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INSTITUTO DE FÍSICA
DE PARTÍCULAS Y DEL COSMOS

Preprint Series in Particles and Cosmos Physics

nº IPARCOS-UCM-24-045

Hydrostatic isothermal spherical DM haloes: hardly from Particle Physics

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September 2024

Plaza de las Ciencias, 1 28040 Madrid, Spain

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Abstract

Determining the Dark-Matter (DM) mass unit with any precision, a problem similar to Avogadro's in molecular physics, might require a measurement straddling over to the microscopic realm (such as Brownian motion back then).
Still, rough estimates on a log scale can be obtained from macroscopic transport coefficients alone, in particular thermal conductivity for theories with DM selfinteractions yielding some pressure.
Analyzing this, we provide a formula for that mass unit which is proportional to the cube of the heat conductivity
quotiented by the volumetric heat capacity. It leads us to conclude that not all of the following conditions can be simultaneously met:
a) DM is made of microscopic components (such as elementary particles or hadronlike composites).
b) Dark Matter can be thought of as a gas of said particles.
c) Dark Matter in galaxies is distributed in spherical, nearly isothermal (that is, standard) haloes which are pressure-supported in hydrostatic equilibrium.
If one is willing to adopt elongated haloes such as suggested by galactic rotation curves, or if their support is not hydrostatic, then there is no restriction here on Dark Matter's granularity; but the requirement that commonly used isothermal haloes relax to thermal equilibrium efficiently enough can impose a severe constraint on the mass of Dark Matter's units, apparently excluding a microscopic gas.

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