博 士 論 文 公 聴 会

ご 案 内

下記の要領で博士論文公聴会を開催します。皆様のご来聴をお待ちしております。

記

日　時 ： ２０２６ 年5月２２日（金）　16：50　～ 18：20

場　所 ： Ｆ６０８号室

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題　目 ：Structural Diversity of Dwarf Galaxies in a Cosmological Simulation Suite: Toward Understanding the Full Population

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論文題目 : Structural Diversity of Dwarf Galaxies in a Cosmological Simulation Suite: Toward Understanding the Full Population

論文要旨 :

Observations reveal a wide diversity of dwarf galaxy morphologies and kinematics, posing emerging challenges to cosmological simulations. These tensions, such as the difficulty in reproducing the observed size distribution, have been discussed in the context of stellar feedback and numerical resolution. More recently, a deficit of rotationally supported dwarf galaxies has been proposed, further highlighting the incomplete understanding of dwarf galaxy diversity. However, in these cases, the role of halo assembly history remains largely unexplored in a ΛCDM context. We present CROCODILE-DWARF, a new suite of cosmological zoom-in hydrodynamic simulations of field dwarf galaxies designed to isolate and characterize the role of assembly history. We select isolated halos with masses $M_{200} \sim 10^{10}\,M_{\odot}$ at $z = 0$, with concentrations spanning $c_{200} = 5\text{-}14$, as a proxy for assembly history. The simulated galaxies, with stellar masses $M_{\star} \sim 10^{7}\,M_{\odot}$, are broadly consistent with the observed stellar-to-halo mass, mass-metallicity, and size-mass relations for nearby dwarf galaxies.

We quantify how assembly history shapes the structural properties of dwarf galaxies. Assembly timing regulates the gas content: early-assembling, high-concentration halos form stars efficiently and become gas-poor by $z = 0$, whereas late-assembling, low-concentration halos remain gas-rich owing to delayed star formation and late-time gas accretion. We find a trend between gas rotational support and the cumulative merger mass fraction, indicating that mergers, including those with mass ratios as small as $0.01\text{-}0.1$, contribute to kinematic diversity. Late-time major mergers can trigger the formation of extended, rotationally supported gas disks by delivering fresh gas and aligned angular momentum; this suggests a pathway to rotationally supported dwarf galaxies, a population rarely produced in earlier simulations.

Despite this diversity, we also find a remarkable structural universality at the $R_{1,\star}$ radius, a recently proposed physically motivated size definition at which the stellar surface density reaches $1\,M_{\odot}\,\mathrm{pc}^{-2}$. Our simulations reproduce the tight stellar mass-$R_{1,\star}$ relation reported in recent studies, and we suggest that the near-constancy of the dark matter surface density at $R_{1,\star}$, independent of halo concentration, may explain the tightness of this relation.

Overall, these results provide insights into the galaxy-halo connection underlying the structural diversity of dwarf galaxies, suggesting that assembly history contributes to morphological and kinematic variation while a universal structural property emerges at $R_{1,\star}$. The connection between the $R_{1,\star}$ radius and underlying dark matter structure will be further explored in future work