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When Stars Collapse in Silence: Magnetar-Black Hole Variability Under the Veil of Dark Matter

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Abstract

Magnetars, a rare class of neutron stars, are known for their ultra-strong magnetic fields and high-energy emission variability. Their origin, evolution, and interactions especially with black holes present unique challenges to astrophysical models. This study investigates the dynamic behavior of magnetar–black hole systems, focusing on how hidden dark matter, either distributed in their local environment or potentially influencing the black hole's properties during formation, could affect their observable characteristics. Two possibilities are considered: that black holes may be embedded in dense dark matter environments, or that they themselves may be composed of or formed from dark matter. Using Universe Sandbox and MATLAB, combined with real observational datasets from known pulsars and compact object surveys, the research models how dark matter might amplify magnetic field decay, alter accretion patterns, and modulate high-energy emissions. Particular attention is given to variability patterns that could mimic or interfere with traditional variable stars used in distance measurement. These anomalous signatures, if unaccounted for, may lead to biases in interpreting time-domain data from surveys such as Gaia, LSST, and TESS. This work underscores the need to include exotic compact object behavior especially those influenced by dark components of the universe when refining stellar population models and cosmic distance indicators. By bridging compact object astrophysics with large-scale survey interpretation, this study opens a potential new avenue for identifying dark matter's indirect effects on stellar systems and deepening our understanding of high-energy cosmic evolution. Keywords: Dark matter interactions, Black hole–magnetar merger, Simulation-based modelling, Compact object astrophysics.