

Black hole-neutron star interactions

December 9, 2010

Motivation

Compact object mergers are

- sources of gravitational waves
- possible GRB central engines

Such mergers may result from

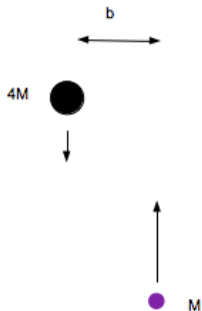
- primordial field binaries
- dynamically formed binaries

Interactions in clusters



Collapsed GC Messier 15 (image from Wikipedia)

The setup



A capture binary forms if

$$\frac{1}{2}\mu w^2 + \delta E \leq 0$$

where

$$\delta E = \delta E(b, w)$$

Numerical relativity

Solve the Einstein equations for gravity:

$$R_{\mu\nu} = 8\pi(T_{\mu\nu} - \frac{1}{2}g_{\mu\nu}T)$$

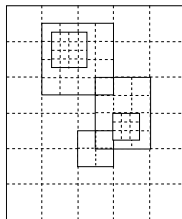
Solve the hydrodynamical equations for the fluid:

$$\nabla_\nu T^\nu{}_\mu = 0, \quad \nabla_\nu(\rho u^\nu) = 0$$

Discretization

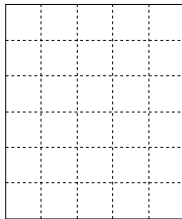
Objective: Focus computational resources where the simulation needs them most.

Figure from Pretorius & Choptuik, JCP **218**, 246 (2006).

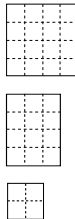


Computational domain, covered by a hierarchy of uniform grids

Level 1 grid



Level 2 grids



Level 3 grids



Movies!

BH-NS simulations with the same impact parameter but different velocities.

- Hyperbolic orbit with $r_p = 5M$: Log density
- Same thing with 40% larger velocities: Log density and Movies: Lapse