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Constraining the Pair Instability Mass Gap with Gravitational Waves Detected by a Model-Independent Search

Abstract

The advanced LIGO-Virgo detectors have identified over 90 binary black hole (BBH) mergers, providing valuable insights into the environments where these systems form and merge. This talk will discuss detection of elusive intermediate-mass black hole (IMBH) mergers, with focus on the pair-instability supernova mass gap. Detecting IMBH systems hold potential for far-reaching astrophysical implications and can provide insights into the formation of supermassive black holes. Template-based searches, which rely on accurate simulated waveforms can miss such events, especially in the presence of non-Gaussian noise. This highlights the importance of model-independent searches like Coherent WaveBurst (cWB) which play a crucial role in detecting gravitational waves from uncommon sources like IMBH and eccentric binary black hole (eBBH) mergers. The cWB search was recently upgraded and uncovers three candidates not found by LVK's matched-filtering searches in LIGO-Virgo-KAGRA's (LVK) third observing run (O3). Notably, the most significant detection involves a binary black hole merger with the primary mass in the pair-instability mass gap with unusually low mass ratio, suggesting a possible dynamical origin. Finally, I will also discuss methods to leverage all the cWB detections with Machine Learning and perform population studies to constrain the lower mass limit of the pair-instability mass gap.