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Light Thermal Dark Matter Beyond p-Wave Annihilation in Minimal Higgs Portal Model

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This study explores a minimal renormalizable dark matter (DM) model, incorporating a sub-GeV Majorana DM and a singlet scalar particle ϕ. Using scalar and pseudo-scalar interactions (couplings c_s and c_p), we investigate implications for DM detection, considering s-wave, p-wave, and combined (s+p wave) contributions in DM annihilation cross-section, as well as loop-correction contributions to DM-nucleon elastic scattering. Identifying a broad parameter space ($10\,\mathrm{MeV} < m_\chi$
$lesssimm_\phi$) within the 2σ allowed region, we explore scenarios ($|c_s| \gg |c_p|$, $|c_s| \ll |c_p|$, and $|c_s| \approx |c_p|$). We find that (i) a non-zero pseudo-scalar coupling alleviates direct detection constraints as a comparison with the previous pure scalar coupling case; (ii) CMB observations set stringent limits on pseudo-scalar interaction dominant cases, making s-wave annihilation viable only for $m_\chi > 1\,\mathrm{GeV}$; (iii) the preferred ϕ-resonance region can be tested in the future indirect detection experiments, such as e-ASTROGAM.

Collaboration (if any)

Primary author: Dr TANG, Tian-Peng (PMO)

Co-authors: Prof. WU, Lei (NNU); Prof. MATSUMOTO, Shigeki (IPMU); Mr CHEN, Yu-Tong (NNU); Prof. TSAI, Yue-Lin Sming (PMO)

Presenter: Dr TANG, Tian-Peng (PMO)

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