Contribution ID: **166** Type: **Poster**

Constraining the acceleration of moving binary black holes with gravitational wave

Friday, December 15, 2023 3:44 PM (1 minute)

Binary black holes (BBHs) are among the most important sources of gravitational waves (GWs). Recent studies suggest that BBHs may form and merge in the vicinity of supermassive black holes (SMBHs), leading to overestimated black hole masses due to gravitational and Doppler redshift. A distinctive characteristic of these GW sources is their acceleration around the SMBH, allowing for their identification through the constraint of this acceleration using GW signals. In this study, GW sources that deviate from the predictions of general relativity in the inspiral-merger-ringdown (IMR) consistency test are considered as potential candidates for acceleration. We construct the accelerated waveform by accounting for relativistic effects, including Doppler shift, aberration, and magnification resulting from the gravitational lensing effect of the SMBH. Through our analysis of detectability, we find that the additional effects beyond Doppler shift can be observed with next-generation ground-based interferometers. Accounting for these effects enhances the probability of detecting the accelerating sources.

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Session Classification: Poster