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Jupiter is a Leptophilic Dark Matter Refrigerator

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Jupiter has long been considered a pre-eminent target for dark matter searches, due to its proximity, mass, and low astrophysical backgrounds. However, low-mass dark matter ($\leq$400 MeV) is expected to efficiently evaporate from the Jovian core via interactions with standard model particles, limiting searches for dark matter effects. We show that in the case of leptophilic dark matter, evaporation rates are strongly suppressed due to the fact that most of Jupiter's hydrogen exists in a metallic state where electrons completely fill the Fermi-Dirac particle distribution and thus cannot donate energy to evaporate the dark matter particle. We show that dark matter down to MeV-masses can remain trapped within Jupiter on Gyr timescales. Applying this effect to previous studies of dark matter-induced airglows on the Jovian surface, we find limits that hit theoretically motivated targets for MeV-scale leptophilic dark matter.

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