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The observed halo shapes suggest that dark matter deviates from the collisionless cold dark matter paradigm

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In the standard cosmological model the dark matter (DM) particles are collisionless and, because of this very nature, they develop halos with the characteristic central cusp known as NFW profile. Real galaxies do not show NFW profiles but, rather, have a DM mass distribution with a central plateau or core, characteristic of self-gravitating systems in thermodynamic equilibrium (SA+20). Within the standard model, the collisionless DM reaches equilibrium through baryon-driven processes able to transform the overall potential from cusp to core (Governato+10). Such mechanism becomes inoperative for galaxies with few stars (stellar mass <10^6 Msun; Penarrubia+12), thus, finding cores in these galaxies would indicate that the DM is not collisionless, reflecting the much sought-after and currently unknown true nature of the DM (whether it is fuzzy, self-interacting, warm, or else). Measuring the DM distribution in these tiny galaxies through traditional dynamical indicators is impossible, but we have developed a tool to constrain the distribution of DM from the stellar photometry alone. Cores in the stellar distribution are very common, and they turn out to be inconsistent with NFW potentials because the phase-space distribution function to match them has to be negative (SA+23). I will put forward the arguments leading to this conclusion, and then apply the technique to six observed Ultra Faint Dwarf galaxies, with stellar masses between 10^3 and 10^4 Msun. They show stellar cores incompatible with NFW potentials, which suggests the DM to deviate from the collision-less cold dark matter paradigm. This result still requires to be put on a solid statistical basis, but the needed data will be available soon provided by the new generation of deep imaging surveys such as the LSST-Vera Rubin Observatory or the Euclid satellite.

Governato+10, Nat, 463, 203
Penarrubia+12, ApJL, 759, L42,
Sanchez Almeida+20, A&A Letters, 642, 14
Sanchez Almeida+23, ApJ, 954, 153

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