Understanding the evolution of stellar-mass black hole binaries

The binary black holes observed by LIGO and Virgo [1] provide a new source of information regarding the end-points of stellar evolution [2, 3]. Multiple potential formation channels have been suggested for these binaries, and each of these have associated physical uncertainties. The details of the formation channels leave imprints on the properties of the binary black holes, such as masses and spins. From these, we can infer how binary black holes form. With 1000 detections, we can use the chirp-mass distribution and merger rate to constrain population parameters for isolated binary evolution (such as common-envelope efficiency, natal kicks and mass-loss rates) to precision of a few percent [4]. The merger rate is expected to evolve with redshift; the cosmological reach of next-generation gravitational-wave detectors will enable measurement of this. I will explain how combining all the information from gravitational-wave observations will provide a tough test of our best models of binary evolution.

References

[1] **LIGO Scientific, Virgo** Collaboration, B. P. Abbott *et al.*, "GWTC-1: A Gravitational-Wave Transient Catalog of Compact Binary Mergers Observed by LIGO and Virgo during the First and Second Observing Runs," `arXiv:1811.12907 [astro-ph.HE]`.

[2] **LIGO Scientific, Virgo** Collaboration, B. P. Abbott *et al.*, "Astrophysical Implications of the Binary Black-Hole Merger GW150914," *Astrophys. J. Lett.* **818** no. 2, (2016) L22, `arXiv:1602.03846 [astro-ph.HE]`.

[3] **LIGO Scientific, Virgo** Collaboration, B. P. Abbott *et al.*, "Binary Black Hole Population Properties Inferred from the First and Second Observing Runs of Advanced LIGO and Advanced Virgo," `arXiv:1811.12940 [astro-ph.HE]`.

[4] J. W. Barrett, S. M. Gaebel, C. J. Neijssel, A. Vigna-Gómez, S. Stevenson, C. P. L. Berry, W. M. Farr, and I. Mandel, "Accuracy of inference on the physics of binary evolution from gravitational-wave observations," *Mon. Not. Roy. Astron. Soc.* **477** no. 4, (2018) 4685–4695, `arXiv:1711.06287 [astro-ph.HE]`.