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Intermediate-mass black holes in the deci-Hz window: formation, detection, and multiband prospects

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Intermediate-mass black holes (IMBHs), with masses between ~ 100 and $100,000$ solar masses, represent a unique yet elusive population of black holes, potentially bridging the gap between stellar-mass and super-massive black holes. For several decades, IMBHs have been investigated through a variety of observational channels, ranging from stellar dynamics in dense star clusters to accretion signatures and tidal disruption events. However, compelling evidence for their existence and, in particular, their formation pathways remains limited.

Gravitational waves offer a new and powerful way to identify and characterize these objects through direct measurements of their masses and spins. Current ground-based detectors probe primarily the lower-mass end of the IMBH spectrum, while future space-based observatories such as the Laser Interferometer Space Antenna (LISA) will access the high-mass end. Deci-Hz interferometers could bridge these regimes, providing sensitivity to a large fraction of the IMBH mass spectrum and potentially enabling truly multiband observations.

In this talk, I will first discuss possible formation pathways for IMBHs, focusing on dense stellar environments where repeated mergers and stellar collisions can drive their hierarchical growth.

I will then discuss the recent observation of GW231123 by the LIGO-Virgo-KAGRA Collaboration. With a component mass in the IMBH regime and remarkably high spins, this event provides an intriguing case study for testing models of IMBH formation and hierarchical growth.

Finally, I will explore the prospects for detecting intermediate-mass-ratio inspirals (IMRIs) across multiple gravitational-wave bands. I will show how deci-Hz observations can significantly expand the population of IMRIs accessible to ground-based detectors and provide a unique opportunity for multiband observations.

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