September 22, 1989 LBL–27738

Quantum Physics and Human Values *

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Abstract

Address to the UNESCO–sponsored conference: Science and Culture in the 21st Century–Agenda for Survival.

*This work was supported by the Director, Office of Energy Research, Office of High Energy and Nuclear Physics, Division of High Energy Physics of the U.S. Department of Energy under Contract DE-AC03-76SF00098.

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1. Introduction

Science created the problem addressed by this conference: it gave to man the power to pollute and ravage nature on an unprecedented scale, and to obliterate his species altogether. However, together with this potentially fatal power, science provided a compensating gift, which, though subtle in character, and still hardly felt in the minds of men, may ultimately be the most valuable contribution of science to human civilization, and the key to human survival.

Science is generally recognized as not merely the practical enterprise of subjugating nature to the will of man, but as also a part of man's unending quest for knowledge about the universe, and his place within it. This quest is motivated not solely by idle curiousity. Each of us, when trying to establish values upon which to base conduct, is inevitably led to questions about the universe and man's place within it. This link between the practical question of values upon which to base conduct and the abstract question of man's place in the universe is not just some airy philosophical invention. Concrete examples of the strong effect upon conduct of beliefs about the universe and man's place in it are legion. When the crusaders marched off to the holy land they were sacrificing their comfort, and were prepared to sacrifice their lives, in the name of their beliefs about the universe, its maker, and their place in that universe. When the Christians allowed themselves to be thrown to the lions, rather than uttering a few simple phrases, they were actually sacrificing their lives in the name of beliefs about the universe, and their place within it. The "kamikazes", the "muslim fanatics", and Bruno burning at the stake all bear vivid witness to the fact that no influence upon human conduct, even the instinct for survival itself, is stronger than the values that can be generated by firmly held beliefs about the nature of the universe and man's place within it.

It is sometimes claimed that science says nothing about values; that science can tell us how to obtain that which we value, but necessarily stands mute on the question of what is valuable. That claim is certainly incorrect. Scientific knowledge impacts strongly upon values. Perhaps the most striking example is the impact of scientific knowledge upon the system of values promulgated by the church during the middle ages. That system rested upon a credo about the nature of the universe, its creator, and man's connection to that creator. Science,

by rendering that credo unbelievable, deflated the system of values erected upon it. Moreover, it put forth a credo of its own. In that "scientific" credo man was converted from a likeness of god, a spark of the divine creative power, endowed with free–will, to a simple automaton – – to a cog in a giant machine that grinds inexorably along a preordained path in the absolute grip of blind mathematical law.

Gone from this "scientific" picture of man is any rational basis for the notion of one's responsibility for his own acts. Each of us is asserted to be merely a mechanical extension of what existed prior to his birth. Over that prior situation one can have no control. Hence, over whatever emerges, preordained, from that prior situation one can bear no responsibility.

Given this conception of man, the rape of the environment becomes wholly rational. This conception provides no rational basis for any value but self interest. Hence behavior promoting the welfare of others, including future generations, becomes rational only to the extent that such behavior serves ultimately one's own interests. Thus science becomes doubly culpable: it not only gives man the power to destroy the ecosystem, but also denies him the basis of a rational system of values that can motivate sufficient moderation in the use of that power.

The mechanical picture of man described above is the picture presented by the "classical" physics of the seventeenth, eighteenth, and nineteenth centuries. In this century that classical picture has been found to be seriously flawed. Even the basic premises of the classical picture have been shown to be strictly incompatible with various phenomena associated with the atomic constitution of matter. The world is thus necessarily different, and, in fact, necessarily profoundly different, from the picture of it provided by classical physics.

This failure of the classical concepts has led physicists to a new approach to the understanding of nature. The new approach is based upon radically different concepts, and leads to a radically different conception of both the universe and man's place in the universe. The next section describes the main features of the quantum conception of nature; the subsequent section describes the associated quantum conception of man. The final section discusses the impact upon human

values of this profound revision of the conception of man.

2. The Quantum Conception of Nature

In approaching the subject of this section the first point to be emphasized is that, strictly speaking, there is *no* quantum conception of nature, in the classical sense of these words. Niels Bohr, the principal architect of the orthodox philosophy of quantum theory, took great pains to make clear the fact that, from this orthodox point of view, the purpose of science in general, and of quantum theory in particular, is not to make claims about the nature of the physical universe itself; it is rather to allow the calculation of expectations pertaining to *results of observations* obtained under specified conditions. The character, or nature, of the universe that causes these expectations to be borne out is, according to this strictly orthodox point of view, not the proper subject matter of science.[1]

The basic reason for adopting this restricted point of view is that the only verifiable assertions about physical systems are, in the final analysis, assertions about observations: assertions about unobservable aspects of the universe are theoretical in character, and intrinsically less secure than testable and extensively tested assertions about results of observations.

The soundness of this orthodox viewpoint is supported today by the fact that there are, currently, three basically different conceptions of the universe that all purport to give the same predictions about observations. Insofar as this is indeed true, and remains true for all conceivable observations, there can be no empirical discrimination between these three radically different pictures of the universe.

This conference is not an appropriate place to describe all three possibilities. I shall discuss here only the "most orthodox" of these three pictures of the universe, namely the one promulgated by Heisenberg. This picture is the one favored by most quantum physicists, and is the one that conforms most closely to the quantum theoretical formalism as it is used in practice. I shall call this conception of nature "the quantum conception", in keeping with its favored status among quantum physicists.

According to this quantum conception of nature, the *actual* things from

which the universe is built are not persisting entities, as in classical physics, but are rather sudden events, called "quantum jumps". These jumps are sudden changes in the so–called "Heisenberg state" of the universe. The Heisenberg state is something like the initial state of the classical universe. But whereas the initial state of the classical universe completely determines the well–defined values of all physical quantities for the entire history of the universe, the Heisenberg state determines, basically, only the relative probabilities of its various possible successor states. Thus we have a picture of the universe evolving by a sequence of discrete "quantum jumps", with each successive state determining only the probabilities of its various alternative possible successor states.

Certain Heisenberg states correspond to the fact that certain physical variables have, at some specified time, reasonably well–defined values. However, due to the Heisenberg uncertainty principle, a quantity that is well defined at one time often becomes less well defined as time progresses.

A typical quantum jump is assumed to be such as to make certain particular *macroscopic* qualitities reasonably well defined, at some particular time. Then the whole process of nature can be envisaged as a sequence of events that tends to work against the diffusive tendency induced by the uncertainty principle, and that, in particular, tends to keep the universe always reasonably well defined as regards the values of its *macroscopic*, and hence observable, degrees of freedom.

The laws that govern the probabilities of the quantum jumps are direct analogs of the laws of classical physics. This analogy between the quantum and classical laws ensures that the laws of classical physics will be approximately respected in the "classical" situations where the classical laws are known to work well.

Standing out against this background of events that act mainly to keep the macroscopic world in close accord to the laws of classical physics are the special "quantum–measurement–type" events. These are events that occur following a period in which there has been a great amplification of some atomic–level difference; i.e., in situations where small differences involving only a few "atoms" have become rapidly amplified to produce large differences in macroscopic, and hence directly observable, quantities.

These quantum–measurement–type events are associated, typically, with the quantum measuring devices that are used to study atomic phenomena, and they were the focus of Heisenberg's discussion of the conception of nature being described here. The functioning of these devices depends on the occurrence within the device of precisely the sort of amplification that was described above.

3. The Quantum Conception of Man

The impact of the quantum conception of nature upon the conception of man arises from the apparently close similarity between human brains and quantum measuring devices.[3] The function of a brain is to process various input data in order, first, to formulate some appropriate possible courses of action, next, to select one of the possible courses of action, and, finally, to supervise the execution of this chosen course of action. The mechanism for this processing is based upon the amplification by nerve cells of differences, within synaptic junctions where the nerve cells meet, that involve very small numbers of Ca^{++}ions. The brain process discussed above culminates in the reduction of the state of the brain to a quasi–stable state that supervises the chosen macroscopic response of the organism.

Computer studies[4] at the classical level show a very sensitive dependence of the final quasi–stable state into which the brain evolves upon the parameters that characterize the synaptic junction. Further studies are needed. But it seems likely that the analogy of brains to quantum measuring devices is appropriate, in that, as in quantum measuring devices, the choice of the final macroscopic state will be fixed by a "quantum jump" of the macroscopic system into one of the alternative possible macroscopic states.

If the brain is indeed analogous in this way to a quantum measuring device then the implications as regards man's place in the universe are profound. These implications follow directly from two basic properties of quantum jumps.

The first basic property of quantum jumps, within the quantum conception of nature, is that the selections, or choices, made by these jumps are *not* controlled by the mathematical laws analogous to the classical laws of motion. Those mathematical laws determine only the *probabilities* of the various alternative possible choices, they do not determine which of the various alternative

possibilities will actually be selected.

These actual selections are, in fact, logically more akin to the choices of the *initial conditions* of classical physics, in that they stand outside of the mathematically determined process, and yet collectively determine the actual form of the macroscopic universe. The whole sequence of quantum events can thus be regarded as a selective processes that creates, or fixes, the actual form of the universe. However, in the quantum conception of nature this process is a gradual process, rather than, as in classical physics, an instantaneous initial choice that fixes *all at once* the entire history of the universe.

The second basic property of the quantum jumps is their nonlocal character. Each such jump is allowed to be associated in a special way with a local region of spacetime. Thus the quantum jumps that we have previously discussed act to fix either the locations of parts of a measuring device or the state of a human brain. However, each such jump induces also compensating changes in far–flung parts of the universe. The precise forms of these changes are specified by quantum theory, and their structure is such that the quantum jump must be fundamentally nonlocal: the quantum jump is intrinsically a shift of the entire universe, and it extends over all space. One cannot conceive of the quantum jump as simply the effect of the injection of some disturbance, or choice, into a localized region of space. The quantum jump, and the choice it represents, is inherently global in character.

The natures of these two properties of quantum jumps induce a profound change in the conception of man's place in the universe, vis–à–vis the place prescribed by classical physics. Man can no longer be seen as a deterministically controlled cog in a giant machine. He appears, rather, as an aspect of the fundamental process that gives form and definition to the universe. This aspect expresses itself through choices that are controlled by no known law of nature, and, although it expresses itself directly *through* the human body, it is intrinsically and immediately connected to the entire universe, in accordance with precise mathematical forms specified by quantum theory.

4. The Impact Upon Human Values.

The question is now: What impact, if any, does this altered perception of

man have upon human values? Does not a completely rational approach still lead one to value only one's own self–interest? Probably so! But this conclusion leads on the the further question: What is the "self" whose interest one values?

Values arise from self–image. Generally one is led by training, teaching, propaganda, or other forms of indoctrination, to expand one's conception of the self: one is taught to perceive the self as an integral part of some social unit such as family, religions group, nation, or the like, and hence to enlarge one's self–interest to include the interest of this unit. In the present context it is not relevant whether this human proclivity for expanding one's self–image is a consequence of a natural malleability, an instinctual tendency, a spiritual insight, or something else. What is important is that we humans do have in fact the capacity to enlarge our image of "self", and that this enlarged self–image can become the basis of a drive so powerful that it becomes the dominant determinant of human conduct, overwhelming every other factor, including even the instinct for personal self–preservation.

Standing opposed to the social forces that work to broaden the concept of self is the force of reason. Reason demands evidence for beliefs. If we seek evidence for beliefs about the nature of the self, in relation to other parts of the universe, then science claims jurisdiction, or at least relevance. Physics represents itself as the basic science. However, physics in its classical form, provides no ground for any extended notion of the self. Each person is simply a localized gathering of atoms temporarily bound together in a quasi–stable configuration. Any notion that the self is basically more than just this collection of atoms, bound together by mathematically determined forces, is seen as a fantasy having no foundation in the empirical facts. Thus reason, acting on the basis of the evidence supplied and interpreted by classical physics, though it can promote an "enlightened" self–interest of the narrowly conceived personal self, provides no ground for any fundamental enlargement of the self. It therefore stands opposed to the social forces.

Transition to the quantum conception of man brings science into alignment with the social forces. Indeed, the scientific evidence, interpreted á la Heisenberg, enlarges the conception of self far beyond the simple ideas promoted by social forces: the self becomes enlarged not simply to an integral part of various

social organizations, but to a nonlocalized intrinsic part of the formative process of the universe itself – to an agency that stands outside the grip of all known mathematical laws, and fills, in some small measure, a role akin to that of setting the initial conditions of the universe, a prerogative reserved in classical physics for some agency lying beyond physics.

This quantum conception of man resembles , in certain limited respects, the image set forth in various religions system. Hence it may be able to tap the powerful resonances evoked in humans by such beliefs. However, unlike those earlier beliefs, the quantum conception is in no way contrary to the evidence of science, but rather arises, almost automatically, from the most widely accepted conception of the universe compatible with the findings of modern science.

The assimilation of this quantum conception of man into the cultural environment of the 21st century must inevitably produce a shift in values conducive to human survival. The quantum conception gives an enlarged sense of self as architect of the universe. From such a self–image must flow lofty values that extend far beyond the confines of narrow personal self interest. The quantum conception, being based on scientific evidence available equally to all men, rather than arising from special historical situations peculiar to, and exploited by, particular social groups, has the potential of providing a universal system of values available and suitable to all men , without regard to the accidents of their origins. With the diffusion of this quantum conception of man science will have fulfilled itself by adding to the material benefits it has already provided to man a philosophical insight of perhaps even greater value.

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