Making universes, constants out of nothing

Why is a proton about 2,000 times more massive than an electron? Why is the force of gravity so much weaker than the other forces of nature?

Such questions have long perplexed researchers interested in understanding why the fundamental constants of nature have the particular values observed in our universe.

Some believe there exists a unique, logically consistent theory of everything from which all constants can, in principle, be calculated — though no one has yet found a completely convincing candidate for this theory.

Others appeal to the notion that these values are to a large extent consistent with the existence of conscious observers who can wonder about such questions. In other words, if one assumes that the production of heavy elements in stars and their dispersal in supernova explosions are essential for the evolution of life, this anthropic principle imposes strict constraints on the values of the electron and proton masses and other constants.

Now, Alexander Vilenkin of Tufts University in Medford, Mass., has taken an alternative approach to determining the most likely values of the fundamental constants of nature — one rooted in quantum cosmology. He outlines his argument in the Feb. 6 PHYSICAL REVIEW LETTERS.

Quantum cosmology posits that incredibly tiny universes spontaneously nucleate out of nothing. All of the universes in this metauniverse are disconnected from one another and generally have different initial conditions and values of the fundamental constants.

Once formed, these universes undergo very brief periods of exceedingly rapid expansion. In effect, during this process of inflation, gravity becomes a repulsive force.

In a variation of this picture, quantum cosmology pioneer Andrei D. Linde of Stanford University has proposed that the universe is a huge, growing fractal. Such a universe consists of many inflating balls, which in turn produce new balls, and so on. Only in pockets where inflation has stopped have the laws of physics become fixed.

Vilenkin assumes that we are one of an infinite number of civilizations living in regions of the metauniverse where inflation has virtually ceased.

"Although it may be tempting to believe that our civilization is very special, the history of cosmology demonstrates that the assumption of being average is often a fruitful hypothesis," he says. "I call this the principle of mediocrity."

"It's a reasonable approach to take," says J. Richard Gott III of Princeton University. In 1993, Gott used a similar viewpoint — calling it the Copernican principle — to estimate our likelihood of colonizing our galaxy and encountering intelligent extraterrestrial life.

Vilenkin argues that for our type of intelligent life to exist, the local universe must have certain features. By applying the principle of mediocrity, "we can explain some values of the constants that otherwise seem [specially selected] and predict some constants that have not yet been measured," he says.

Vilenkin's approach favors local universes in which inflation plays a significant role in creating a large volume with room for lots of civilizations. But this process tends to wash out any quantum fluctuations that could lead to galaxy formation. Hence, the principle of mediocrity favors scenarios in which cosmic strings or other spacetime defects (SN: 10/15/94, p.248) serve as the seeds for galaxies and other cosmic structures.

It also suggests that the cosmological constant — a correction term sometimes added to the equations of general relativity — has a small but appreciable value. Theorists have generally argued that no such correction term is necessary (SN: 1/5/91, p.12).

"Though everything is very speculative at this point, this work suggests that maybe there's another way of thinking about things which would make a nonzero cosmological constant sound much more plausible," says Alan H. Guth of the Massachusetts Institute of Technology.

Vilenkin admits he is pushing the ideas of cosmology and quantum mechanics far beyond the range over which they have been tested. However, "my approach makes direct observational predictions and is therefore falsifiable," he says. *— I. Peterson*

Human irradiation data now on Internet

Over the past year, news stories have recounted, sometimes in vast detail, a host of federally sponsored studies testing radiation's effects on humans. A trove of files describing these discontinued experiments, involving about 9,000 individuals, has now been declassified. By April 15, the documents should be available for computer viewing by historians, health physicists, and anyone else with access to the Internet.

Last week, attorney Ellyn R. Weiss, director of the Department of Energy's year-old Office of Human Radiation Experiments (OHRE), described her group's efforts to identify and unearth documentation pertaining to radiation experimentation carried out since 1944 by DOE's predecessor agencies.

"We started out with a universe of 3.2 million cubic feet of records scattered all over the country," she says. From these, OHRE compiled a database of the most critical 150,000 pages of photos and text, describing slightly more than 150 experiments, Weiss says. But, she adds, "we know about and are trying to piece together information about at least another 150." Those additional data should be on-line later this year.

Files on the first 150 experiments are now being photographed and loaded onto Internet's World Wide Web. Because OHRE scans in the files' text, on-line users can search any of the documents by typing in key words. For instance, keying in Glenn Seaborg (Science Service's board chairman) and plutonium (the element whose discovery helped win him a Nobel Prize) brings up 60 hits — representing 24 separate documents — from the 500 pages currently on-line.

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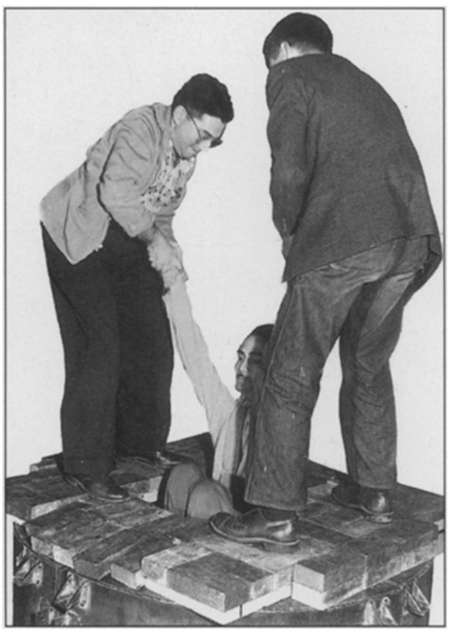

One photo now on Internet shows nuclear medicine pioneer Wright Langham being lowered into the first whole-body radiation counter, at Los Alamos.

The electronic address for the "home page," which allows computer users to browse through attached files, is *http://www.eh.doe.gov/ohre/home.htm.* DOE also offers electronic mail (E-mail) support services for accessing the files at *ohre-support@hq.doe.gov.*

And for those not yet comfortable "surfing the 'net," paper copies of the same photos, memos, and reports await perusal at OHRE's headquarters in Washington, D.C., and its Coordination and Information Center in Las Vegas, Nev. *— J. Raloff*