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Cosmos 'Big Bubble' theorist Alan Guth to deliver Hofstadter Lecture

BY STEPHANIE CHASTEEN

The universe may have started with a bubble, not a bang.

In 1980, an unknown physicist named Alan Guth proposed a modification to the Big Bang theory. Guth suggested that in the first moments of the life of our universe it



Alan Guth

inflated like an enormous bubble. Inflationary theory has been very successful at solving many of the problems that had puzzled scientists for years, including the fact that the Big Bang would not produce a universe large enough to hold even a sheet of paper.

"The bang was there, but it was not big," says Stanford physics Professor Andrei Linde, a cosmological theorist.

Guth, who is now the Victor Weisskopf Professor of Physics at MIT, will deliver a free, public talk at 8 p.m. Monday, Jan. 27, in the SEQ Teaching Center, Room 201. His invited talk, titled

"Cosmic Inflation and the Accelerating Universe," is the 2003 Robert Hofstadter Memorial Lecture. Hosted by Stanford's Physics Department, the lecture is the 11th to honor Nobel Prize-winning physicist Robert Hofstadter, who served on the physics faculty from 1950 until his death in 1990.

Guth also will deliver a more technical colloquium, "Time Travel and Cosmic Strings: A Playground for Theoretical Physicists," at 4:15 p.m. Tuesday, Jan. 28, in the same location.

With Linde and Paul Steinhardt of Princeton, Guth is co-recipient of the 2002 Dirac Medal for groundbreaking work in cosmic inflation theory. He is also author of a popular book, *The Inflationary Universe: The Quest for a New Theory of Cosmic Origins* (1998).

Inflationary theory does not replace Big Bang theory, but adds an extra stage: Before the Big Bang, the universe went through a period of extremely rapid expansion, growing by 30 orders of magnitude in a fraction of a second. It is difficult to imagine something becoming this large this quickly – picture a pea expanding to the size of the Milky Way more quickly than the blink of an eye. After this exponential inflation, expansion slowed to

the sedate pace observed today.

When he came up with the theory of cosmic inflation, Guth was a 34-year old physicist at the Stanford Linear Accelerator Center (SLAC) in the ninth year of a seemingly interminable career as a postdoctoral fellow. He was working on the problem of magnetic monopoles: particles that behave like the North end of a magnet without the South end. The Big Bang model predicted an abundance of magnetic monopoles but none have ever been found – a source of great concern to theoreticians.

A few years earlier, Linde had suggested that, in its early stages, the universe had undergone a series of phase transitions, accompanied by supercooling. Supercooling is seen quite often in phase transitions from one form of matter to another, such as water cooling to ice. In supercooling, water will remain liquid as it cools below 32 degrees Fahrenheit – the temperature at which it normally freezes – but at the slightest disturbance it will immediately freeze. Guth and Cornell postdoctoral scholar Henry Tye were working on the problem of how supercooling in the early universe would affect the production of magnetic monopoles.

"So I went home one night and did that calculation and discovered that it would have a dramatic effect on the evolution of the universe," Guth says of his revelation. The supercooled matter would cause gravity to reverse direction, so that objects would repel each other, resulting in exponential inflation. It would also make magnetic monopoles exceedingly rare.

The impact of the theory was immediate.

"People realized that this was a good idea," says Linde. "You can solve a lot of cosmological problems just by one simple trick."

And what's next for inflation? Guth is excited about current theories of eternal inflation, which picture the universe as a huge, growing fractal.

"Once started, inflation never stops, but an eternal inflationary tree spawns a never-ending succession of bubble universes, each of which evolves according to the inflationary Big Bang description," says Guth.

And so, says Linde, "the universe becomes immortal." ■

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