BLACK HOLES

Plurality of singularities

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Assuming that black holes are solely the end products of stellar evolution (that is, neglecting primordial black holes), a galaxy the mass of the Milky Way should host millions of ~30 $M_\odot$ black holes, according to a study compiled by Oliver Elbert and collaborators. If 1% of black holes become involved in a merger then the Advanced Laser Interferometer Gravitational-Wave Observatory (LIGO) should detect mergers between >50 $M_\odot$ black holes within a decade, based on its current rate.

The computation of the binary black hole (BBH) merger rate requires a detailed understanding of galaxy formation and numerical relativity. However, an estimate can be made for the BBH merger rate for stellar remnant black holes because the rate depends on observable quantities that are reasonably well known: the stellar initial mass function (IMF), the relationship between metallicity and galaxy mass, and the overall number density of galaxies. Elbert et al. calculate that the number of black holes of all masses scales linearly with galaxy mass for galaxies with stellar masses, $M_\star \lesssim 10^{10}\ M_\odot$. Combining this with an IMF, the authors predict that most low-mass black holes should reside in massive galaxies, like our own, while higher mass black holes should generally be found in dwarf galaxies. Metallicity also comes into play here because stellar mass black hole formation is suppressed in high metallicity environments: more metals means more circumstellar dust, which is linked to a higher mass-loss rate.

Perhaps the most uncertain part of the calculation is that of the merger timescale. The authors leave this as a free parameter in their reckonings, but some constraints can be inferred from the three current LIGO detections, which give a rate of 12–213 mergers per cubic gigaparsec (B. P. Abbott et al. *Phys. Rev. Lett.* **118**, 221101; 2017). Thus a typical merger timescale for a 1% binary merger efficiency would be $\lesssim$5 Gyr.

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