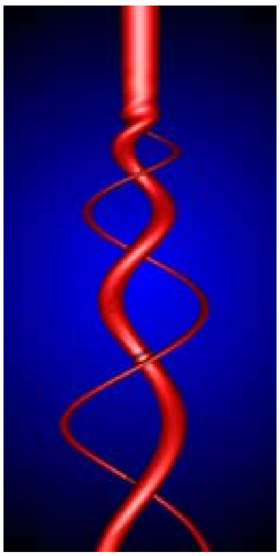
Solving Einstein's theory

November 3 2011



A team of University researchers will get their hands on some of Europe's fastest supercomputers in a bid to crack Einstein's theory of relativity and help describe what happens when two black holes collide.

Experts in gravitational waves from the School of Physics and Astronomy have secured almost 16.7 million hours worth of supercomputer time to simulate and map the most violent events in the universe since the big bang – namely, collisions of black holes.

The team will use more than 1,900 computer processors over the next year to try and solve the equations of Einstein's general theory of relativity.

The ultimate goal of the simulations is the direct observation of black-hole collisions through the gravitational waves they emit.

"Gravitational waves are ripples in space and time – predicted by Einstein almost 100 years ago," according to Mark Hannam, School of Physics and Astronomy, who will lead the Cardiff research team.

"However, despite Einstein's predictions – they have not yet been directly detected. Gravitational waves are generated by accelerating masses, such as orbiting black holes, similar to the way accelerating electrical charges emit electromagnetic waves, like light, infra-red and radio waves - with the important difference that gravitational waves are far weaker.

"For this reason it is electromagnetic waves that have told us everything we have learnt about the cosmos since ancient times. If we could also detect gravitational waves, that would push open a new window on the universe, and tell us about its `dark side'," he added.

Over the past decade a network of gravitational wave detectors has been built, including the US Laser Interferometer Gravitational-Wave Observatory (LIGO) and the European GEO600 and Virgo detectors, with the ambitious goal of not only making the first direct detection of the gravitational waves, but also to observe the entire Universe through gravitational radiation.

Cardiff's researchers work on theoretical modelling of black-hole-binary collisions using state-of-the-art numerical techniques and high performance computer clusters, strong field tests of gravity with gravitational-wave observations and the development of algorithms and software to search for gravitational waves.

Researchers at Cardiff play leading roles within the LIGO Scientific Collaboration, in particular in gravitational-wave searches for compact binary coalescences, supernovae, gamma-ray bursts, and other transient sources.

Coalescing black holes are prime candidates for the first observations. The results of this project will help to identify the sources of these signals, and contribute to answering important open questions in astrophysics and fundamental physics, such as whether the objects created in these cosmic collisions are really black holes, or even more exotic objects like naked singularities.

In the process the team hope to be able to test if Einstein's theory of gravity is correct, or whether, just as Newton's gravity gave way to Einstein's, perhaps Einstein's relativity gives way to even deeper insights into the nature of space and time.

The research team comprises more than 20 physicists working at Cardiff, the Universities of Jena, Vienna, and the Balearic Islands, the Albert Einstein Institute in Potsdam, and the California Institute of Technology. Solving Einstein's equations on supercomputers to accurately describe black holes became possible only after a series of breakthroughs in 2005, and the mostly young researchers are excited to be part of a scientific revolution.

"The detectors are pushing against the limits of current technology, and now we will help them with simulations that are at the cutting edge of computing power. Access to such vast computing resources is a fantastic boost for scientific research in Wales," Dr. Hannam added.

While supercomputing resources in Europe used to be relatively scarce, the PRACE Research Infrastructure now provides access to world-class supercomputers for European research projects, which undergo a competitive peer review process.

The PRACE infrastructure currently consists of three world-class supercomputers, which can each perform about 1 Petaflop which is a thousand billion arithmetic operations per second. The first machine in the network, the German Jugene, started operation in 2010, and it was joined in early 2011 by the French machine Curie, and the German system Hermit is about to officially start operation on November 1.

Future computers in the PRACE network are planned in Germany, Italy, and Spain.

Provided by Cardiff University

Citation: Solving Einstein's theory (2011, November 3) retrieved 17 April 2024 from https://phys.org/news/2011-11-einsteins-theory.html