Galactic Assembly in Different Dark Matter Models

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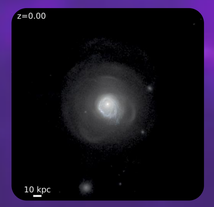
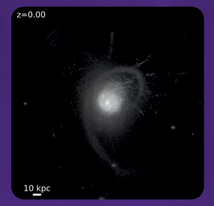
SCAN ME

Motivation

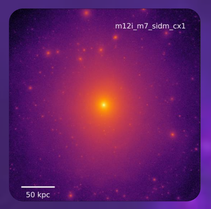
- 85% of all matter in the Universe is Dark Matter
  - Has gravity but emits no light
  - We CAN'T see it at all



- We CAN see stars
  - Galaxies, streams, phase-mixed objects
  - These substructures come from cosmology + dark matter theories



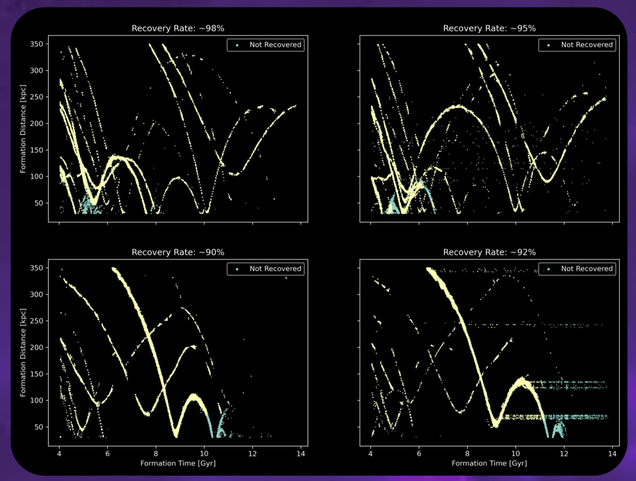
- Different dark matter (DM) types lead to differences in formation
  - CDM: Cold
  - SIDM: Self-Interacting



- Thus, stars tell us what the DM is doing...so we can visualize it!

Fig 1. (Top to bottom) Simulation images[1] of nothing, stars in CDM, stars in SIDM, and dark matter distributions in SIDM, respectively.

Deconstructing A Galaxy



- Substructure Tracking Pipeline
  - Trace building blocks of galaxies
  - Average star recovery rate of 94%

Fig 2. Star recovery rates of the subhalo/stream tracking pipeline for two CDM and two SIDM simulations. Everything in yellow overlapping green represents star particles that were successfully tracked.

- Halo Merging
  - Building blocks form a "tree" through assembly
    - Groups of stars (right) fall into larger DM groups (halos), effectively snowballing
    - Eventually all tiny groups of stars and DM result in the galaxy at the end

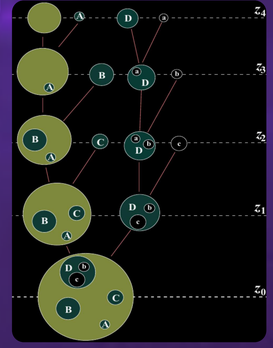


Fig 3. Stellar and DM Halo merger tree diagram.[2]

A Universe in Your Pocket: FIRE-2

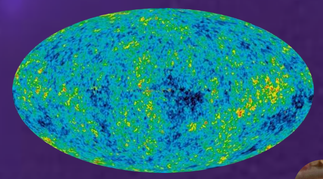


Fig 4. The Planck CMBR, or Cosmic Microwave Background Radiation[3]. The oldest light in the Universe.

Fig 5. (Left to right) Snapshots of gas, star, and DM formation from FIRE-2 simulations[3,4].

Recovered Substructure

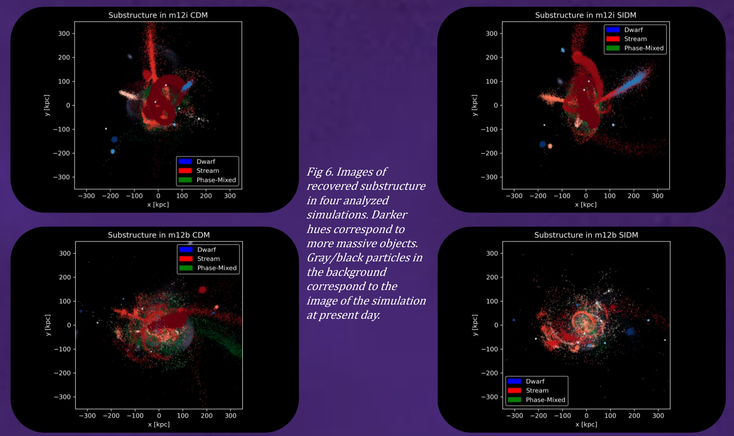


Fig 6. Images of recovered substructure in four analyzed simulations. Darker hues correspond to more massive objects. Gray/black particles in the background correspond to the image of the simulation at present day.

Galaxy Halos in CDM & SIDM

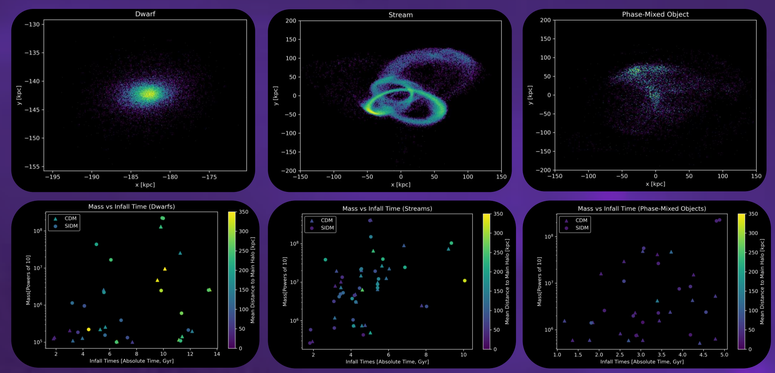


Fig 7. (Top) Images of different types of stellar substructure at present day. (Bottom) Stellar mass vs infall time graphs, colored by distance to the center of the simulation at present day. Note: CDM and SIDM datasets present no statistical difference across all comparisons.

Future Work

Subhalo Mapping
- Initial conditions
- Case-by-case comparison of evolution

New Subhalo Catalog
- Updated list for more simulations
- Properties, characteristics, and flags for special cases

Analysis of Chemodynamics
- Measuring quantities such as mass-metallicity ratios

References

1. Vargya et al, 2022
2. Zavala & Frenk, 2019
3. Wetzel et al, 2016
4. Hopkins 2015

Acknowledgements

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