually encounter it must then be understood in terms of both the particle and the field, which latter always accompanies the particle.

To return to the old classical concept of a particle in this way may, at first sight, seem to be a step backward relative to the much more subtle and dynamic notion of reality contained in the implicate order. However, as will be brought out in the course of this lecture, the action of the Schrödinger field on the particle has a number of qualitatively new features that carry us a long way from the old classical mechanical concepts. Indeed, these will ultimately bring us to an enriched form of the implicate order that will contain the principles of determination and stabilization of what is actualized that have thus far been lacking.

When one looks at the meaning of Schrödinger's equation expressed in terms of this model, one sees that it implies the need to add to the classical forces acting on the particle an additional new kind of force, derivable from what I called the quantum potential, Q . To complete the model, it is also necessary, however, to bring in the following statistical postulate: One supposes that, although each electron follows a well-defined trajectory, in a series of experiments arranged to give the same Schrödinger field Ψ , there will be a statistical distribution of particle positions with a probability proportional to the intensity of the Schrödinger wave. It is easy to show mathematically that the above postulate is consistent, in the sense that with the passage of time this probability distribution will be maintained by the motions of the particles under the assumed quantum potential, Q .

The basically new features of the quantum theory come mainly from the new properties of the quantum potential. Of these, one of the most important is that this potential is related to the Schrödinger wavefunction in such a way that it does not depend on the intensity of the waves, but only on the form. This implies that the Schrödinger wave does not act like, for example, a water wave on a floating object to push the particle mechanically with a force proportional to its intensity. Rather, a better analogy would be to a ship on automatic pilot guided by radar waves. The ship with its automatic pilot is a self-active system, but the form of its activity is

determined by the information content concerning its environment carried by the radar waves. This latter is independent of the intensity of these waves (as long as they can be received by the equipment available), but depends only on their form, which in turn reflects the form of the environment.

We may illustrate this point by considering what happens to an ensemble of electrons that pass through a system of two slits and are detected on a screen, as shown in the Figure.

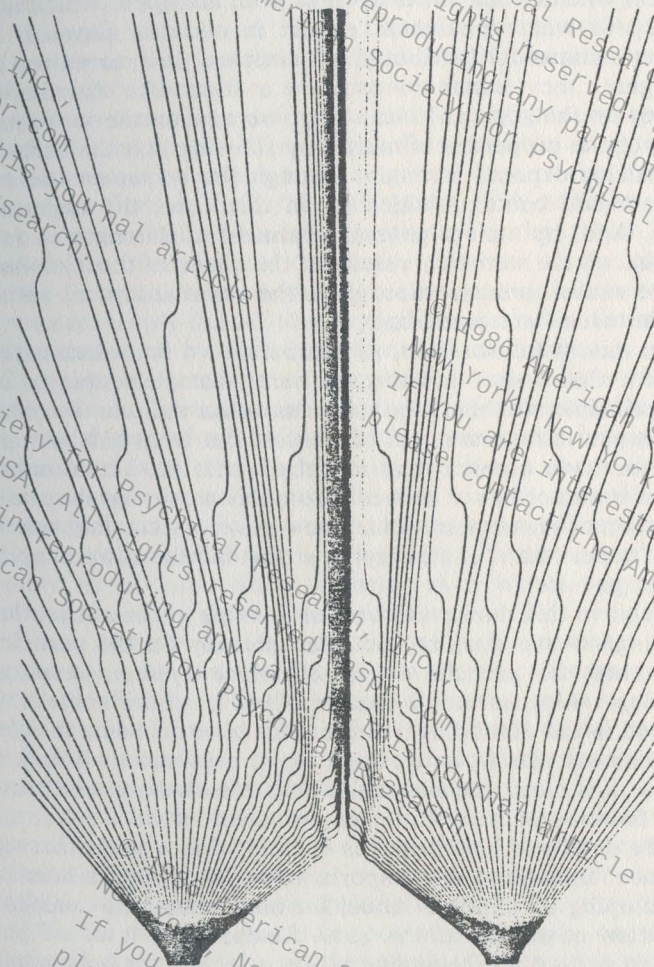


Figure. Particle trajectories through two slits. The figure is taken from Philipidis, Dewdney, & Hiley, *Quantum interference and the quantum potential*. *Nuovo Cimento*, 1979, 52b, 15.

Each of these electrons follows a well-defined track that can be shown mathematically to be perpendicular to the wave front at the point where the particle is. Suppose we consider a specified particle located such that it goes through one of the slits. Afterwards, it will follow a complicated path, so that the particle is significantly affected by a quantum potential determined by the interference of waves from both slits. Even at distances so great that the wave intensity is small, the trajectory of the particle can strongly reflect distant features of the environment. Thus, the path depends very much on whether one slit is open or both are open, which is quite contrary to what one would expect in classical physics. If we consider a statistical distribution of particles, then, as we can see in the Figure, they bunch to produce a fringe-like distribution of particles on the screen. In this way, we explain the wave-particle duality of the properties of matter by showing that the behavior of the particles depends strongly, through the wave, on the overall environmental context (which is, in this case, the experimental set-up). And, by a more general treatment of this nature, one can show that all the statistical results of the quantum theory follow, so that the causal interpretation gives the same statistical results as does the usual interpretation.

From this, it follows also, as can be shown in a more extensive treatment that I shall not discuss here, that Heisenberg's uncertainty principle still holds for the *phenomena* that can be obtained, for example, in measurement processes. But what has been gained is that we have a conceptual model of what the actual individual electron is and of how it moves. From this we derive the statistical distribution of phenomena, which now plays a secondary role in the theory rather than a primary one (as indeed also happens in classical physics).

To achieve this, however, we had to bring in the notion that the Schrödinger wave does not act mechanically on the particle, but rather, that the particle, as a self-active system, responds to something analogous to *information* about its entire context that is contained in the Schrödinger wave. This gives us some insight into the wholeness that is, as we have seen, essential to Bohr's view. For now, it is clear that we cannot always isolate the electron from distant features of its relevant environment, if we want to understand the details of how it moves even in what would otherwise be free space. But even more important for our purposes here is that by developing an intuitive model for how something analogous to information comes in at the most fundamental level of physics known to us, we are beginning to get a feeling for how mind and matter may ultimately not be nearly so different as they may seem to be at first sight.

THE MANY-PARTICLE SYSTEM AND QUANTUM WHOLENESS

Thus far, we have restricted ourselves to a consideration of the motions of a single particle. When we extend this approach to the many-particle system, the analogy between mind and matter becomes much closer.

The first step in making such an extension is to note that for a many-particle system, the Schrödinger wavefunction is no longer capable of being represented in the ordinary three-dimensional space, called *configuration space*, in which there are three dimensions for each particle. A single point in this multidimensional space corresponds to a certain configuration of the entire system of particles—hence the name, *configuration space*.

There is no direct way to imagine such a configuration space. In spite of this, however, it is nevertheless possible to extend the one-particle model that has been described here to the N -particle system. One finds in fact that the system of N -particles is now subject to a generalized kind of quantum potential, which implies the possibility of a nonlocal connection between all the particles. As in the one-particle case, this is because the quantum potential does not necessarily fall off to a negligible value when the particles are separated even by macroscopic orders of distance.

At first sight, it seems that such a nonlocal connection, which can produce a kind of instantaneous contact of distant particles, would violate the theory of relativity, which requires that no signal can be transmitted faster than light. It is possible to show, however, that the quantum potential cannot be used to carry a signal, that is, that it could not constitute a well-ordered series of impulses that could transmit a well-defined *meaning*. But I shall not, however, go into more detail into this point here, as it is not very directly relevant to the main theme of this talk.

As I have already stated, the notion of such a nonlocal connection goes quite far outside the framework of concepts generally accepted in classical physics. But, of course, it is a perfectly rational idea. And indeed, I would say that much of the resistance that it has encountered is of the nature of the kind of prejudice that tends to arise against any unfamiliar notion.

As strange as nonlocality may seem to be in the context of the science of the past few centuries, however, I want to emphasize here that the quantum potential has an even stranger and more radically novel feature, to which little attention has thus far been paid. This is that the quantum potential depends on the $3N$ -dimensional wavefunction of the whole system in a way that cannot be expressed as a preassigned relationship among all the particles. Thus, when two atoms are brought together, the forces

between the constituent particles may be attractive for certain wavefunctions and repulsive for others. A stable molecule is made possible, for example, by the attractive quantum potential that goes with certain wavefunctions. Indeed, it is in this way that one can begin to understand intuitively the current explanation of chemical bonding, in terms of the quantum theory.

Another example of this new feature of the quantum potential is obtained by considering that in a superconducting state, which may arise at very low temperatures, an electric current flows indefinitely without friction, because electrons are not scattered by irregularities or obstacles in the metal in which they are flowing. In terms of the causal interpretation, one sees that in a superconducting state, the quantum potential is such as to induce an organized and coordinated movement of the electrons, resembling a ballet dance, in which the electrons go around irregularities and obstacles without being scattered. On the other hand, in the ordinary state, which exists at higher temperatures, the quantum potential is different in such a way that the electrons behave more like a disorganized crowd of people than like a group of ballet dancers.

All the novel features of the causal interpretation of the quantum theory that have been discussed above can be understood in terms of the notion that we have already introduced, that is, that the wavefunction constitutes a kind of information content. Thus, it is well known that information (e.g., in a computer) can be ordered in as many dimensions as may be convenient or appropriate. And so the multidimensional nature of the wavefunction now presents no insoluble problem of interpretation. The fact that the movements of particles are related through a nonlocal quantum potential depending on the state of the whole also creates no such problem, if we suppose that each particle is guided, not by its own "private" information, but rather, by a common "pool" of information belonging to the whole system.

This behavior is evidently basically similar to what happens in the ballet dance, in which all the dancers are moving in accordance with a "score," which also constitutes a common "pool" of information that guides each of the dancers. In the case of the electrons, the "score" is, of course, the wavefunction. As with the dancers, the electrons are thus participating in a common action based on a common pool of information, rather than pushing and pulling on each other mechanically according to laws like those of classical physics.

However, the analogy of the ballet dance is, like all analogies, of limited validity. Firstly, the wavefunction changes with time according to Schrödinger's equation, whereas the score of a ballet is

generally fixed beforehand. We may therefore improve the analogy by saying that the electrons move as if they were participating in a dance with a score that is changing in accordance with certain rules. Moreover, because the movement of the electrons depends on their initial configuration, we should have to suppose in addition that the "score" determines not a single dance, but a whole set of dances that are different according to the different original configurations of the dancers. Or to put it differently, each "score" contains a vast range of potential dances, only one of which is actualized by a particular initial configuration of dancers. Processes are therefore possible that are much more complex and subtle than those that could be contained in the analogy of a single preassigned dance with a fixed score.

A very simple example of how such a view of quantum processes works may be obtained by interpreting the change of a system from one quantum state to another as a change from one "dance" to another. This change will, in general, take place only for a certain range of initial configurations of electrons that bring the system to what may be called a *crisis point*, that leads in turn to a fundamental change in the pattern of the dance (this kind of process has been called a catastrophe by Renee Thom, 1975). A more detailed mathematical analysis shows that such a transformation of the "dance" takes place without the need for introducing the sort of arbitrary assumption of "collapse" of the wavefunction that seems to be implied in this process by the usual interpretation of the quantum theory.

A similar notion applies to more complex processes. Thus, one can show mathematically that when the wavefunction of a system falls into two or more independent factors, the movement will breakup into corresponding independent "dances." The breakup of a whole system (e.g., a molecule) can be understood in this way. And the inverse process in which two or more subwholes combine to form a larger whole then corresponds to having groups of particles engaged in independent dances that come together to form a single dance based on a common score.

How, then, do we account for our large-scale experience in which matter generally behaves as if it were constituted of independent parts that interact mechanically rather than participate in a common movement? It can be shown by means of a detailed analysis, which is being written up (Bohm & Hiley, 1985), that at appreciable temperatures, the wavefunction of a whole system does indeed break up into a large number of factors corresponding to many relatively independent subwholes. The higher the temperature, the further this breakup goes. Under ordinary conditions of temperature, the subwholes are fairly small, so that the

quantum properties show up only in studies of even smaller structures (e.g., those at the atomic level). However, at very low temperatures (e.g., in superconductivity), they begin to show up at the macroscopic level, as they do also under special conditions established in laboratory measurements (e.g., in those demonstrating quantum nonlocality).

In this way, we are able further to bring out in the fundamental behavior of matter the essential quality of wholeness, to which we have already referred in our discussion of the ideas of Bohr as well as in our discussion of the one-particle model. We can get an intuitive feeling for the meaning of this wholeness, not only through thinking of the particle as responding to information capable of reflecting even its distant environment, but more deeply, as participating in a single overall "dance," guided by a common "pool" of information. This notion of wholeness can now be extended to encompass the measurement process itself. Whereas the observing apparatus and the observed system are significantly connected, they are participating in a single "dance," following a common "score." Eventually, the two systems fall back into independent "dances." There will then be a statistical distribution of such dance patterns, which vary according to the statistical distribution of initial configurations for the whole system. But now, the "dances" of the two systems will be correlated, so that by knowing what happens to the apparatus, one will also know what has happened to the "observed system."

However, such a complex process of participation evidently goes far beyond what is meant by a merely mechanical interaction. It is therefore not really correct to call what happens a measurement, nor indeed even an observation. Rather, it is a *mutual transformation* of both systems, which can only be understood in terms of a "whole score" that cannot even appear in one system or the other alone. The ordinary notion of a measurement in which observing instrument and what is observed are clearly distinct but interacting systems, becomes relevant as a valid approximation only in the classical limit, where the system falls into a large number of sub-wholes engaged in nearly independent "dances." Clearly, such notions of the wholeness of observer and what is observed will be relevant also at the level of our own conscious experience; and we shall return to a discussion of this point later.

ON INFORMATION AND ITS MEANING

In the interpretation of the quantum theory that has been proposed here, we have at least implicitly brought in the notion of information as something that need not belong only to human

consciousness, but that may indeed be present, in some sense, even in inanimate systems of atoms and electrons. This may seem strange in the light of our usual way of thinking about the subject. But actually, many physicists (e.g., Brillouin, 1964) have equated information content with the negative of the entropy of a system and have thus already given this notion a significance beyond the purely subjective.

However, a much more evident example of giving information an objective significance can be obtained by considering the computer. Thus, in a computer, a silicon chip is said to contain information in "bits" corresponding to the objective states of the elements of such a chip. In the silicon chip, the information is not only present objectively in the way described above. More importantly, it is objectively *active*, in the sense that it can determine how currents will flow throughout the computer as a whole and even outside the computer, through the working together of the hardware and the software. Such activity of information may be called a kind of *objective meaning*.

At first sight, it may seem even stranger to attribute objectivity to meaning than it seems to do this to information. What I am proposing here is that such a notion of meaning as a certain kind of activity that may be objective is a natural generalization of our own subjective experience of meaning. Thus, a major part of what is commonly signified by meaning is just the activity, virtual or actual, to which a given structure of information can give rise in us. For example, in reading a map, we apprehend the meaning of its information content as a whole set of virtual or potential activities that would be appropriate in the territory represented by the map. If we are actually traveling in the country itself, then at any moment, some particular aspect of this meaning may be actualized (or not actualized), according to the overall context of that moment. Similarly, in a computer, the information in a particular chip has a wide range of virtual or potential activities to which it may give rise. Only some of these are actualized in the activity of the computer as a whole, in a way determined by the overall context of the entire structure of the computer and by all the information that has been put into it.

It may be objected at this point that the computer has been designed, built, and programmed by human beings, so that it is, after all, still some kind of extension of the subjective consciousness of human beings. One can meet this objection by considering the DNA molecule, which, according to molecular biologists, constitutes a code, that is, a language. The meaning of this code is "read" by the processes within the cell, for example, by those involving RNA molecules, which bring about the construction of

proteins. The meaning of the code is thus the activity that it guides. Most of this meaning is potential or virtual, because only a small part of the information content of the DNA molecule is being "read" at any given moment (in accordance with the total context of the cell with its environment). Basically, this is similar to what happens in map reading and in a computer. But here we have an objective activity not produced by human means that can be understood as the meaning of an objective information content.

One may quite generally see the essential relationship of information and its meaning with the aid of the notion of energy. That is to say, information is a *form* that literally "informs" (i.e., forms from within) an "unformed" energy to give rise to a corresponding determinate activity. Consider, for example, a radio wave, on which information is carried as a form. This wave has a certain small energy, but it is not the energy of the wave that comes out of the loud speaker. Rather, the form of the radio wave is impressed, through a vacuum tube or a transistor, on the (relatively) unformed electrical energy acting in the radio. Similarly, the form in the state of the silicon chips enters into the energy in the computer to "give shape" to a corresponding activity. Likewise, in our subjective experience, when we see a printed page, for example, the form of the letters gives rise in our nervous and physical energy to a whole set of virtual activities (e.g., in the imagination), some of which may be further actualized according to context and circumstance.

If we now return to the causal interpretation of the quantum theory, it is clear that the "dance" of the electrons may similarly be regarded as the objective meaning of the information content in the "score" of the wavefunction. As in the previous examples, the wavefunction contains information implying a vast range of potential or virtual activities. In this case, these will be actualized by entering into the energy of the self-active particles in ways that depend on the initial configuration of the whole system. The notion of participation, guided by a common "pool" of information and its meaning, is thus given an objective significance. In this way, we see that, even at the most fundamental levels of physical law known at present, the mechanical notion of an interactive universe is seen to be inadequate. It is in need of replacement by the notion of an objectively participative universe that includes our own participation as a special case.

In the causal interpretation, the wavefunction satisfies Schrödinger's equation in the same way as in all other treatments, and this implies, as has been shown (e.g., by Feynman), a movement of enfoldment and unfoldment. But now this notion of movement in the implicate order applies to the information content and not directly to the particle. The particle is indeed a concept based

on the explicate order. Its explicate order of movement will then be an expression of the information content enfolded in the implicate order, as the movement of the dancers is an expression of the information content enfolded in the score. This will hold even when we go to the many-particle system with its multidimensional wavefunction, which still constitutes an implicate order, though one of immensely greater subtlety and complexity than that of the one-particle system.

However, even at this point, the theory remains with the somewhat arbitrary feature of simply bringing together the particle with an implicate order. But, if we go to the quantum mechanical field theory (rather than the theory that applies to particles) we can then drop the notion of the particle as basic altogether. The field is now playing the role that the particle played in the theory that we have been discussing thus far. In this way, we are freed of all traces of our original mechanical point of departure, based on the use of the classical particle concepts. Even the particles can now be shown to be constantly created, sustained, and annihilated in a process in which the energy of the field as a whole is given relatively stable and autonomous forms by an "information pool" contained in the wavefunction of the universe. This development shows that the implicate order now contains its own principles of actualization and stabilization of forms, the need for which I pointed out near the beginning of this talk. This is a very important point, but as it is not of primary relevance in the context that I am discussing, I shall not carry it further here.

INFORMATION AND MEANING AT THE LEVEL OF MIND

One of the main things that we have discovered thus far is how matter and mind turn out to be similar in key ways when we interpret the quantum theory as we have done here. I shall now show that further insight into the similarity can be obtained by starting instead from the side of mind.

With the aid of a little reflection, we can see that a major part of the activity of mind is just the apprehension of meaning. Thus, if we are looking at something that is not very clear, our main question has to do not with a detailed description of the various sensations that we are experiencing, but with: "What does the whole set of sensations mean?"

Moreover, as has indeed already been indicated earlier, a major part of the significance of meaning is just the activity, virtual or actual, to which a given structure of information may give rise. It is easy to verify this in extensive detail in our subjective experience. For example, if on a dark night, a configuration of sensations

suggesting a shadow suddenly presents itself, this could give rise to a thought informing us that what confronts us may be an assailant. This information means the possibility of danger, which is expressed as a whole range of virtual activities, such as fighting, running, and freezing. The very presence in the mind of these virtual activities is, however, *not* a purely "mental" process. Rather, it is inseparable from all sorts of related physical and chemical processes, such as excitation of nerves, release of adrenalin and other hormones, rapid heart beat, tensing of the muscles, etc. On the other hand, a thought informing us that what confronts us is probably only a shadow will lead to a correspondingly different set of virtual and actual activities of this nature. Further reflection shows, moreover, that such a state of affairs is general and pervasive in the whole of our experience (e.g., consider our reactions to meanings such as "friend" or "enemy," "good" or "bad," etc.).

We have seen earlier, however, that the concept of information and its meaning can be extended, so that the active relationship between them described above holds also in an objective sense, as for example, with computers, DNA, and quantum processes. At first sight, one may nevertheless tend to think that there is still an important way in which our subjective experience is different. For here, the action flowing out of meaning can be mediated by conscious reflection in thought, whereas in the objective examples, it is not. But actually, even in the field of subjective experiences, such action is *immediate*. That is to say, we do not *first* apprehend meaning and *then* think and decide to act. Rather, each meaning is an activity, and this activity is inseparable from what it is. Of course, a certain meaning may not imply the necessity of immediate action, but rather, it may call for reflection in thought. However, such a suspension of immediate action, leading instead to the action of reflective thinking, is still, of course, just another kind of action that is inseparable from the meaning in question. Or to put it differently, no matter what happens, it happens according to the *total* meaning that prevails at the moment when this action takes place.

It seems clear from all this that meaning is simultaneously both mental and physical in nature. It can thus serve as the link or "bridge" between these two sides of reality. This link is indivisible, in the sense that information contained in thought, which we feel to be on the "mental" side, is at the same time a neurophysiological, chemical, and physical activity, which is clearly what is meant by this thought on the "material" side.

But we have up to this point considered only a small part of the

significance of meaning. 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 more subtle level of information, whose meaning is an activity, virtual or actual, that is able to organize the original items of information into a single 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 evidently go on indefinitely.

Each of these levels may then be seen from the mental or from the material side. From the mental side it is an information content with a certain sense of meaning as virtual activity. But from the material side it is an actual activity that operates to organize the less subtle levels, and the latter thus serve as the "material" on which such operation takes place among us. Thus, at each stage, the meaning is the link or bridge between the two sides.

Our proposal is, then, that a similar relationship holds even at indefinitely greater levels of subtlety. I am suggesting that this possibility of going beyond any specifiable level of subtlety is the essential feature on which intelligence is based. That is to say, the whole process is not intrinsically limited by any definable pattern of thought, but is in principle constantly open to fresh creative and original perception of new meanings.

This way of looking at the subject contrasts strongly with the commonly held notion, which was mentioned earlier in connection with the discussion of the ideas of Descartes, that matter and mind are separate substances. Indeed, the current usage of the word *psychosomatic* exemplifies such a notion, implying as it does, that "psyche" or "mind" and "soma" or "body" are separate entities that can nevertheless somehow interact. In our view, however, the mental and the material are two sides of one overall process that are (like form and content) separated only in thought and not in actuality. Rather, there is one energy that is the basis of all reality. As in the examples discussed earlier in connection with physics (e.g., the vacuum tube or transistor, the computer, the electron and its "dance," etc.), the *form* on the mental side gives shape to the activity of this energy, which latter acts on less subtle forms of process that constitute, for this activity, the material side. Each part thus plays both roles, that is, the mental and the material, but in different contexts and connections. There is never any real division between mental and material sides at any stage of the overall process.

The above implies, in contrast to the usual view, that meaning is

an inherent and essential part of reality as a whole and is not merely a purely abstract and ethereal quality having its existence only in the mind.

AN EXTENSION OF THE QUANTUM THEORY

Let us now return to a consideration of the quantum theory. What is its relationship to the question of the interweaving of the physical and the mental that has been suggested here?

Firstly, let me remind you that, because the wavefunction may be regarded as information whose meaning is in the dance of the electrons, there is a basic similarity between the quantum behavior of a system of electrons and the behavior of mind. Along these lines, the nonlocal connections of electrons in this "dance" might seem, at first sight, to offer some hope of explaining parapsychological phenomena. But as we have already seen earlier, such behavior of material systems could be important only under the carefully controlled conditions of a highly refined quantum mechanical measurement, or else at very low temperatures. Neither of these possibilities seems to have any bearing on the actual processes undergone by the brain and nervous system. These take place under conditions that are not controlled in this way and at temperatures that are much too high to produce typical long-range behavior.

It seems clear, then, that if we wish to relate mental processes to the quantum theory, the latter will somehow have to be extended. The simplest way of doing this is to improve the analogy of mental processes and quantum processes by considering that the latter would also go on to indefinitely great levels of subtlety.

To bring about such an extension, one could begin by supposing, for example, that as the wavefunction constitutes information whose meaning is to give form to the dance of the particles, so that is a super-wavefunction whose meaning is to give form to the dance of the ordinary or first order wavefunction. This latter would now no longer generally satisfy Schrödinger's equation. The current quantum theory would then be an approximation, holding only when the action of the super-wavefunction can be neglected.

Of course, there is no reason to stop at this super-wavefunction. One could go on to suppose a series of wavefunctions of indefinitely many orders, with the wavefunction of each order constituting information that gives form to the activity of the next lower order wavefunction. 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 mind and body.

One may then ask: What is the relationship of these two pro-

cesses? 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 reach the level of the wavefunction and of the "dance" of the particles. There is no unbridgeable gap or barrier between any of these levels. Rather, at each stage, some kind of meaning is the bridge. This implies that the ordinary quantum mechanical wavefunction represents just one stage in the whole succession of levels of active meaning.

The content of our own consciousness is then some part of this process of the overall activity of meaning. It is implied that, in some sense, a rudimentary consciousness is present even at the level of particle physics. It would also be reasonable to suppose an indefinitely greater kind of consciousness that is universal and that pervades the entire process. But it is clear that each kind and level of consciousness may have a relative autonomy and stability, in spite of its being immersed in an immensely greater context of process that is simultaneously mental and physical.

IMPLICATIONS FOR PARAPSYCHOLOGICAL PHENOMENA

Clearly, the theory that has been sketched throughout this talk has a wide range of implications for parapsychological phenomena. I shall, however, discuss only a few of these here—those that may have a general bearing on parapsychological research—rather than go into any attempt to make a detailed application to particular experiments.

First, it is evident that this theory is directly relevant to understanding the relationship of mind and matter as experienced under normal conditions. In this regard, the main unusual feature of parapsychological phenomena is that they generally involve what may be called a nonlocal connection between the consciousness of a person who is in one place and an object, event, or person in some distant place (and perhaps even at some distant time), under conditions in which one can see no known physical basis for this sort of connection.

Because we have ruled out the ordinary quantum potential as an explanation for such connection (because the conditions are not appropriate), it is clear that we will have to look to the activity flowing out of the super-quantum wavefunction for this purpose (and ultimately to that of yet higher order wavefunctions). But the ordinary quantum mechanical wavefunction, on which this acts, is already in a multidimensional configuration space that cannot, in general, be understood as a structure in three-dimensional space.

More generally, at higher orders of subtlety, there is even less reason for supposing that information and meaning are necessarily located in space. Indeed, especially at the level of wavefunctions of the higher orders, one may say that contact can depend more on similarity or "resonance" of meanings than on location in space.

On this basis, psychokinesis could arise if the mental processes of one or more people were focused on meanings that were in harmony with those guiding the basic processes of the material systems in which this psychokinesis was to be brought about. In this way, for example, the wavefunctions of radioactive atoms in a sample could be altered, if perhaps only slightly. What is crucial here is that under conditions of a stationary state, the causal interpretation implies that the particles are at rest (Bohm, 1952a, 1952b). The slightest modification of the wavefunction that did not satisfy Schrödinger's equation could bring about a drift of particles in some particular direction, and this could significantly change the probability of decay. The result would be a small change in the observed statistical counting rates of the general sort that has actually been reported in many experiments. It would, however, require a much greater penetration of the "meaning" of the dance of the particles to bring about a systematic change that was large.

Telepathy and transmission of thoughts and dreams can always be looked at as particular forms of psychokinesis, which act directly from brain to brain to convey thoughts or dream images. Remote viewing would be more difficult to explain on this basis. But the possibility is open that when harmony or resonance of "meanings" is established, the action works both ways, so that the "meanings" of the distant system could act in the viewer to produce a kind of inverse psychokinesis that would, in effect, transmit an image of that system to him.

Of course, to say much more on this subject, it is necessary to develop a more detailed mathematical theory of how the super-wavefunction is related to the wavefunction. There are a few clues in physics as to how one might proceed, coming mainly from exploring the possibility of relating the super-wavefunction to thermodynamical and statistical mechanical properties such as entropy. However, I shall not go into these points in further detail here. Eventually, consideration of parapsychological evidence could perhaps also help suggest new ideas toward this end.

As a matter of fact, the theory that has been proposed here is similar in some ways to certain somewhat more detailed theories developed by Walker (1973) and later by Mattuck and Walker (1979), which may perhaps help to provide a line of research that may be fruitful. They too propose modifications of Schrödinger's equation brought about by the effects of mind on matter. All these

suggestions, however, involve a set of rather complicated and arbitrary mathematical assumptions, merely in order to get well-defined events to take place even under ordinary conditions (i.e., through the "collapse" of the wavefunction). The advantage of the causal interpretation is that it directly explains this level of material process in a simple and natural way without any further mathematical assumptions. New kinds of action of the mental in the physical then come in only at levels at which the ordinary quantum mechanical laws are not valid.

In this connection, there is another very important point that I would like to make here. This is that it is not enough to propose abstract mathematical laws. As suggested earlier in the talk, it is also necessary that these laws be intuitively comprehensible. This is because the laws are themselves meanings, which can participate significantly in the overall process of the interweaving mental and physical sides that, according to our proposals, constitutes reality as a whole. From this, it follows that even in applying a theory of this relationship of mind and matter, a person has in this very act to be doing what he is talking about, that is, participating in a common meaning with another object, process, or person(s). In this kind of participation, our habitual analysis in terms of a separate observer and observed object is no longer relevant, for it leaves out the meaning common to both, which is crucial to what is actually happening.

Now, it seems inevitable if one assumes that all one has is a set of mathematical formulas, without any intuitive understanding, that one will look on this set of formulas as referring to something entirely other, both to itself and to the person who is thinking about the formulas. Such a pattern of thinking implies that one has to use the formulas to calculate what may be done to the observed object and to try, as a separate being, to act on that object to bring about whatever results that may be desired. This, indeed, is characteristic of the entire approach of modern science and technology to the whole of life. To change this is not at all easy for us who have followed this pattern of perception and action almost from our earliest days.

The ability to feel and intuitively comprehend the meaning of one's ideas in addition to expressing them precisely and mathematically can play a very important part in the development of a new attitude of participation. Such an attitude will not emphasize the distinction between observer and observed, which is almost certainly not the best approach in the context of parapsychological research. Out of this can arise a new common meaning that is not directed mainly to getting results of a predetermined nature. That is to say, an intuitively graspable theory may be of help not only in

permitting the comprehension of the phenomenon on an intellectual level. It may itself be a significant factor in bringing about the kind of participation that should be most conducive to eliciting these phenomena more readily. At the very least, it should help free us from these presuppositions and preconceptions that pervade our way of thinking and whose meanings constitute an active block to the participating consciousness that is needed in this field.

What is under discussion here is, of course, not merely a way of understanding and working with parapsychological phenomena. It is a different self-world view, emerging out of modern physics and yet going beyond the restrictive framework from which modern physics grew. In this way, the discoveries of modern physics come to give support to the movement in which the rigid division between observer and observed can be dropped—a movement that could evidently be the beginning of a fundamental change in consciousness itself.

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