Particle Interactions Near Merging Black Hole Binaries

Science Mission Directorate

Our work in simulating the merger of comparable-mass black hole binaries may help deepen our understanding of the large-scale structure of the universe.

As part of this work, we extract the emitted gravitational waves (GW) that may be detected from mergers, and investigate the possibility of simultaneous detection of GW and electromagnetic (EM) signals in the X-ray and gamma-ray bands for certain massive black hole sources.

Our target mission is the proposed NASA–European Space Agency mission LISA, the Laser Interferometer Space Antenna, which will detect GWs from many sources, including massive black hole binary mergers out to redshifts of z ~10. We provide the data necessary for generating the gravitational wave templates that are crucial to determining the parameters of these sources.

Our models simulate black hole mergers by solving the vacuum Einstein equations of General Relativity. The challenge of solving these complex equations is being aided by supercomputer resources at NASA Ames Research Center and NASA Goddard Research Center, which offer long wall-clock times for the large parallel jobs (using 500–1,000 cores) needed for successful binary simulations. Visualization expertise at NASA Ames has enabled us to distinguish between physical and unphysical behaviors in coupled gravity + matter simulations.

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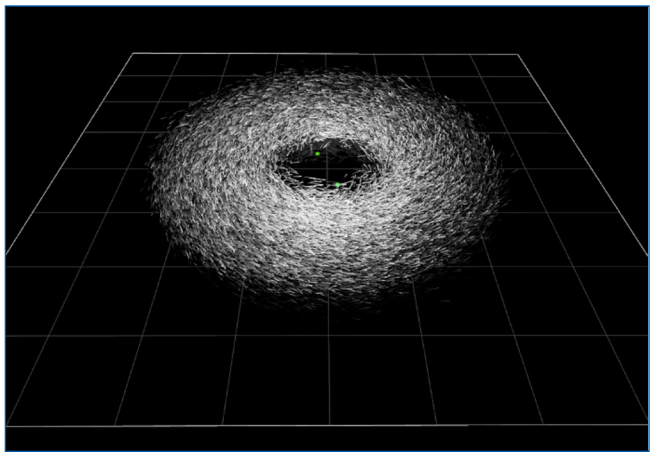

Directional tracks of Keplerian test particles as they begin to move around a merging, spinning black hole binary. *Chris Henze, NASA/Ames*