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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 $gtrsim50 - 130M_{\odot}$ 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 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 detectors, IMBH searches are challenging due to their similarity to transient bursts of detector noise, known as glitches. In this work, we optimize a matched filtering algorithm, the state-of-the-art for searches, using Machine Learning. In particular, we employ a multi-layer perceptron network that targets IMBHs, distinguishing them from glitches in real single-detector data. Our algorithm successfully recovers over 90% of simulated IMBH signals. Furthermore, we detect GW190521 with high confidence.

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