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Dark matter in QCD-like theories with a theta vacuum: cosmological and astrophysical implications

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QCD-like theories in which the dark matter (DM) of the Universe is hypothesized to be a thermal relic in the form of a dark pion has been extensively investigated, with most studies neglecting the CP-violating θ -angle associated with the topological vacuum. We point out that a non-vanishing θ could potentially trigger resonant number-changing processes giving rise to the observed relic density in agreement with perturbative unitarity as well as observations of clusters of galaxies. This constitutes a novel production mechanism of MeV DM and an alternative to those relying on the Wess-Zumino-Witten term. Moreover, for specific meson mass spectra, similar resonant scatterings serve as a realization of velocity-dependent self-interacting DM without a light mediator. Explicit benchmark models are presented together with a discussion of possible signals, including gravitational waves from the chiral phase transition associated with the dark pions.

Authors: GARCIA-CELY, Camilo; ZAPATA, Oscar; LANDINI, giacommo (IFIC and Universidad de Valencia)

Presenter: LANDINI, giacommo (IFIC and Universidad de Valencia)

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