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f^2 scaling of the PTA signals, induced gravitational waves, and primordial black holes

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The recent pulsar timing array (PTA) data show evidence of the stochastic gravitational wave (GW) background around the nanohertz frequency range. With the power-law fit, the data, particularly those of the NANOGrav, favor the spectral index of the cosmological strength of the GWs, Omega_GW(f), around 2. We discuss explanations of the PTA data by GWs induced by curvature perturbations. In particular, we interpret the f^2 scaling of the induced GWs in three ways, focusing on two of them in which the infrared tail of the GW spectrum fits the data. In the first scenario, we assume a sharp peak of the power spectrum of the curvature perturbations, and the induced GWs are associated with primordial black holes (PBHs) with O(10^(-4)) solar mass. Mergers of these PBHs emit the GW signals at higher frequencies and provide us the possibility for testing the scenario by future GW observations if PBHs are not overproduced. In the second scenario, we consider a cosmological era dominated by fluid with its stiff (w=1) equation of state. An advantage of this scenario is that PBH overproduction is much less likely. Thus, the PTA data offer us a clue on a resonance-like phenomenon during inflation or a non-minimal cosmological era before the big-bang nucleosynthesis.

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