

Binary mergers in strong gravity background of Kerr black hole

Monday, 16 September 2024 16:20 (20 minutes)

Binary-black-hole (BBH) mergers can take place close to a supermassive black hole (SMBH) while being in a bound orbit around the SMBH. In this paper, we study such bound triple systems and show that including the strong gravity effects of describing the SMBH with a Kerr metric can significantly modify the dynamics, as compared to a Newtonian point particle description of the SMBH. We extract the dynamics of the system, using a quadrupole approximation to the tidal forces due to the SMBH. We exhibit how the gyroscope precession is built into this dynamics, and find the secular Hamiltonian by both averaging over the inner and outer orbits, the latter being the orbit of the BBH around the SMBH. We study the long-time-scale dynamics, including the periastron precession and GW radiation-reaction of the binary system, finding that the strong gravity effects of the SMBH can enhance the von Zeipel-Lidov-Kozai mechanism, resulting in more cycles, higher maximum eccentricity, and thereby a shorter merger time, particularly when the binary is close to, or at, the innermost stable orbit of the SMBH. We end with an analysis of the peak frequency of the GW emission from the binary system, highlighting possible observable signatures in the ET and LISA frequency bands.

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Session Classification: Contributed Talks 2