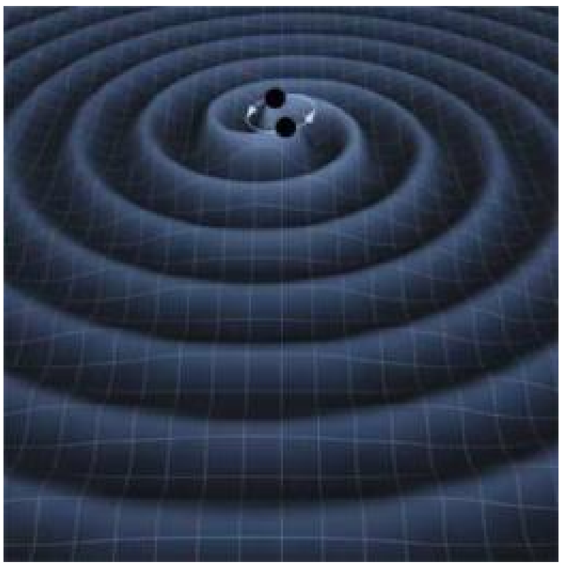
Black Holes in Star Clusters stir up Time and Space (w/ Video)

December 16 2009



An artist's representation of the burst of gravitational waves resulting from the collision of a colliding pair of black holes. Credit: LIGO Scientific Collaboration (LSC) / NASA.

(PhysOrg.com) -- Within a decade scientists could be able to detect the merger of tens of pairs of black holes every year, according to a team of astronomers at the University of Bonn's Argelander-Institut fuer Astronomie, who publish their findings in a paper in *Monthly Notices of the Royal Astronomical Society*. By modelling the behaviour of stars in clusters, the Bonn team find that they are ideal environments for black holes to coalesce. These merger events produce ripples in time and space (gravitational waves) that could be detected by instruments from as early as 2015.

Clusters of stars are found throughout our own and other galaxies and most stars are thought to have formed in them. The smallest looser ‘open clusters’ have only a few stellar members, whilst the largest tightly bound ‘globular clusters’ have as many as several million stars. The highest mass stars in clusters use up their hydrogen fuel relatively quickly (in just a few million years). The cores of these stars collapse, leading to a violent supernova explosion where the outer layers of the star are expelled into space. The explosion leaves behind a stellar remnant with gravitational field so strong that not even light can escape - a black hole.

When stars are as close together as they are in clusters, then although still rare events, the likelihood of collisions and mergers between stars of all types, including black holes, is much higher. The black holes sink to the centre of the cluster, where a core that is completely made of up of black holes forms. In the core, the black holes experience a range of interactions, sometimes forming binary pairs and sometimes being ejected from the cluster completely.

Now Dr Sambaran Banerjee, Alexander von Humboldt postdoctoral fellow, has worked with his University of Bonn colleagues Dr Holger Baumgardt and Professor Pavel Kroupa to develop the first self-consistent simulation of the movement of black holes in star clusters.

The scientists assembled their own star clusters on a high-performance supercomputer, and then calculated how they would evolve by tracing the motion of each and every star and black hole within them.

According to a key prediction of Einstein’s General Theory of Relativity, black hole binaries stir the space-time around them, generating waves that propagate away like ripples on the surface of a lake. These waves of curvature in space-time are known as gravitational waves and will temporarily distort any object they pass through. But to date no-one has succeeded in detecting them.

In the cores of stars clusters, black hole binaries are sufficiently tightly bound to be significant sources of gravitational waves. If the black holes in a binary system merge, then an even stronger pulse of gravitational waves radiates away from the system.

Based on the new results, the next generation of gravitational wave observatories like the Advanced Laser Interferometer Gravitational-wave Observatory (Advanced LIGO) could detect tens of these events each year, out to a distance of almost 5000 million light years (for comparison the well known Andromeda Galaxy is just 2.5 million light years away).

Advanced LIGO will be up and running by 2015 and if the Bonn team are right, from then on we can look forward to a new era of gravitational wave astronomy.

Sambaran comments, "Physicists have looked for gravitational waves for more than half a century. But up to now they have proved elusive. If we are right then not only will gravitational waves be found so that General Relativity passes a key test but astronomers will soon have a completely new way to study the Universe. It seems fitting that almost exactly 100 years after Einstein published his theory, scientists should be able to use this exotic phenomenon to watch some of the most exotic events in the cosmos."

More information: A preprint of the paper, which will appear in *Monthly Notices of the Royal Astronomical Society*, is available at arxiv.org/abs/0910.3954

Provided by Royal Astronomical Society

Citation: Black Holes in Star Clusters stir up Time and Space (w/ Video) (2009, December 16) retrieved 16 April 2024 from https://phys.org/news/2009-12-black-holes-star-clusters-space.html

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.