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[Galactic distribution of merging neutron stars and black holes] Galactic distribution of merging neutron stars and black holes

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theoremTheorem[section]

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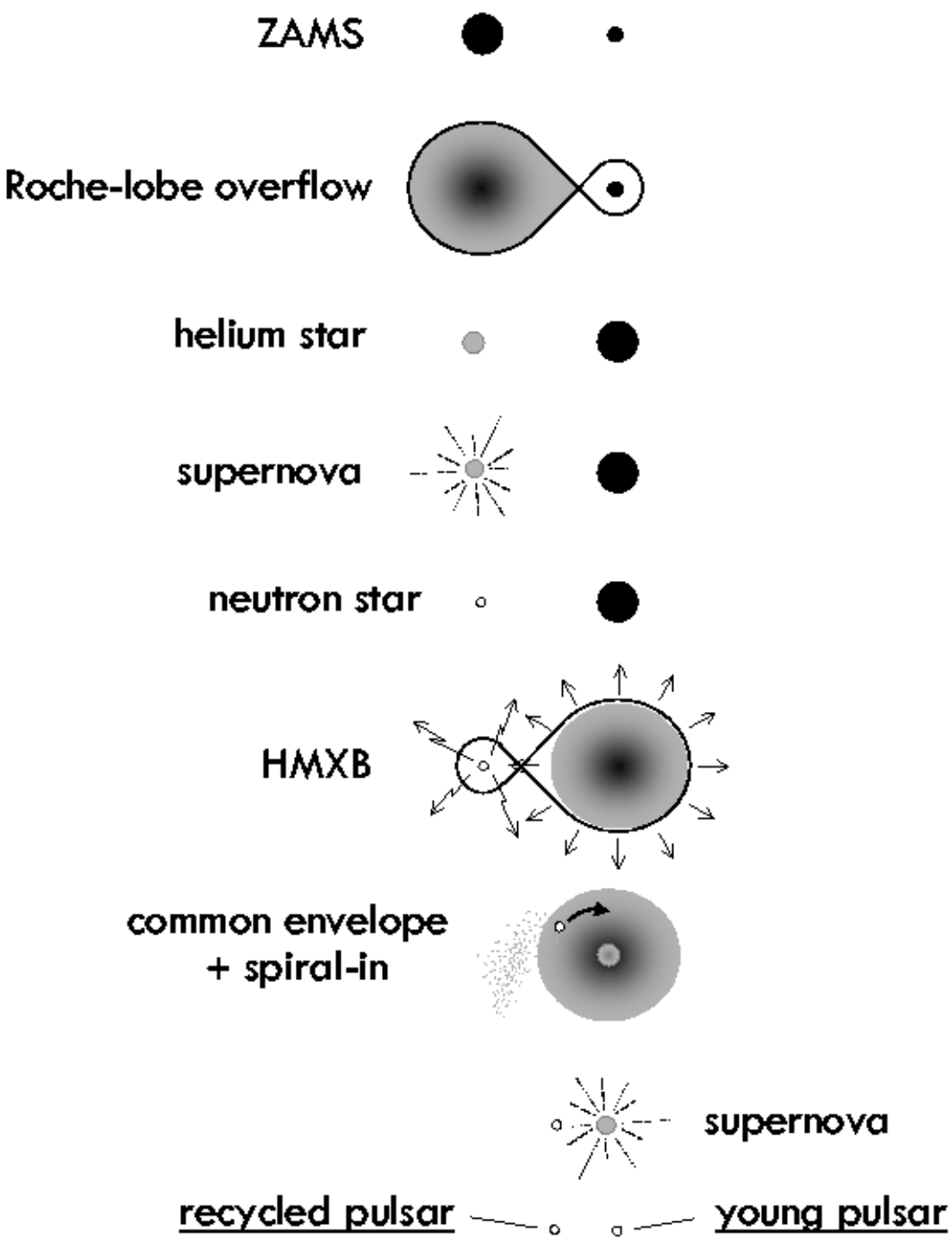
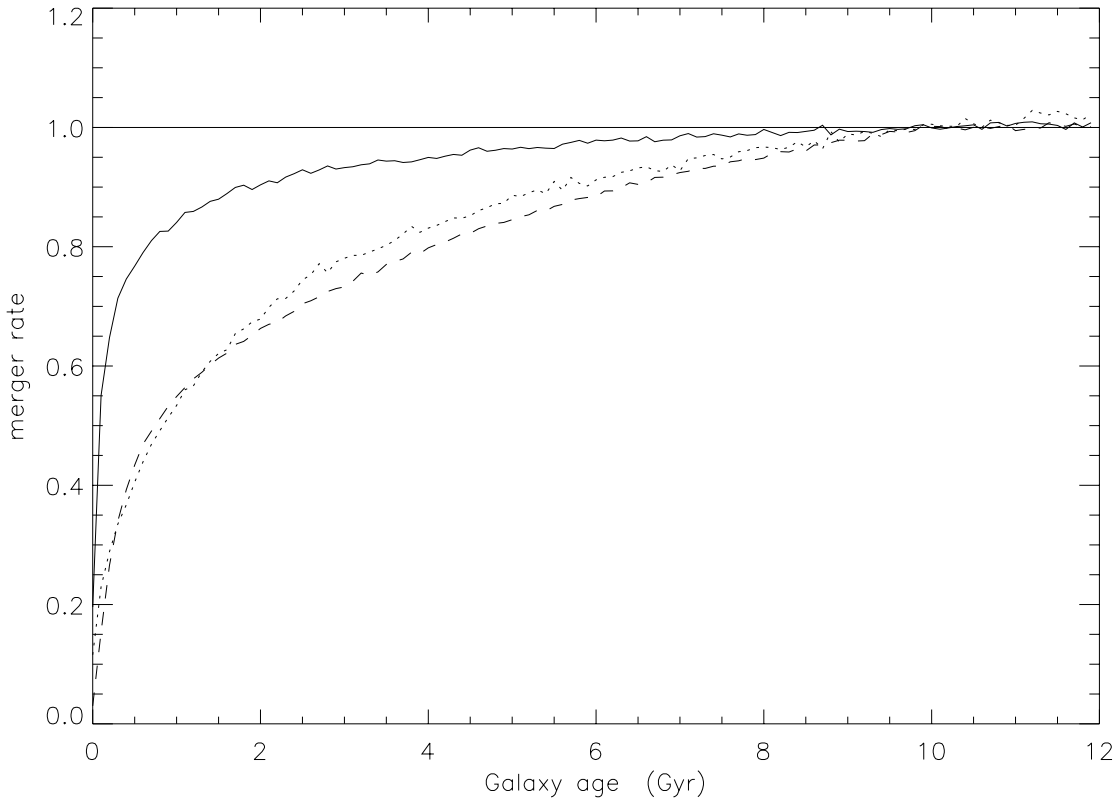
abstract We have performed detailed population synthesis on a large number (2×10^7) of binary systems in order to investigate the properties of massive double degenerate binaries. We have included new important results in our input physics in order to obtain more reliable estimates of the merging timescales and relative formation rates. These improvements include refined treatment of the binding energy in a common envelope, helium star evolution and reduced kicks imparted to newborn black holes. The discovery and observations of GRB afterglows and the identification of host galaxies have allowed comparisons of theoretical distributions of merger sites with the observed distribution of afterglow positions relative to host galaxies. To help investigate the physical nature of short- and long-duration γ-ray bursts (GRBs), we compute the distances of merging neutron stars (NS) and/or black holes (BH) from the centers of their host galaxies, as predicted by their formation scenario combined with motion in galactic potentials. Furthermore, we estimate the formation rate and merging rate of these massive double degenerate binaries. The latter is very important for the prospects of detecting gravitational waves with LIGO/VIRGO. We find that the expected detection rate for LIGO II is ~ 850 yr^{-1} for galactic field sources and that this rate is completely dominated by merging BHBH binaries. Even LIGO I may detect such an event (~ 0.25 yr^{-1}). Our preferred model estimate the Galactic field NSNS merger rate to be $\sim 1.5 \times 10^{-6}$ yr^{-1}. For BHBH systems this model predicts a merger rate of $\sim 9.7 \times 10^{-6}$ yr^{-1}. Our studies also reveal an accumulating numerous population of very wide orbit BHBH systems which never merge ($\tau \gg \tau_{\rm Hubble}$).


ZAMS
Roche-lobe overflow
helium star
supernova
neutron star
HMXB
common envelope
+ spiral-in
supernova
recycled pulsar
young pulsar


1.2
1.0
0.8
0.6
0.4
0.2
0.0
merger rate
0
2
4
6
8
10
12
Galaxy age (Gyr)