DAVID BOHM QUANTUM THEORY pdf

1: David Bohm - Wikipedia

David Joseph Bohm FRS (/ b oÊŠ m /; December 20, - October 27,) was an American scientist who has been described as one of the most significant theoretical physicists of the 20th century and who contributed unorthodox ideas to quantum theory, neuropsychology and the philosophy of mind.

Quotes[edit] There is no reason why an extraphysical general principle is necessarily to be avoided, since such principles could conceivably serve as useful working hypotheses. For the history of scientific research is full of examples in which it was very fruitful indeed to assume that certain objects or elements might be real, long before any procedures were known which would permit them to be observed directly. Physical Review 35 2: Of course, we must avoid postulating a new element for each new phenomenon. But an equally serious mistake is to admit into the theory only those elements which can now be observed. For the purpose of a theory is not only to correlate the results of observations that we already know how to make, but also to suggest the need for new kinds of observations and to predict their results. In fact, the better a theory is able to suggest the need for new kinds of observations and to predict their results correctly, the more confidence we have that this theory is likely to be good representation of the actual properties of matter and not simply an empirical system especially chosen in such a way as to correlate a group of already known facts. We have reversed the usual classical notion that the independent "elementary parts" of the world are the fundamental reality, and that the various systems are merely particular contingent forms and arrangements of these parts. Rather, we say that inseparable quantum interconnectedness of the whole universe is the fundamental reality, and that relatively independent behaving parts are merely particular and contingent forms within this whole. It gradually emerged that something more important was actually involved â€" the awakening of the process of dialogue itself as a free flow of meaning among all the participants. In the beginning, people were expressing fixed positions, which they were tending to defend, but later it became clear that to maintain the feeling of friendship in the group was much more important than to hold any position. Such friendship has an impersonal quality in the sense that its establishment does not depend on a close personal relationship between participants. A new kind of mind thus begins to come into being which is based on the development of a common meaning that is constantly transforming in the process of the dialogue. People are no longer primarily in opposition, nor can they be said to be interacting, rather they are participating in this pool of common meaning which is capable of constant development and change. In this development the group has no pre-established purpose, though at each moment a purpose that is free to change may reveal itself. The group thus begins to engage in a new dynamic relationship in which no speaker is excluded, and in which no particular content is excluded. Thus far we have only begun to explore the possibilities of dialogue in the sense indicated here, but going further along these lines would open up the possibility of transforming not only the relationship between people, but even more, the very nature of consciousness in which these relationships arise. The individual is universal and the universal is the individual. The word "individual" means undivided, so we could say that very few individuals have ever existed. We could call them dividuals. Individuality is only possible if it unfolds from wholeness. Ego-centeredness is not individuality at all. Yet at a deeper level [matter and consciousness] are actually inseparable and interwoven , just as in the computer game the player and the screen are united by participation. As quoted in New Scientist February , p. Yet, in spite of this world-wide system of linkages, there is, at this very moment, a general feeling that communication is breaking down everywhere, on an unparalleled scale Why does thought require attention? Every thinking requires attention, really. If we ran machines withinout paying attention to them, they would break down. Our thought, too, is a process, and it requires attention, otherwise its going to go wrong. But then, we went on to consider the general disorder and confusion that pervades the consciousness of mankind. What he was seriously proposing is that all this disorder, which is the root cause of such widespread sorrow and misery, and which prevents human beings from properly working together, has its root in the fact that we are ignorant of the general nature of our own processes of thought. Or to put it differently it may be said that we do not see what is actually happening, when we are engaged in the activity of thinking. This field is basically that which is

manifest, or tangible. The essential quality of the infinite, by contrast, is its subtlety, its intangibility. This quality is conveyed in the word spirit, whose root meaning is "wind, or breath. This energy, or spirit, infuses all living beings, and without it any organism must fall apart into its constituent elements. That which is truly alive in the living being is this energy of spirit, and this is never born and never dies. As quoted in Infinite Potential: Wholeness and the Implicate Order [edit] I would say that in my scientific and philosophical work, my main concern has been with understanding the nature of reality in general and of consciousness in particular as a coherent whole, which is never static or complete but which is an unending process of movement and unfoldment Then there is the further question of what is the relationship of thinking to reality. As careful attention shows, thought itself is in an actual process of movement. That is to say, one can feel a sense of flow in the stream of consciousness not dissimilar to the sense of flow in the movement of matter in general. May not thought itself thus be a part of reality as a whole? If he thinks of the totality as constituted of independent fragments, then that is how his mind will tend to operate, but if he can include everything coherently and harmoniously in an overall whole that is undivided, unbroken and without border for every border is a division or break then his mind will tend to move in a similar way, and from this will flow an orderly action within the whole. My suggestion is that at each state the proper order of operation of the mind requires an overall grasp of what is generally known, not only in formal logical, mathematical terms, but also intuitively, in images, feelings, poetic usage of language, etc. This kind of overall way of thinking is not only a fertile source of new theoretical ideas: The quantum theory, as it is now constituted, presents us with a very great challenge, if we are at all interested in such a venture, for in quantum physics there is no consistent notion at all of what the reality may be that underlies the universal constitution and structure of matter. If on the other hand we apply the world view in which the world is regarded as a continuous field, we find that this field must also be discontinuous, as well as particle-like, and that it is as undermined in its actual behaviour as is required in the particle view of relation as a whole. In relativity, movement is continuous, causally determinate and well defined, while in quantum mechanics it is discontinuous, not causally determinate and not well defined. Each theory is committed to its own notions of essentially static and fragmentary modes of existence relativity to that of separate events, connectable by signals, and quantum mechanics to a well-defined quantum state. One thus sees that a new kind of theory is needed which drops these basic commitments and at most recovers some essential features of the older theories as abstract forms derived from a deeper reality in which what prevails in unbroken wholeness. The notion that all these fragments are separately existent is evidently an illusion, and this illusion cannot do other than lead to endless conflict and confusion. Indeed, the attempt to live according to the notion that the fragments are really separate is, in essence, what has led to the growing series of extremely urgent crises that is confronting us today. Thus, as is now well known, this way of life has brought about pollution, destruction of the balance of nature, over-population, world-wide economic and political disorder and the creation of an overall environment that is neither physically nor mentally healthy for most of the people who live in it. Individually there has developed a widespread feeling of helplessness and despair, in the face of what seems to be an overwhelming mass of disparate social forces, going beyond the control and even the comprehension of the human beings who are caught up in it. Changing Consciousness [edit] Full title: For both the rich and the poor, life is dominated by an ever growing current of problems, most of which seem to have no real and lasting solution. Clearly we have not touched the deeper causes of our troubles. It is the main point of this book that the ultimate source of all these problems is in thought itself, the very thing of which our civilization is most proud, and therefore the one thing that is "hidden" because of our failure seriously to engage with its actual working in our own individual lives and in the life of society. Suppose you have two religions. Thought defines religion â€” the thought about the nature of God and various questions like that. Such thought is very important because it is about God, who is supposed to be supreme. The thought about what is of supreme value must have the highest force. So if you disagree about that, the emotional impact can be very great, and you will then have no way to settle it. Two different beliefs about God will thus produce intense fragmentation â€” similarly with thoughts about the nature of society, which is also very important, or with ideologies such as communism and capitalism, or with different beliefs about your family or about your money. Whatever it is that is very important to you,

fragmentation in your thought about it is going to be very powerful in its effects. Difference exist because thought develops like a stream that happens to go one way here and another way there. We often find that we cannot easily give up the tendency to hold rigidly to patterns of thought built up over a long time. We are then caught up in what may be called absolute necessity. This kind of thought leaves no room at all intellectually for any other possibility, while emotionally and physically, it means we take a stance in our feelings, in our bodies, and indeed, in our whole culture, of holding back or resisting. This stance implies that under no circumstances whatsoever can we allow ourselves to give up certain things or change them. We may momentarily relieve the population problem, the ecological problem, and so on, but they will come back in another way. Of course, one of the main legitimate functions of thought has always been to help provide security, guaranteeing shelter and food for instance. However, this function went wrong when the principal source of insecurity came to be the operation of thought itself. Culture is shared meaning. Suppose we were able to share meanings freely without a compulsive urge to impose our view or conform to those of others and without distortion and self-deception. Would this not constitute a real revolution in culture. Therefore it would be wrong and misleading to break it up into my thought, your thought, my feelings, these feelings, those feelings. I would say that thought makes what is often called in modern language a system. A system means a set of connected things or parts. But the way people commonly use the word nowadays it means something all of whose parts are mutually interdependent â€" not only for their mutual action, but for their meaning and for their existence. A corporation is organized as a system â€" it has this department, that department, that department And also the body is a system. Society is a system in some sense. Similarly, thought is a system. That system not only includes thought and feelings, but it includes the state of the body; it includes the whole of society â€" as thought is passing back and forth between people in a process by which thought evolved from ancient times. But with the growth of civilization it has developed a great deal. It was probably very simple thought before civilization, and now it has become very complex and ramified and has much more incoherence than before. It is not a fault here, there or here, but it is a fault that is all throughout the system. Can you picture that? It is everywhere and nowhere. You may say "I see a problem here, so I will bring my thoughts to bear on this problem". But "my" thought is part of the system. Thought is constantly creating problems that way and then trying to solve them. Collaborations with others[edit] Dialogue, as we are choosing to use the word, is a way of exploring the roots of the many crises that face humanity today. It enables inquiry into, and understanding of, the sorts of processes that fragment and interfere with real communication between individuals , nations , and even different parts of the same organization. In our modern culture men and women are able to interact with one another in many ways: In our view this condition points to a deep and pervasive defect in the process of human thought. David Peat It is proposed that a form of free dialogue may well be one of the most effective ways of investigating the crisis which faces society , and indeed the whole of human nature and consciousness today.

DAVID BOHM QUANTUM THEORY pdf

2: David Bohm - Quantum Mind

This superb text by David Bohm, formerly Princeton University and Emeritus Professor of Theoretical Physics at Birkbeck College, University of London, provides a formulation of the quantum theory in terms of qualitative and imaginative concepts that have evolved outside and beyond classical theory.

The Completeness of the Quantum Mechanical Description Conceptual difficulties have plagued quantum mechanics since its inception, despite its extraordinary predictive successes. The basic problem, plainly put, is this: It is not at all clear what quantum mechanics is about. What, in fact, does quantum mechanics describe? It might seem, since it is widely agreed that any quantum mechanical system is completely described by its wave function, that quantum mechanics is fundamentally about the behavior of wave functions. His difficulty had little to do with the novelty of the wave function: That it is an abstract, unintuitive mathematical construct is a scruple that almost always surfaces against new aids to thought and that carries no great message. The screen however does not show a more or less constant uniform surface glow, but rather lights up at one instant at one spot â€¦. But then what does? We are told that no distinction is to be made between the state of a natural object and what I know about it, or perhaps better, what I can know about it if I go to some trouble. Actuallyâ€”so they sayâ€”there is intrinsically only awareness, observation, measurement. But it is becoming increasingly difficult to find any who, when pressed, will defend this interpretation. It seems clear that quantum mechanics is fundamentally about atoms and electrons, quarks and strings, not those particular macroscopic regularities associated with what we call measurements of the properties of these things. But if these entities are not somehow identified with the wave function itselfâ€”and if talk of them is not merely shorthand for elaborate statements about measurementsâ€”then where are they to be found in the quantum description? There is, perhaps, a very simple reason why it is so difficult to discern in the quantum description the objects we believe quantum mechanics ought to describe. Perhaps the quantum mechanical description is not the whole story, a possibility most prominently associated with Albert Einstein. They concluded with this observation: While we have thus shown that the wave function does not provide a complete description of the physical reality, we left open the question of whether or not such a description exists. We believe, however, that such a theory is possible. See the entries on the Einstein-Podolsky-Rosen argument in quantum theory and on quantum entanglement and information. In relation to a theory incorporating a more complete description, Einstein remarked that the statistical quantum theory would â€¦ take an approximately analogous position to the statistical mechanics within the framework of classical mechanics. He concluded that It is therefore not, as is often assumed, a question of a re-interpretation of quantum mechanicsâ€”the present system of quantum mechanics would have to be objectively false, in order that another description of the elementary processes than the statistical one be possible. For example, Max Born, who formulated the statistical interpretation of the wave function, assured us that No concealed parameters can be introduced with the help of which the indeterministic description could be transformed into a deterministic one. Hence if a future theory should be deterministic, it cannot be a modification of the present one but must be essentially different. We still find, a quarter of a century after the rediscovery of Bohmian mechanics in , statements such as these: The proof he [von Neumann] published â€¦, though it was made much more convincing later on by Kochen and Specker , still uses assumptions which, in my opinion, can quite reasonably be questioned. This quotation is significant because Wigner was one of the leading physicists of his generation. Unlike most of his contemporaries, moreover, he was also profoundly concerned about the conceptual foundations of quantum mechanics and wrote on the subject with great clarity and insight. There was, however, one physicist who wrote on this subject with even greater clarity and insight than Wigner himself: Bell whom Wigner praises for demonstrating the impossibility of a deterministic completion of quantum theory such as Bohmian mechanics. But in I saw the impossible done. It was in papers by David Bohm. Bohm showed explicitly how parameters could indeed be introduced, into nonrelativistic wave mechanics, with the help of which the indeterministic description could be transformed into a deterministic one. If only to point out what was wrong with it? Why did von Neumann not consider it? Should it not be taught, not as the only way, but as an antidote to the

prevailing complacency? To show us that vagueness, subjectivity, and indeterminism, are not forced on us by experimental facts, but by deliberate theoretical choice? Bell , reprinted in c: On the contrary, until his untimely death in , Bell was the prime proponent, and for much of this period almost the sole proponent, of the very theory, Bohmian mechanics, that he supposedly demolished. Bohmian mechanics is of course as much a counterexample to the Kochen-Specker argument for the impossibility of hidden variables as it is to the one of von Neumann. It is obviously a counterexample to any such argument. However reasonable the assumptions of such an argument, some of them must fail for Bohmian mechanics. Wigner was quite right to suggest that the assumptions of Kochen and Specker are more convincing than those of von Neumann. They appear, in fact, to be quite reasonable indeed. However, they are not. The impression that they are arises from a pervasive error, an uncritical realism about operators, that we discuss below in the sections on quantum observables , spin , and contextuality. It would be hard to argue against the reasonableness of such an assumption, even if one were so bold as to doubt its inevitability. Bell showed that any hidden-variables formulation of quantum mechanics must be nonlocal, as, indeed, Bohmian mechanics is. But he showed much much more. In a celebrated paper he published in , Bell showed that quantum theory itself is irreducibly nonlocal. That this did not happen is no doubt due in part to the obscurity of orthodox quantum theory and to the ambiguity of its commitments. It almost did happen: For details see Hemmick and Shakur , chapter 4. It was, in fact, his examination of Bohmian mechanics that led Bell to his nonlocality analysis. In the course of investigating Bohmian mechanics, he observed that: For a discussion of how nonlocality emerges in Bohmian mechanics, see Section Bell showed that the predictions of standard quantum theory itself imply nonlocality. Thus if these predictions govern nature, then nature is nonlocal. More conclusive still is the experiment of Weihs et al. It is important to note that to the limited degree to which determinism plays a role in the EPR argument, it is not assumed but inferred. Bell a, reprinted c: Note well then that the following argument makes no mention whatever of determinism. The difficulty is not created by any such picture or any such terminology. It is created by the predictions about the correlations in the visible outputs of certain conceivable experimental set-ups. Let me summarize once again the logic that leads to the impasse. The EPRB correlations are such that the result of the experiment on one side immediately foretells that on the other, whenever the analyzers happen to be parallel. If we do not accept the intervention on one side as a causal influence on the other, we seem obliged to admit that the results on both sides are determined in advance anyway, independently of the intervention on the other side, by signals from the source and by the local magnet setting. But this has implications for non-parallel settings which conflict with those of quantum mechanics. So we cannot dismiss intervention on one side as a causal influence on the other. For further insight into the various controversies see Maudlin and Goldstein et al. Nonetheless, the opinion of Bell himself about what he showed is perfectly clear. History The pilot-wave approach to quantum theory was initiated by Einstein, even before the discovery of quantum mechanics itself. While the notion of the electromagnetic field as guiding field turned out to be rather problematical, Max Born explored the possibility that the wave function could play this role, of guiding field or pilot wave, for a system of electrons in his early paper founding quantum scattering theory Born Heisenberg was profoundly unsympathetic. In , de Broglie found an equation of particle motion equivalent to the guiding equation for a scalar wave function de Broglie However, despite what is suggested by Bacciagaluppi and Valentini , de Broglie responded very poorly to an objection of Wolfgang Pauli Pauli concerning inelastic scattering, no doubt making a rather bad impression on the illustrious audience at the congress. Born and de Broglie very quickly abandoned the pilot-wave approach and became enthusiastic supporters of the rapidly developing consensus in favor of the Copenhagen interpretation. He was the first person to genuinely understand its significance and implications. John Bell became its principal proponent during the sixties, seventies and eighties. For a very good discussion of the history of quantum mechanics, the debates about its foundations, and about the reception of Bohmian mechanics in particular, see Bricmont See also Beller Rather, it governs the motion of the fundamental variables, the positions of the particles: In the Bohmian mechanical version of nonrelativistic quantum theory, quantum mechanics is fundamentally about the behavior of particles; the particles are described by their positions, and Bohmian mechanics prescribes how these change with time. In this sense, for Bohmian mechanics the particles are primary, or primitive,

while the wave function is secondary, or derivative. For no sharp definition of such a scale could be made. But to admit things not visible to the gross creatures that we are is, in my opinion, to show a decent humility, and not just a lamentable addiction to metaphysics. In any case, the most hidden of all variables, in the pilot wave picture, is the wavefunction, which manifests itself to us only by its influence on the complementary variables. The theory is then defined by two evolution equations: When external magnetic fields are present, the gradient should be understood as the covariant derivative, involving the vector potential. This deterministic theory of particles in motion accounts for all the phenomena of nonrelativistic quantum mechanics, from interference effects to spectral lines Bohm It does so in an entirely ordinary manner, as we explain in the following sections. For a scalar wave function, describing particles without spin, the form of the guiding equation above is a little more complicated than necessary, since the complex conjugate of the wave function, which appears in the numerator and the denominator, cancels out. However, the form above has two advantages: First, it makes sense for particles with spinâ€”and, in fact, Bohmian mechanics without further ado accounts for all the apparently paradoxical quantum phenomena associated with spin. This demonstrates that it is wrong to claim that the predictions of quantum theory are incompatible with the existence of hidden variables, with an underlying deterministic model in which quantum randomness arises from averaging over ignorance. Bohmian mechanics provides us with just such a model: For any quantum experiment we merely take as the relevant Bohmian system the combined system, including the system upon which the experiment is performed as well as all the measuring instruments and other devices used to perform the experiment together with all other systems with which these have significant interaction over the course of the experiment. The guiding equation for the big system then transforms the initial configuration into the final configuration at the conclusion of the experiment. It then follows that this final configuration of the big system, including in particular the orientation of instrument pointers, will also be distributed in the quantum mechanical way.

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3: David Bohm - Wikiquote

David Joseph Bohm (December 20, - October 27,) was an American scientist who has been described as one of the most significant theoretical physicists of the 20th century and who contributed innovative and unorthodox ideas to quantum theory, neuropsychology and the philosophy of mind.

He was raised mainly by his father, a furniture-store owner and assistant of the local rabbi. Despite being raised in a Jewish family, he became an agnostic in his teenage years. He then transferred to the theoretical physics group directed by Robert Oppenheimer at the University of California, Berkeley Radiation Laboratory, where he obtained his doctorate. He was active in communist and communist-backed organizations, including the Young Communist League , the Campus Committee to Fight Conscription, and the Committee for Peace Mobilization. During his time at the Radiation Laboratory, Bohm was in a relationship with the future Betty Friedan and also helped to organize a local chapter of the Federation of Architects, Engineers, Chemists and Technicians , a small labor union affiliated to the Congress of Industrial Organizations CIO. During the war, Bohm remained at Berkeley, where he taught physics and conducted research in plasma , the synchrotron and the synchrocyclotron. He completed his Ph. According to biographer F. David Peat see reference below, p. Without security clearance, Bohm was denied access to his own work; not only would he be barred from defending his thesis, he was not even allowed to write his own thesis in the first place! Bohm later performed theoretical calculations for the Calutrons at the Y facility in Oak Ridge, Tennessee , which was used for the electromagnetic enrichment of uranium for the bomb dropped on Hiroshima in In May , the House Un-American Activities Committee called upon Bohm to testify because of his previous ties to suspected communists. Bohm invoked his Fifth Amendment right to refuse to testify, and he refused to give evidence against his colleagues. He was acquitted in May , but Princeton had already suspended him. Quantum theory and Bohm diffusion[edit] Main articles: Bohm diffusion and De Broglieâ€"Bohm theory The Bohmian trajectories for an electron going through the two-slit experiment. A similar pattern was also observed for single photons. As a postgraduate at Berkeley, he developed a theory of plasmas , discovering the electron phenomenon now known as Bohm diffusion. But Bohm became dissatisfied with the orthodox interpretation of quantum theory he wrote about in that book. Starting from the realization that the WKB approximation of quantum mechanics leads to deterministic equations and convinced that a mere approximation could not turn a probabilistic theory into a deterministic theory, he doubted the inevitability of the conventional approach to quantum mechanics. He initially called his approach a hidden variable theory, but he later called it ontological theory, reflecting his view that a stochastic process underlying the phenomena described by his theory might one day be found. Bohm and his colleague Basil Hiley later stated that they had found their own choice of terms of an "interpretation in terms of hidden variables" to be too restrictive, especially since their variables, position, and momentum "are not actually hidden. He applied for and received Brazilian citizenship , but by law, had to give up his US citizenship ; he was able to reclaim it only decades later, in , after pursuing a lawsuit. Anderson , Donald Kerst , Marcos Moshinsky , Alejandro Medina, and the former assistant to Heisenberg , Guido Beck , who encouraged him in his work and helped him to obtain funding. The Brazilian CNPq explicitly supported his work on the causal theory and funded several researchers around Bohm. His work with Vigier was the beginning of a long-standing cooperation between the two and Louis De Broglie , in particular, on connections to the hydrodynamics model proposed by Madelung. There, he met Sarah "Saral" Woolfson, whom he married in Aharonovâ€"Bohm effect Schematic of double-slit experiment in which Aharonovâ€"Bohm effect can be observed: In , Bohm and Aharonov discovered the Aharonovâ€"Bohm effect , showing how a magnetic field could affect a region of space in which the field had been shielded, but its vector potential did not vanish there. That showed for the first time that the magnetic vector potential , hitherto a mathematical convenience, could have real physical quantum effects. His collected papers are stored there. Implicate and explicate order At Birkbeck College, much of the work of Bohm and Basil Hiley expanded on the notion of implicate, explicate, and generative orders proposed by Bohm. Such features can be considered to be independent only up to a

certain level of approximation in which certain criteria are fulfilled. They used the word " holomovement " for the activity in such orders. Holonomic brain theory In a holographic reconstruction, each region of a photographic plate contains the whole image. In collaboration with Stanford University neuroscientist Karl H. Pribram , Bohm was involved in the early development of the holonomic model of the functioning of the brain, a model for human cognition that is drastically different from conventionally-accepted ideas. Those concerns were a natural extension of his earlier interest in Marxist ideology and Hegelian philosophy. His views were brought into sharper focus through extensive interactions with the psychological philosopher Jiddu Krishnamurti , beginning in In the seminar, Bohm develops several interrelated themes. He points out that thought is the ubiquitous tool that is used to solve every kind of problem: Yet thought, he maintains, is also inadvertently the source of many of those problems. He recognizes and acknowledges the irony of the situation: If there is a fault in the functioning of thought, therefore, it must be a systemic fault, which infects the entire network. The thought that is brought to bear to resolve any given problem, therefore, is susceptible to the same flaw that created the problem it is trying to solve. What is required in order to correct the distortions introduced by thought, according to Bohm, is a form of proprioception, or self-awareness. Neural receptors throughout the body inform us directly of our physical position and movement, but there is no corresponding awareness of the activity of thought. Such an awareness would represent psychological proprioception and would enable the possibility of perceiving and correcting the unintended consequences of the thinking process. In his book Science, Order and Creativity, Bohm referred to the views of various biologists on the evolution of the species, including Rupert Sheldrake. Martin Gardner reported this in a Skeptical Inquirer article and also critiqued the views of Jiddu Krishnamurti , with whom Bohm had met in and had had many subsequent exchanges. Bohm Dialogue To address societal problems during his later years, Bohm wrote a proposal for a solution that has become known as " Bohm Dialogue ", in which equal status and "free space" form the most important prerequisites of communication and the appreciation of differing personal beliefs. An essential ingredient in this form of dialogue is that participants "suspend" immediate action or judgment and give themselves and each other the opportunity to become aware of the thought process itself. Bohm suggested that if the "dialogue groups" were experienced on a sufficiently-wide scale, they could help overcome the isolation and fragmentation that Bohm observed in society. Later life[edit] Bohm continued his work in quantum physics after his retirement, in His final work, the posthumously-published The Undivided Universe: He was elected Fellow of the Royal Society in His condition worsened and it was decided that the only treatment that might help him was electroconvulsive therapy. Bohm showed improvement from the treatments and was released on 29 August, but his depression returned and was treated with medication. Quantum Theory, New York: U of Pennsylvania Press, Quanta and Reality, A Symposium, with N. Hanson and Mary B.

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4: Quantum Theory by David Bohm

David Bohm on Quantum Theory (Bohm's ontological interpretation of quantum theory) Against Orthodoxy. Bohm challenged the dominant assumptions of science and of scientists, and this disposition was not well received.

David Peat and John Briggs, was originally published in Omni, January A text only version of this interview is available to download. David Bohm In David Bohm wrote what many physicists consider to be a model textbook on quantum mechanics. Ironically, he has never accepted that theory of physics. They are busy applying quantum mechanics to areas its original creators never imagined. Stephen Hawking, for example, used it to describe the creation of elementary particles from black holes and to argue that the universe exploded into being in a quantum-mechanical event. Bucking this tide of modern physics for more than 30 years, Bohm has been more than a gadfly. His objections to the foundations of quantum mechanics have gradually coalesced into an extension of the theory so sweeping that it amounts to a new view of reality. Believing that the nature of things is not reducible to fragments or particles, he argues for a holistic view of the universe. He demands that we learn to regard matter and life as a whole, coherent domain, which he calls the implicate order. Part of the difficulty is that his implicate order is rife with paradox. Another problem is the sheer range of his ideas, which encompass such hitherto nonphysical subjects as consciousness, society, truth, language, and the process of scientific theory making itself. The son of a furniture dealer, Bohm was born in Wilkes-Barre, Pennsylvania, in He studied physics at the University of California with J. From there he moved to Israel, then England, where he eventually became professor of physics at Birkbeck College in London. Bohm is perhaps best known for his early work on the interactions of electrons in metals. He showed that their individual, haphazard movement concealed a highly organized and cooperative behavior called plasma oscillation. In Bohm, working with Yakir Ahronov, showed that a magnetic field might alter the behavior of electrons without touching them: If two electron beams were passed on either side of a space containing a magnetic field, the field would retard the waves of one beam even though it did not penetrate the space and actually touch the electrons. During the Fifties and Sixties Bohm expanded his belief in the existence of hidden variables that control seemingly random quantum events, and from that point on, his ideas diverged more and more from the mainstream of modern physics. His books Causality and Chance in Modern Physics and Wholeness and the Implicate Order, published in and , respectively, spell out his new theory in considerable detail. In the Sixties Bohm met the Indian philosopher Jiddu Krishnamurti, and their continuing dialogues, published as a book, The Ending of Time, helped the physicist clarify his ideas about wholeness and order. Recently retired from Birkbeck College, Bohm is now trying to develop a mathematical version of his implicate-order hypothesis-the kind of precise, testable theory that other physicists will take seriously. The objects in his universe, even the subatomic particles, are secondary; it is a process of movement, continuous unfolding and enfolding from a seamless whole that is fundamental. So far Bohm has been unable to find an experimental aspect that could support his ideas in the same way. Although recently recovered from serious heart surgery, Bohm continues to make frequent trips throughout Europe and to the United States, where he lectures, talks to colleagues, and encourages students. His ideas have been enthusiastically received by philosophers, neuroscientists, theologians, poets, and artists. Bohm was interviewed by John Briggs and F. Additional comments are taken from a previous interview in England by writer Llee Heflin. Can you recall when you first experienced the sense of the wholeness that you now express as the implicate order? When I was a boy a certain prayer we said every day in Hebrew contained the words to love God with all your heart all your soul, and all your mind. My understanding of these words, that is, this notion of wholeness--not necessarily directed toward God but as a way of living--had a tremendous impact on me. I also felt a sense of nature being whole very early. When I first studied quantum mechanics I felt again that sense of internal relationship--that it was describing something that I was experiencing directly rather than just thinking about. The notion of spin particularly fascinated me: I felt that somehow that described experience with the processes of the mind. In thinking about spin I felt I was in a direct relationship to nature. In quantum mechanics I came closer to my intuitive sense of nature. What do you mean? The main problem is that quantum mechanics gives

only the probability of an experimental result. Neither the decay of an atomic nucleus nor the fact that it decays at one moment and not another can be properly pictured within the theory. It can only enable you to predict statistically the results of various experiments. Physics has changed from its earlier form, when it tried to explain things and give some physical picture. Now the essence is regarded as mathematical. Now they may find an algorithm by which they hope to explain a wider range of experimental results, but it will still have inconsistencies. They hope that they can eventually explain all the results that could be gotten, but that is only a hope. How did the founders of quantum mechanics initially receive your book Quantum Theory? When we met he said the book had done about as well as you could do with quantum mechanics. But he was still not convinced it was a satisfactory theory. His objection was not merely that it was statistical. He felt it was a kind of abstraction; quantum mechanics got correct results but left out much that would have made it intelligible. I came up with the causal interpretation [that the electron is a particle, but it also has a field around it. The particle is never separated from that field, and the field affects the movement of the particle in certain ways]. Things that are far away from each other profoundly affect each other. He believed only in local action. I realized then the problem is that coordinates are still the basic order in physics, whereas everything else has changed. Your key concept is something you call enfoldment. Could you explain it? Everybody has seen an image of enfoldment: You fold up a sheet of paper, turn it into a small packet, make cuts in it, and then unfold it into a pattern. The parts that were close in the cuts unfold to be far away. This is like what happens in a hologram. Enfoldment is really very common in our experience. All the light in this room comes in so that the entire room is in effect folded into each part. If your eye looks, the light will be then unfolded by your eye and brain. As you look through a telescope or a camera, the whole universe of space and time is enfolded into each part, and that is unfolded to the eye. You spoke of coordinates and order a moment ago. How do they tie in with enfoldment? Do you mean coordinates like those on a grid? Yes, but not necessarily straight lines. They are a way of mapping space and time. Since space-time may be curved, the lines may be curved as well. It became clear that each general notion of the world contains within it a specific idea of order. The ancient Greeks had the idea of an increasing perfection from the earth to the heavens. Modern physics contains the idea of successive positions of bodies of matter and the constraints of forces that act on these bodies. The order of perfection investigated by the ancient Greeks is now considered irrelevant. The most radical change in the notion of order since Isaac Newton came with quantum mechanics. When you apply quantum theory to general relativity, at very short distances like ten to the minus thirty-three centimeters, the notion of the order of space and time breaks down. Can you replace that with some other sense of order? First you have to ask what we mean by order. Everybody has some tacit notion of it, but order itself is impossible to define. Yet it can be illustrated. In a photograph any part of an object is imaged into a point. This point-to-point correspondence emphasizes the notion of point as fundamental in sense of order. Cameras now photograph things too big or too small, too fast or too slow to be seen by the naked eye. This has reinforced our belief that everything can ultimately be seen that way. Physics is more like quantum organism than quantum mechanics. I think physicists have a tremendous reluctance to admit this. There is a long history of belief in quantum mechanics, and people have faith in it. So our image is the lens, the apparatus suggesting the point. The point in turn suggests electrons and particles. And the track of particles on the photograph. Now what instrument would illustrate wholeness? Waves from the whole object come into each part of the hologram. This makes the hologram a kind of knowledge of the whole object. But you are always getting information about the whole object, no matter how much or little of it you take. Returning to the actual situation, we have a constant dynamic pattern of waves coming off an object and interfering with the original wave. Within that pattern of movement, many objects are enfolded in each region of space and time. Classical physics says that reality is actually little particles that separate the world into its independent elements. We could picture the electron not as a particle that exists continuously but as something coming in and going out and then coming in again.

DAVID BOHM QUANTUM THEORY pdf

5: The Undivided Universe: An Ontological Interpretation of Quantum Theory by David Bohm

To be specific, Bohm, with his deterministic pilot wave theory, was fighting against the instrumentalist approach of quantum mechanics in which the free will of humans directly contradicts the deterministic view of reality that Bohm himself seemingly detested.

David Bohm Save David Joseph Bohm FRS [1] ; December 20, â€” October 27, was an American scientist who has been described as one of the most significant theoretical physicists of the 20th century[2] and who contributed unorthodox ideas to quantum theory , neuropsychology and the philosophy of mind. To complement it, he developed a mathematical and physical theory of "implicate" and "explicate" order. In this, his epistemology mirrored his ontology. He pursued his scientific career in several countries, becoming first a Brazilian and then a British citizen. He abandoned Marxism in the wake of the Hungarian Uprising in He was raised mainly by his father, a furniture-store owner and assistant of the local rabbi. Despite being raised in a Jewish family, he became an agnostic in his teenage years. He then transferred to the theoretical physics group directed by Robert Oppenheimer at the University of California, Berkeley Radiation Laboratory, where he obtained his doctorate. He was active in communist and communist-backed organizations, including the Young Communist League , the Campus Committee to Fight Conscription, and the Committee for Peace Mobilization. During his time at the Radiation Laboratory, Bohm was in a relationship with the future Betty Friedan and also helped to organize a local chapter of the Federation of Architects, Engineers, Chemists and Technicians , a small labor union affiliated to the Congress of Industrial Organizations CIO. During the war, Bohm remained at Berkeley, where he taught physics and conducted research in plasma , the synchrotron and the synchrocyclotron. He completed his Ph. According to biographer F. David Peat see reference below, p. Without security clearance, Bohm was denied access to his own work; not only would he be barred from defending his thesis, he was not even allowed to write his own thesis in the first place! Bohm later performed theoretical calculations for the Calutrons at the Y facility in Oak Ridge, Tennessee , which was used for the electromagnetic enrichment of uranium for the bomb dropped on Hiroshima in In May , the House Un-American Activities Committee called upon Bohm to testify because of his previous ties to suspected communists. Bohm invoked his Fifth Amendment right to refuse to testify, and he refused to give evidence against his colleagues. He was acquitted in May , but Princeton had already suspended him. Quantum theory and Bohm diffusion The Bohmian trajectories for an electron going through the two-slit experiment. A similar pattern was also observed for single photons. As a postgraduate at Berkeley, he developed a theory of plasmas , discovering the electron phenomenon now known as Bohm diffusion. But Bohm became dissatisfied with the orthodox interpretation of quantum theory he wrote about in that book. Starting from the realization that the WKB approximation of quantum mechanics leads to deterministic equations and convinced that a mere approximation could not turn a probabilistic theory into a deterministic theory, he doubted the inevitability of the conventional approach to quantum mechanics. He initially called his approach a hidden variable theory, but he later called it ontological theory, reflecting his view that a stochastic process underlying the phenomena described by his theory might one day be found. Bohm and his colleague Basil Hiley later stated that they had found their own choice of terms of an "interpretation in terms of hidden variables" to be too restrictive, especially since their variables, position, and momentum "are not actually hidden. He applied for and received Brazilian citizenship , but by law, had to give up his US citizenship ; he was able to reclaim it only decades later, in , after pursuing a lawsuit. Anderson , Donald Kerst , Marcos Moshinsky , Alejandro Medina, and the former assistant to Heisenberg , Guido Beck , who encouraged him in his work and helped him to obtain funding. The Brazilian CNPq explicitly supported his work on the causal theory and funded several researchers around Bohm. His work with Vigier was the beginning of a long-standing cooperation between the two and Louis De Broglie , in particular, on connections to the hydrodynamics model proposed by Madelung. There, he met Sarah "Saral" Woolfson, whom he married in In , Bohm and Aharonov discovered the Aharonovâ€”Bohm effect , showing how a magnetic field could affect a region of space in which the field had been shielded, but its vector potential did not vanish there. That showed for the first time that the magnetic

vector potential , hitherto a mathematical convenience, could have real physical quantum effects. His collected papers are stored there. Such features can be considered to be independent only up to a certain level of approximation in which certain criteria are fulfilled. They used the word " holomovement " for the activity in such orders. In collaboration with Stanford University neuroscientist Karl H. Pribram , Bohm was involved in the early development of the holonomic model of the functioning of the brain, a model for human cognition that is drastically different from conventionally-accepted ideas. Those concerns were a natural extension of his earlier interest in Marxist ideology and Hegelian philosophy. His views were brought into sharper focus through extensive interactions with the psychological philosopher Jiddu Krishnamurti , beginning in In the seminar, Bohm develops several interrelated themes. He points out that thought is the ubiquitous tool that is used to solve every kind of problem: Yet thought, he maintains, is also inadvertently the source of many of those problems. He recognizes and acknowledges the irony of the situation: If there is a fault in the functioning of thought, therefore, it must be a systemic fault, which infects the entire network. The thought that is brought to bear to resolve any given problem, therefore, is susceptible to the same flaw that created the problem it is trying to solve. What is required in order to correct the distortions introduced by thought, according to Bohm, is a form of proprioception, or self-awareness. Neural receptors throughout the body inform us directly of our physical position and movement, but there is no corresponding awareness of the activity of thought. Such an awareness would represent psychological proprioception and would enable the possibility of perceiving and correcting the unintended consequences of the thinking process. In his book Science, Order and Creativity, Bohm referred to the views of various biologists on the evolution of the species, including Rupert Sheldrake. Martin Gardner reported this in a Skeptical Inquirer article and also critiqued the views of Jiddu Krishnamurti , with whom Bohm had met in and had had many subsequent exchanges. An essential ingredient in this form of dialogue is that participants "suspend" immediate action or judgment and give themselves and each other the opportunity to become aware of the thought process itself. Bohm suggested that if the "dialogue groups" were experienced on a sufficiently-wide scale, they could help overcome the isolation and fragmentation that Bohm observed in society. Later life Bohm continued his work in quantum physics after his retirement, in His final work, the posthumously-published The Undivided Universe: He was elected Fellow of the Royal Society in His condition worsened and it was decided that the only treatment that might help him was electroconvulsive therapy. Bohm showed improvement from the treatments and was released on 29 August, but his depression returned and was treated with medication. Quantum Theory, New York: Quanta and Reality, A Symposium, with N. Hanson and Mary B. Wholeness and the Implicate Order , London: Science, Order, and Creativity , with F. Meaning And Information , In: The Search for Meaning: An ontological interpretation of quantum theory, with B. On Creativity, editor Lee Nichol. Discussions, with Jiddu Krishnamurti, London: Creativity and Science, with Charles Biederman. The Essential David Bohm. The Unity of Everything:

DAVID BOHM QUANTUM THEORY pdf

6: David Bohm Society: Quantum Theory

Theoretical physicist David Bohm (colleague of Albert Einstein and J. Krishnamurti) believed that quantum physics invalidates the old model of 'reality' - that there are two kinds of substance.

Although he tried to make the world more sensible with his pilot-wave model, he also argued that complete clarity is impossible. He reached this conclusion after seeing an experiment on television, in which a drop of ink was squeezed onto a cylinder of glycerine. When the cylinder was rotated, the ink diffused through the glycerine in an apparently irreversible fashion. Its order seemed to have disintegrated. But when the direction of rotation was reversed, the ink gathered into a drop again. But then when we look deeper at these essential things they turn out to have some feature of appearances. As his interview with Horgan shows, he did not even think that one can reduce everything to mathematics. It would require a unification of art and science. He might be right. Much seems stalled just now. Can there really be a Theory of Everything? A research team led by a Heriot-Watt scientist has shown that the universe is even weirder than had previously been thought. In the universe was officially proven to be weird. John Bell theorized that maybe the particles can signal faster than the speed of light. Observation instantly defines what properties a particle has and if you assume they had properties before we measured them, then you need evidence, because right now there is none which is why realism is dead, and materialism dies with it. How does the particle know what we are going to pick so it can conform to that? These have ruled out all hidden-variables theories based on joint assumptions of realism, meaning that reality exists when we are not observing it; and locality, meaning that separated events cannot influence one another instantaneously. To be specific, Bohm, with his deterministic pilot wave theory, was fighting against the instrumentalist approach of quantum mechanics in which the free will of humans directly contradicts the deterministic view of reality that Bohm himself seemingly detested. As Steven Weinberg states in the following article, in the instrumentalist of quantum mechanics humans are brought into the laws of nature at the most fundamental level. The instrumentalist approach,, the wave function,, is merely an instrument that provides predictions of the probabilities of various outcomes when measurements are made. It is not that we object to thinking about humans. We may in the end have to give up this goal,,, Some physicists who adopt an instrumentalist approach argue that the probabilities we infer from the wave function are objective probabilities, independent of whether humans are making a measurement. In quantum mechanics these probabilities do not exist until people choose what to measure, such as the spin in one or another direction. Unlike the case of classical physics, a choice must be made,,, http: Which is a very, very, deep message about the nature of reality and our part in the whole universe. We are not just passive observers. So we know that we cannot assume â€” to put it precisely, we know that it is wrong to assume that the features of a system, which we observe in a measurement exist prior to measurement. I mean in a certain cases. So in a sense, what we perceive as reality now depends on our earlier decision what to measure.

7: Interview with David Bohm - F. David Peat

Bohmian mechanics, which is also called the de Broglie-Bohm theory, the pilot-wave model, and the causal interpretation of quantum mechanics, is a version of quantum theory discovered by Louis de Broglie in and rediscovered by David Bohm in

The Implicate Order This article discusses the vision David Bohm intuited from his insight gnosis into the quantum world. This vision discerns the characteristics of an evolving cosmos in process; and, also, it ponders upon the implications for humanity. During his later years he linked a formidable knowledge of the history and philosophy of science to his keen experience as a physicist. In recent years, Bohm attempted to explain an ontological basis for quantum theory. The basis of quantum theory can be summarized in three propositions: In the subatomic world, few things can be predicted with percent precision; however, accurate predictions can be made about the probability of any particular outcome. One has to work with the probabilities rather than certainties, because it is impossible for an observer to describe all aspects of a particle at once speed and location. Electromagnetic energy such as light or heat does not always behave like a continuous wave--rather it is grainy, because energy can be transferred only in quantum packages. Therefore, light has a dual character. Under certain circumstances, it may display wavelike aspects; and in other circumstances, it may have the characteristics of particles. In principle, any individual element could reveal "detailed information about every other element in the universe. Bohm believes that the bizarre behavior of the subatomic particles might be caused by unobserved subquantum forces and particles. Indeed, the apparent weirdness might be produced by hidden means that pose no conflict with ordinary ideas of causality and reality. Bohm believes that this "hiddeness" may be reflective of a deeper dimension of reality. He maintains that space and time might actually be derived from an even deeper level of objective reality. This reality he calls the Implicate Order. Within the Implicate Order everything is connected; and, in theory, any individual element could reveal information about every other element in the universe. Holography relies upon wave interference. If two wavelengths of light are of differing frequencies, they will interfere with each other and create a pattern. Proceeding from his holographic analogy, Bohm proposes a new order--the Implicate Order where "everything is enfolded into everything. Bohm puts it thus: Such movement of light waves is present everywhere and in principle enfolds the entire universe of space and time in each region. This enfoldment and unfoldment takes place not only in the movement of the electromagnetic field but also in that of other fields electronic, protonic, etc. These fields obey quantum-mechanical laws, implying the properties of discontinuity and non-locality. The totality of the movement of enfoldment and unfoldment may go immensely beyond what has revealed itself to our observations. Within this milieu there are independent sub-totalities such as physical elements and human entities with relative autonomy. The layers of the Implicate Order can go deeper and deeper to the ultimately unknown. It is this "unknown and undescribable totality" that Bohm calls the holomovement. The holomovement is the "fundamental ground of all matter. Summarizing, Bohm uses analogies most ingeniously as he attempts to simplify his theory. Bohm suggests that instead of thinking of particles as the fundamental reality, the focus should be on discrete particle-like quanta in a continuous field. On the basis of this quantum field, Bohm breaks down the Implicate Order into three categories: The first category is the original, "continuous field" itself along with its movement. Bohm likens this continuous field to a television screen displaying an infinite variety of explicate forms. The second category is obtained by considering superquantum wave function acting upon the field. Bohm considers it to be similar to a computer which supplies the information that arranges the various forms--in the first category. Folling this analogy, Bohm sees the whole process as a closed loop; it goes from the screen to the computer to the Player and back to the screen. Bohm believes in a special cosmic interiority. Everything that is and will be in this cosmos is enfolded within the Implicate Order. There is a special cosmic movement that carries forth the process of enfoldment and unfoldment into the explicate order. This process of cosmic movement, in endless feedback cycles, creates an infinite variety of manifest forms and mentality. This Player, the Cosmic Mind, is moving cyclically onward and onward accruing an infinity of experienced being! For Bohm it is the plenum; it is an "immense

background of energy. He calls this the "holomovement. Bohm also refers to a law in the holomovement. Holonomy, through a wide range of aspects, can be considered a "movement in which new wholes are emerging. It is the interplay between the implicate and the explicate orders. It is the flow of matter, manifested and interdependent, towards consciousness. He considers the particle, fundamentally, to be only an "abstraction that is manifest to our senses. It flows out of the law of the Implicate Order, a law that stresses the relationships between the enfolded structures that interweave each other throughout cosmic space rather than between the "abstracted and separate forms that manifest to the senses. Bohm also declares that the "implicate order has to be extended into a multidimensional reality. Thus we have to say that the holomovement enfolds and unfolds in a multidimensional order, the dimensionality of which is effectively infinite. Thus the principle of relative autonomy of sub-totalities--is now seen to extend to the multi-dimensional order of reality. What is seen is that there is a certain "relationship between the images appearing on the two screens. The same can be said of all living matter. There is no dichotomy. For Bohm it is the development of consciousness! For Bohm consciousness "involves awareness, attention, perception, acts of understanding, and perhaps yet more. Consciousness, Bohm notes, can be "described in terms of a series of moments. Bohm considers the human individual to be an "intrinsic feature of the universe, which would be incomplete--in some fundamental sense" if the person did not exist. He believes that individuals participate in the whole and consequently give it meaning. Because of human participation, the "Implicate Order is getting to know itself better. The individual is in total contact with the Implicate Order, the individual is part of the whole of mankind, and he is the "focus for something beyond mankind. The collectivity of individuals have reached the "principle of the consciousness of mankind," but they have not quite the "energy to reach the whole, to put it all on fire. In the depths of the Implicate Order, there is a "consciousness, deep down--of the whole of mankind. It is this collective consciousness that is truly one and indivisible, and it is the responsibility of each human person to contribute towards the building of this consciousness of mankind, this noosphere! That is absolutely what has to be done and nothing else can work. Referring to all the elements of the cosmos, including human beings, as projections of an ultimate totality, Bohm notes that as a "human being takes part in the process of this totality, he is fundamentally changed in the very activity in which his aim is to change that reality, which is the content of his consciousness. But what is it doing? Meditation means "to reflect, to turn something over in the mind, and to pay close attention. Possibly Bohm is considering the infinite potential of what he terms "multidimensional reality. It is a Player who operates in a feedback universe. Bohm provides the analogy of the "continuous field," the information, and the Player of the whole game. This process is ever endless, ever expanding or evolving, as the Player gathers all to itself. The player continuously grasps itself. ORDER Bohm believes that a special cosmic energy holds the All together, and this cosmic energy follows a cosmic law order. Bohm refers to it as the law in the holomovement. His viewpoint is that of "wholeness. These new holistic aspects may appear possibly to have some autonomy, but ultimately they are all aspects of the All. What makes the mechanical thought process relevant is intelligence. The "ground of intelligence must be in the undetermined and unknown flux, that is also the ground of all definable forms of matter. So it will be ultimately misleading and indeed wrong to suppose, for example, that each human being is an independent actuality who interacts with other human beings and with nature. Rather, all these are projections of a single totality. As a human being takes part in the process of this totality, he is fundamentally changed in the very activity in which his aim is to change that reality which is the content of his consciousness. Consciousness is part of the play of the cosmic process, grasping itself through its sub-totalities into higher and higher levels of consciousness. Logically, if cosmic sub-totalities such as human beings can be considered to be persons of which only a few are developing toward higher levels of Personhood , than through the feedback interchange, the cosmos is becoming progressively personalized as well. It is a Person. And this Player is also creative! It is a Presence within cosmic energy. The Bohm cosmic model also suggests that this "holiness" has existed since the foundation of the cosmos. It is present in the cyclical process of the universe. It is pure, active intelligence from which all that is manifest in the cosmos comes. It acts through an inwardness in consciousness. It enfolds information into the many levels of consciousness, into all of life. What does Bohm have to say about the human condition? For Bohm there are the evils of disorder which causes suffering and death. Bohm does not

believe that there is disorder at the level of the non-human universality, rather it is at the level of humanity--mainly because of ignorance. Nature has allowed humanity the luxury to make mistakes, because humankind must have the "possibility of being creative. He uses the analogy of a live oak tree.

8: Quantum Theory - David Bohm - Google Books

David Bohm seemed driven by both impulses. He is renowned for promoting a sensible (according to Einstein and other experts) interpretation of quantum mechanics.

9: De Broglieâ€“Bohm theory - Wikipedia

The de Broglie-Bohm theory, also known as the pilot wave theory, Bohmian mechanics, Bohm's interpretation, and the causal interpretation, is an interpretation of quantum mechanics. In addition to a wavefunction on the space of all possible configurations, it also postulates an actual configuration that exists even when unobserved.

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Csa travel pro policy H.R. 36, H.R. 3858, and H.R. 4103 Facts and fakes about Cuba Passages north anthology Aliphatic nucleophilic substitution Mien kampf Fuhrer! Attracting purple martins Setting the scene for the changing face of Korean management Working with and working for indigenous communities by Joe Watkins and T.J. Ferguson. Piano notes for new hindi songs 2015 Report of the joint committee appointed to enquire what business is necessary to be done during the prese Introduction to modernity lefebvre Complementary and alternative medicine in society : an introduction David Mischoulon and Jerrold F. Rosen The life of victory ; His cross and mine ; Lambs among wolves Nineveh and Its Remains, Vol. 2 Dual Nationality, Social Rights and Federal Citizenship in the U.S. and Europe Astronomical photography with the forty-inch refractor and the two-foot reflector of the Yerkes observato Virus elimination and validation Nicola Boschetti and Anna Johnston Per state to facilitate the separation of state and local influences. The Four stages of life Pictorial essay George A. Talbot Historical geography of crop plants Van Richtens Arsenal (Ravenloft d20 3.0 Fantasy Roleplaying) Order in music offers harmony in life Reading Rilkes Orphic Identity (Studies in Modern German Literature,) Life histories of three species of freshwater fishes in Beaufort Sea drainages, Yukon Territory Causes of unemployment in the coal and other domestic industries. Wb minister list 2017 Mysteries of the dark moon Policy making in a three party system Eliminate Colorectal Cancer Act of 2001 Dandelions of Tibet Spreading Improvement Across Your Health Care Organization Dan Romanelli takes a rabbit to market. PLUS: The man who fueled Bugs TV stardom. Autocad plant 3d tutorial A Golden treasury of nursery verse Calculated performance of the NASA Lewis icing research tunnel Cardiac Output and Regional Flow in Health and Disease (Developments in Cardiovascular Medicine) Prevention : changing childrens diet and physical activity patterns via schools, families, and the enviro Loan of guns to Michigan Military Academy.