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Maxwell-Boltzmann gas with nonstandard self-interactions: A novel approach to galactic dark matter

Balakin A., Sussman R., Zimdahl W.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

Using relativistic kinetic theory, we study spherically symmetric, static equilibrium configurations of a collisionless Maxwell-Boltzmann gas with nonstandard self- interactions, modeled by an effective one-particle force. The resulting set of equilibrium conditions represents a generalization of the classical Tolman-Oppenheimer-Volkov equations. We specify these conditions for two types of Lorentz-like forces: one coupled to the 4-acceleration and the 4-velocity and the other one coupled to the Riemann tensor. We investigate the weak field limits in each case and show that they lead to various Newtonian type configurations that are different from the usual isothermal sphere characterizing the conventional Newtonian Maxwell-Boltzmann gas. These configurations could provide a plausible phenomenological and theoretical description of galactic dark matter halo structures. We show how the self-interaction may act phenomenologically as an effective cosmological constant and discuss possible connections with Modified Newtonian Dynamics (MOND).

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