Designing a test of neutrinos as dark matter candidates

January 11 2008, By Miranda Marquit

One of the biggest mysteries of the universe deals with questions of dark matter. There are several experiments and models being designed all over the world to try and determine what would make good dark matter candidates. And with the Large Hadron Collider (LHC) at CERN in Switzerland, some of these experiments may be ready for testing.

A model that could see testing at the LHC is one developed by Anupam Mazumdar, a scientist at the Lancaster University in the United Kingdom and his colleagues Rouzbeh Allahverdi, at the University of New Mexico in the United States, and Bhaskar Dutta, at Texas A&M University.

Their model shows how inflation generates the “seed for structure,” and describes how cold dark matter accounts for “missing” matter in the universe. Thirdly, the model’s inflation explains neutrino masses. The results of the paper can be found in “Unifying Inflation and Dark Matter with Neutrino Masses” in *Physical Review Letters*.

“We know dark matter has to exist,” Mazumdar tells *PhysOrg.com*. “We see its influences. But it has to interact really weakly with the rest of the universe. This is why the right-handed supersymmetric neutrinos – sneutrinos – are a dark matter candidate. The right handed sneutrinos also give rise to tiny neutrino masses observed in nature.”

Mazumdar also explains that the universe is expanding: “It undergoes inflation.” So Mazumdar and his peers wondered if it was possible to tie inflation to dark matter and neutrino masses. “We wanted to see if we could tie these things together in a model that can be tested in a laboratory.”

Part of the challenge involved in putting together their model included the fact that in most standard models that address this question, the inflaton field values are entered by hand. Inflatons are characterized by integer spin. “We had to figure out how to talk about an inflaton as a scalar particle and try to identify what an inflaton is, exactly,” Mazumdar says.

He goes on to explain that no single particle acts like an inflaton. Instead, a combination of particles is needed. “When we combined an sneutrino, a standard Higgs particle and a supersymmetric lepton, we found they act like an inflaton whose masses and couplings are not ad-hoc but well motivated and constrained by the current experimental limits.”

“The model shows that the inflaton which is responsible for inflating is also responsible for neutrino masses….This component could also act like dark matter,” Mazumdar continues. “Now it is something that can be verified in experiments. Once the properties of the supersymmetric neutrino are found, the testable properties can help us identify dark matter.”

“We are always looking for evidence to back up observation,” Mazumdar points out. “Until now, finding ‘missing’ matter has relied on cosmic microwave background experiments. It was thought that inflation could only be tested by this method. Now we have proposed a simple model that would allow inflation testing on earth.”

Mazumdar hopes that the model he and his peers have developed can be tested at the LHC by the end of this year or the beginning of next year. “This could answer the questions of why neutrinos have such small mass, and whether they would make a good dark matter candidate and the inflaton candidate.”