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SLAC physicist Eva Silverstein named 1999 MacArthur Fellow

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Eva Silverstein, a theoretical physicist whose studies have provided interesting new ideas about the nature of the universe, is one of this year's MacArthur Fellows.

An assistant professor at the Stanford Linear Accelerator Center (SLAC), she is one of 32 individuals who will receive fellowships this year, the John D. and Catherine T. MacArthur Foundation of Chicago announced on Wednesday, June 23. Each fellow will receive five years of unrestricted "no strings attached" support ranging from $200,000 to $375,000 to use as he or she sees fit. Silverstein will receive $235,000.

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Silverstein, 28, studies string theory, a mathematical description of the universe that uses microscopic vibrating strings, rather than conventional particles, as basic building blocks. Her work, done in collaboration with Shamit Kachru at the University of California-Berkeley, has linked recent theories of particle physics and cosmology.

"This is overwhelming, really a tremendous surprise," Silverstein said. "But in any case the work that I'm being recognized for was done in collaboration with a colleague, Shamit Kachru, whose contributions were as crucial as my own and deserve similar recognition."

Burton Richter, director of SLAC, a Department of Energy research laboratory, said that "Eva is one of the most brilliant of the younger generation of theorists. She is a driven worker, a magnet for graduate students, and, incidentally, is the best soccer player on the theory team. I expect great things from her, and the MacArthur Fellowship indicates that others think the same."

Stanford physics Professor Stephen Shenker, a string theorist and former MacArthur Fellow, also praises Silverstein, adding that "she is a catalyst in group discussions and collaborations, which is the way physics is done these days, and she has an amazing ability to nucleate new ideas."

An example of this ability is a unique approach that she and Kachru developed that involves one of the key issues in string theory: the fact that it has 10 dimensions, rather than just the four that people can perceive. String theorists have attacked this problem by assuming that the other six dimensions are "compactified," curled up so small that they cannot be detected. Take the case of a straw. Viewed from a distance, it appears to have only one dimension, length: Its width and depth are too small to see. But simple circular compactification produced unrealistic results. So string theorists developed a number of other, far more complicated compactification schemes.

Kachru and Silverstein constructed a simple type of compactification, using an approach called orbifold theory, that folds up string theory's extra six dimensions into a shape something like that of a tetrahedron and has a number of interesting and important ramifications:

- One is a simpler explanation of empty space. Quantum mechanics requires that any vacuum be filled with particles and antiparticles that are continually being created and annihilated. As a result, a vacuum possess a certain amount of energy, although a tiny amount compared to that carried by particles. In order to explain this, theorists have invented a theory called supersymmetry that postulates a number of particles that have not yet been observed. Most string theories have incorporated this theory. But Kachru and Silverstein have shown that string theory can explain the vacuum state without invoking supersymmetry. Their model has some other, unrealistic features, but the theorists are searching for better ones using some new ideas that they have developed.

- Kachru and Silverstein's calculations are also consistent with recent estimates of the size of the cosmological constant, a term invented by Einstein to counteract the expansion of the universe because he thought the universe must be static. He later renounced the constant, calling it his "biggest mistake." But physicists have related it to vacuum energy and resurrected it to explain certain aspects of recent supernova observations, but at a dramatically smaller magnitude than that predicted by most string theory formulations. Kachru and Silverstein have shown that, in some approximations, string theory without supersymmetry contains low-energy vacuum states that generate a realistically small cosmological constant.
- Their approach, if successful, also could help reconcile Einstein's theory of gravity with quantum mechanics, the rules that govern the subatomic realm. At very low energies their model, like most string models, produces basic quantum mechanical equations, called gauge theories, that share general features with the standard model of particle physics that describes all the known particles. Because such models also contain gravity, they reduce the problem of integrating the two theories into a more familiar form, although one that theoreticians have yet to solve.

Silverstein received her bachelor's degree from Harvard in 1992 and her doctorate from Princeton in 1996. She worked for a year as a postdoctoral associate at Rutgers University before coming to SLAC. In the past year, she won a fellowship from the Alfred P. Sloan Foundation and an Outstanding Junior Investigator Award from the Department of Energy. SR