Researchers Develop Method to Identify Sparticles in Big Bang Conditions

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Three Northeastern University researchers have proposed a new approach for the highly anticipated discovery of supersymmetric particles, often called sparticles. The methodology, which was published in the December 21 issue of the *Physical Review Letters*, is based on identifying the hierarchical mass patterns of sparticles, which are assumed to exist in a new class of particle physics theories beyond the Standard Model.

The expected production of the sparticles at high energy particle colliders is strongly correlated with the sparticle mass patterns. Pran Nath, Daniel Feldman and Zuowei Liu at Northeastern have utilized this correlation to identify the sparticles at the Large Hadron Collider (LHC) at the European Organization for Nuclear Research in Geneva, Switzerland. The LHC, which is close to completion and set to begin testing within months, will be the world's largest machine to produce sub-atomic particles in conditions similar to when the Big Bang occurred.

"The LHC will allow for the exploration of elementary particle physics at energy scales that have never been probed before," said Nath, a Matthews Distinguished Professor of Physics at Northeastern. "This research has the potential to deepen our understanding of the nature of physics at its most basic level," he said.

The 32 sparticle masses can stack up in many different ways, creating a landscape of mass hierarchies with numerous possible sparticle mass patterns. Stacking the first four sparticles creates a landscape with close

to ten thousand possibilities, and the landscape of possibilities becomes enormous if all 32 sparticles are included. Only one possibility out of this incredibly large number exists in nature, and that exact possibility can be discovered at the LHC.

The new approach was developed based on the well motivated supergravity model (mSUGRA), which was co-authored by Nath in 1982 and is one of the leading candidates for new physics beyond the Standard model. In this new work, the researchers have shown that the number of possibilities is reduced enormously, down to just sixteen mass patterns for the 4 lightest sparticles, in mSUGRA.

The authors studied the signature space of the sixteen patterns at the LHC and propose ways in which researchers at the LHC can discriminate among the patterns and identify the lowest lying sparticles. Because the mass hierarchies influence the overall production rate of various sparticles, their hierarchical mass pattern will determine their signatures.

"We truly stand on the threshold of revolutionary discoveries in particle physics and the study of patterns and pattern recognition that we propose could be very significant in the search for sparticles, as well as for the discovery of new physics at the LHC," said Nath.

Source: Northeastern University