

## 'Superstrings' could raise cosmic clatter

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Albert Einstein theorized long ago that moving things would warp the fabric of space and time, which according to his findings are united as a four-dimensional space-time. As the objects travel, they would also emit ripples of gravity called gravitational waves.

No one has detected that yet, but some researchers believe they could find such waves coming from strange, wispy cosmic structures called superstrings. Cosmic superstrings are theorized to wiggle and oscillate, producing gravitational waves, and then to slowly shrink as they lose energy until they disappear. (Courtesy University of Washington.) Many physicists are interested in a complex, controversial set of ideas called string theory, which casts the four basic forces identified in nature as manifestations of one, underlying force. The four are called electromagnetism, weak, strong and gravity. String theory is sometimes criticized for being untestable, even scientific. But some versions of it predict the formation of exotic structures that the researchers say would have observable effects: cosmic superstrings. These are narrow tubes of energy left over from the beginning of the universe, and stretched to enormous lengths by the expansion of the universe, said cosmologist Craig Hogan of the University of Washington in Seattle, Wash. If the theory is correct, there are countless cosmic superstrings stretched like galaxy-sized rubber bands, he added. They resemble ultra-thin tubes with some of the early universe preserved inside, Hogan said. The strings can form into loops that flop around and emit gravitational waves. In the process, they give off their energy and eventually disappear. "They're so light that they can't have any effect on cosmic structure, but they create this bath of gravitational waves just by decaying," he said. The theory holds that eventually time something moves it emits a gravitational wave. Colliding black holes would send out more waves than anything, typically a million times more power than is produced by all the galaxies in the universe. Some gravitational waves could theoretically be heard, Hogan said. But most have a frequency, or speed of vibration, too low to hear "10 to 20 octaves, or full scales, below the range of human hearing." "Big masses tend to take a long time to move about, so there are more sources at lower frequencies," he said. "Sensing these vibrations would add the soundtrack to the beautiful imagery of astronomy." A proposed orbiter called the Laser Interferometer Space Antenna, being developed by NASA, could provide the first measurements of very low frequency gravitational waves, perhaps the first such measurements at any frequency, Hogan said. In addition to the expected wave sources, these signals also might come from superstrings "providing the first real physical evidence that these strings exist," he said. Hogan and Matt Pies, a doctoral student at the university, were scheduled to present calculations for gravitational waves generated by cosmic strings, as well as the larger rationale for the space antenna mission, on Monday at the American Astronomical Society meeting in Seattle. An Earth-based project called the Laser Interferometer Gravitational-Wave Observatory also is trying to observe gravitational waves. But its search in higher frequencies where Hogan believes waves from superstrings would be much harder to detect, because of background noise. "The strings, if they exist, are part of that noise, but we want to listen in at lower frequencies and try to detect them," he said.

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