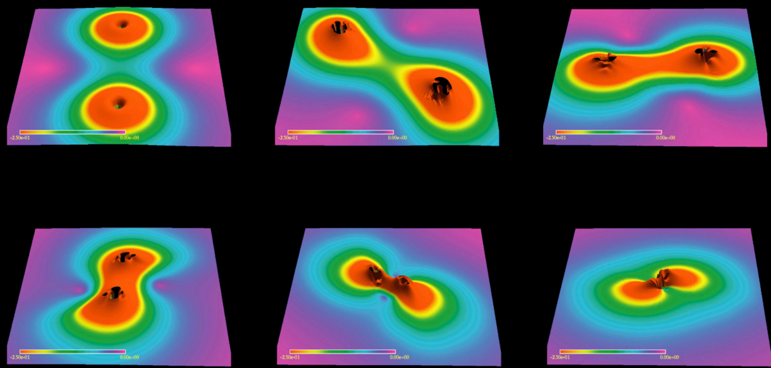
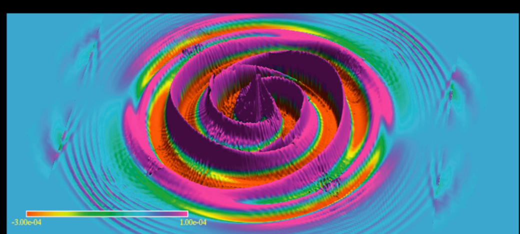
National Aeronautics and Space Administration
www.nasa.gov

SCIENCE MISSION DIRECTORATE

Modeling Gravitational Wave Sources for LISA



Snapshots showing a time sequence of the field representing the dynamics of two merging black holes.



A snapshot showing the field representing gravitational waves generated from two inspiralling black holes.

We model the astrophysical coalescence of comparable-mass, massive black hole binaries for different mass ratios and spins and calculate the resulting gravitational wave (GW) signatures. A key feature of our work is the use of mesh refinement techniques to handle the wide range of physical scales involved, from the black holes (~1M) to the gravitational waves (~10-100M), and to enable extraction of gravitational waveforms in the wave-zones.

Our methodology involves solving a closely coupled system of partial differential equations with many variables on a very large computational domain. Moreover, we use highly structured component-grids that are distributed across many processors, with a significant amount of communication between processors. Our simulations typically require hundreds of gigabytes and run on several hundred processors for hundreds of hours.

Astrophysical motivation guides our simulations. The waveforms determined by these simulations will be applied to analyzing and interpreting observed GW data from the Laser Interferometer Space Antenna (LISA) mission. Linear momentum loss due to asymmetrical radiation of GW in the unequal mass mergers imparts “kicks” to the merger remnant. High kick velocities from such mergers have the potential to strongly impact our understanding of how massive black holes have developed over cosmological time-scales.

http://universe.gsfc.nasa.gov/gravity/research/numrel.html