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New probe for non-Gaussianities with primordial black hole induced gravitational waves

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We propose a new probe of primordial non-Gaussianities through the observational window of gravitational waves (GW) being induced by ultra-light ($M_{\rm PBH} < 10^9$g) primordial black holes (PBHs). An existence of primordial non-Gaussianity can leave imprints on the clustering properties of PBHs and the spectral shape of the induced GW signal. Focusing on local-type non-Gaussianities, we find a distinctive double-peaked GW energy spectrum which, depending on the PBH mass M and the initial PBH abundance at formation time, i.e. $\Omega_{\rm PBH,f}$, can lie within the frequency bands of forthcoming GW detectors, including LISA, ET, SKA and BBO, hence rendering this signal promisingly detectable by GW experiments and promoting it as a novel portal probing non-Gaussianities. Moreover, by accounting on BBN bounds on the non-Gaussian GW amplitude we set model-independent constraints on the effective $\tau_{\rm NL}$, denoted as $\bar{\tau}_{\rm NL}(k)$, on scales $k > 10^5 {\rm Mpc}^{-1}$, which read as $\bar{\tau}_{\rm NL}(k)\mathcal{P}_{calR}(k) < 2\times 10^{-20}\Omega_{\rm PBH,f}^{-17/9}\left(\frac{M_{\rm PBH}}{10^4{\rm g}}\right)^{-17/9}$, where $\mathcal{P}_{calR}(k)$ is the primordial curvature power spectrum.

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