research highlights

GRAVITATIONAL WAVES

Three-for-one deal

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Although we have good estimates for the total mass (and constraints on the spin) of the black holes that merged and sent out the gravitational waves detected by the Advanced Laser Interferometer Gravitational-Wave Observatory, there is much to do to understand the black hole progenitors. The classical isolated binary formation channel involves chemical composition, star formation and dynamical evolution preceding the merger. With so many parameters, a statistical approach can help, in this case a fiducial model. Simon Stevenson *et al.* use a rapid binary population synthesis code, COMPAS, or Compact Object Mergers: Population Astrophysics and Statistics, to find that two of the detections are consistent with a 10% solar metallicity progenitor (GW151226 and LVT151012), whereas GW150914 is more consistent with 1% solar metallicity.

But the evolution pathway is similar for all three events. For example, for GW151226 the initial main sequence O stars have masses $\sim 64 M_{\odot}$ (primary) and $\sim 28 M_{\odot}$ (companion) and an orbital period of ~ 300 days. At the end of its main sequence, the primary initiates mass transfer to the companion and eventually collapses to a $\sim 19 M_{\odot}$ black hole. Meanwhile the companion, having accreted $\sim 3 M_{\odot}$ from the primary, initiates a mass transfer that is dynamically unstable, leading to the formation and subsequent ejection of a common envelope. The companion then collapses to a black hole of $\sim 6 M_{\odot}$. And finally, after 100 Myr the binary merges through gravitational wave emission. This picture largely agrees with the results of other stellar population synthesis codes, but we will need more events to fine-tune the many uncertainties of binary evolution.

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