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Cosmological Constraints on First-Order Phase Transitions

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First-order phase transitions exist in many models beyond the Standard Model and can generate detectable stochastic gravitational waves for a strong one. Using the cosmological observables in big bang nucleosynthesis and cosmic microwave background, we derive constraints on the phase transition temperature and strength parameter in a model-independent way. For a strong phase transition, we find that the phase transition temperature should be above around 2 MeV for both reheating photon and neutrino cases. For a weak one with a temperature below 1 MeV, the phase transition strength parameter is constrained to be smaller than around 0.1. Implications for using a first-order phase transition to explain the NANOGrav observed gravitational wave signal is also discussed.

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