Physicists create BlackMax to search for dimensions in space at the Large Hadron Collider

November 7 2008

A team of theoretical and experimental physicists, with participants from Case Western Reserve University, have designed a new black hole simulator called BlackMax to search for evidence that extra dimensions might exist in the universe.

Information about BlackMax's creation has been published in Physical Review Letters in the article, "BlackMax: A Black-Hole Event Generator with Rotation, Recoil, Split Branes and Brane Tension."

Black holes are theorized to be regions in space where the gravitational field is so strong that nothing can escape its pull after crossing what is called the event horizon. BlackMax simulates these regions.

Approximately two years in the making, the computer program enables physicists to test theories about the production and decay of black holes and takes into account new types of effects on both the creation and evaporation of black holes at the new Large Hadron Collider (LHC) currently being commissioned at the European Center for Nuclear Research (CERN) in Geneva, Switzerland.

For example, black holes created at the LHC would be expected to start off spinning.

The spinning of the black hole increases the fraction of the black hole's

mass that is dissipated as gravitons–elementary quanta of gravity, which could be used to provide a clue to the existence and structure of extra dimensions. Black holes are being studied with BlackMax by members of the ATLAS Experiment at LHC, one of the two principal large particle detectors at the new collider. Case Western Reserve physicists working with Glenn Starkman on the project are his former doctoral student Dejan Stojkovic, now a visiting professor on the faculty of the State University of New York (SUNY) at Buffalo, and De-Chang Dai, who recently graduated with his doctoral degree in physics, and is now a postdoctoral fellow working with Stojkovic. Other collaborators are experimental physicists Cigdem Issever and Jeff Tseng of Oxford University and Eram Rizvi from Queen Mary College at the University of London.

ATLAS works much like investigators who search the site of plane crash, and then piece together the debris to find the cause of the plane's disintegration.

BlackMax, by predicting how those pieces will fall, should allow physicists looking at data from the ATLAS experiment to see whether the pattern of particles released into the detector matches what one would expect when a black hole is produced and then falls apart.

The ordinary non-gravitational collisions predicted by the Standard Model of particle physics tend to produce fragments of the proton clumped into a small number of jets.

Decays of black holes should produce more particles than usual. These particles should also come out unusually isotropically—in every direction—and the mix of particles should be more democratic - including for example electrons and similar particles that are not found within the proton.

Starkman said that if black holes are found at the LHC it will enable scientists to understand the connection between gravity and quantum mechanics, resolving the inconsistency between two of the great intellectual triumphs of the 20th century - quantum mechanics and Einstein's General Theory of Relativity.

It would also mean the existence of other dimensions to space, and explain why gravity is such a weak force compared to the other three fundamental forces of nature–electromagnetism and the strong and weak nuclear forces.

According to Starkman, the black holes under study at LHC will be very small, extremely hot at more than billion times the temperature of the sun, and their lifespan will consequently be so short that they will decay within tiny fractions of a second of their creation.

He added that there is not enough time for the black hole to cross a human hair, "never mind leaving the detector," he said.

"What's more important is that the universe has been doing this experiment for billions of years by bombarding the earth's atmosphere (not to mention all the myriad stars) with cosmic rays. So we know if black holes are made at the LHC, they are entirely safe," said Starkman.

Source: Case Western Reserve University