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Collisionless relaxation of galaxy clusters and the dark wave (if it exists).

This paper reports a stochastic theory of gravitational relaxation based on a Lévy-fractional Klein-Kramers equation with self-consistent entropy term. The use of fractional derivatives in this equation is motivated with nonequilibrium phase-space dynamics breaking the restrictive assumptions of Gaussianity, lack of correlation and nearness to virialized state. Astrophysical applications of the theory concern gravitational evolution of galaxy clusters with non-minimally coupled cold dark matter. One hard result pertaining to the statistical model is that position correlations between galaxies are attracted by the power law $r^{-7/4}$, which approximates the canonical scaling $r^{-1.8}$ found in observations. The kinetic description, considered in this paper's work, is compatible with an idea that the relaxation of galaxy clusters to virialized state could be collisionless and mediated by hypothetical "dark waves", collective excitations of the coupled baryonic-dark matter system driven by the variation of local curvature on suitably small spatial scales.

Reference:

A. V. Milovanov, Stochastic theory of gravitational relaxation and Lévy-fractional Klein-Kramers equation, Europhys. Lett. EPL **140** (2022) 59001.

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