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Subjective Experience as a Window on Foundational Physics

Project Summary

Our intuitive view of physical reality, a view that grows out of everyday experience, is often in tension with the world-view described by physics. It turns out that many of our most fundamental beliefs about the physical world lack a firm scientific foundation.

One such example concerns the nature of time. We experience that time has a certain direction: we are born, grow old, and die; eggs break; liquids mix; and our offices tend to get more disordered - not the other way round. Yet remarkably, time has no such in-built direction in either classical or quantum theory. Those theories mostly work just as well from past to future as from future to past. A related issue concerns the passage of time, a very fundamental human experience. Yet, in the "block universe" of Einstein's general theory of relativity, time does not pass or flow, it simply is. There are temporal durations, but no flux of time as such. How then do we square our common belief in a moment of time called the present with Einstein's formulation of space-time?

Then there's the age-old mystery of free will. We believe that we have the ability to alter our future by means of our actions in the present through our own free will. But, how can the macroscopic mind "choose" future physical states when the physical world evolves according to microscopic laws of physics that are wholly deterministic? (This remains true even in quantum mechanics; according to the conventional interpretation, although physical reality is not deterministic, the probabilities for different realities still are.)

Most basic of all is our belief in a definite physical reality. Whenever we measure something, we obtain a definite outcome. For example, we might ask, "Where is the electron?" and with the usual kinds of measurements, we find a definite answer, suggesting that the electron indeed had a position at the time of asking. And yet this experience seems to fly in the face of quantum theory, which seems to assert that the location of an electron is not a fact about the world, but a matter of chance. Indeed, the core quantities that physicists calculate using quantum theory are probabilities. Is there then a definite reality that the theory of quantum mechanics,

perhaps incomplete in its description of the world, wrongly describes as being probabilistic? Or is probability fundamental and irreducible, a pointless ``playing with dice,'' as Einstein put it? In which case, how does one reconcile the role of chance with the appearance of fact?
The aim of our proposal, then, is to investigate the areas of tension between objective scientific description and our conscious experience. Although there is no consensus concerning the tensions between these different descriptions or of the role of the observer, recent advances in the foundations of physics and quantum theory offer hope for a fresh approach. As one example, a recent reformulation of quantum mechanics provides a very different picture of the nature of time, suggesting that a reconciliation of subjective temporal passage and the static, or block time, of orthodox physics might lie with the linkage between future and past states. Indeed, our general methodology for addressing the profound questions outlined above will be to investigate different approaches and formulations of quantum mechanics (our most basic and successful scientific theory), to shed new light on the sources of tension with our everyday experience, in the hope of illuminating aspects of the character of what could be called ultimate reality, be it purely physical reality or reality inclusive of such phenomena as mind and consciousness.

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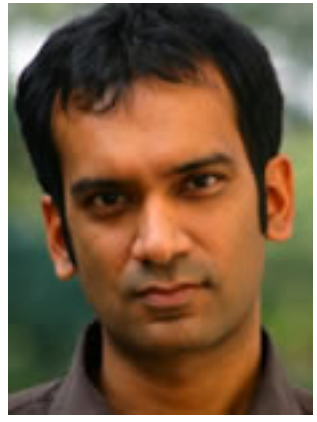

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