Superstrings could add gravitational cacophony to universe's chorus

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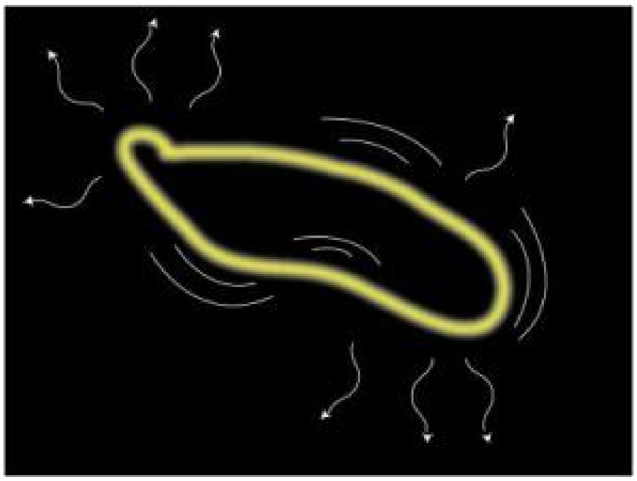

Cosmic superstring loops wiggle and oscillate, producing gravitational waves, then slowly shrink as they lose energy until they disappear. Credit: Matt DePies/UW

Albert Einstein theorized long ago that moving matter would warp the fabric of four-dimensional space-time, sending out ripples of gravity called gravitational waves. No one has observed such a phenomenon so far, but University of Washington researchers believe it is possible to detect such waves coming from strange wispy structures called cosmic superstrings.

Many physicists consider a complex and sometimes-controversial premise called string theory to be a leading candidate to unify their understanding of the four basic forces of nature – gravity, electromagnetic, weak and strong. String theory is sometimes criticized for being untestable or even unscientific, but some versions now predict an exotic behavior with observable effects: the formation of cosmic superstrings, narrow tubes of energy left from the beginning of the universe that have been stretched to enormous lengths by the expansion of the universe, said UW cosmologist Craig Hogan.

If the theories are correct, there are countless cosmic superstrings stretched like a galactic-sized rubber band. They resemble ultra-thin tubes with some of the vacuum of the early universe preserved inside, Hogan said. The strings can form into loops that "flop around" and emit gravitational waves as they decay 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.

Theory holds that every time something moves it emits a gravitational wave. Colliding black holes send out more waves than anything else, typically a million times more power than is produced by all the galaxies in the universe. While some gravitational waves could occur at frequencies high enough that a human theoretically could hear them, many more of the sources have very low frequencies, 10 to 20 octaves below the range of human hearing, Hogan said.

"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 that we are used to seeing. All this time, we have been watching a silent movie."

A proposed orbiting observatory called the Laser Interferometer Space Antenna, being developed by the National Aeronautics and Space Administration, 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, such as binary stars and black holes, these signals also might include the first direct evidence of cosmic superstrings.

"If we see some of this background, we will have real physical evidence that these strings exist," he said.

Calculations for gravitational waves generated by cosmic strings, as well as the larger rationale for the space antenna mission, are being presented today at the American Astronomical Society national meeting in Seattle in a poster by Hogan and Matt DePies, a UW physics doctoral student and visiting physics lecturer.

An Earth-based project called the Laser Interferometer Gravitational-Wave Observatory also is attempting to observe gravitational waves, but it is searching in higher frequencies where Hogan believes waves from superstrings would be much harder to detect. That's because the background noise would make it difficult to identify the waves emitted by strings.

"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.

Source: University of Washington