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Gamma-ray flux limits from nearby brown dwarfs: Implications for dark matter annihilating into long-lived mediators.

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Brown dwarfs (BDs) are celestial objects representing the link between the least massive main-sequence stars and giant gas planets. I will present a recent analysis (Bhattacharjee et al.,2023) where consider a sample of nine nearby ($<$ 11 pc distance), cold and old BDs and look for gamma-ray signal from the direction of these objects using 13 years of \textit{Fermi}-LAT data. In the absence of any gamma-ray excess, we set 95\% confidence level upper limits on the gamma-ray flux with a binned-likelihood approach.

I will then show how this null result can be used to constrain particle dark matter (DM). If the DM of the universe is constituted of particles with non-negligible couplings to the standard model, BDs may efficiently accumulate them through scatterings. DM particles eventually thermalize and can annihilate into light, long-lived, mediators which later decay into photons outside the BD.

Within this framework, we set a stacked upper limit on the DM-nucleon elastic scattering cross section at the level $\sim 10^{-38}$ cm^2 for DM masses below 10 GeV. Our limits are comparable to similar bounds from the capture of DM particles in celestial objects but have the advantage of covering a larger portion of the parameter space in mediator decay length and DM mass and being less affected by DM modeling uncertainties.

Reference:
Bhattacharjee et al.,2023 - “Gamma-ray flux limits from brown dwarfs: Implications for dark matter annihilating into long-lived mediators” -Pooja Bhattacharjee, Francesca Calore, and Pasquale Dario Serpico - Phys. Rev. D 107, 043012 –Published 10 February 2023

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