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Searching binary black holes in Milky Way and other nearby galaxies with LISA

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In 2034, within the rapidly changing landscape of gravitational-wave astronomy, the Laser interferometer Space Antenna will be the first space-based detector that will observe the gravitational spectra in the millihertz frequency band. It has recently been proposed that numerous LIGO/VIRGO sources will also be detectable by LISA. LISA will be able to detect binary black holes from our Milky Way galaxy and its neighbourhood, evolving from their early inspiral stages. Interestingly, the sources that appear to be circular in the LIGO band may be eccentric in the LISA band, depending on the earlier stages of their evolution. We aim to explore the gravitational-waves emitted from black hole binaries in our Milky Way galaxy and its neighbourhood, as they are expected to be observable with LISA. The study of the properties of these gravitational-waves will enable us to predict their progenitor stars, formation channels, metallicities, astrophysical conditions of the formation of these binaries, and traceback earlier stages of their evolution. We combine the Latte simulation from the Feedback in relativistic environments (FIRE-2) project with the next-generation population synthesis code POSYDON to investigate the detectability of the binary black hole population in both the LISA and the LIGO frequency bands, as a function of eccentricity and their horizon distances, using a Monte-Carlo approach. Also, we study how one can disentangle different formation channels of these binaries using LISA, and estimate the rate at which these binaries form in the Milky Way galaxy and other nearby galaxies. These explorations will identify the primary properties of the binary systems that will be detectable within the range of LISA.

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