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Probing WIMPs in space-based gravitational wave experiments

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Although searches for dark matter have lasted for decades, no convincing signal has been found without ambiguity in underground detections, cosmic ray observations, and collider experiments. We show by example that gravitational wave (GW) observations can be a supplement to dark matter detections if the production of dark matter follows a strong first-order cosmological phase transition. We explore this possibility in a complex singlet extension of the standard model with CP symmetry. We demonstrate three benchmarks in which the GW signals from the first-order phase transition are loud enough for future space-based GW observations, for example, BBO, U-DECIGO, LISA, Taiji, and TianQin. While satisfying the constraints from the XENON1T experiment and the Fermi-LAT gamma-ray observations, the dark matter candidate with its mass around ~ 1 TeV in these scenarios has a correct relic abundance obtained by the Planck observations of the cosmic microwave background radiation.

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