Greatest Mysteries: How Did the Universe Begin?

By Ker Than Staff Writer , posted: 13 August 2007 @ 06:01 am ET

Editor's Note: *We asked several scientists from various fields what they thought were the greatest mysteries today, and then we added a few that were on our minds, too. This article is one of 15 in LiveScience's "Greatest Mysteries" series running each weekday.* (copied from: http://www.space.com/scienceastronomy/070813_mm_universe.html)

How did the universe come to be?

It is perhaps the greatest Great Mystery, and the root of all the others. The rest of humanity's grand questions-How did life begin? What is consciousness? What is dark matter, dark energy, gravity?-stem from it.

"All other mysteries lie downstream of this question," said Ann Druyan, the author and widow of astronomer Carl Sagan. "It matters to me because I am human and do not like not knowing."

Even as the theories attempting to solve this mystery grow increasingly complex, scientists are haunted by the possibility that some of the most critical links in their chain of reasoning is wrong.

Fundamental mysteries

According to the standard Big Bang model, the universe was born during a period of inflation that began about 13.7 billion years ago. Like a rapidly expanding balloon, it swelled from a size smaller than an electron to nearly its current size within a tiny fraction of a second.

Initially, the universe was permeated only by energy. Some of this energy congealed into particles, which assembled into light atoms like hydrogen and helium. These atoms clumped first into galaxies, then stars, inside whose fiery furnaces all the other elements were forged.

This is the generally agreed-upon picture of our universe's origins as depicted by scientists. It is a powerful model that explains many of the things scientists see when they look up in the sky, such as the remarkable smoothness of space-time on large scales and the even distribution of galaxies on opposite sides of the universe.

But there are things about it that make some scientists uneasy. For starters, the idea that the universe underwent a period of rapid inflation early in its history cannot be directly tested, and it relies on the existence of a mysterious form of energy in the universe's beginning that has long disappeared.

"Inflation is an extremely powerful theory, and yet we still have no idea what caused inflation-or whether it is even the correct theory, although it works extremely well," said Eric Agol, an astrophysicist at the University of Washington.

For some scientists, inflation is a clunky addition to the Big Bang model, a necessary complexity appended to make it fit with observations. Nor was it the last such addition.

"We've also learned there has to be dark matter in the universe, and now dark energy," said Paul Steinhardt, a theoretical physicist at Princeton University. "So the way the model works today is you say, 'OK, you take some Big Bang, you take some inflation, you tune that to have the following properties, then you add a certain amount of dark matter and dark energy.' These things aren't connected in a coherent theory."

"What's disturbing is when you have a theory and you make a new observation, you have to add new components," Steinhardt added. "And they're not connected ... There's no reason to add them, and no particular reason to add them in that particular amount, except the observations. The question is how much you're explaining and how much you're engineering a model. And we don't' know yet."

An ageless universe

In recent years, Steinhardt has been working with colleague Neil Turok at Cambridge University on a radical alternative to the standard Big Bang model.

According to their idea, called the ekpyrotic universe theory, the universe was born not just once, but multiple times in endless cycles of fiery death and rebirth. Enormous sheet-like "branes," representing different parts of our universe, collide about once every trillion years, triggering Big Bang-like explosions that re-inject matter and energy into the universe.

The pair claims that their ekpyrotic, or "cyclic," theory would explain not only inflation, but other cosmic mysteries as well, including dark matter, dark energy and why the universe appears to be expanding at an ever-accelerating clip.

While controversial, the ekpyrotic theory raises the possibility that the universe is ageless and self-renewing. It is a prospect perhaps even more awe-inspiring than a universe with a definite beginning and end, for it would mean that the stars in the sky, even the oldest ones, are like short-lived fireflies in the grand scheme of things.

"Does the universe resemble any of the physical models we make of it? I'd like to hope that the effort society pours into scientific research is getting us closer to fundamental truths, and not just a way to make useful tools," said Caltech astronomer Richard Massey. "But I'm equally terrified of finding out that everything I know is wrong, and secretly hope that I don't."