City Tech physicist thinks small and big with CERN Large Hadron Collider research

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New York City College of Technology Physics Professor Giovanni Ossola thinks both small and big. He is currently developing a new tool that will lead to more precise computations involving the actions of particles (the smallest components of matter) in the world's largest particle (proton) accelerator, the Large Hadron Collider (LHC). And he has big plans to involve his students in the information and discoveries being made by him and other scientists from around the world.

Thanks to a two-year National Science Foundation research grant of $114,450, Dr. Ossola is well on his way to achieving these goals.

The collider is a $10 billion machine built by the European Organization for Nuclear Research (CERN) on the France-Switzerland border. CERN's main area of research is particle physics: finding answers to questions about the universe, what it is made of and how it works. LHC replicates the conditions of the universe immediately after "the Big Bang" in order to help physicists understand its effects and to examine matter's smallest components.

The collider circulates a high-energy proton beam around its 17-mile tunnel to cause particle smashing. By studying what happens when two protons collide, resulting in the creation and scattering of different particles, physicists learn about the laws of nature and determine whether they have discovered something new, such as a particle not previously observed.

Dr. Ossola explains, "They hope to see something they can't explain, and then investigate."

He is developing new computer codes for the precise and efficient computation of the theoretical predictions involved in the LHC experiments. His work is based on a technique called the Ossola-Papadopoulos-Pittau (OPP) Method, named for the scientists who began this work in 2006 -- Dr. Ossola, Dr. Costas G. Papadopoulos (National Center for Scientific Research Demokritos, Athens, Greece) and Dr. Roberto Pittau (Universidad de Granada, Spain).

The LHC experiment involves thousands of people in the scientific community, says Dr. Ossola. "A huge amount of data will need to be processed, analyzed, and then compared with theoretical models and predictions." The LHC will study the collision of two protons at high energies: in each collision, the two initial protons "disappear" to create several different particles moving in various directions.

Since Dr. Ossola's work focuses on computing the theoretical predictions for scattering of particles, it is expected to make a significant contribution to the LHC experiment in particular and contemporary physics in general.

"The Standard Model of Particle Physics allows researchers to formulate predictions about the behavior of the particles after the collision," he explains. "Our results are in the form of probability distributions, namely, we can predict how many times a specific event (a set of particles with a certain energy scattering at certain angles) will show up in the experiment."

Dr. Ossola's NSF-funded project, "Automated Computation of One-Loop Scattering Amplitudes," will build upon work begun with his previous collaborators. He discussed the parameters of this project in

presentations he made in 2009 at several prestigious conferences: "Matter to the Deepest" in Ustron (Poland), "LoopFest" in Madison, WI, "CIPANP09" in San Diego, CA, and "High Energy Physics" in Bari, Italy. Most recently, he was invited to present his work at Brookhaven National Laboratory on Long Island.

One of Dr. Ossola's goals for his project is to forge stronger research ties between CERN and City Tech. Since European university students can more easily visit the LHC, he wants to find ways to bring information and discoveries here, to organize meetings, and present results. "From a scientific point of view, it is important to have a connection between the research work that we do at City Tech and the main events taking place at CERN. This connection can be reinforced by visiting CERN, inviting speakers to the College, and giving presentations for faculty and students about the various themes of the LHC experiment."

He hopes to get more government funding to help students travel to CERN, and by the end of the initial grant period, to create a group of universities and students who interact with one another, and a group doing relevant work at City Tech. "Some students will be involved directly in small research projects that will allow them to be exposed to the challenges of fundamental research, and, hopefully, to share their enthusiasm for exploration and discoveries." Several students have already expressed interest.

Dr. Ossola -- who is from Torino, Italy, and now lives in Downtown Brooklyn -- developed his interest in physics with the encouragement of his mentors. "As a student I was interested mostly in disciplines that deal with human efforts to represent and understand the reality around us: physics and philosophy. They are two different ways human beings look at themselves in the big picture of Nature. Physics is a more realistic career path." He adds that the various technologies involved in the construction of a huge machine such as a collider may also be applicable

to other fields such engineering, construction, and computer technology.

"The mysteries of our universe can be a very intriguing topic... dark matter, dark energy, super-symmetric particles, anti-matter are words that trigger curiosity," says Dr. Ossola, who earlier in his career was a Marie Curie Fellow at the Institute of Nuclear Physics, National Center for Scientific Research Demokritos, Athens, Greece.

However, he notes, "This is not a field in which in two years you can expect to win the championship. It's an ongoing process of refining." Dr. Ossola will continue that process on his next visit to CERN in January 2010.

Source: New York City College of Technology