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Supercooled Dark Scalar Phase Transitions explanation of NANOGrav data

The evidence of a Stochastic Gravitational Wave Background (SGWB) in the nHz frequency range is posed to open a new window on the Universe. A preferred explanation relies on a supercooled first order phase transition at the 100 MeV–GeV scale. We address address its feasibility going from the particle physics model to the production of the gravitational waves. We take a minimal approach for the dark sector model introducing the fewest ingredient required, namely a new U(1) gauge group and a dark scalar that dynamically breaks the symmetry. Supercooling poses challenges in the analysis that put under question the feasibility of this explanation: we address them, going beyond previous studies by carefully considering the effects of a vacuum domination phase and explicitly tracking the phase transition from its onset to its completion. We find that the proposed model can successfully give origin to the observed PTA SGWB signal. The strong supercooling imposes a correlation between the new gauge coupling and the scalar quartic one, leading to a significant hierarchy between the (heavier) gauge boson and the dark scalar. ultimately, information on phase transitions from SGWB observations could provide a direct probe of the microphysics of the Early Universe and be used to guide future searches of dark sectors in laboratories.

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