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Merger rate of stellar black hole binaries above the pair-instability mass gap

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In current stellar evolutionary models, the occurrence of pair-instability supernovae plays a key role in shaping the resulting black hole (BH) mass population, preventing the formation of remnants between about $[60,\ 120]\mathrm{M}_\odot$.
We develop a simple approach to describe BHs beyond the pair-instability gap, by convolving the initial mass function and star formation rate with the metallicity evolution across cosmic time and SEVN, a code to evolve single stars up to $\mathrm{M} < 350\,\mathrm{M}_\odot$. Under the ansatz that the underlying physics of binary formation does not change beyond the gap, we then construct the cosmic population of merging BH binaries.
We found that LIGO/Virgo at design sensitivity will detect between $\simeq [0.4,\ 7]\,\mathrm{yr}^{-1}$ with both mass components above the gap, considering the most pessimistic and optimistic scenario. Similarly, the expected rate for third generation ground-based detectors, like Einstein Telescope, ranges between $[10,\ 460]\,\mathrm{yr}^{-1}$.
Moreover, at lower frequencies, LISA can individually detect these binaries up to thousands of years from coalescence. The number of multiband events, i.e. merging in less than four years, is expected to be in the range $[1,\ 20]$. While ET will detect all these events, LIGO/Virgo is expected to detect $< 50\%$ of them.
Finally the undetected systems are expected to contribute to the stochastic background in the LISA band. We estimate that this background may be in principle detected with a signal-to-noise ratio between $\simeq 2.5$ and $\simeq 80$.
Our work has been accepted for publication: \href{https://iopscience.iop.org/article/10.3847/2041-8213/ab3f33/meta}{A. Mangiagli et al., ApJL 883, L27}

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