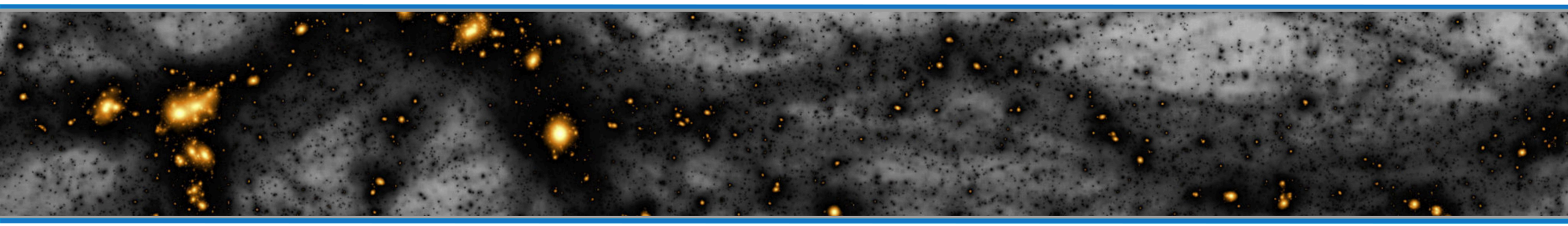


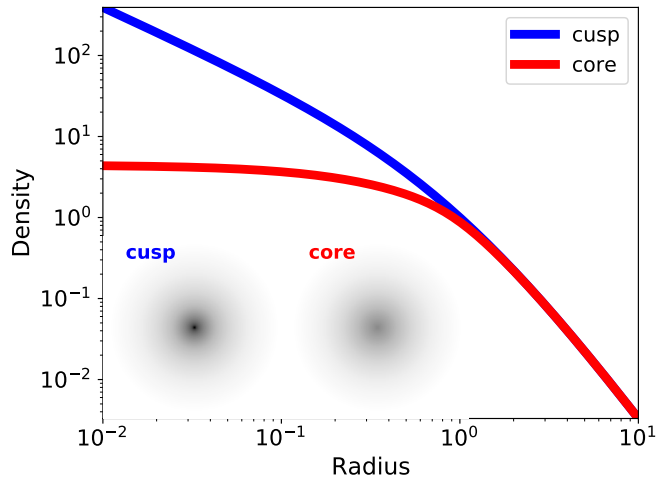
How could we probe the angular dependence of dark matter self-interactions?

Moritz S. Fischer (Sternwarte München - LMU)

Collaborators:
Klaus Dolag, Marcus Brüggen, Felix Kahlhoefer, Antonio Ragagnin, Andrew Robertson, Kai Schmidt-Hoberg

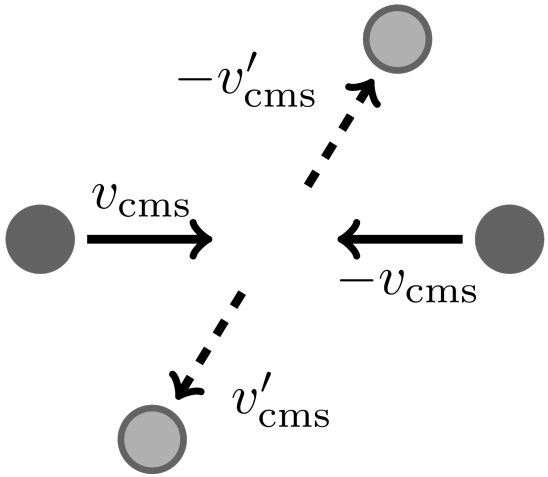
SIDM and Small-Scale Problems

- ΛCDM can explain cosmological large-scale structure remarkably well
- There are several issues on small scales (small-scale crisis)
- Self-interacting dark matter (SIDM) is promising, can solve or at least mitigate small-scale problems.
  - e.g. SIDM can form density cores

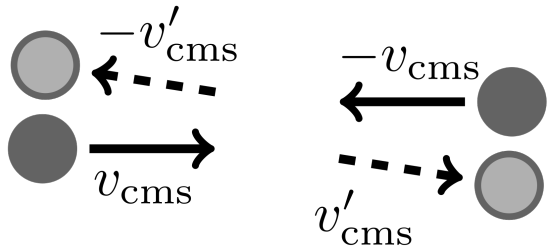


The Collision Term

We distinguish two regimes:



large-angle scattering
– rare –



small-angle scattering
– frequent –

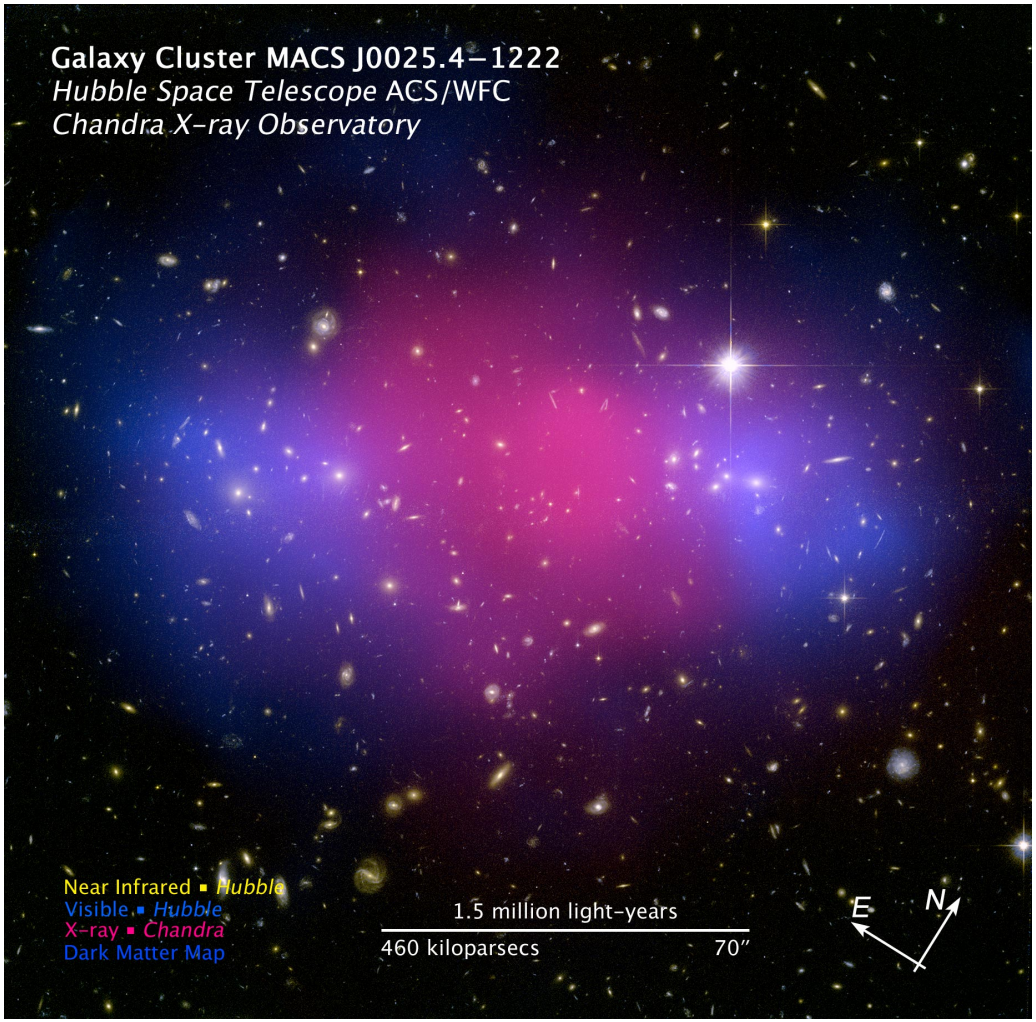
Effective Description: Drag Force

$$\delta v_{\parallel} \neq 0 \Rightarrow F_{\mathrm{drag}}$$

$$\delta v_{\perp} = 0 \text{ but } \delta v_{\perp}^2 > 0$$

Description of drag force from Kahlhoefer et al. 2014

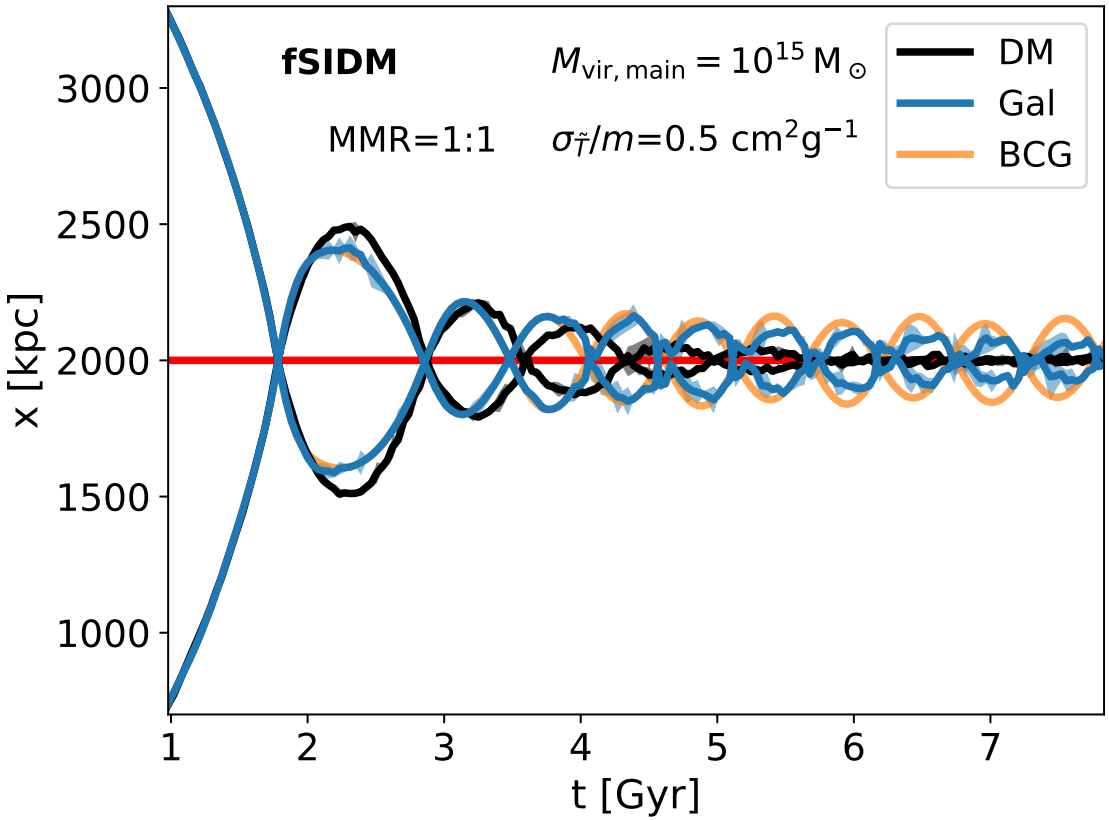
Galaxy Cluster Merger



Credits: NASA, ESA, CXC, M. Bradac (University of California, Santa Barbara), and S. Allen (Stanford University)

Equal-Mass Merger

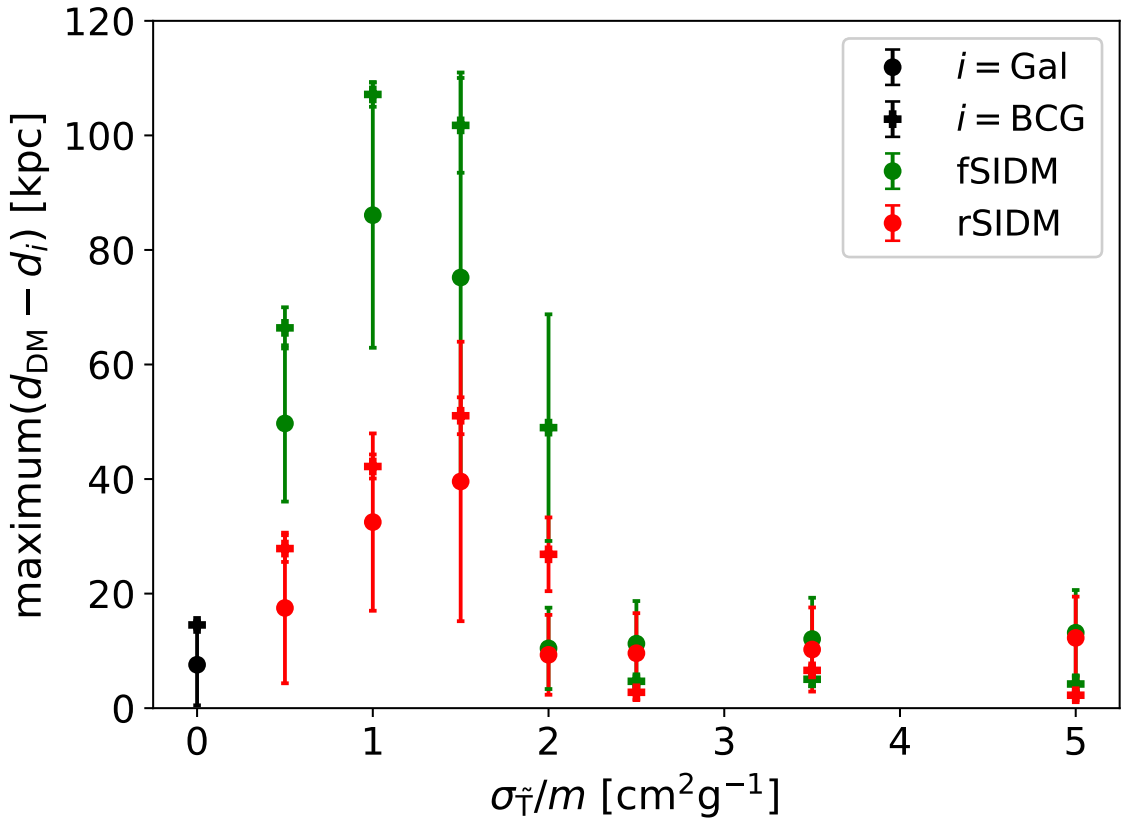
Offsets at later merger stages are much larger



Fischer et al. 2021b

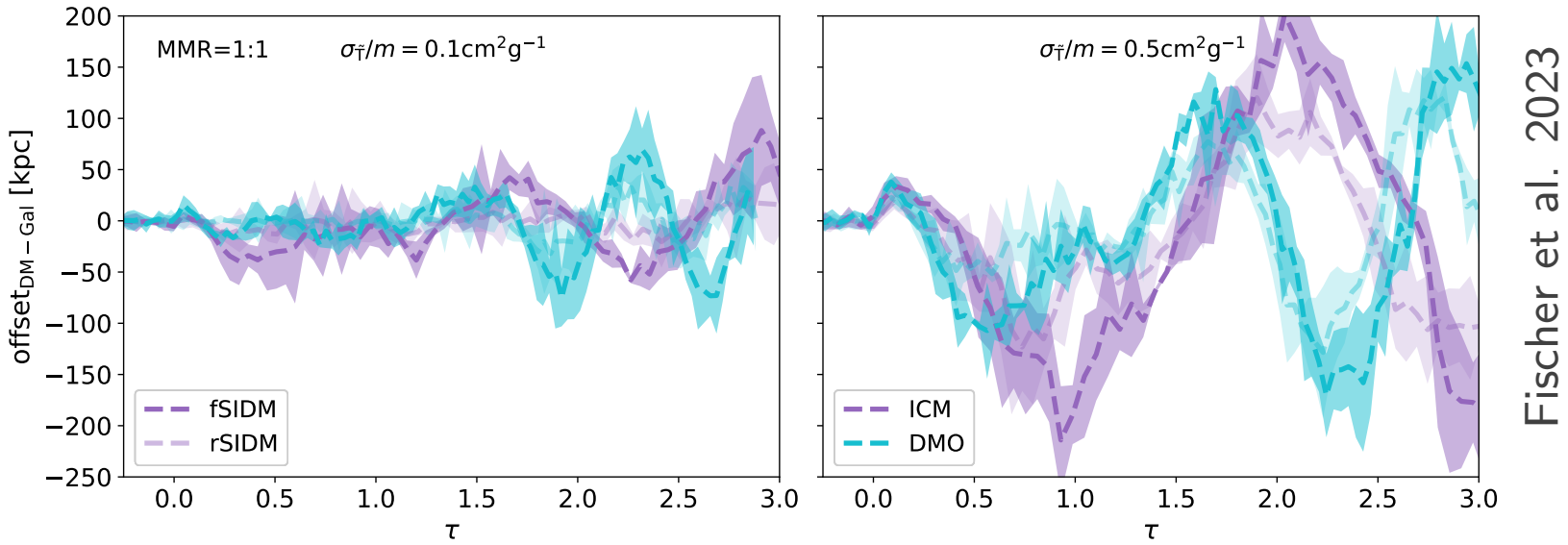
Maximum Offset

The maximum achievable offset is much larger for fSIDM than for rSIDM



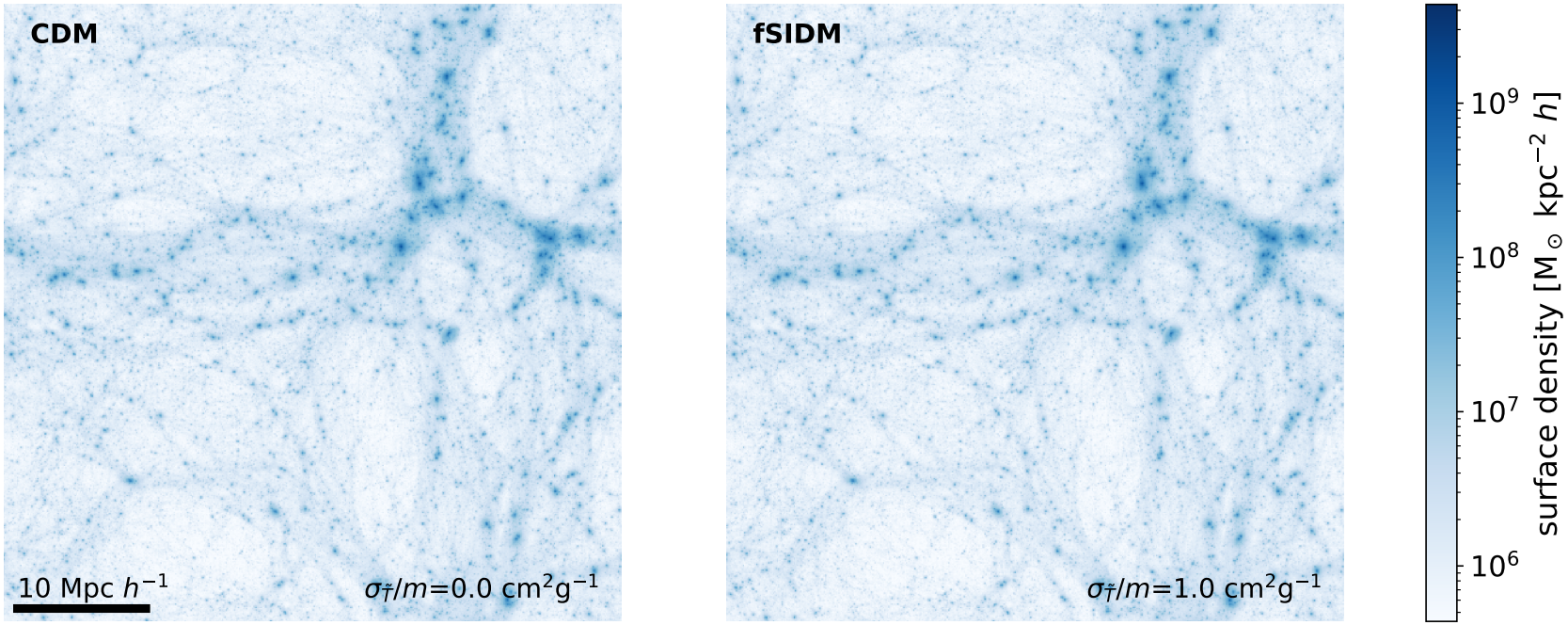
Fischer et al. 2021a

Equal-Mass Merger: Offsets comparison



Offsets at later times are much larger when including ICM

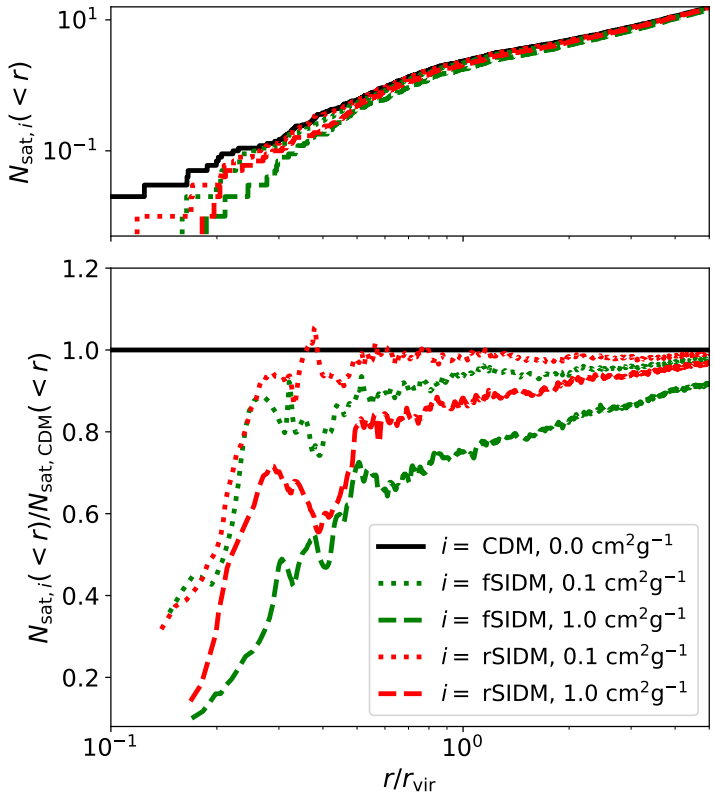
Cosmological Study



Fischer et al. 2022

No differences on large scales

Cosmological Study: Satellite Abundance

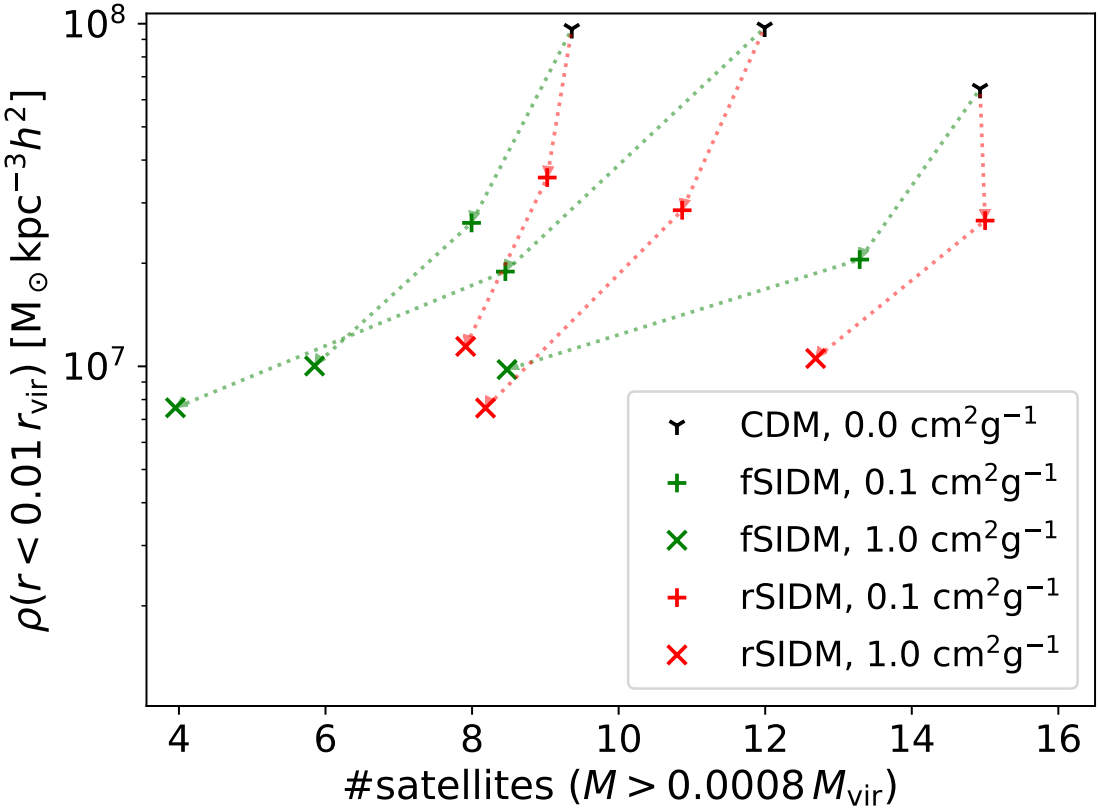


Fischer et al. 2022

Interestingly large suppression of satellites for fSIDM

Central Density vs. Number of Satellites

Qualitative difference between rare and frequent scattering



Fischer et al. 2022

Take Home Messages

N-body simulations of fSIDM are ...

1. possible

- We developed a new numerical scheme,
- based on an effective description (drag force).

2. important

- fSIDM and rSIDM have different phenomenology (offsets, satellite abundance),
- significant difference also at small cross-sections ($\lesssim 0.1\,\mathrm{cm}^2/\mathrm{g}$).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