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John Horgan, Senior Writer
Scientific American
415 Madison Ave.
New York, NY 10017

Dear Mr. Horgan:

I really enjoyed your article "Quantum Philosophy" in the July, 1992, issue of *Scientific American*. It succinctly summarized a number of excellent experiments which show the "mystery" of quantum physics. I was also heartened to see the word "philosophy" in your title, as physics has gone far too long down the logical positivist road on which only "observables" exist. Since physicists are living within the very world they are trying to describe, perhaps Gödel and Turing have as much to say as Schrödinger and Heisenberg. Gödel's theorem, that there are unprovable truths in mathematics, is obviously true and just as obviously unprovable. Perhaps a similar theorem holds for physics.

The "mystery" of quantum mechanics may be why physicists refuse to believe their own equations. The equations of both classical and quantum physics are symmetrical with respect to time (we still don't understand the minor violations of CPT), and no inconsistencies result if we simply take these equations at face value. In other words, the equations of the universe look the same, whether we go forwards or backwards in time. If we take this view seriously, then an atom emitting a photon looks just like an atom absorbing a photon in reverse, and vice versa. Since the emission of photons is used to perform the experiments you described, and since the absorption of photons is used to "detect" the results, the time-reversed experiment would have the detector emitting the photons and the laser absorbing them. Once you can get over the shock of such an explanation, all of the experiments you describe make perfect sense.

In a time-reversible universe, the function computing any "future" state of the world must be injective (1-1), or else it could not be reversed. In such a universe, *information is conserved*. In other words, the wave function can never "collapse", if by "collapse" we mean that irrevocable choices are made from a large number of "possibilities". Of course, there are physical processes which exhibit exponential non-linearities—e.g., avalanche photon detectors—but all of these nonlinear processes in these detectors are still reversible. A corollary to time-reversibility is the fact that the future of the universe is just as determined as its past—i.e., time is completely symmetrical, and the boundary conditions for our equations may just as easily lie in the future as well as the past. (Neither Feynman nor Dirac would have any trouble with this view.)

As citizens living *within* such a universe, we must determine what *logical* limits exist on our ability to perform observations on our own system, just as Gödel and Turing determined what logical limits exist on a computer's ability to understand its own behavior. Heisenberg's uncertainty principle may be the physicist's analogue to Gödel's theorem. Schrödinger and Heisenberg may really be saying that the world is completely deterministic, but there is no way to "observe" this determinism *from within the system*.

Physicists have always had great difficulty in taking their own equations seriously, if we can believe Kuhn. Scientific revolutions are often delayed until the timing is "politically correct"; e.g., look at how long it took before Einstein said that Maxwell's equations should be taken literally. Since it is not politically correct to believe in determinism in the Twentieth Century, it may take another eight years (or even 108 years) before this view can be acknowledged.

Sincerely,



Henry G. Baker, Ph.D.