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The Characteristic Mass for Cusp–Core Transformation in Dark Matter Halos

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Shinozaki et al. in prep. present an analytical model that embeds the cusp–core transition into the c – M relation of dark matter halos. The model accounts for deviations from scaling relations in galaxies, where central surface densities fall below c – M predictions. In contrast, UFDs retain high central densities consistent with CDM. Assuming supernova(SN) feedback drives the transition, the model predicts it operates within a characteristic halo mass range of 10^8 – $10^{11} M_\odot$, defining a critical stellar mass and a “forbidden region” where core formation is ineffective. The framework is validated by analysis using SPARC and UFD data (Hayashi, Kaneda, Mori & Shinozaki in prep.). These data confirm that most galaxies lie outside this region and can undergo the transition, while groups, clusters, and UFDs remain trapped within it. The observed diversity in low-mass density profiles likely arises from variations in star formation efficiency and the coupling efficiency between SN feedback and the dark matter potential.

References

Kaneda, Mori, Otaki (2024), PASJ, 5, 1026

Author: SHINOZAKI, Michi (University of Tsukuba)

Co-authors: MORI, Masao (University of Tsukuba); Ms KANEDA, Yuka (University of Tsukuba); Dr HAYASHI, Kohei (National Institute of Technology, Sendai College)

Presenter: SHINOZAKI, Michi (University of Tsukuba)

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