Universe offers 'eternal feast,' cosmologist says

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There is no such thing as a free lunch, some say, but they would be wrong. In fact, the entirety of the universe defies them. According to Stanford physics Professor Andrei Linde, one of the architects of the inflationary theory, our universe (and all the matter in it) was born out of a vacuum.

"Recent developments in cosmology have irreversibly changed our understanding of the structure and fate of our universe and of our own place in it," says Linde, who will discuss the inflationary view of the universe at the annual meeting of the American Association for the Advancement of Science.

In the same session, titled "Multiverses, Dark Energy and Physics as an Environmental Science," physics Professor Leonard Susskind of Stanford will talk about string theory and its relation to inflationary theory and physics Professor Lawrence Krauss of Case Western Reserve University will represent the skeptic view.

The conventional theory of the Big Bang says that the newborn universe was huge, containing more than 10^80 [ten raised to the power of eighty] tons of matter. But physicists were stumped for an explanation of where all this matter came from. Inflationary theory solves this problem by showing how our universe could emerge from less than a milligram of matter, or perhaps even from literally nothing.

From the Big Bang theory to inflation

Physicist Alan Guth of MIT proposed the inflationary theory in 1981, but its original version did not work until Linde improved it. Guth and Linde realized that rather than expanding at an ever-decreasing rate, as was predicted by the Big Bang theory, the universe could have inflated at exponentially rapid speeds.

Just as a landscape is diverse with peaks and valleys, quantum fluctuations in the fabric of space-time form an energetic landscape. The energy driving expansion of the universe, Linde explained, is a bit like a ball rolling around a bowl. As the ball rolls down the side of the bowl, the intensity of quantum fluctuations decreases until it reaches the stable point at the bottom. The heat created by these oscillations at the bottom of the bowl is what caused the Big Bang, and the preceding stage of inflation is what made the bang so incredibly big, Linde said.

"Quantum events are taking place all around us," he said. "They are very, very small." Some of these small quantum events caught up in the process of rapid expansion of space became galaxies along the way.

"If galaxies are the result of quantum fluctuations," said Linde with a shrug, "imagine what we are."

'An unexpected gift' from string theory

The possibility that enormously large galaxies originated from tiny quantum fluctuations may seem too strange to be true. But many aspects of inflationary theory were confirmed by recent astronomical observations, for which the observers won the Nobel Prize in 2006. This gives some credence to an even more surprising claim made by Linde: During inflation, quantum fluctuations can produce not only galaxies, but also new parts of the universe.

Take an expanding universe with its little pockets of heterogeneous quantum events. At some point one of those random events may actually "escape" from its parent universe, forming a new one, Linde said. To use the ball analogy, if it experiences small perturbations as it rolls, it might at some point roll over into the next valley, initiating a new inflationary process, he said.

"The string theorists predict that there are perhaps 10^1,000 [ten raised to the power of one thousand] different types of universes that can be formed that way," Linde said. "I had known that there must be many different kinds of universes with different physical properties, but this huge number of different possibilities was an unexpected gift of string theory."

According to string theory, there are ten dimensions. We live aware of four of them-three of space plus one of time. The rest are so small that we cannot experience them directly. In 2003, Stanford physicists Shamit Kachru, Renata Kallosh and Andrei Linde, with their collaborator Sandip Trivedi from India, discovered that these compacted dimensions want to expand, but that the time it would take for them to do so is beyond human comprehension. When a new universe buds off from its parent, the configuration of which dimensions remain small and which grow large determines the physical laws of that universe. In other words, an infinite number of worlds could exist with 10^1,000 different types of physical laws operating among them. Susskind called this picture "the string theory landscape."

For many physicists, it is disturbing to think that the very laws and properties that are the essence of our world might only hold true as long as we remain in that world. "We always wanted to discover the theory of everything that would explain the unique properties of our world, and now we must adjust to the thought that many different worlds are possible," Linde said. But he sees an advantage in what some others could see as a problem: "We finally learned that the inflationary universe is not just a free lunch: It is an eternal feast where all possible dishes are served."

Source: Stanford University

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