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Cosmic-ray cooling by dark matter in astrophysical jets

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Astrophysical jets from powerful active galactic nuclei (AGN) have recently been proposed as promising probes of dark matter (DM) in the sub-GeV mass range. These jets accelerate cosmic rays (CRs) to very high energies, which can then interact with their environments to produce multiwavelength (MW) emission ranging from radio frequencies to TeV γ rays. If DM consists of light particles, their interactions with CRs could introduce an additional cooling mechanism, altering the expected MW emission.
In this talk, I will discuss an analysis of the MW spectrum of Markarian 421—a well-studied AGN—using a multizone leptonic jet model that includes interactions between CR electrons and DM particles. I will describe the uncertainties in the astrophysical jet dynamics, which have previously been neglected when constraining the CR–DM interactions. I will demonstrate a strong degeneracy between the particle acceleration efficiency in the jets and the DM–electron cross-section $\sigma_{\text{DM-e}}$, where lower acceleration efficiencies yield tighter constraints on $\sigma_{\text{DM-e}}$. Assuming a maximal efficiency of 10%, I will present 5σ upper limits on $\sigma_{\text{DM-e}}$ for various DM masses, and compare these limits with previous estimates based on a fiducial AGN emission model.

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