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Ameliorating transient noise bursts in gravitational-wave searches for intermediate-mass black holes

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The formation mechanism of supermassive black holes is yet unknown, despite their presence in nearly every galaxy, including the Milky Way. As stellar evolution predicts that stars cannot collapse to black holes $gtrsim50 - 130\,\mathrm{M}_\odot$ due to pair-instability, plausible formation mechanisms include the hierarchical mergers of intermediate-mass black holes (IMBHs). The direct observation of IMBH populations would not only strengthen the possible evolutionary link between stellar and supermassive black holes, but unveil the details of the pair-instability mechanism and elucidate their influence in galaxy formation. Conclusive observation of IMBHs remained elusive until the detection of gravitational-wave (GW) signal GW190521, which lies with high confidence in the mass gap predicted by the pair-instability mechanism. Despite falling in the sensitivity band of current GW detectors, IMBH searches are challenging due to their similarity to transient bursts of detector noise, known as glitches.

In this work, we enhance a matched filtering algorithm using Machine Learning. In particular, we employ a multi-layer perceptron network that targets IMBHs, distinguishing them from glitches in real single-detector data from the third observing run. Our algorithm successfully recovers over 90% of simulated IMBH signals in O3a and over 70% in O3b. Furthermore, we detect GW190521, GW190403_051519, GW190426_190642 and GW190909_11414 with high confidence.

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