Black hole-neutron star interactions

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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

\[ \delta E = \delta E(b, w) \]
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:

\[ \nabla_\nu T^\nu_\mu = 0 , \; \nabla_\nu (\rho u^\nu) = 0 \]
Objective: Focus computational resources where the simulation needs them most.

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