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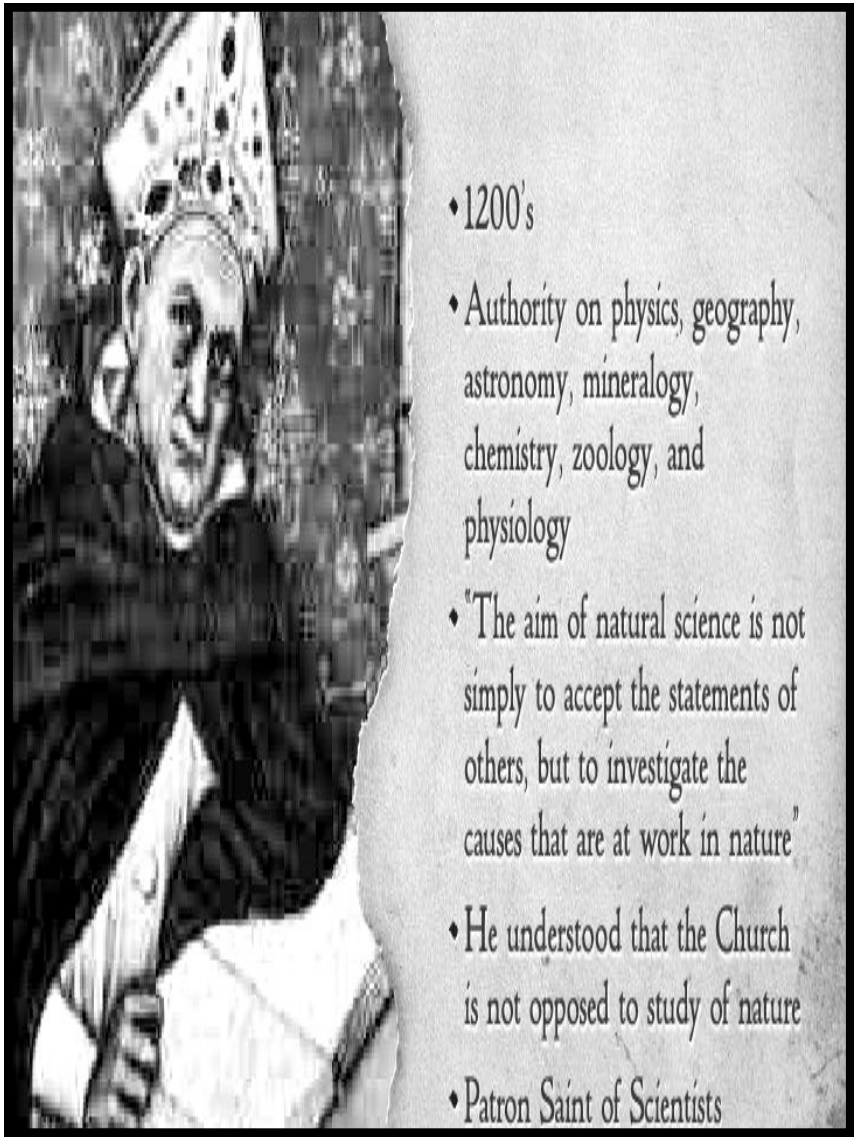
Catholic Physics - Reflections of a Catholic Scientist - Part 29

Philosophic Issues in Cosmology 3: Mathematical Metaphysics--Quantum mechanical models for early stages of the universe.

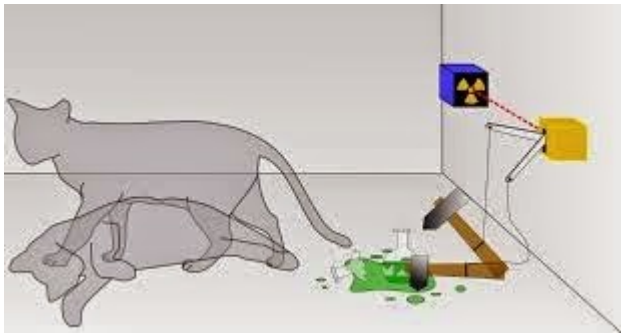


Philosophic Issues in Cosmology 3: Mathematical Metaphysics--Quantum mechanical models for early stages of the universe.

"Perhaps the best argument in favour of the thesis that the Big Bang supports theism is the obvious unease with which it is greeted by some atheistic physicists. At times this has led to scientific ideas, such as continuous creation or an oscillating universe, being advanced with a tenacity which so exceeds their intrinsic worth that one can only suspect the operation of psychological forces lying very much deeper than the usual desire of a theorist to support his/her theory (emphasis added). Chris Isham*

This is the third of 8 articles on philosophical issues in cosmology. Most of the material has been drawn from George Ellis's article, previously referenced, and articles in Quantum Cosmology and the Laws of Nature --Scientific Perspectives on Divine Action (see Reference** below).

We concluded the second post in this series with the observation that General Relativity must break down at some point close to the extrapolated t=0, near the big bang, and that perforce, quantum mechanical models had to be used for a theory of creation. As Ellis, Isham and Grib point out, there are fundamental problems in doing so.



Schrodinger's Cat--simultaneously alive and dead until the box is opened (from Wikipedia.Org)

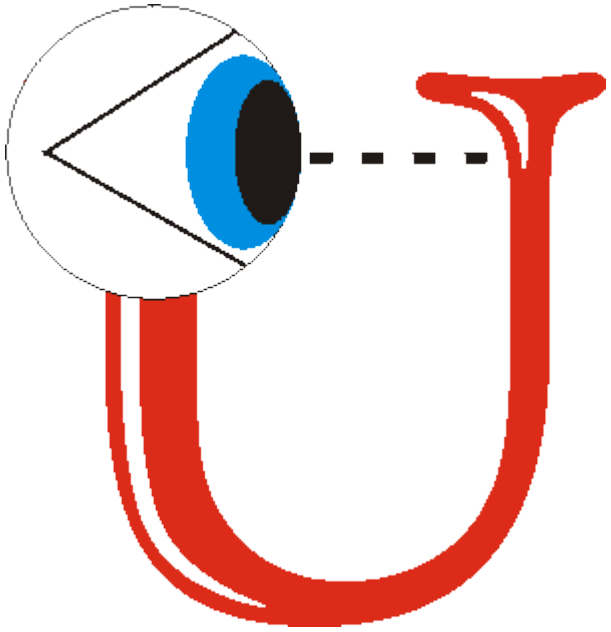
As far as bubble universes go, chaotic inflation is a hypothesis. There are, however, some recent preliminary results from B-mode measurements of the Cosmic Background radiation that support the existence of inflation (not necessarily chaotic inflation).

Nevertheless it should be clear that none of these models can be confirmed or denied by measurements. Thus they are outside the realm of science, but properly belong to the domain of mathematical metaphysics (my take). As in the Hartle-Hawking model, assumptions are made to remove the singularity at t=0, R=0. Such models without a singularity are to many physicists more aesthetically pleasing than those with, because to them the absence of a singularity is consistent with the absence of a Creator.

References

*Chris Isham, "Creation of the Universe as Quantum Process" in Physics, Philosophy and Theology--A Common Quest for Understanding.

**Chris Isham, "Quantum Theories of the Creation of the Universe"; Andrej Grib, "Quantum Cosmology, the Role of the Observer, Quantum Logic" in Quantum Cosmology and the Laws of Nature--Scientific Perspectives on Divine Action (click on the book icon, and then on the article listed on the right).



Wheeler's Participatory Universe Icon
From the University of Toronto site

Wheeler construes this basic relation to consciousness as implying a universe of information ("It from Bits"), so that by looking back in time we create the past universe, as symbolized in the famous icon shown at the left.

Grib's quantum logic model invokes a reality of non-Boolean logic that we (as observers) convert to Boolean logic situations, which is the only type of logic that our minds can comprehend. Grib speculates that perhaps it was God who made the initial observation to create a "real" universe (one perceived according to Boolean logic). According to Grib, time is a framework (lattice) for arraying the non-Boolean events in a framework that can be scanned as Boolean, and quantum mechanics is the theory for converting the non-Boolean system to Boolean.

A major one is the so-called measurement problem, which is at the heart of difficulties in the interpretation of quantum mechanics. The quantum mechanical state function can be represented as a superposition of several possible states that could be measured—when the measurement is made and a particular state results, then the superposition "collapses" into the state that is measured (e.g. Schrodinger's cat paradox).

An associated difficulty is the probability interpretation for measurement: the universe state function (wave function) gives probabilities that particular values of dynamical variables will be measured—what does probability mean in this context; are there an infinite number of possible universes (corresponding to various possible measurements) and who does the measurement? To quote Christopher Isham* (referring to the measurement problem):

"This poses the obvious problems of (i) when is an interaction between two systems to count as a measurement by one system of a property of the other? and (ii) what happens if there is an attempt to restore a degree of unity by describing the measurement process in quantum mechanical terms rather than the language of classical physics which is normally used? There is no universally accepted answer to either of these questions." (emphasis added). Chris Isham*

That being said, the following quantum mechanical models have been proposed for the origin of the universe (the list is not exhaustive, and only general comments on each will be given; for more information please see the cited articles):

Quantum fluctuations in the vacuum (Tryon, 1979).

Tunneling from "superspace" into "real" space-time (Vilenkin, 1983)

The Hartle-Hawking Block Universe, replacement of t by ti (i=square root of -1) (Hartle, Hawking, 1981)

Chaotic Inflation (Linde, 1986)***

The Participatory Universe (Wheeler, 1990)

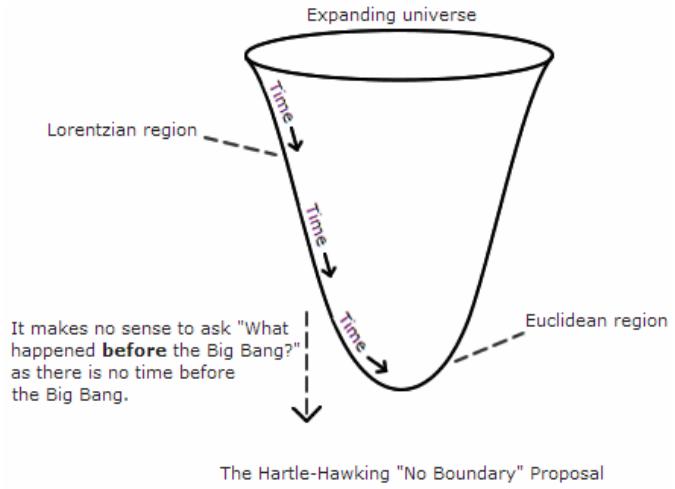
Creation from non-Boolean logic to Boolean by an observer" (Grib,1990)**

Note that in none of these (except possibly 3 or 5) was the creation "ex nihilo"; for 1, the vacuum pre-existed; for 2 the "superspace" (a hypothetical space of multi-dimensions); for 4, previous universes from which a "bubble" universe emerged via inflation; for 6, a hypothetical space of quantum universe states.

Model 1, Quantum fluctuations in the vacuum, is deficient in the following respect. There is nothing in this model to specify a unique time at which the fluctuations to enable creation should occur. Accordingly there might be creation of many universes, interacting with each other, but such has not been observed. And to emphasize again, a vacuum is not "nothing"...there is space, virtual particles, annihilation and creation operators, occupied zero-point energy levels from which the fluctuations occur.

For 3, the Hartle-Hawking model, the replacement of t by ti gives a term t^2 instead of -t^2 in the Schrodinger equation for the universe, which enables a solution without a singularity. The variable t becomes space-like, rather than time-like at very early values, and the space-like ti gradually becomes a time-like variable (goes back to t) as the value of t increases. An exact value for the time of origin becomes undefined (where does the earth start, at the South pole?).

The diagram illustrates this (vertical axis is increasing "t"). Note that there is no experimental justification for the replacement of t by ti; the justification is "esthetic", that is the substitution removes the singularity at t=0. It is said that the coordinate ti "gradually changes" from space-like to t, time-like...how is the gradual change effected? Is the universe a fraction f with ti and a fraction 1-f with t? I have never seen this explained.



Hartle-Hawking Model (from StrangeNotions.com)

In order to understand the significance of models 5 (the Participatory Universe of John Wheeler) and 6 (the quantum logic model of Andrej Grib), a comment on an interpretation of quantum mechanics that links quantum mechanics to consciousness will be helpful. (See also references in my previous posts "Do quantum entities have free will.." and "Quantum Divine Action via God, the Berkeleyan Observer..".)

The Participatory Universe and Quantum Logic models stem from the interpretation, first set forth by Von Neumann, London and Wigner, that since measurement is done by an observer, the final step in the measurement process must be awareness of the measurement result by the consciousness of the observer. Accordingly the conscious observer must be an intrinsic part of quantum mechanics.