Cosmic strings might emit cosmic sparks, answer cosmological questions

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(PhysOrg.com) -- For astronomers, understanding what happened in the early moments of the universe could answer many questions in physics and astronomy. One possible player in the early universe is cosmic strings, which arise naturally in particle physics models. However, cosmic strings are quite strange hypothetical entities: they're thinner than a proton, but can be as long as the universe. Cosmic strings might have formed as imperfections when the early universe was undergoing drastic phase changes.

"If cosmic strings were found to exist, it would tell us that the universe was very hot (trillion trillion degrees) in the first fraction of a nanosecond," physicist Tanmay Vachaspati told *PhysOrg.com.* "It would tell us that the fundamental theory must admit string solutions. Further studies of the properties of the strings could tell us if string theory may be correct. So the discovery of cosmic strings would be truly remarkable for a wide cross-section of physicists and astronomers."

Cosmic strings are also superconducting, and can be viewed as elastic, current-carrying wires that permeate the cosmos as closed loops and infinitely long curves. The strings oscillate under their own tension, giving off very strong electromagnetic radiation.

Possibly, a recent observation of a radio burst, or spark, could have been caused by such a superconducting cosmic string. That's the idea being suggested by Vachaspati, from the Institute for Advanced Study in Princeton, New Jersey, and Case Western Reserve University in

Cleveland, Ohio.

Vachaspati has developed a prediction that cosmic strings could produce potentially observable radio sparks, and recently published his study in *Physical Review Letters*. Previous attempts to observe cosmic strings have focused primarily on high-energy emission such as gamma rays, rather than lower-energy radio waves.

The recent radio spark was observed by Dunc Lorimer and colleagues, and reported in 2007. No host galaxy has been identified for the spark, which lasted only a millisecond, and had a high central frequency of 1.4 GHz. Vachaspati found that the radio spark's properties, such as its duration, fluence, spectrum, and event rate, match well with a superconducting cosmic string that carries a current of about 100,000 GeV.

"Lorimer et al's result is the first radio burst to be detected at cosmological distances," Vachaspati said. "Their observation triggered the idea that radio bursts may be a good way to search for strings."

Such a spark could come from a point called a "cusp" on an idealized, one-dimensional cosmic string. For a brief instant, a cusp reaches the speed of light, and this localized region emits a very strong electromagnetic radiation. Vachaspati found that an observer located at a large distance and slightly off the beam direction could see this radiation as a spark similar to the one observed by Lorimer's group.

Whether this particular radio spark was caused by cosmic strings or something else, Vachaspati explains that the important thing is how his predictions could influence particle physics. For example, the existence or absence of cosmic strings could be used to constrain various fundamental models.

He explained that the superconducting cosmic string model may be tested in a variety of ways, such as looking for signatures of decaying particle emission, looking for unusual "fanlike" radiation patterns from kinks on the strings, and finding more radio sparks located outside of galaxies.

More information: Vachaspati, Tanmay. "Cosmic Sparks from Superconducting Strings." *Physical Review Letters*, 101, 141301 (2008).