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BH binary formation in AGN disks: dynamics, hydrodynamics, and GW signatures

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The possibility of binary black hole (BH) mergers in the accretion disks around active galactic nuclei (AGN) has recently received much attention. Studying the formation processes of these binaries allows us to more reasonably predict the rate and the observational properties of their mergers. In this talk, I will present our works on the mechanisms of forming tightly bound BH binaries in AGN disks via close encounters between two single BHs. First, using long-term N-body simulations, we find that two encountering BHs can form a bound binary via **GW bremsstrahlung**. This mechanism is important in low-density regions of the disks where the gas forces are weak. Mergers of the resulting binaries can have large eccentricities when entering the LIGO band and a broad distribution of orbital inclinations relative to the original AGN disk. Then, using a series of high-resolution 2D global hydrodynamical simulations, we demonstrate that binaries can also be formed by the **collisions of the BHs' gaseous minidisks** (which can produce a strong post-collision drag) if the host AGN disk is dense enough. Binaries assembled in this scenario may have compact semi-major axes and large eccentricities. We also diagnose the formation conditions of prograde and retrograde binaries using a 2D shearing-box model, and the results suggest that prograde binaries form at a slower rate than retrograde ones except when the gas density is sufficiently high.

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