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Probing Dark Matter Spike with Gravitational Waves from Early EMRIs in the Milky Way Center

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Cold dark matter may form dense structures around supermassive black holes (SMBHs), significantly influencing their local environments. These dense regions are ideal sites for the formation of extreme mass-ratio inspirals (EMRIs), in which stellar-mass compact objects gradually spiral into SMBH, emitting gravitational waves (GWs). Space-based gravitational-wave (GW) observatories, such as LISA and Taiji, will be sensitive to these signals, including early-stage EMRIs (E-EMRIs) that persist in the low-frequency band for extended periods. Here we investigate the impact of dark matter-induced dynamical friction on E-EMRIs in the Milky Way Center, model its effect on the trajectory, and calculate the resulting GW spectrum.

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