Looking for neutralinos at the Large Hadron Collider

July 9 2008, By Miranda Marquit

"We are looking at the heavens, and using the very biggest things to help up predict what will happen with the very smallest things," David Toback tells *PhysOrg.com.* Toback is a professor at Texas A&M University in College Station, and he believes that there is a way to combine cosmology and particle physics in a way that can help us learn more about the universe.

"We're interested in the dark matter question," Toback continues. "Our current best guess is that the particles we know and love only make up about four percent of the stuff in the universe. Twenty-three percent of the universe is dark matter. The rest is dark energy. But I'm interested in dark matter, which should be made of particles. We want to know the properties of the bulk of the *matter* in the universe. This is a question that interests both cosmologists and particle physicists."

Toback and his colleagues at Texas A&M, Richard Arnowitt, Bhaskar Dutta, Alfredo Gurrola, Teruki Kamon and Abram Krislock, have been working on a model that allows them to use information obtained from the Large Hadron Collider (LHC) to predict the amount of dark matter left over from the beginning of the universe. Their work is published in *Physical Review Letters*: "Determining the Dark Matter Relic Density in the Minimal Supergravity Stau-Neutralino Coannihilation Region at the Large Hadron Collider."

"Our goal is to see whether our understanding of particles in the universe, the theory of supersymmetry, is correct. If it is, it will explain one of the most important questions in particle physics and cosmology in one fell swoop," Toback says.

Supersymmetry is a theory that predicts that all elementary particles with spin are paired to other particles whose spin differs by half a unit. "One of the things that makes it special," Toback says, "is that supersymmetry is a theory that predicts new particles. And one of the particles predicted is called a neutralino." Neutralinos are thought to be heavy and stable, and they represent the leading candidate to explain the amount of cold dark matter indirectly detected in the universe.

The problem is that no one has been able to measure dark matter directly yet. This is where the LHC comes in. This $6 billion project is scheduled to begin operation later this summer, smashing protons into each other. The LHC is the largest and highest energy particle accelerator in the world, and Toback thinks that there's a good chance that neutralinos could be produced from the collisions between protons. The data produced by the LHC will be made available to scientists around the world, including the team at Texas A&M.

"If our results are correct we now know much better where to look for this dark matter particle at the LHC," Toback explains. "We've used precision data from astronomy to calculate what it would look like at the LHC, and how quickly we should be able to discover and measure it." He and his colleagues have even gone so far to be show that with their measurements with LHC data they would be able to predict the amount of dark matter in the universe. This could be compared to what is seen from the WMAP satellite. "If we get the same answer," he continues, "that would give us enormous confidence that the supersymmetry model is correct. If nature shows this, it would be remarkable."

Toback says that the work he is doing with his peers at Texas A&M could make a connection between particle physics and cosmology. "If this works out, we could do real, honest to goodness cosmology at the LHC. And we'd be able to use cosmology to make particle physics predictions."