

that because *Eomaia* doesn't belong to a modern order, it leaves the major discrepancy unchanged. In that case, paleontologists will have to wait for more gems to emerge from Liaoning or elsewhere.

—ERIK STOKSTAD

COSMOLOGY

Eternal-Universe Idea Comes Full Circle

The branes are planes and make the cosmos wane. So says a new theory published online by *Science* this week (www.sciencexpress.org). Surprisingly, the theory—an alternative to the standard, inflationary picture of the formation and demise of the universe—describes a sheetlike “brane” universe that eternally dies and rises from its ashes, hearkening back to the long-discarded steady-state model of a cosmos without beginning or end.

“It seems like a consistent philosophical framework. Time is infinite, space is infinite, and they have always been here,” says Cambridge University’s Neil Turok, one of the authors of the theory. “It’s exactly what the steady-state-universe people wanted. Our model really realizes their goal.”

The new idea is an extension of the ekpyrotic or “Big Splat” theory, which Turok and other physicists introduced last year as an alternative to inflation (*Science*, 13 April 2001, p. 189). Inflationary theory says that for less than 10^{-30} of a second, the universe expanded at an incredible rate—an idea that can explain features of our universe such as the astonishing similarity of widely separated regions in space and the nature of the cosmic background radiation. Turok, along with Paul Steinhardt of Princeton University and two other colleagues, sought an alternative to inflation based upon the mathematical framework of M theory, a popular successor to superstring theory. The result: the ekpyrotic universe, which describes the birth of our universe in the collision of enormous four-dimensional membranes, or branes. Not only did the ekpyrotic model make similar predictions to inflationary theory, it got rid of the troubling “singularity” of the big bang itself.

The latest version is a more sophisticated variant of the original ekpyrotic theory. Two infinite branes—our own universe and a “mirror universe”—live a tiny fraction of a meter apart. “If you wait long enough, the branes approach one another,” says Steinhardt. They collide, and the energy of that collision creates all the matter and energy in our universe. The membranes “bounce” and separate again. The newborn universe, on its brane, then evolves and eventually burns out.

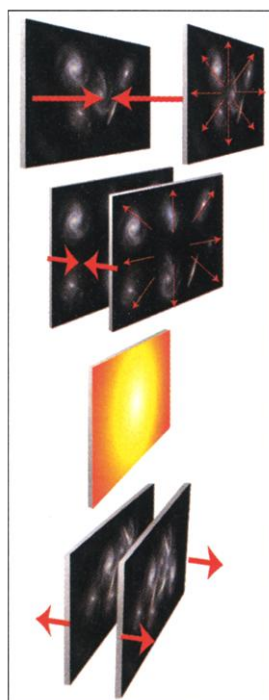
The theorists were surprised to realize that the collapse-and-bounce process repeats itself ad infinitum. Because the surfaces of

the membranes are constantly stretching—thanks to an expansion factor known as the cosmological constant—the “ashes” of each dying universe are diluted and scattered, making it possible to bounce again and again without causing a buildup of brane-bound debris that would end the process. The universe is born, dies, and is reborn again.

The inventor of the inflationary-universe model, physicist Alan Guth of the Massachusetts Institute of Technology in Cambridge, Massachusetts, says the new theory’s links to M theory and string theory are “exciting” but don’t guarantee its future. “I think it really does come down to the physics of the bounce,” Guth says.

To Turok, the new theory is not only mathematically consistent but aesthetically pleasing. “I never had any strong philosophical opinion of this before I worked on it. I was very skeptical of cyclic models,” he says. “But as soon as I started working on this, I appreciated that time marched on—that there was no beginning of time.” Will the new theory catch on? Time will tell.

—CHARLES SEIFE



No end. In new model, colliding sheetlike “brane” universes stamp out repeated big bangs.

BIODEFENSE

New Anthrax Vaccine Gets a Green Light

After years of trying to interest people in a new, genetically engineered anthrax vaccine, researchers learned last week that the U.S. government wants to buy one—in a hurry. The National Institute of Allergy and Infectious Diseases (NIAID) in Bethesda, Maryland, announced 18 April that it is seeking bids to develop and test candidates. The Department of Health and Human Services (HHS) plans to follow up with a contract to buy 25 million doses of the winner, to be added to the nation’s emergency stockpile. President George W. Bush has already requested \$250 million in his 2003 budget for the project.

The only anthrax vaccine licensed in the United States today is a mixture of proteins produced by a tame form of *Bacillus anthracis*, the bacterium that causes anthrax. This anthrax vaccine adsorbed (AVA), as it’s called, was developed for animal-hide workers in the 1950s and is now used primarily by the military. Although some claim that AVA causes serious side effects, a panel from the Insti-

tute of Medicine concluded last month that it is effective and reasonably safe.

But it isn’t ideal for general use, says Carole Heilman, director of NIAID’s division of microbiology and infectious diseases, primarily because immunity builds up slowly. Vaccinees require a series of six shots over 18 months, followed by a yearly booster. Instead, NIAID wants a vaccine that requires no more than three shots and that would work so rapidly that it could be given after exposure to anthrax spores.

Researchers have been exploring many alternatives to AVA. But because speed is of the essence, says Heilman, NIAID has decided to go with the most extensively tested new vaccine: one based on a protein in the bacterium’s toxin complex called protective antigen (PA). This

protein is part of the mélange present in AVA, and researchers believe that it is the main contributor to protection. However, they don’t know how potent a vaccine based on PA will be in humans. Studies by Arthur Friedlander and others at the U.S. Army Medical Research Institute of Infectious Diseases in Fort Detrick, Maryland, have shown that recombinant PA, produced by non-spore-forming *B. anthracis*, protects rhesus monkeys against inhalational anthrax; they also suggest that fewer injections of the vaccine might suffice to elicit immunity and that the vaccine might have fewer side effects than AVA.

Some say the choice for injected PA is needlessly conservative, citing other, more promising approaches. “It’s very disappointing that [NIAID] is sticking to the tried and true,” says Uma Ryan, CEO of AVANT Im-



Yesterday’s vaccine. The government wants a modern successor to AVA for the civilian population.