PROBING EXTENDED MASS DISTRIBUTIONS OF PRIMORDIAL BLACK HOLES IN NANOGRAV AND LVK

SEMINAR

DR. NILANJANDEV BHAUMIK
ICTP-AP, Beijing

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Primordial black holes (PBHs) serve as key probes of the early Universe and cosmic evolution. In this study, we explore the formation of PBHs near the QCD phase transition, driven by a broadly peaked inflationary scalar power spectrum. This mechanism naturally results in an extended PBH mass distribution and generates two distinct stochastic gravitational-wave backgrounds (SGWBs): a scalar-induced SGWB from second-order tensor perturbations at the time of PBH formation, and a merger-driven SGWB arising from the evolution of the PBH binary population. We analyze both SGWB components using Bayesian methods, incorporating data from the NANOGrav 15-year dataset and the first three observing runs of LVK. We also project the continuous-wave signals expected from mini extreme–mass-ratio inspirals (mini-EMRIs), enabling direct comparison with existing constraints from NANOGrav and LVK.

Our parameter-space analysis reveals regions where the combined SGWB signal may be detectable by future ground- and space-based gravitational-wave observatories. Notably, the extended PBH mass spectrum naturally leads to the formation of mini-EMRIs, which are promising targets for next-generation ground-based detectors such as upgraded versions of LVK, ET, and CE. In much of the parameter space, the astrophysical SGWB masks the primordial contribution in the frequency range accessible to ground-based detectors. As a result, in scenarios with extended PBH mass functions, the detection of mini-EMRIs provides a more reliable probe of the PBH landscape than SGWB measurements alone.

Everyone is invited to attend