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## The Fertile Universe

### An Interview With George V. Coyne

By Jim McDermott

#### *What is the status of the Big Bang theory today?*

You know, I don't like the term "theory"; I like "the best scientific explanation we have." At least in American English, "theory" has come to mean "an idea." I got out of the bathtub or out of the shower and saw this frog jump, and I said, "You know, that frog jumps the same way I saw these guys jumping hurdles in the summer Olympics. We must come from frogs." That's a theory.

Well, a scientific theory is more than that. A scientific theory is the best explanation we have today of all the facts we have today—all the observations, all the laboratory work, all the telescopic observations and all of this.

By the "Big Bang," what we mean is that the universe at one time was very hot and very dense, if not infinitely hot and infinitely dense (whatever that means), and today it's very expanded, much less dense and cool. That's all Big Bang cosmology means. It doesn't necessarily say that there could not be a whole series of expansions and collapses. It does not necessarily say that there was *a* beginning, although it more or less implies it. (In fact, in the early days of Big Bang cosmology, its opponents were opposed to it because it sounded too theological—if the universe has a beginning, then somebody had to begin it.)

And that is the best explanation we have today of all the observations we have of the universe. There's more helium in the universe than could be produced in the total age of the universe by all the stars in the universe. Where did that extra helium come from? It came from the universe itself, which at one time was as hot as a star is today—that is, hot enough to produce some helium before it expanded. Likewise, there are deuterium and a number of light elements whose abundance is greater than could be produced by all the stars in the universe in the total age of the universe. So there had to be some of that stuff produced already before stars began to form. That's also a sign that we had a very hot early universe.

#### *How do you respond to people who think that the Big Bang somehow contradicts the tenets of Christianity?*

I say to them that it doesn't. There's nothing in science that opposes any religious belief that I know of. Nothing. And in fact, I always put it this way: if—and it's a big capital IF—in addition to being a scientist, I'm also a religious believer, why shouldn't I use my scientific knowledge to look at my religious beliefs? For instance, if I believe that God created the universe, then its nature must say something about God, right?

To my mind, it does. In fact, I'd say my scientific knowledge of the universe as a whole and of life in the universe says a great deal about God.

#### *What does it say?*

It says that God did not create a ready-made universe, he did not create a universe like a Lego kit, putting all the pieces out and having somebody out there, over time, assemble them. He created a universe that has a dynamism, a creativity of its own. He shared his own creativity with the universe that he made.

You know, theologians have for centuries had this notion of continuous creation, creation as not a single event in the past, 14 billion years ago, but ongoing. It really helps me in my religious belief, in my prayer for instance, to think of a god who is constantly nurturing the universe; he gave the universe its own creativity, its own dynamism, and he's working *with* the universe rather than *dominating* the universe.

This requires reinterpreting what we mean by omnipotence and omniscience. Did life come to be in such a necessary way that in the very beginning of the expansion, God could have predicted that life would come to be? It is an open question, but I lean toward no, he couldn't, because it's not certain that it would come to be. There were some chance processes involved. It wasn't just chance, but there were chance events involved in the evolution of life.

***It seems as though your thinking makes the subject of God's attention the whole universe rather than just human beings.***

That's correct. I'm not denying that human beings are especially loved by God, but they're seen against the background of the whole universe.

How did life come to be? Did it come by chance or by necessity? Speaking scientifically now, there's a third element involved, it's what I call the fertility of the universe. There are 1022 stars in the universe—that's 10 with 22 zeros behind it. Each of those stars is born and is going to die, and as it dies it spews out all this chemistry into the universe—carbon, nitrogen, hydrogen, etc. Another generation of stars is formed from some of that material—the sun is a third-generation star—and that process is extremely important. If it were not happening, we would not be here. The hydrogen, nitrogen, oxygen, carbon emitted—these are the building blocks of all the sugars, amino acids, and then up to DNA, etc. In fact, in order to have the chemical abundance necessary to form even primitive life, we had to have three generations of stars. That is, we needed three generations of stars to get enough carbon to make toenails and hair (for those who have it), earlobes and all that.

The universe has been doing this for 14 billion years. That's what I mean by fertility, all these stars pouring out all this chemistry over a long period of time. Now that sounds very materialistic, and it is. But does that deny that God is working with this process to make a human being? To me, a universe that has such a dynamism to it doesn't deny God, it glorifies God. God did not take a rib from the side of Adam. He did not preconstruct life. Rather, life came to be because God made a universe in which he hoped and thought life would come to be in his image and likeness.

***Do you experience tension between your scientific work and your faith?***

All the science I studied, I studied as a Jesuit. I didn't know any better. I entered at 18, and grew up in the Society from that time on, so all my science was done against that background of a religious believer. I've never felt any schizophrenia about it.

But working at the Vatican Observatory and spending many years in Rome, I've always felt, and still feel somewhat, there's something about the church that gets on my nerves. It's this suspicion, with Galileo to begin with and with Darwin, that science is tainted with atheism. There's this feeling that if it all happened this way, then God does not have everything under control.

My point is: God doesn't want to have everything under control. He wants the universe to have its own autonomy and dynamism. The universe shares in his autonomy and dynamism.

→ the Archbishop of Vienna, Austria

I had to take on Cardinal Schönborn about this. He said that neo-Darwinian evolution is not compatible with Catholic doctrine [The New York Times, 7/8/05]. That's wrong. It's simply wrong. When I tell people this, most of the replies I get ask, "How could you contradict a cardinal?" I have to tell people that, being a cardinal, or even a pope, does not mean that everything you say is correct.

John Paul II set a great stage, and the current pope is really following that. Benedict has done a magnificent job regarding the compatibility of the culture of science and the culture of religious belief (and in particular the Catholic Church). In his homily at the vigil of Pentecost, for instance, he made a beautiful statement. Using the language of evolution, he said that the greatest mutation that ever happened was the Lord's resurrection. He went on to say what he meant by it, using a kind of scientific language—going much beyond science, of course—in his theological and spiritual musings. He's a great supporter of ours. As a cardinal he came to the observatory with his whole office staff almost every year. They'd spend an hour there; he'd ask all kinds of questions. He loved to come by.

### ***What's one project going on at the observatory right now?***

Father Bill Stoeger of our staff works on the structure of the universe, cosmology from a theoretical point of view. One of the interesting things he is studying is the idea of the multiverse, that is, that we're only one of many universes. The basis for the concept lies in the nature of our own universe. There are many constants of nature—the velocity of light, the gravity constant, the mass of the proton, the electric charge on the electron. Then there are the laws of nature like the conservation of energy. If there were a slight difference in any one of those constants, we would not be here. For instance, if the ratio of the mass of the proton to the electron were only slightly different, the sun would have burned up its thermonuclear fuel too soon, before earth or any planets could form. Likewise, if the constant of gravity were slightly different, stars would be born and die so rapidly that there would not be any possibility of forming planetary systems. And so on. If any one of these constants were slightly different, we would not be here. That's why it is said that our universe is "fine tuned" for life.

Now how do you explain that? Well, a religious believer can immediately say that God did it. But a scientist can't step outside the natural phenomenon that he observes. Given that, one explanation is that there were many universes created after the initial expansion, each one with its own series of constants and laws of nature, and we just happen to be in the one that's fine tuned.

It's very theoretical, very contested, and Bill is deeply involved in finding out whether it's scientific at all—that is, whether it can be proven, whether there's a test for it. To be scientific, it has to be verifiable. There has to be a way of proving it true or false. I myself don't think there is.

### ***What astronomical or scientific discovery or advance might we see in the next 10 years?***

I know one I'd like to see. If we could discover life, even primitive forms of life that are clearly independent of life on the earth, that would be the biggest discovery since science came to be.

### ***Is it possible?***

Yes, although I don't know specifically. We're beginning to build up more and more knowledge of the conditions for life. For example, having planetary systems is one of the conditions for life, and we've discovered more than 150 planets around other stars. But we haven't discovered a planet like the earth, because it's technically not possible to do that yet. We're building our resources.

Why do I say it would be momentous? Well, life is so hard to begin. If we found that life began twice

independently—that is, it was not carried here from elsewhere, and it was not carried from here to elsewhere—then we are overcoming the thought that it's so rare that it could only be on the earth. If it happened twice, it happened many, many times. And that changes the whole nature of the universe. The universe becomes fertile with life.

But we don't know that yet. Life could be extremely rare, if not unique to the earth. We just don't know.

Every time we think we know it all, we're thrown back on our heels. We've now discovered that the universe will never collapse, because it's accelerating in its expansion. This defies the law of gravity. Since there is material in the universe, and material exerts gravity, the universe should be constantly slowing down in its expansion. But at large distances the universe is not being pulled back, it's going faster. So that means there has to be some dark energy in the universe that's pushing against gravity. God knows what that is. We're ignorant.

Scientists don't give that impression often enough to people. We measure the distance to the moon in millimeters; we're big shots. We know it all. But when you do science, you know how little we know.

**George V. Coyne, S.J.**, 73, recently retired as director of the Vatican Observatory, where he worked since 1969. In his 28 years as director, he improved the technological capacities of the observatory, including the development of the Vatican Advanced Technology Telescope, started the Vatican Observatory Foundation and developed ways of incorporating education into the observatory's mission of astronomical research. Among Father Coyne's many honors, he has had a comet named after him. **Jim McDermott, S.J.**, an associate editor of America, interviewed Father Coyne about current issues in science and religion shortly before he was succeeded in August by José G. Funes, S.J., a member of the observatory staff.

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1. What is the "Big Bang theory"? Why is "theory" not a good term to use here?
2. Does the Big Bang theory contradict Christianity? Explain — be sure to explain how scientific knowledge of the universe says a great deal about God.
3. What is "the fertility of the universe"?
4. Does God want control of everything? Explain.
5. How is our universe "fine tuned" for life?