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Dynamical Friction of Black Holes Embedded in Turbulent AGN Disks

Supermassive black holes in galactic nuclei are expected to accumulate a cusp of stellar-mass black holes around them. If the galactic nucleus evolves into an active galactic nucleus (AGN), these black holes will cross the AGN's gaseous disk twice per orbit, each time experiencing a gaseous dynamical friction force. This dynamical friction will induce alignment and circularization of the black holes within the AGN disk, potentially enhancing their interaction rate in the so-called AGN channel for gravitational wave formation. Consequently, many studies assume that black holes ultimately settle into perfectly circular and aligned orbits within the AGN disk.

However, accretion in AGN disks is fueled by turbulent motions within the gas. We demonstrate that turbulence counteracts dynamical friction, preventing the complete alignment and circularization of embedded black holes. We illustrate how to correlate local disk properties (density, sound speed, alpha viscosity) to the minimum values of eccentricity and inclination that embedded black holes can reach.

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