

# COSMOLOGICAL PRESUPPOSITIONS

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## Abstract

Religious and/or philosophical presuppositions with which a scientist begins can affect work in any area of science. But physical cosmology, the study of the entire physical universe, is especially susceptible to such influence because it almost inevitably touches on questions of ultimate origins and purpose. The fact that a theory is motivated (in whole or part) by such presuppositions does not mean that it is wrong. But that possibility can alert other scientists to the need for some “tendency criticism”.

We can never be sure what presuppositions a scientist starts with but can make reasonable guesses. I will consider first some significant historical examples - Einstein’s introduction of the cosmological constant, Milne’s kinematic relativity, and the steady state theory of Bondi, Gold and Hoyle. These display an interesting range of possible presuppositions - Spinoza’s pantheism, Christianity and atheism.

We will then look at two areas of current interest - cosmic acceleration (with associated theories of dark energy and the cosmological constant) and debates about the possible creation of the universe from “nothing”.

## Introduction

Scientists develop their theories from a variety of initial presuppositions. Einstein argued that the fundamental principles of a physical theory are not found by induction from empirical data but are “free inventions of the human intellect”.<sup>1</sup> Even less are metaphysical beliefs, including religious ones, based simply on experience of the world.

Philosophical or religious beliefs may play important roles in the development of cosmological theories, especially when some of those theories are quite speculative. Scientific cosmology is more than just astrophysics on a large scale. Sagan’s claim that “The cosmos is all that is or ever was or ever will be”<sup>2</sup> illustrates the influence that our total world views can have on our cosmologies. On the other hand, the fact that we don’t like a scientist’s metaphysics doesn’t mean that his or her theory is wrong!

Perhaps equally important is the fact that the religious or anti-religious as-

sumptions of non-scientists will interact with cosmological theories they hear about. For example, whether or not people understand the big bang theory to support belief in the Christian doctrine of creation, atheism, or neither will depend to a great extent on whether they start with that doctrine or with a caricature of it.

I discuss here three historical examples involving pantheism, Christianity and atheism, and ask the important “So what?” question. We will then look at presuppositions in some current cosmological debates.

## **Pantheism and a Static Universe**

When Einstein began in 1917<sup>3</sup> to apply general relativity to cosmology it was commonly accepted that the universe in its overall aspect was unchanging. It's not obvious that that should have been so - the proper motions of stars had been known for two centuries. But Einstein did assume a static universe. His main concern was to express Mach's principle, the idea that the inertia of bodies was due to other matter in the universe. With a static universe, the only solution of his field equations was the flat, empty space-time of special relativity, with no other matter to determine the inertia of a particle.

So he included a “cosmological term” which represents a repulsive force that gets stronger with distance. That could balance the ordinary attractive aspect of gravitation and make a static universe possible. The result was a closed three-dimensional space like the surface of a four-sphere whose radius, the density of matter, and the “cosmological constant”  $\lambda$  (which determined the magnitude of the cosmological term) were related. Space was finite but had no boundary, making boundary conditions “at infinity” unnecessary.

Why did Einstein assume a static universe? It was conventional wisdom, but he wasn't one who always conformed to popular views. If he'd approached the problem without that assumption he might have predicted cosmic expansion before there was observational evidence for it.

One answer has been given by physicist and philosopher Max Jammer, a colleague of Einstein's at Princeton who wrote the book Einstein on Religion.<sup>4</sup> Einstein identified his religion with Spinoza's pantheism, in which God, who is immutable, can be identified with the divine attributes, including “an extended thing [like space]”. Thus, Jammer suggested, Einstein identified the unchanging God with the unchanging universe.<sup>5</sup>

A few years later Einstein initially rejected Friedmann's non-static solution of the field equations because he overlooked a simple calculational error.<sup>6</sup> This

suggests that he had a real investment in a static model. Scientists usually don't tell us religious motives that lie behind their theories, and Einstein wouldn't have been inclined to do so after he abandoned the cosmological term. But Jammer's suggestion is plausible, and the possible influence of Spinoza is also consistent with Einstein's belief in determinism and denial of free will.

It's interesting that today's Young Earth Creationists believe that God created a perfect, and thus static, world. One of them, Robert Gentry, has tried to adapt a static solution of Einstein's equations to fit such beliefs.<sup>7</sup>

While Einstein and others theorized, astronomers were discovering that the "spiral nebulae" were galaxies outside the Milky Way and studying their spectra. In 1929 Hubble found an empirical relation between redshifts in those spectra and the distances of galaxies. De Sitter, Friedmann and Lemaître had already found solutions of Einstein's equations that represent expanding universes and could explain this relation. In cosmological models based on general relativity, these redshifts are not, properly speaking, due to the Doppler effect. Instead, light waves in transit between source and receiver are stretched out because of the expansion of space. (In an "engine driven" model which is at rest when light is emitted and absorbed but expanding in between, there will still be a redshift.)

Because of these discoveries, Einstein renounced the cosmological constant. But that is not the end of its story, as we will see later.

## **Christianity and a Temporal Origin of the Universe**

The British astrophysicist Milne took a different approach. Consider, he said, a sphere of non-interacting particles initially moving in random directions with speeds from zero to that of light.<sup>8</sup> Particles moving outward will continue to do so, while those moving inward will pass the origin and start moving outward. Eventually all will be moving away from the center, with the fastest being farthest away. If these particles represent galaxies, light emitted from one and received by another will be Doppler shifted toward the red end of the spectrum.

At first this seems to imply a unique center of the expansion. But in the limit in which the radius of the initial sphere goes to zero, the boundary of the distribution is a sphere moving at the speed of light, and relativity tells us that an observer on any galaxy will see her or himself at its center! This is so for the whole swarm of galaxies - each observer is at the center. Uniformity of the universe for galactic observers is Milne's "cosmological principle".

Milne developed this cosmological model and “kinematic relativity”, his own version of special relativity. (He didn’t accept general relativity.) His theory gets little attention today, but his ideas were influential in the early development of cosmology. While Milne’s model is quite different from those based on general relativity that came to be described as “big bang” models, it shares with them a feature often seen to have religious significance, a temporal origin.

Of interest for us now is Milne’s last book, Modern Cosmology and the Christian Idea of God.<sup>9</sup> Near the beginning he states, “To say that the universe is rational is to say that its Creator is rational. Thus one cannot avoid the position that one’s religious beliefs must colour and control one’s attitude to science and scientific hypothesis.<sup>10</sup> That makes it seem likely that that traditional Christian belief in a temporal origin of creation influenced the development of his cosmology. For Milne’s God was not just the deity of philosophical theism. At the end of the book he says, “I was brought up as a mathematical physicist; I was also brought up as a member of the Church of England. And though I have had my periods of agnosticism, I have always recovered from them. I do most fervently believe that this universe was created by Almighty God.”

It would be superfluous to list all the people, scientists and otherwise, who have thought that big bang cosmological models support the biblical picture of creation. I will comment on that after we look at a quite different type of model.

### **Atheism and an Eternal Universe**

In the 1930s and early 1940s cosmology had a serious time scale problem. Hubble’s linear relation between recessional speed of a galaxy and its distance gives a characteristic time, the inverse of the Hubble constant  $H$ . In models without a cosmological constant this is on the order of the time since the beginning of cosmic expansion. In the 1930s,  $1/H$  was about 2 billion years, less than the age of the earth’s crust given by radioactive dating. Something was wrong if the earth was older than the universe!

Two forms of a radical solution were proposed by Bondi and Gold and by Hoyle.<sup>11</sup> In their steady state theory, there was no “beginning of cosmic expansion.” The universe always has been and always will be expanding, with matter coming into being to keep the overall state of the universe the same. The time scale difficulty could be resolved if the age of the Milky Way was somewhat greater than average galaxy.

Bondi and Gold based their model on a “perfect cosmological principle,” that the universe on a large scale looks the same to any galactic observer at any

time. The origin of new matter was a consequence of that. Hoyle, on the other hand, added a “creation field” term to Einstein’s equations. Both approaches gave the same overall structure of the universe.

I haven’t been able to find anything explicit about Gold’s religious views, but those of Bondi and Hoyle were decidedly negative. Bondi was active in atheist and secular humanist causes, while Hoyle could be derisive of both religion and “materialism”.<sup>12</sup> One might jump to the conclusion that they proposed their theory to get rid of what looked too much like an initial “creation instant”.

But while Bondi and Hoyle were undoubtedly happy with a theory that didn’t have an obvious place for God to intervene, their models were proposed to solve a genuine problem, that of the cosmic time scale. Furthermore, the hopes of Gamow and others that all the elements heavier than helium could be formed in an initial hot, dense state were unrealistic. Because their model had no such state anyway, proponents of the steady state theory - and especially Hoyle - began to develop our current theories of the formation of heavy nuclei in stellar interiors and supernova eruptions.

The time scale problem was removed by better determinations of galactic distances, and in the 1960s quasars and the microwave background radiation retired the steady state theory to the history of science museum. Some current theories, like eternal inflation, have similarities with it. Some atheists may favor such theories, but they have not been introduced just to get rid of any perceived need for God. On the other hand, religious believers can see them, as they could see the steady state theory, as consistent with creation seen as eternal dependence upon God.

## **Theological Presuppositions**

For completeness, we also should consider presuppositions that both religious and non-religious people have about belief in creation. I’ll consider three issues here. First, how important for the Christian doctrine of creation is a temporal origin of the universe?

Evidence now is very strong that cosmic expansion began in a hot, dense state about 14 billion years ago. Many Christians (as well as Jews and Muslims) think this supports Genesis 1:1 in its traditional translation: “In the beginning God created the heavens and the earth.” Some scientists were unhappy with the demise of the steady state theory, which seemed to them more elegant than its big bang competitor. In his 1978 book God and the Astronomers,<sup>13</sup> Robert Jastrow - who called himself as “an [agnostic](#) in [religious](#) matters” - put it this way.

For the scientist who has lived by his faith in the power of reason, the story ends like a bad dream. He has scaled the mountains of ignorance; he is about to conquer the highest peak; as he pulls himself over the final rock, he is greeted by a band of theologians who have been sitting there for centuries.

But serious theologians are more careful. Georges Lemaître was both a Catholic priest and an astrophysicist. He did some of the early work on expanding solutions of Einstein's equations and proposed the predecessor of modern big bang theories with his "primeval atom". He was not happy that Pope Pius XII cited such scientific ideas as vindication of the Christian doctrine of creation.

The classic big bang picture is consistent with belief in divine creation and the traditional picture of "the beginning". It's another matter to say that it "proves" that picture. The claim of Aquinas that we could know from reason that God created the world is questionable. There is a reason why we say in the Nicene Creed, "We believe in one God, the Father Almighty, maker of heaven and earth, and of all things visible and invisible." Aquinas went on to say that it is an article of faith, based on scripture, that the world had a temporal origin.<sup>14</sup> But that depends both on the way the first verses of Genesis are translated and on one's understanding of the genre of the first Genesis creation account.

The traditional Christian view does hold that "all things" in that creedal statement I quoted includes time - "The universe was created not in time but with time" as Augustine said.<sup>15</sup> It is easiest to understand this if the cosmos did have a temporal origin at a finite time in our past. But it is possible to understand creation as eternal dependence of the world on God - or, with process theologians, to deny strict *creatio ex nihilo* and see eternal coexistence of God and the world.

And Christians should not tie their faith closely to a temporal origin of the universe, because there are plenty of theoretical ways of going "back before the big bang." My first published physics paper was such a model,<sup>16</sup> and some of my other work has explored such theories. Theories don't always agree with reality, but sometimes they do.

The second thing to note is that sometimes Christians can unconsciously smuggle theologically problematic ideas into their theories. Milne, as we've seen, developed a model in which the whole universe began in a single point. But he also argued that for the whole universe to be created in one instant, God had to give it a point origin in space. Relativity (special or kinematic) denies any absolute meaning to simultaneity for spatially separated events. This may sound

plausible to physicists, but it denies the contingency of creation - the idea that God created the universe freely and could have made a different world.

A third point is that there is regrettable ignorance about what the Christian doctrine of creation means on the part of some scientists who are atheists. Krauss's A Universe from Nothing, with the subtitle Why There Is Something Rather than Nothing is the best example.<sup>17</sup> His argument is simple: The quantum vacuum isn't nothing, so gravitation can pull particles out of the quantum vacuum, so something can come from nothing. It is easy to see that this is just a "bait and switch" tactic.

It's true that quantum theory, relativity and gravitation together allow massive particles to emerge from a state of zero energy, but the fields from whose quantum vacua we start and gravitational interactions are not "nothing" in the sense in which Christian theology speaks of *creatio ex nihilo*. Hawking makes a similar blunder.<sup>18</sup>

## The Cosmological Constant Again

I had hoped to say more about the checkered history of Einstein's cosmological constant  $\lambda$  after he rejected it because of the evidence for cosmic expansion. Many relativists and cosmologists have been strongly prejudiced against the cosmological term in the field equations, though they are somewhat humbled by the discovery that cosmic expansion is speeding up in a way that can be explained by that term. I have dealt with some of the issues in a recent paper that makes use of Schrödinger's affine generalization of general relativity.<sup>19</sup> The non-metric geometry of that theory requires a non-zero value for the cosmological constant. The cosmological term can then be used to cancel out the huge vacuum energy of quantum field theories which would play havoc with a realistic cosmology. But further discussion of this will have to wait.

## References

<sup>1</sup> Albert Einstein, "On the Method of Theoretical Physics" in Essays in Science (Philosophical Library, n.d.), p.15.

<sup>2</sup> Carl Sagan, Cosmos (Random House, 1980), p.4.

<sup>3</sup> Einstein's 1917 paper "Cosmological Considerations on the General Theory of Relativity" is reprinted in Jeremy Bernstein and Gerald Feinberg (ed.), Cosmological Constants: Papers in Modern Cosmology (Columbia U., 1986), pp.16-26.

<sup>4</sup> Max Jammer, Einstein and Religion (Princeton, 1999).

<sup>5</sup> *Ibid.*, pp.62-63, 148, 257.

- <sup>6</sup> Einstein's two notes are reprinted in Bernstein & Feinberg, Cosmological Constants, pp.66-67.
- <sup>7</sup> Robert V. Gentry, "A New Redshift Interpretation," Modern Physics Letters A 12 (1997), 2919; J. Brian Pitts, "Has Robert Gentry Refuted Big Bang Cosmology? On Energy Conservation and Cosmic Expansion", Perspectives on Science and Christian Faith 56.4 (2004): 260.
- <sup>8</sup> E.A. Milne, "World Structure and the Expansion of the Universe", Nature 130 (1932): 9.
- <sup>9</sup> Milne, Modern Cosmology and the Christian Idea of God (Oxford, 1952). Pp. 134-140 of E.A. Milne, Relativity, Gravitation and World Structure (Oxford, 1935) are also relevant here.
- <sup>10</sup> This and the next quotation are from Milne, Modern Cosmology, pp.23 & 160 respectively.
- <sup>11</sup> Perhaps the best popular presentation of the steady state theory is D.W. Sciama, The Unity of the Universe (Doubleday, 1959). For the anti-religious element see [https://www.scienceand-christianbelief.org/serve\\_pdf\\_free.php?filename=SCB+18-2+McConnell.pdf](https://www.scienceand-christianbelief.org/serve_pdf_free.php?filename=SCB+18-2+McConnell.pdf) .
- <sup>12</sup> E.g., Fred Hoyle, The Nature of the Universe (Mentor, 1950), pp.120-128.
- <sup>13</sup> Robert Jastrow, God and the Astronomers (Warner, 1978). The following quotations are from pp. 1 and 105-106.
- <sup>14</sup> Thomas Aquinas, The Summa Theologica of Saint Thomas Aquinas, vol.1 (Encyclopaedia Britannica, 1952), pt.1, Q 46, Art. 2, pp.253-255
- <sup>15</sup> "*Non est mundus factus in tempore, sed cum tempore.*" Aurelius Augustinus, The City of God, book 11, chap.6, in vol.3 of Loeb Classical Library (Harvard U., 1968), pp. 446-449.
- <sup>16</sup> George L. Murphy, "Big Bang Model without Singularities", Phy. Rev.D8 (1973): 4231.
- <sup>17</sup> Lawrence M. Krauss, A Universe from Nothing (Free Press, 2012). My review is in Perspectives on Science and Christian Faith 65, no.2, (2013): 137.
- <sup>18</sup> Stephen Hawking and Leonard Mlodinow, The Grand Design (Bantam, 2012), Ch. 8.
- <sup>19</sup> George L. Murphy, "Affine Geometry, Planck Length and Cosmic Acceleration", Journal of the Washington Academy of Sciences 101.4, 33, Winter 2015.