A Pictorial Representation of Current Constraints on Condensed Dark Matter

T.M. Eubanks

P.O. Box 141, Clifton Virginia 20124

Abstract
This document provides a graph representing the current constraints on Compact Ultra-Dense Objects (CUDOs)\(^{(1,2)}\). It is intended to be updated as new constraints are published or found. For background to this figure, see\(^{(3,4)}\).

Keywords:

1. Acknowledgements
This document has benefited from discussions over time with Bruce Bills (JPL), Jan Rafelski (U. Arizona) and Ariel Zhitnitsky (U. British Columbia). Philippe Mermod (U. Geneva) alerted me to the power of mica crystals to constrain the flux of small CUDOs.

References


Figure 1: Solar System and Galactic limits on CUDOs as a function of mass, assuming a monochromatic CUDO mass spectrum. $\rho_{CDM} (\text{Halo})$ denotes the Galactic Halo dark matter density, as estimated using stellar kinematics$^5$. Shaded regions are the mass ranges excluded by various observational constraints, and theoretically or observationally favored mass ranges are delineated by horizontal arrows. The “Mica Tracks” constraint is based on a failure to find evidence of the passage of CUDOs through crystals of Mica exposed (in rock) for 600 to 900 million years$^{6,7}$. The Mica constraint applies to CUDOs with masses as small as $\sim 10^{-13}$ kg; substantially smaller condensed matter objects are typically called “strangelets” or “nuclearites,” and are expected to behave more like microphysical particles; constraints on these objects are described in$^{8,9}$. The lunar Apollo ALSEP and terrestrial USGS constraints are seismological$^{10}$, using the entire celestial body as a detector. The femtolensing$^{11}$, Kepler microlensing$^{12}$ and ground-based microlensing$^{13,14}$ constraints apply to condensed objects of any density, the other constraints are most rigorous for objects with densities near the nuclear density. The “VFR asteroid”$^4$ and “axion domain wall”$^{15,16}$ mass ranges suggested by observations and theory, respectively, are not substantially excluded by any of these constraints.


