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Gravitational-wave parameter estimation to the Moon and back: synergies between ground and LGWA for BBHs

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LGWA will expand our observational reach and help us access new sources of GWs. At the same time, third-generation (3G) gravitational-wave (GW) detectors will usher GW science into the big-data era, with tens to hundreds of thousands of detections each year. In this talk, I will discuss the complementarity of ground-based detectors and LGWA, with a focus on the multiband observation potential for binary black holes (BBHs).

I will present an assessment of the detectability for BBH populations consistent with the latest LIGO–Virgo–KAGRA reconstruction. LGWA alone could have observed more than one-third of the events detected through GWTC-4.0, and could detect 90 events per year merging in the ground-based band out to redshifts $z \sim 3 - 5$. Current detectors at design sensitivity would yield one to a few hundred multiband counterparts with LGWA. In contrast, 3G detectors could observe most BBHs detected by LGWA that merge in their frequency band ($7 M_{\odot} \times 2272; M_{\text{tot}} \times 2272; 600 M_{\odot}$), enabling systematic joint analyses of hundreds of events.

The short time to merger from the deci-Hz to Hz–kHz band (typically months to a year) enables early warning, targeted follow-up, and archival searches. I will highlight the promising case of intermediate-mass BBHs, presenting an injection study for a GW231123-like system that accumulates $\sim 10^5$ inspiral cycles in LGWA. I will further discuss some parameters for which LGWA can deliver an exquisite reconstruction.

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