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***Catholic Physics - Reflections of a  
Catholic Scientist - Part 2***  
***Quantum Divine Action via God, the Berkeley-  
an Observer: the Delayed Choice Experiment***

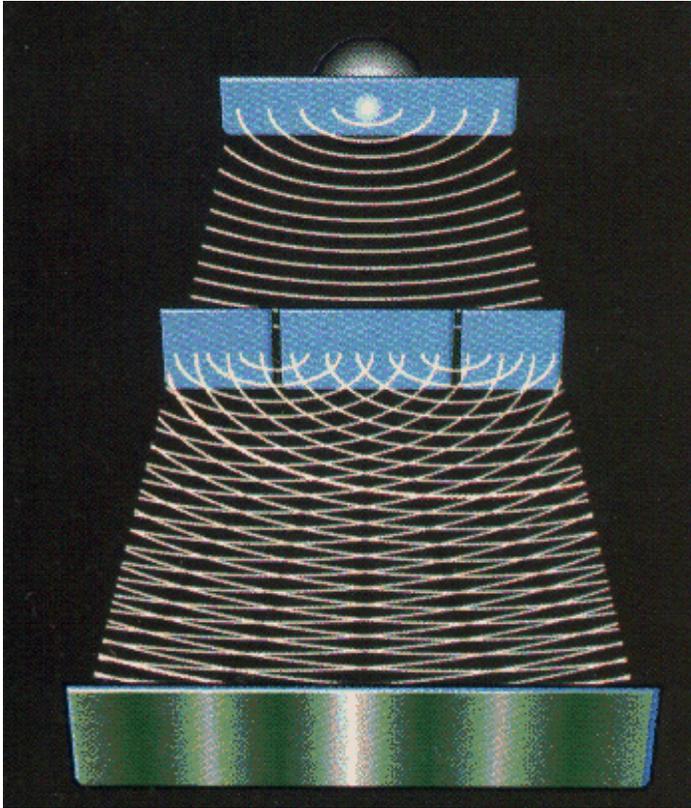


- ♦ 1200's
- ♦ Authority on physics, geography, astronomy, mineralogy, chemistry, zoology, and physiology
- ♦ "The aim of natural science is not simply to accept the statements of others, but to investigate the causes that are at work in nature"
- ♦ He understood that the Church is not opposed to study of nature
- ♦ Patron Saint of Scientists

# Catholic Physics - Reflections of a Catholic Scientist - Part 2

Thoughts on belief, knowledge and faith--rational and irrational; my journey to faith, and on the "Limits of a limitless science" (to paraphrase Fr. Stanley Jaki). A discourse on the consonance of what science tells us about the world, and the dogma/teachings of the Catholic Church; you don't have to apologize for being Catholic if you're a scientist.

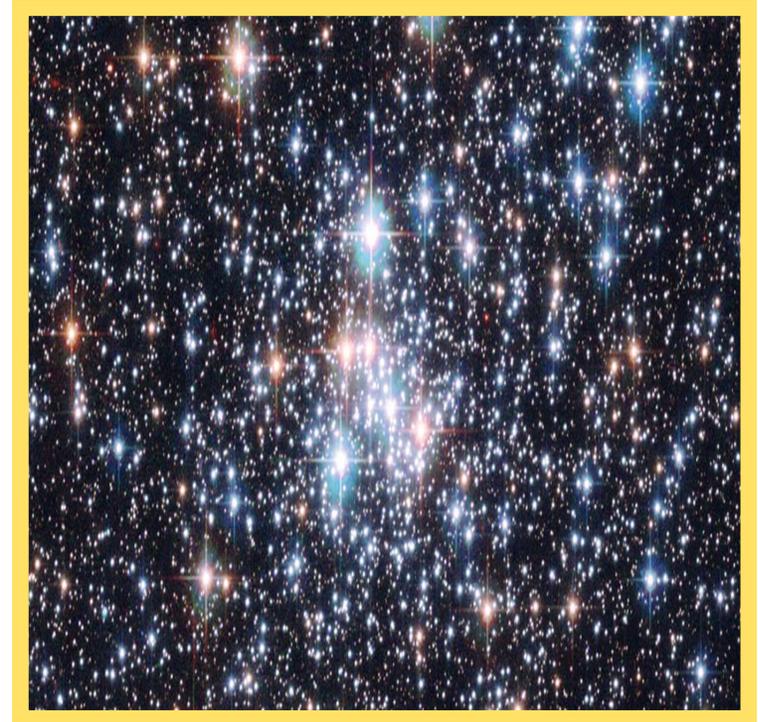
Quantum Divine Action via God, the Berkeleyan Observer: the Delayed Choice Experiment



Young's Double Slit Experiment, [abyss.uoregon.edu](http://abyss.uoregon.edu)

together the universe non-locally as a whole. This reminds one of the words of the Apostle John, 'All things come into being through him, and without him not one thing came into being that has being.' (John 1:3) and of the words of the Apostle Paul, 'All things have been created through him and for him... and to him all things hold together.' (Colossians 1:16,17)... We infer that 'all things' refers to the universe. Not only are all distant parts the universe woven together throughout space, but also its future and its past are entangled throughout time, as if the universe were one seamless garment."

From a series of articles written by: Bob Kurland - a Catholic Scientist



the choice of quantum entity behavior by his choice of measurement technique, even if the decision point for the observer is after the decision point for the quantum entity.

Now, there's been a fair bit of physics (mostly hand-waving) up to now, but no theology or philosophy. What are the philosophical/theological implications of the delayed choice experiment? I believe this has been best expressed by the American physicist Raymond Chiao, in his article "Quantum Non-Localities: Experimental Evidence" in Quantum Mechanics--Scientific Perspectives on Divine Action, V.5 (publ: Vatican Observatory and Center for Theology and Natural Science; see below for link).

"I shall assume as a basic principle that the universe we live in bears witness to the Creator who created it (emphasis added)...let us generalize Berkeley's philosophical principle to a 'neo-Berkeleyan point of view' in which God is the Observer of the universe, in the quantum sense of 'observer' This generalization starts from small systems...in which an observer created reality is seen to occur upon every elementary act of observation, and ends up with large systems--in particular with the entire universe. In this viewpoint, every elementary, individual quantum event...is a result of a creative act of the universal Observer, in which all properties of all particles come into existence on their observation, in continual acts of creatio ex nihilo, which constitutes a kind of creatio continua occurring everywhere at once. Thus the existence of the universe itself is contingent upon the continual observations of the Creator. The idea of contingency of existence, in the sense of the utter dependency of the universe for its properties and existence at each moment upon its Creator, is thereby introduced via quantum physics into philosophy and theology ... Furthermore, this viewpoint suggests a new meaning of the immanence of the Creator with respect to creation, since God is acting everywhere at once in the universe. Thus God is omnipresent, omniscient, and omnipotent...The neo-Berkeleyan viewpoint introduced here suggests not only a continual creatio ex nihilo qua creatio continua by an immanent Creator, but also a singular creatio ex nihilo by a transcendent Creator. Moreover, the above Einstein-Podolsky-Rosen effects imply a quantum non-separability, which ties

"There was a young man who said, 'God Must think it exceedingly odd If he finds that this tree Continues to be When there's no one about in the Quad.'

REPLY - 'Dear Sir: Your astonishment's odd: I am always about in the Quad. And that's why the tree Will continue to be, Since observed by Yours faithfully, GOD.' "

Msgr. Ronald Knox, commenting on Berkeleyan idealism.

"I think I can safely say that nobody understands quantum mechanics."

Richard Feynman (Nobel Prize winner for work in quantum electrodynamics), The Character of Physical Law

"I am a Quantum Engineer, but on Sundays I Have Principles."

John Stewart Bell (of The Bell's Theorem) as quoted in Quantum [un]speakables: from Bell to quantum information.

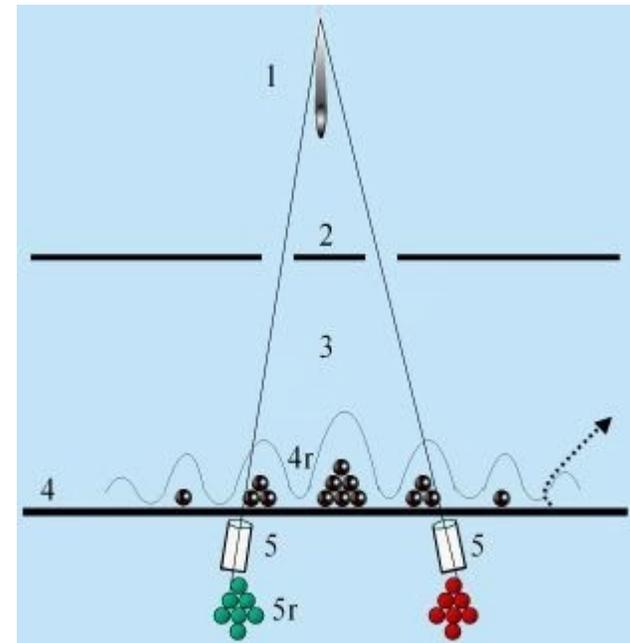
Many articles and books have been written about possible mechanisms for God's action in the world by means of a quantum mechanical agency. I can't possibly in this brief post even summarize all of them, but references are posted below. Rather, I'll focus on a particular experiment, the delayed choice experiment first proposed by the great American physicist, John Wheeler. (See also Aspect's delightful lecture about his experimental test of the idea.) Before discussing the delayed choice experiment, we should try to explain the quantum double-slit experiment on which it is based. (I'm going to trust that the reader will hit the linked sources to get background material on quantum mechanics.)

If you pass a wave, be it light, water or particles showing their wavelike nature, through two parallel slits you'll see a diffraction pattern, alternating intense and dark bands, as depicted in the diagram above. Waves will have a positive amplitude at a peak, and a negative amplitude at a trough, so that when two waves meet at points with both peaks, there will be a bigger peak, and at points with a peak and a trough, they will cancel to give zero, showing the interference pattern. Now the fascinating quantum behavior of particles is that a single particle will seem to go through both slits simultaneously, interfering with itself until it hits the screen, at which point the wave collapses and the particle is at a single point. As the linked animation shows, when many particles go through, the pattern shown on the screen is one of interference fringes, just as produced by waves. If you try to detect through which slit a particle goes (i.e. use the camera in the animation), then you perturb the situation and the particle loses its wavelike character, so that the screen pattern becomes that for classical particles going through the two slits, a scattering without the interference fringes.

Here's Wheeler's gedanken delayed slit experiment in essence. When does the quantum entity decide to behave like a particle or like a wave? Is it just as it goes through the slit? Is it after it goes through the slit? Or???

What happens if you try to change the type of measurement after it has gone through the slit? If, instead of a screen, you use two telescopes oriented and at a distance such that they will determine which slit the particle has gone through, will you detect particle- or wave-like behavior? Layer 4 in the diagram (4r) shows the detecting screen with a diffraction pattern (wave behavior). Layer 5 in the diagram shows the two telescopes, collimated and oriented to detect the slit origin, and 5r, the pattern with no diffraction (particle behavior). Wheeler proposed an astronomical version of the experiment, using gravitational lensing to provide the two different pathways/slits. If images from two spatially separated telescopes were looked at separately (as in layer 5 in the diagram), no interference would result; if the images from the two telescopes were combined and looked at together, phase interference would occur with a pattern

of interference fringes. There's an interesting and significant corollary to this experiment. The light source--some distant galaxy--is millions or billions of years in the past--but you're affecting it by the present day measurement. From which corollary Wheeler derived his notion of the participatory universe, created by observation, both in the present and the past. (And, one might ask, what happens if you go far enough back in the past that no observer was present--but more of that below.)



Wheeler's Delayed Choice Experiment  
[http://www.bottomlayer.com/bottom/basic\\_delayed\\_choice.htm](http://www.bottomlayer.com/bottom/basic_delayed_choice.htm)

The delayed choice experiment has been realized experimentally. Rather than using two slits, half-silvered mirrors provide the two paths--reflection and transmission, and a technique called quantum erasure provides the delayed choice of measurement type. The results are as Wheeler predicted in his gedanken experiment. The observer controls