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Stellar-mass binary black hole mergers and dormant black hole-star binaries from young massive and open star clusters

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In the first part of the presentation, I shall recapitulate my recent endeavours in investigating the role of dynamical interactions in moderate mass star clusters in producing stellar-mass binary black hole (BBH) mergers over cosmic time. Dynamical BBH mergers are obtained from long-term direct N-body evolutionary models of ~10^4 M_sun, pc-scale young massive clusters evolving into moderate-mass open clusters. These models consistently include recent stellar-origin black hole and neutron star masses and natal kicks, (pulsation) pair-instability supernova, black hole spins, post-Newtonian treatment, and general-relativistic recoil kicks. The resulting BBH merger rate and its cosmic evolution are compared with those from the LIGO-Virgo-KAGRA observations. I shall then demonstrate a new, in-progress model grid that incorporates the effect of external, galactic tidal field on clusters. This homogeneous grid spans over galactocentric distances 1.0-8.5 kpc. While strong tidal field dissolves the clusters much faster, it also accelerates their core collapse, favouring interactions among the clusters' BHs, so that the BBH merger production is not quenched. I shall demonstrate how various galactic star formation profiles potentially modify BBH-merger properties, e.g., their delay time distribution. In the second part, I shall focus on the dormant (or detached) BH-star binaries in the galactic field that these model clusters produce. Such binaries are of high current interest due to the recent discoveries of detached field BH-star binary candidates, namely, Gaia-BH1 and Gaia-BH2. The above star cluster models are particularly suitable for studying such binaries since the models are evolved at least until all BHs are practically depleted from them, making the clusters' contribution to the field BH-star binary population complete. These models produce field Gaia-BH1- and Gaia-BH2-like binaries at rates of ~ 10^-7 per M_sun. I shall compare these results with those from other recent studies.

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