Contribution ID: **9** Type: **not specified**

Supermassive Primordial Black Holes from a Catalyzed Dark Phase Transition for Little Red Dots

JWST has revealed an abundant population of compact, low-metallicity Little Red Dots (LRDs) at high redshift, challenging conventional scenarios in which supermassive black holes (SMBHs) grow from stellar-mass seeds. We consider a scenario in which the SMBHs are instead supermassive primordial black holes (SMPBHs), formed directly in a decoupled, subdominant dark sector undergoing a first-order phase transition. Unlike conventional stochastic phase transitions, our mechanism is based on the catalysis by domain walls (DWs): most of the Universe completes the transition rapidly, while rare long-lived false-vacuum domains survive because of DW statistics and collapse into PBHs. This mechanism naturally yields SMPBH seeds with masses up to $M_{\rm PBH} \sim O(10^{10}) M_\odot$, whose abundance can account for the observed LRD population. It also avoids the usual tensions with phase transition completion, $\Delta N_{\rm eff}$, and large curvature perturbations. The dark phase transition simultaneously generates an ultra-low-frequency stochastic gravitational-wave background peaking near the pulsar-timing-array range, providing a test of this dark-sector origin of LRDs. This presentation is based on arXiv: 2604.01304.

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