Contribution ID: **144** Contribution code: **P7** Type: **Poster**

Gravitational Wave Phase Shifts in Eccentric Black Hole Mergers as a Probe of Dynamical Formation Environments

Monday, 19 August 2024 16:42 (2 minutes)

We quantify for the first time the gravitational wave (GW) phase shift appearing in the waveform of eccentric binary black hole (BBH) mergers formed dynamically in three-body systems. For this, we have developed a novel numerical method where we construct a reference binary, by evolving the post-Newtonian (PN) evolution equations backwards from a point near merger without the inclusion of the third object, that can be compared to the real binary that evolves under the influence from the third BH. From this we quantify how the interplay between dynamical tides, PN -effects, and the time-dependent Doppler shift of the eccentric GW source results in unique observable GW phase shifts that can be mapped to the gravitational dynamics taking place at formation. We further find a new analytical expression for the GW phase shift, which surprisingly has a universal functional form that only depends on the time-evolving BBH eccentricity. The normalization scales with the BH masses and initial separation, which can be linked to the underlying astrophysical environment. GW phase shifts from a chaotic 3-body BH scattering taking place in a cluster, and from a BBH inspiraling in a disk migration trap near a super-massive BH, are also shown for illustration. When current and future GW detectors start to observe eccentric GW sources with high enough signal-to-noise-ratio, we propose this to be among the only ways of directly probing the dynamical origin of individual BBH mergers using GWs alone.

Affliation

Niels Bohr Institute

Current Position

PhD Student

Primary authors: Dr SAMSING, Johan (Niels Bohr Institute); HENDRIKS, Kai (Niels Bohr Institute)

Co-authors: Dr LIU, Bin (Zheijang University); Dr D'ORAZIO, Daniel (Niels Bohr Institute); Dr ZWICK, Lorenz (Niels Bohr Institute)

Presenter: HENDRIKS, Kai (Niels Bohr Institute)

Session Classification: Flash Poster Presentations (in-person)