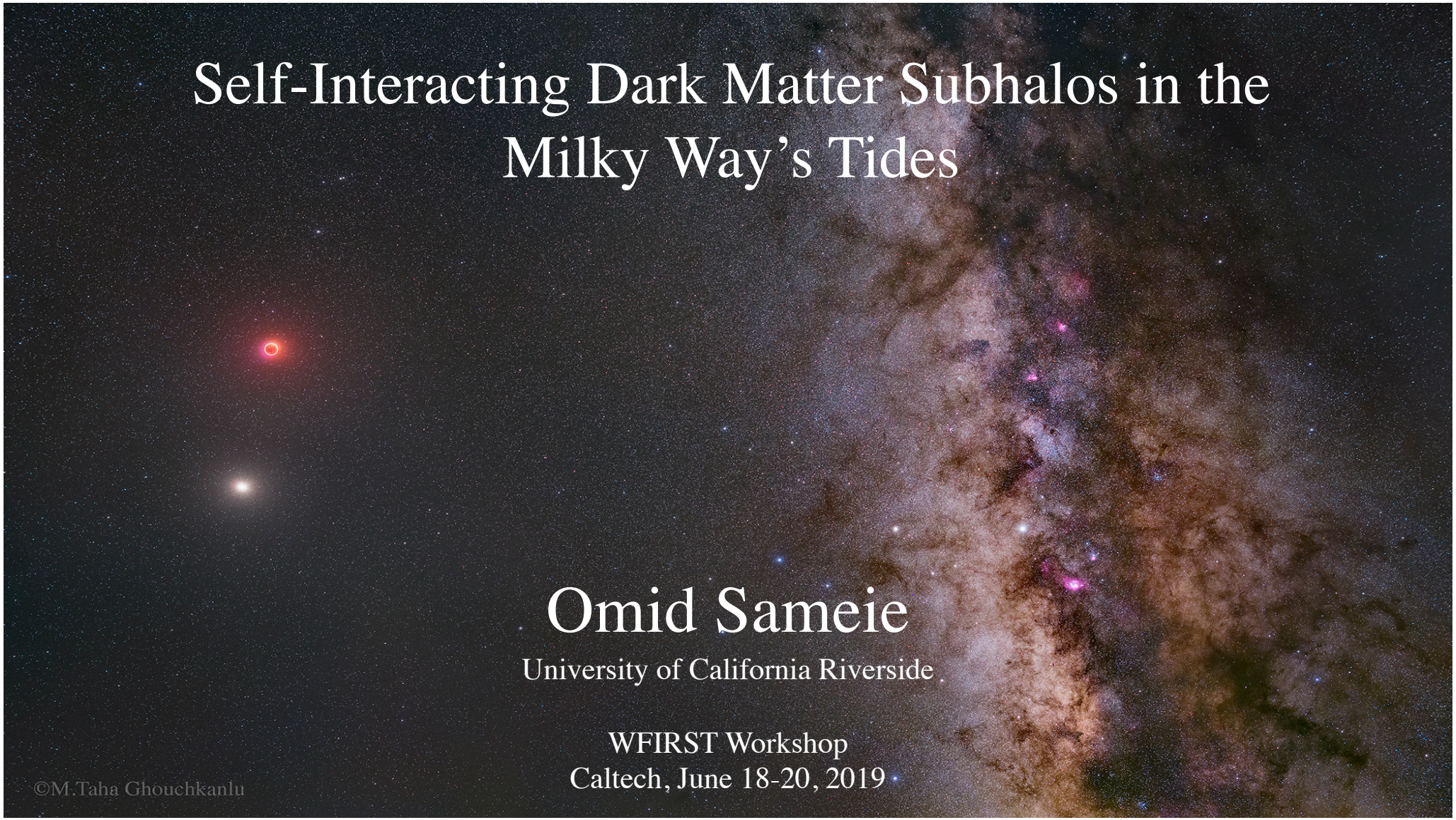
Self-Interacting Dark Matter Subhalos in the Milky Way's Tides



Omid Sameie

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WFIRST Workshop
Caltech, June 18-20, 2019

Standard model: collisionless Cold Dark Matter (CDM)

Cold: dark matter particles are non-relativistics

Collisionless: It interacts only through gravity

Small-scales puzzles:

Too-Big-To-Fail

Core vs. Cusp

Diversity in the field

Diversity in the Local Group

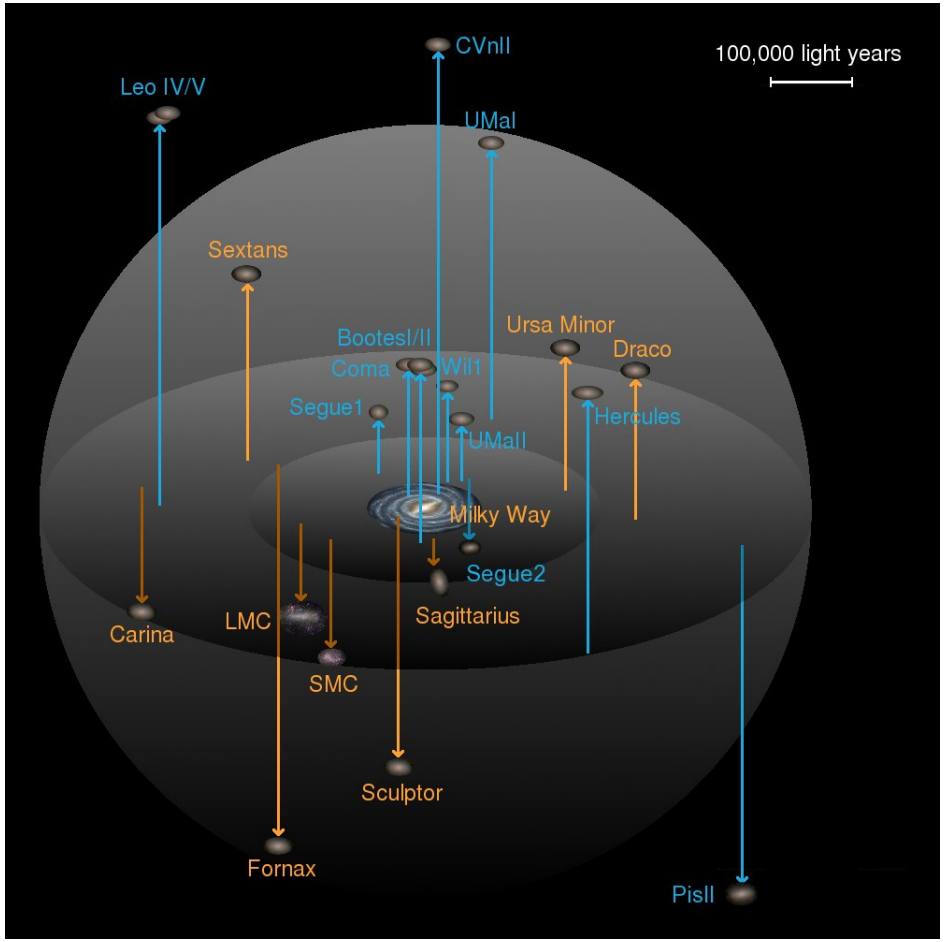
Successful on extra-galactic scales

Milky Way satellites:

Good measurements of both stellar and dark matter content of these satellites

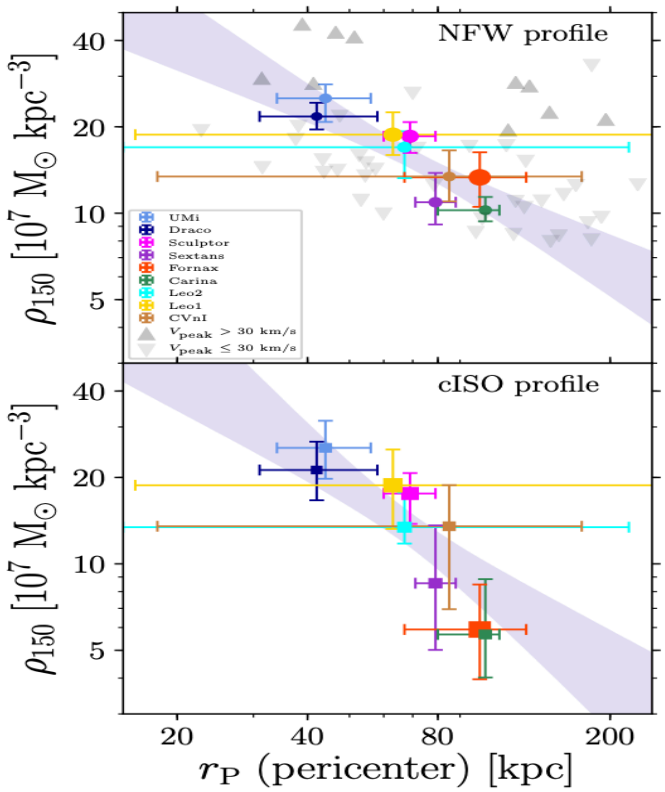
Keck Telescopes

Magellan Telescope

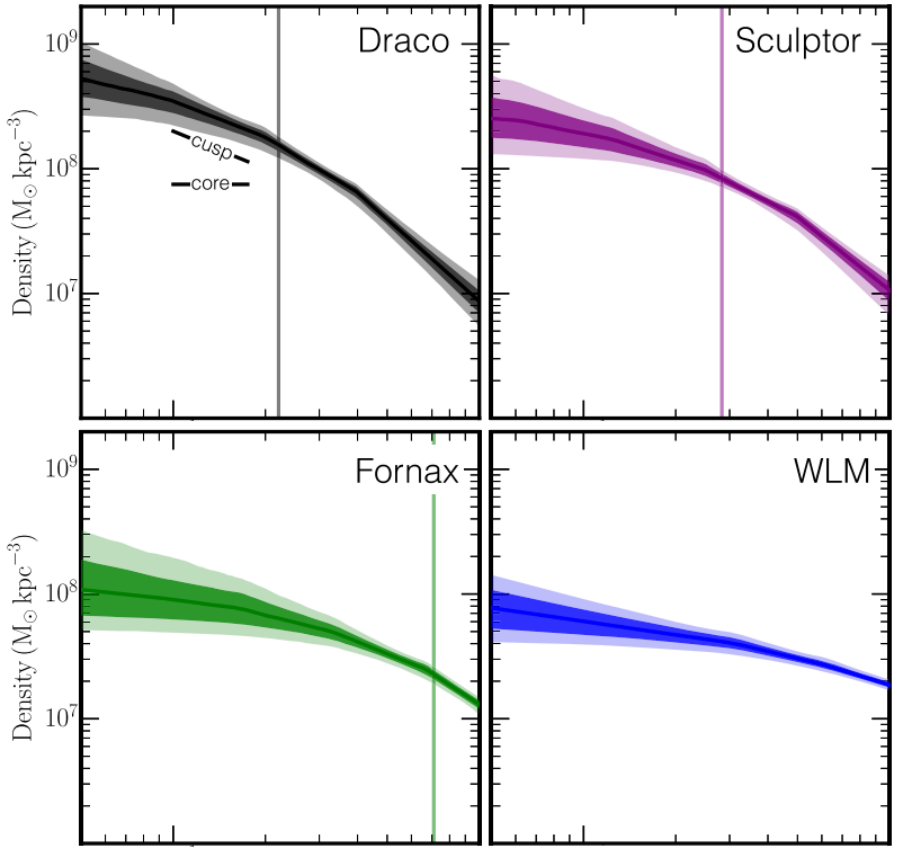


Omid Sameie

Diversity in the central dark matter density of MW satellites



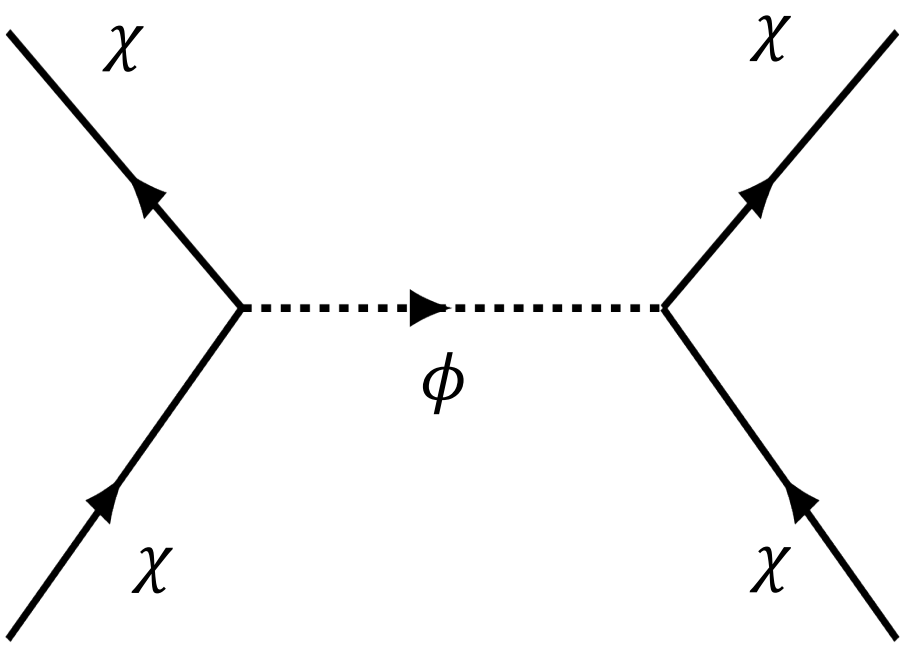
Kaplinghat+ 2019



Read+ 2019

Self-Interacting Dark Matter (SIDM): an alternative to CDM

Physics of dark matter self-interactions



SIDM cross-section: $\frac{\sigma_x}{m_x}$

≡ strength of interactions

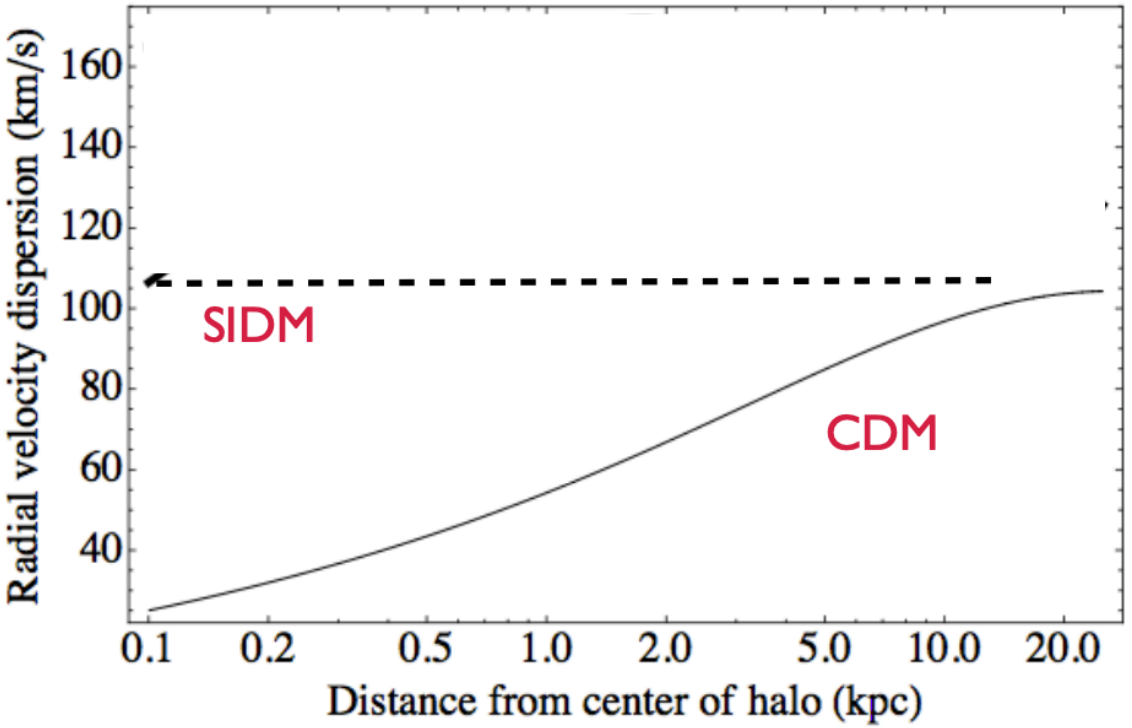
Interaction rate ∝

1: Cross section

2: Relative velocity of particles

Physics of dark matter self-interactions

1. Central velocity dispersion increases
2. Central dark matter density decreases



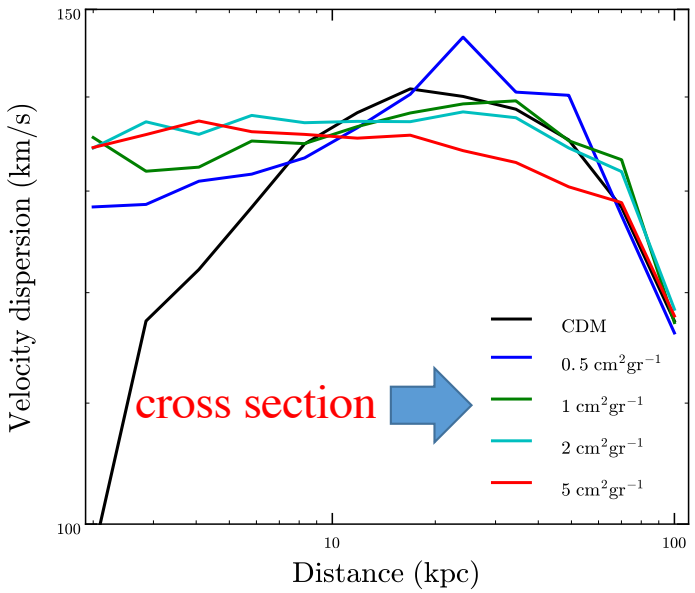
Credit: Hai-Bo Yu

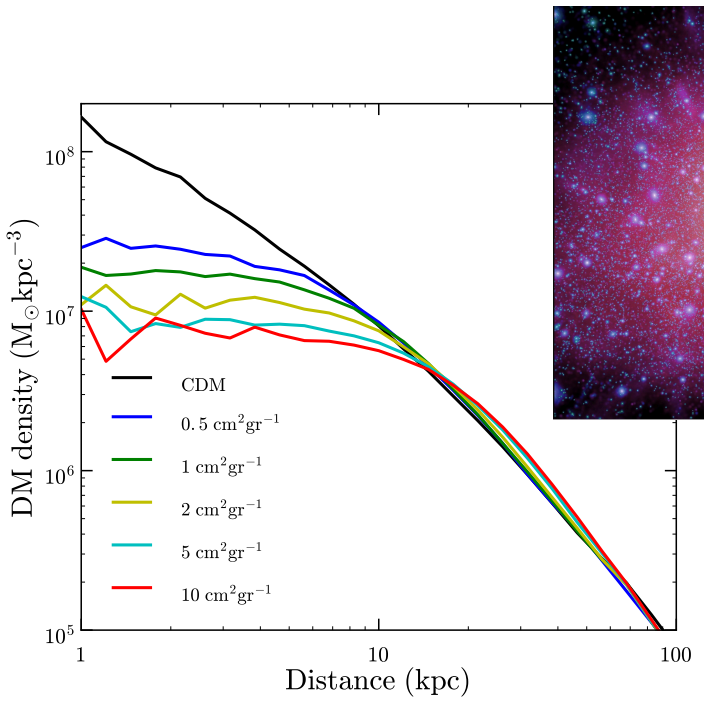
Interaction rate ∝

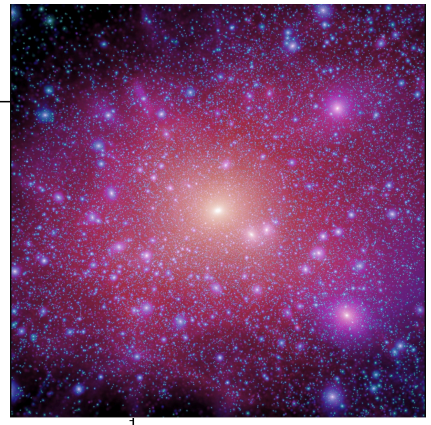
1: Cross section

2: Relative velocity of particles

Numerical simulations: SIDM vs. CDM

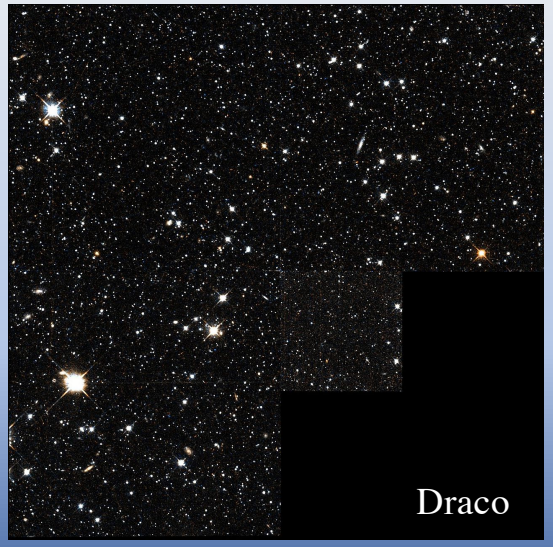




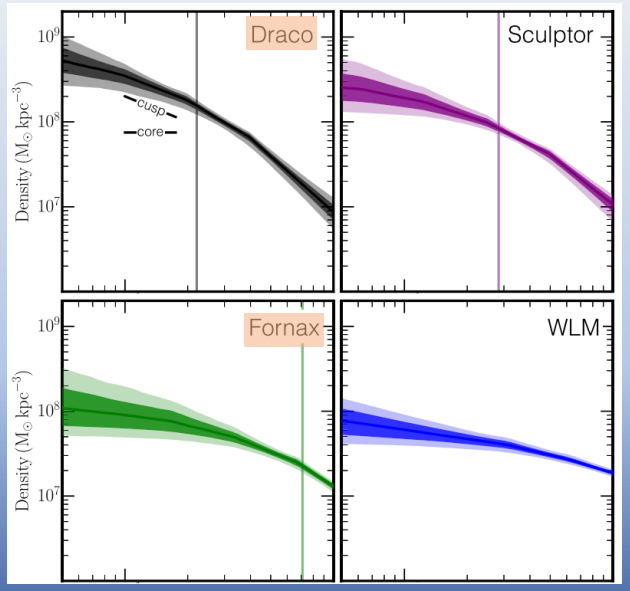


Higher $\frac{\sigma_x}{m_x} \sim$ larger core size

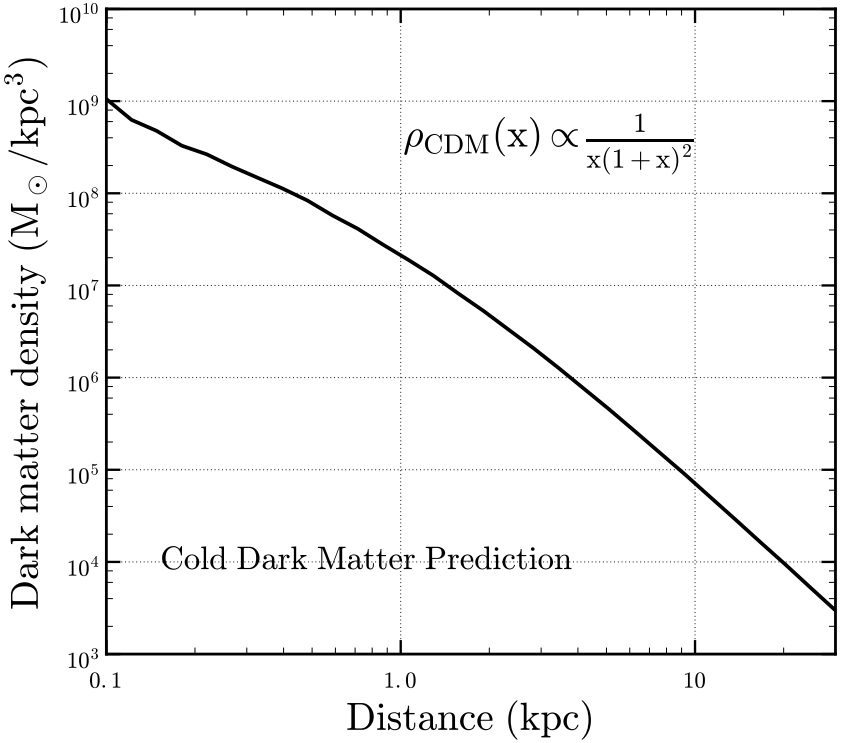
Evolution of SIDM subhalos under tidal interactions



Credit:HST/ESO

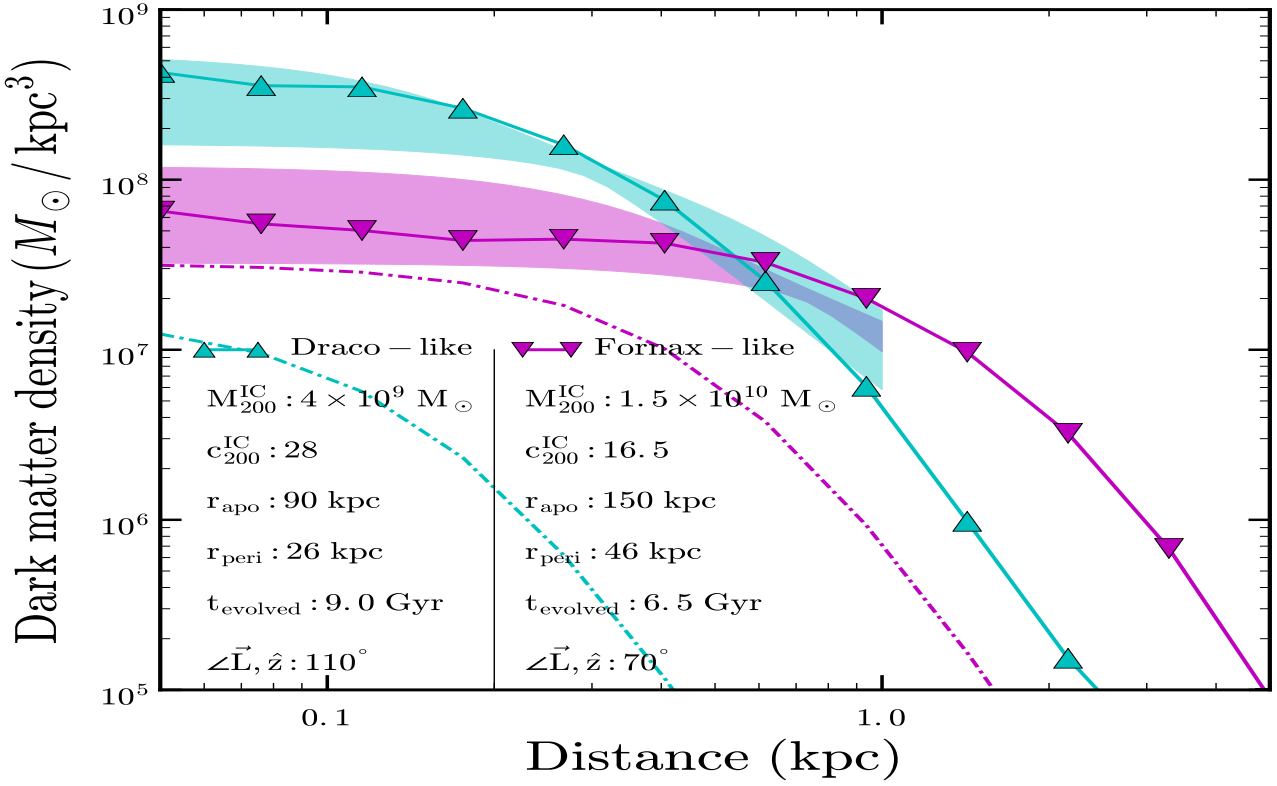


Simulations setup



We study the evolution of density profiles of the MW satellites

The two most extreme cases: Draco and Fornax

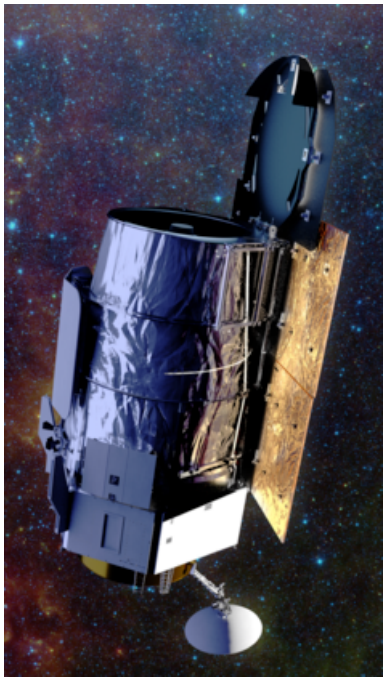


Sameie et al. (arXiv1904.07872, submitted)

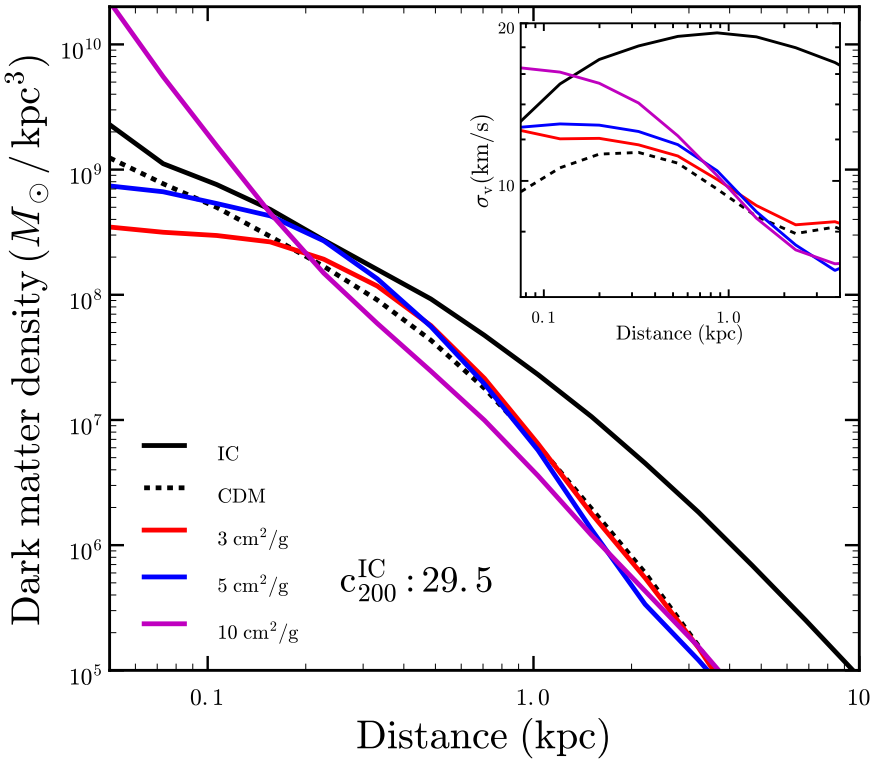
$$c_{200} \equiv \frac{\text{virial radius}}{\text{length scale}}$$

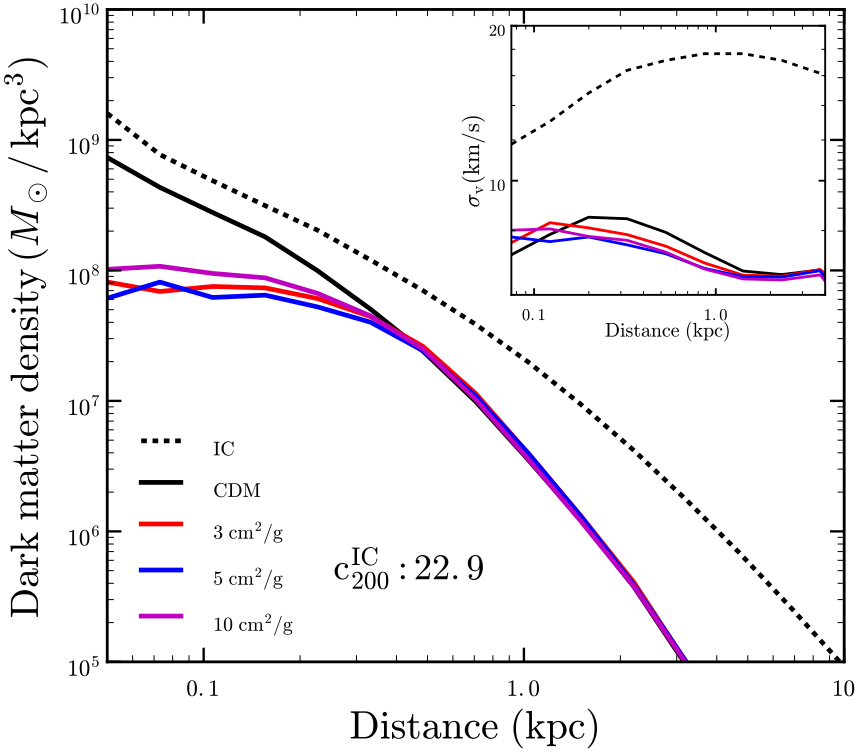
Summary

- Milky Way satellites are unique laboratories to study the nature of dark matter
- Measured dark matter contents of these satellites show huge spread at the central region
- Interplay between tidal forces and SIDM offers a novel explanation to the diversity observed in the central density of MW satellites
- Next generation of telescopes including LSST and **WFIRST** can further constrain the nature of dark matter



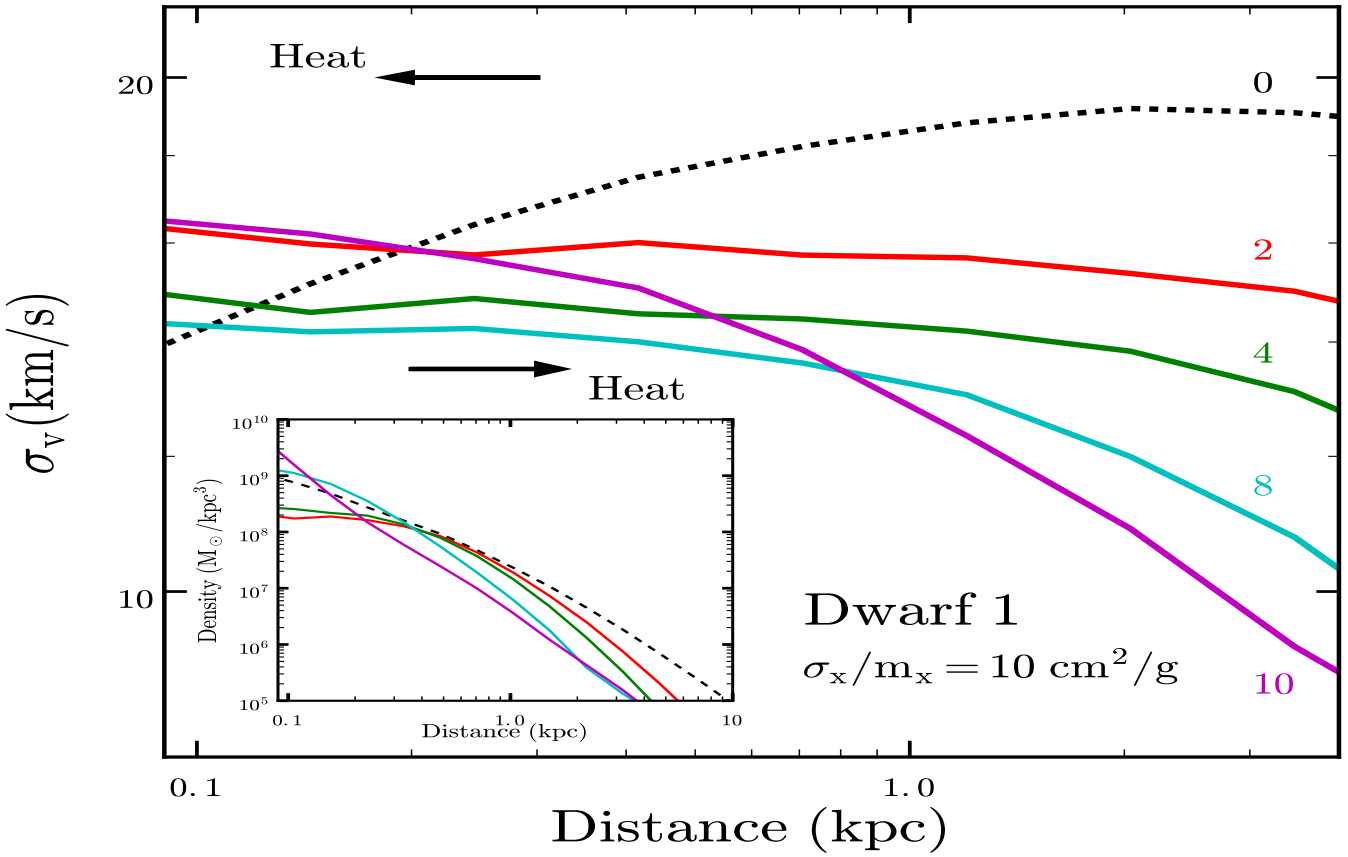
Dark Matter density profiles:





Sameie et al. 2019

Thermalisation/Tidal Stripping



Sameie et al. 2019b