Gravity waves could hold key to supersymmetry

November 5 2008, By Miranda Marquit

(PhysOrg.com) -- "In Geneva," Anupam Mazumdar tells *PhysOrg.com*, "there is a big effort to discover supersymmetry particles at the Large Hadron Collider. But that is not the only way to find these particles. We should also be able to see supersymmetry in the sky through the observation of gravitational waves."

Mazumdar, a physicist at Lancaster University in Britain, worked with Alex Kusenko at the University of California, Los Angeles to simulate what kind of frequency distribution would result from the fragmentation of unstable scalar condensate. The two say that a number of devices, including the Advanced Laser Interferometer Gravitational-Wave Observatory (LIGO), the Laser Interferometer Space Antenna (LISA) and the Big Bank Observer (BBO), would be able to detect the gravitational waves they describe in “Gravitational waves from fragmentation of a primordial scalar condensate into Q-balls,” which has been accepted for publication in *Physical Review Letters*.

Supersymmetry is speculated to go beyond the standard model of physics to introduce particles that solve some of the problems that cannot be solved using only the particles that have been observed thus far. In supersymmetry, the standard particles we are familiar with have superpartners that differ from the standard by half a unit of spin. For example, the superpartners of standard model fermions are s-fermions.

“The gravity wave is fundamental to theory from Einstein,” Mazumdar says. “But we have not yet seen it in the frequencies described. However, primordial inflation is one of the many cosmic sources that could produce these waves." The gravitational waves described by Mazumdar and Kusenko begin as a condensate formed in the early universe of s-fermions.

"At a certain point," Mazumdar explains, "the condensate starts oscillating due to the presence of scalar, s-fermion, masses, whose masses are roughly determined by the scale of supersymmetry breaking. Due to the inherent nature of quantum corrections the condensate is not absolutely stable and fragments during the coherent oscillations. The fragmentation process leads to the formation of non-topological solitons, known as Q-balls. Since the fragmentation process is so violent and anisotropic, it excites gravity waves." These waves, he says, have an amplitude and frequency detectable by LIGO.

Mazumdar says that, while many hope to find evidence of supersymmetry when the LHC is fully operational, it is not the only place where one can look for the signs of supersymmetric particles. Besides, he points out, evidence of supersymmetry may not be found at the LHC. Looking to the cosmos, then, would be another option. This is where the sophisticated cosmological observation devices – especially LIGO – come in. "Our model shows frequencies exactly where LIGO is sensitive," he says. "We also show a place where the frequency would be distinguishable from binaries, black holes and pulsars, which would also form gravity waves."

"The frequency we show has a broader spectrum, and its uniqueness would provide evidence of this s-fermion condensate," he continues. "Such a condensate could have also inflated the primordial universe, while explaining the origin of tiny perturbations in the cosmic microwave background radiation."

However, Mazumdar admits, it may take some time to detect these waves and take the observations. “We’re hoping to detect these in four to five years at LIGO,” he says. “Scientists may find evidence of supersymmetry at the LHC, but we are hoping to find links to it in cosmology.”

Article reference: Kusenko, Alexander and Anupam, Mazumdar “Gravitational waves from fragmentation of a primordial scalar condensate into Q-balls” arxiv.org/abs/0807.4554.