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merging clusters as a testbed for self-interacting dark matter

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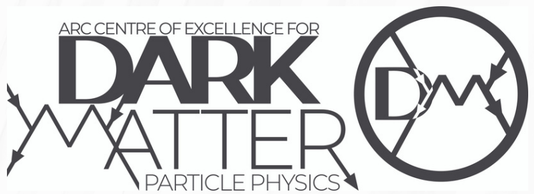


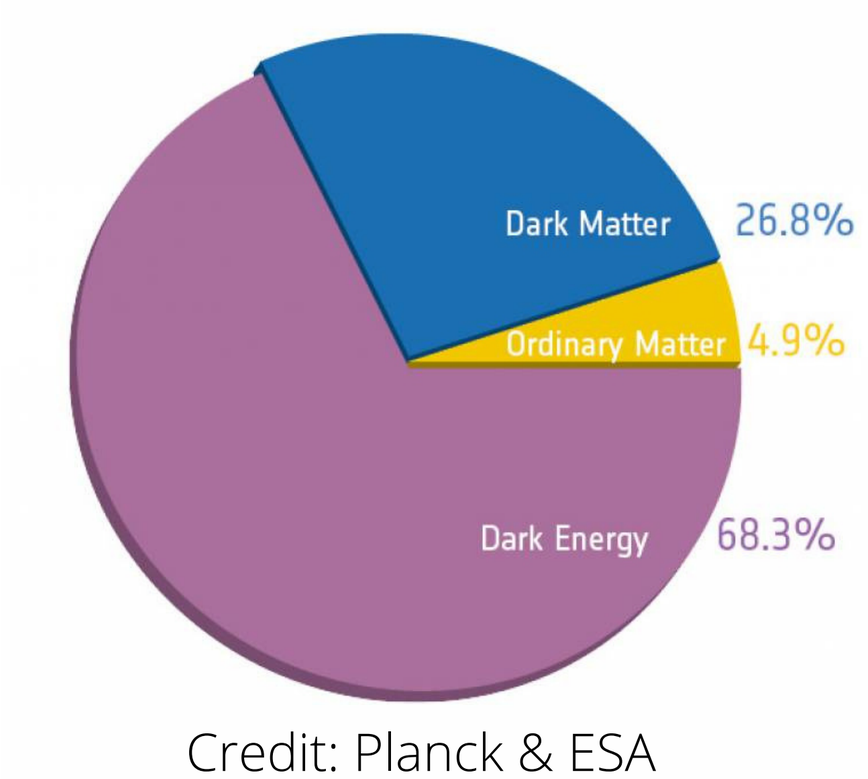
THE UNIVERSITY OF SYDNEY

Durham University
Institute for Computational Cosmology

The ΛCDM model

The standard model of cosmology

- Cosmological constant **Λ**
  ⟶ Dark energy
- **Cold** dark matter (CDM)
  ⟶ **Collisionless**
- Ordinary matter

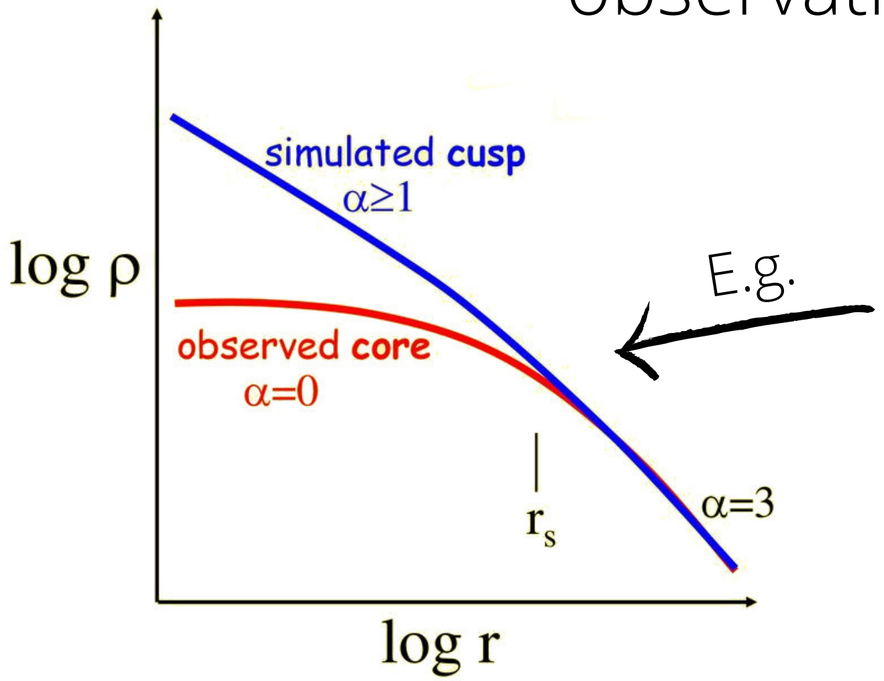


Credit: Planck & ESA

Structure formation is hierarchical

Discrepancies with CDM

CDM paradigm explains
observations on **large scales** well



E.g.

Discrepancies on **subgalactic scales**

Not **collisionless**, but **self-interacting** DM (SIDM)?

Why look at clusters?

Interaction rates scale with density

+

Local velocity dispersion

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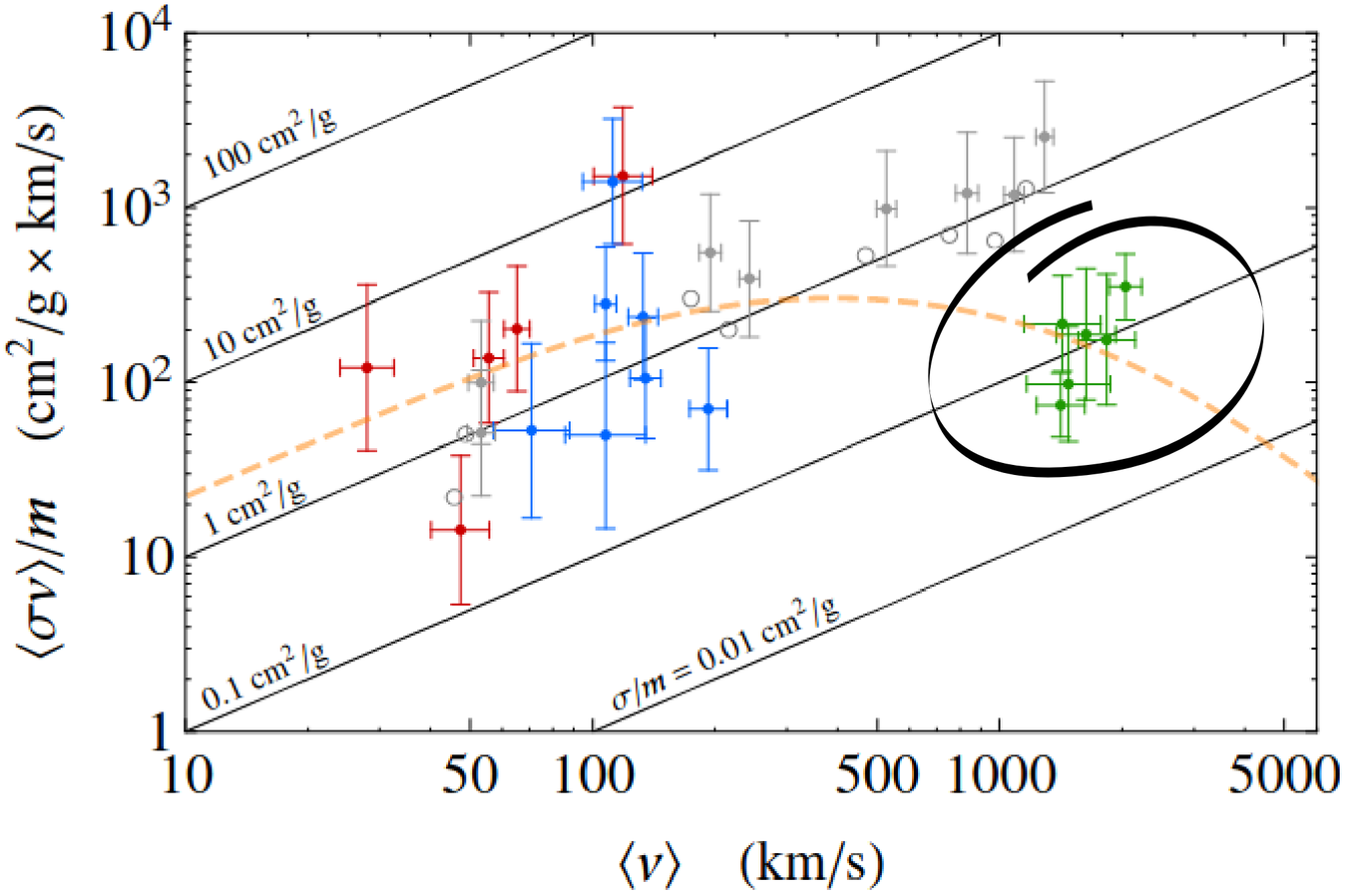
Look at massive systems, i.e. **clusters!**



DM distribution can be probed by strong and weak gravitational lensing

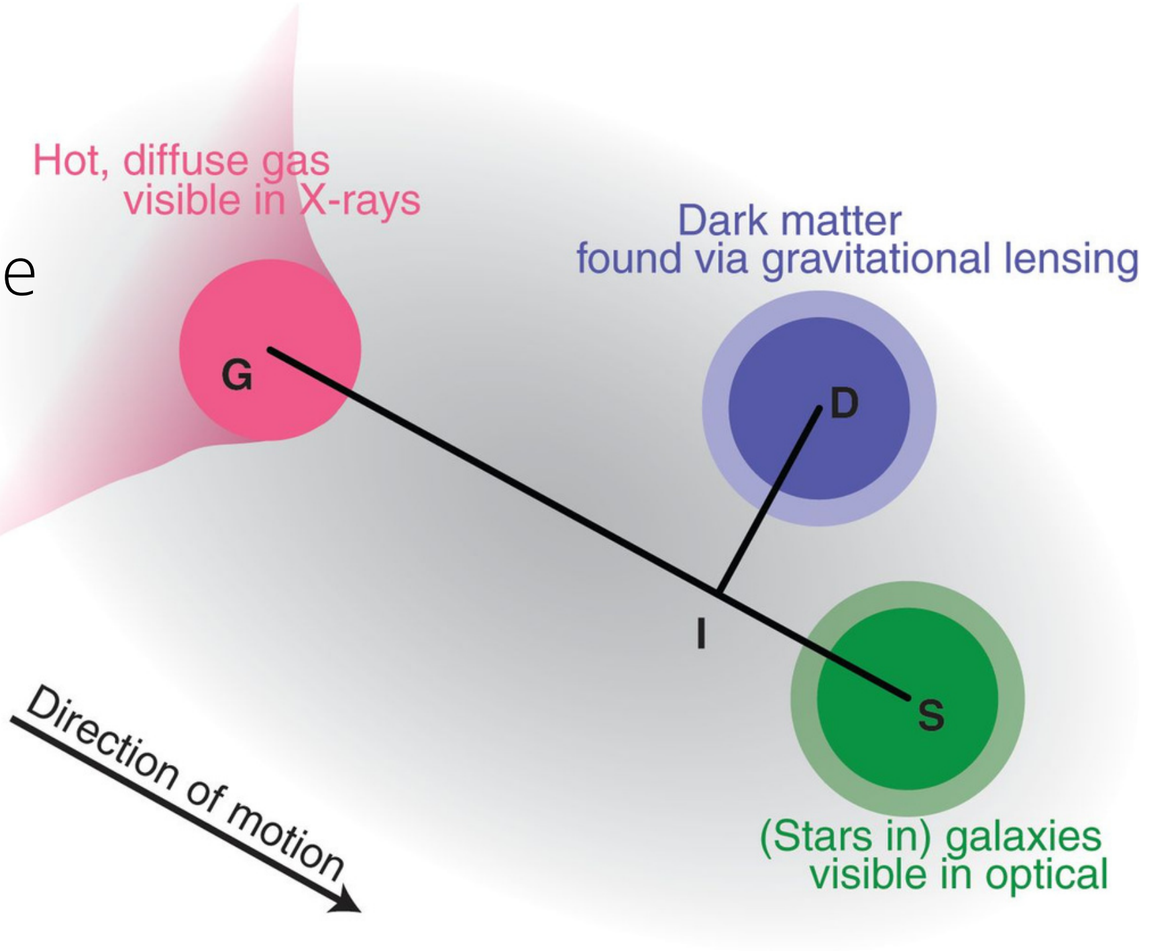
Merging clusters

"Cosmic Collider"

Galaxies: collisionless test particles
Gas: dissociated through ram pressure

CDM:
DM remains incident with galaxies

SIDM:
Drag from self-interactions offsets
DM from galaxies



This Work

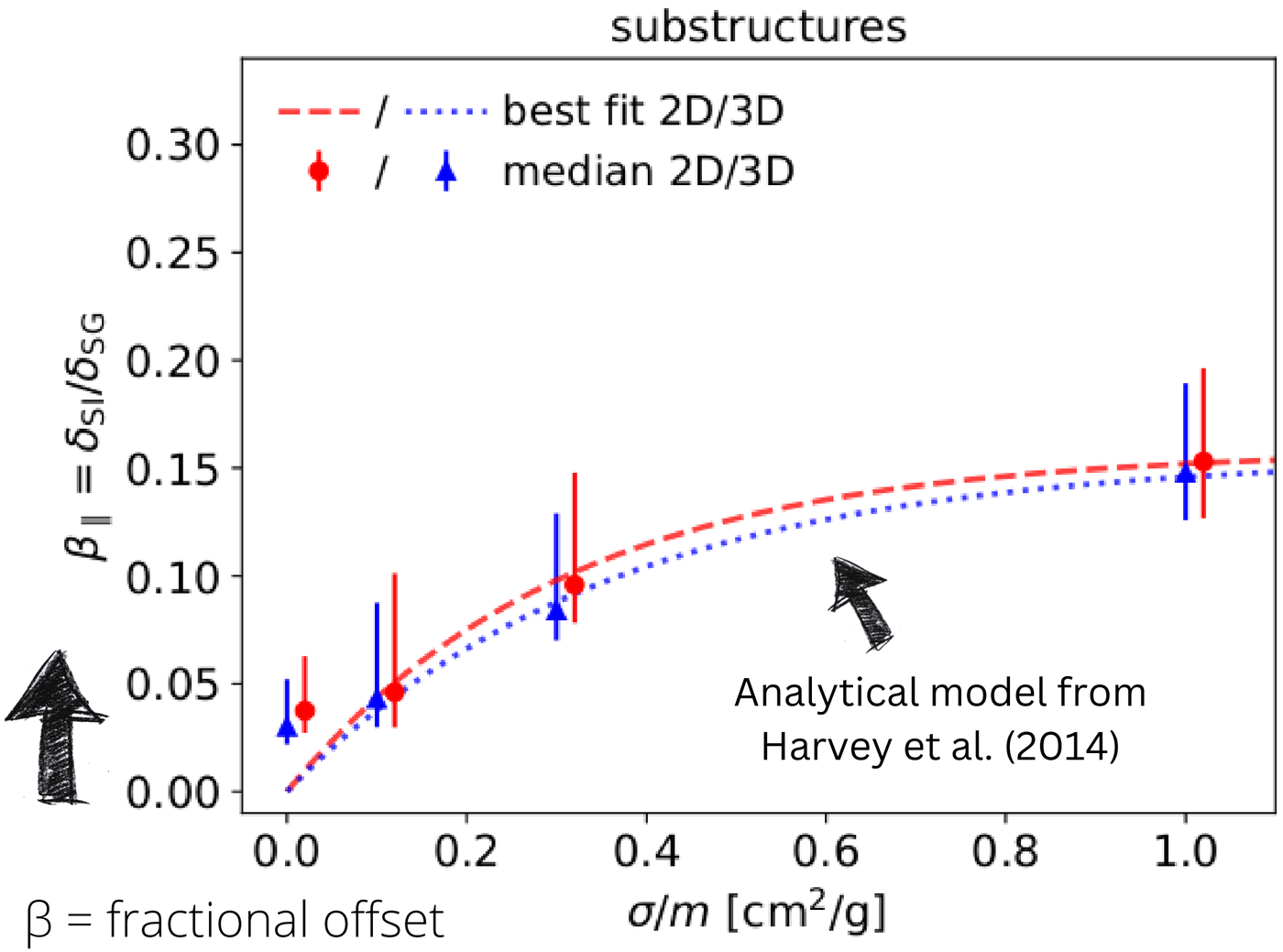
Compare offsets of galaxies and DM in simulated clusters with CDM and SIDM

Our 'mergers':
Most **massive clusters** with
subhaloes > 5% cluster mass

BAHAMAS 400 Mpc/h Box
Run with CDM & SIDM
σ/m: 0.1, 0.3, 1.0 cm^2/g

Find **centres** of **particle distributions** using **shrinking-spheres** method

Some results



β = fractional offset

Offset increases with cross-section!

But CDM non-zero?

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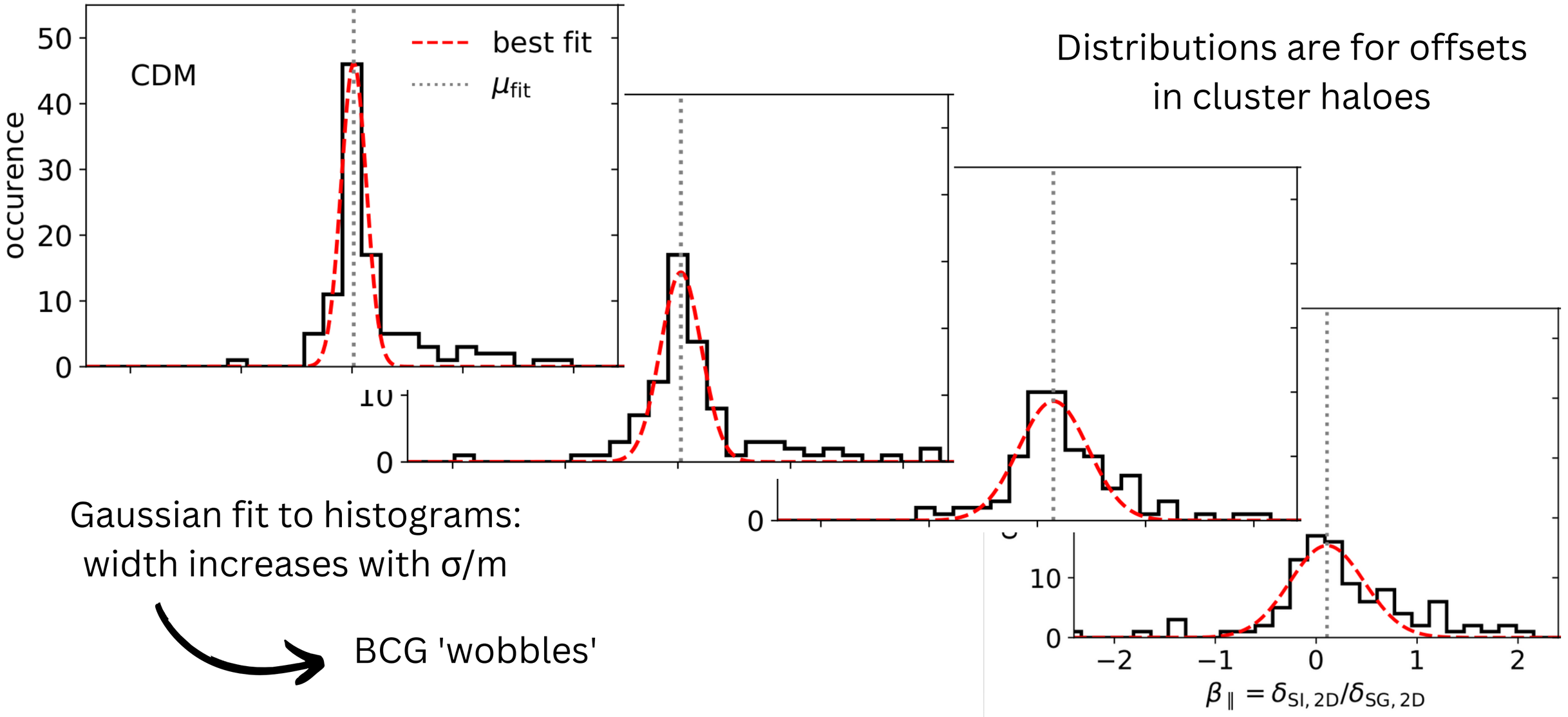
Physical or systematics?

Some results

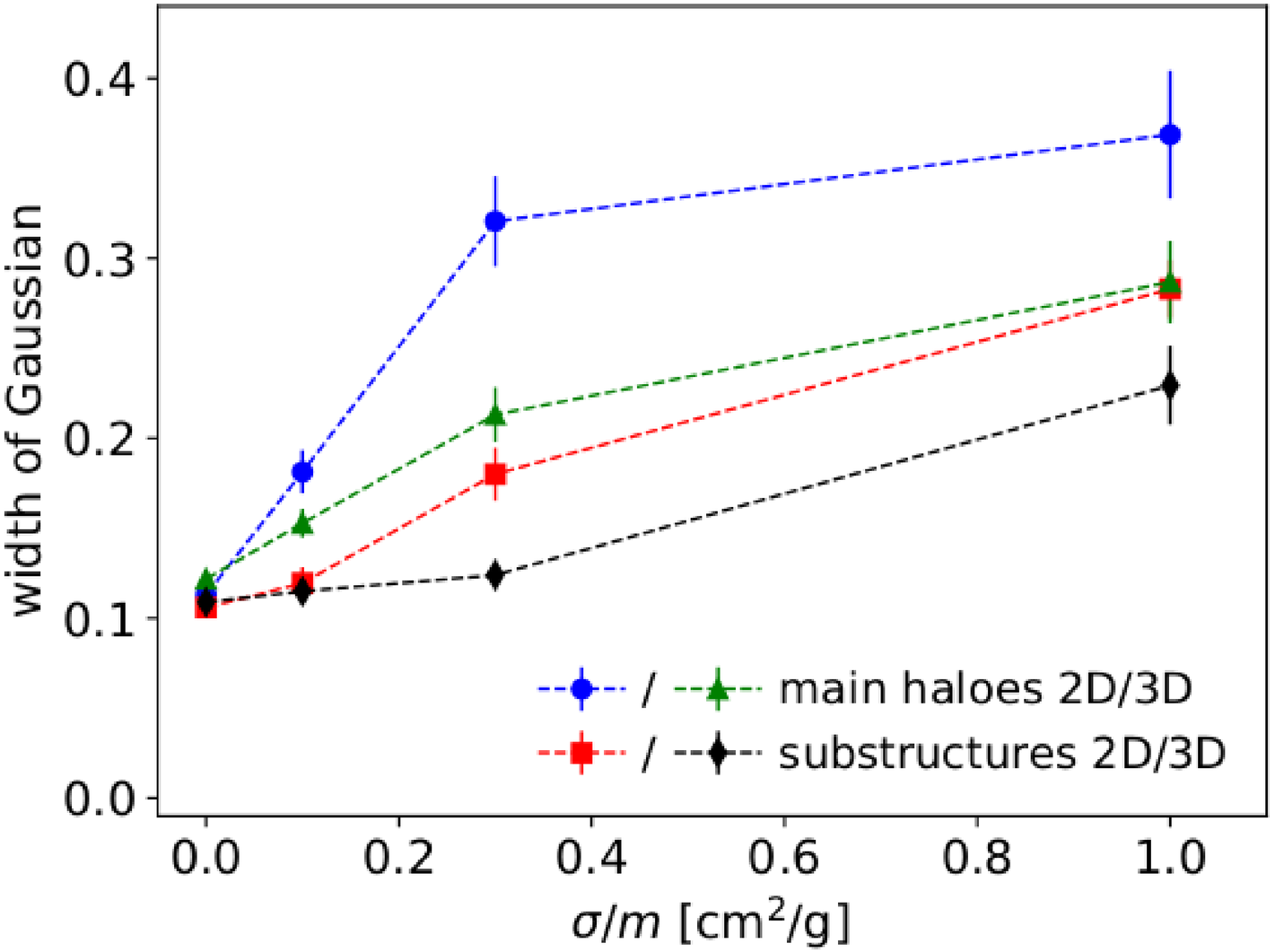
Distributions are for offsets in cluster haloes



Gaussian fit to histograms:
width increases with σ/m

BCG 'wobbles'

Some results



Effect stronger in cluster haloes

Effect stronger in 2D?

Summary & next steps

- Offsets increase with cross-section, but CDM on average not zero
- Width of distributions increase with cross-section: BCG wobbles?

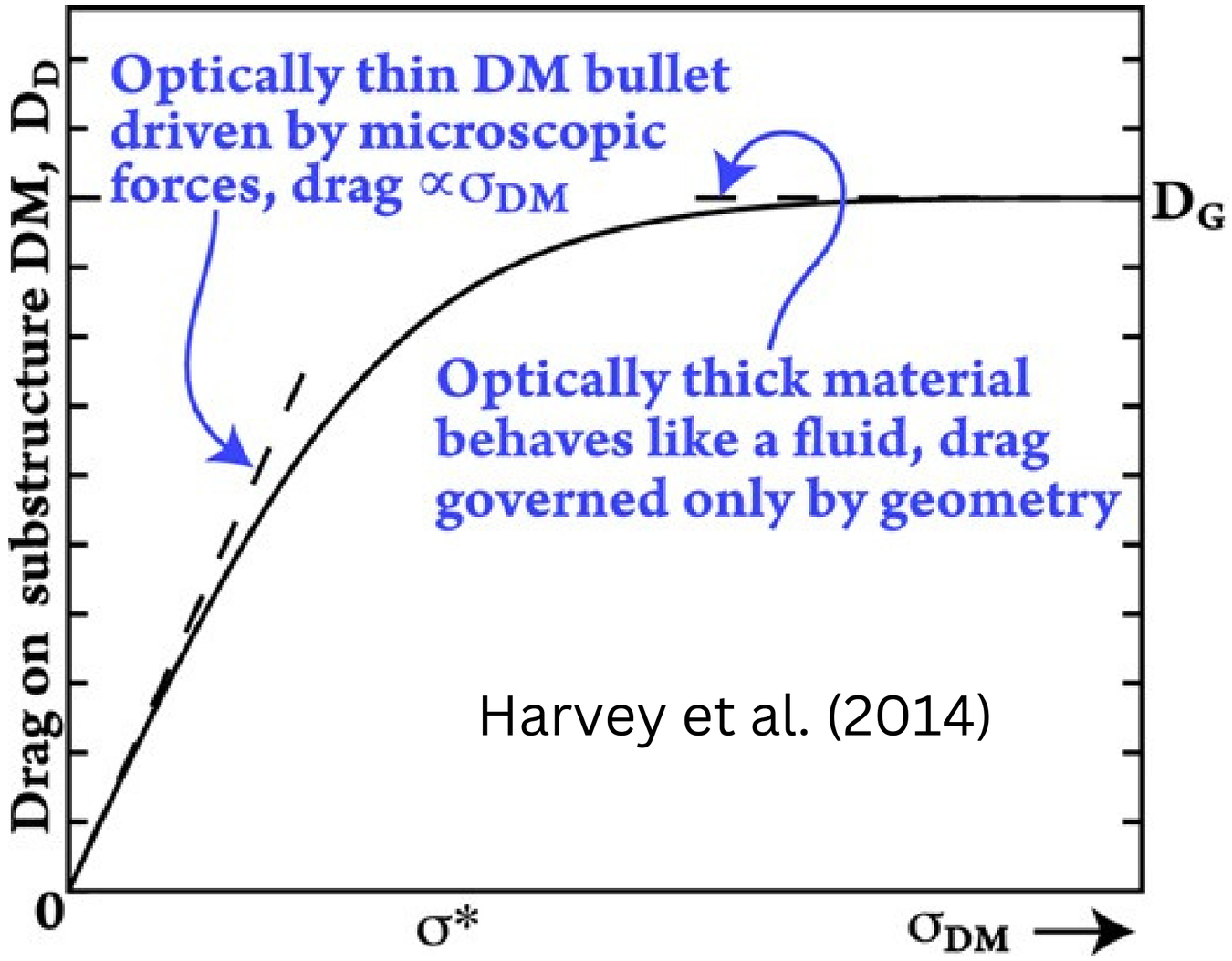
Why do the CDM simulations produce a net positive offset?

Perform similar tests with observational techniques:

- Centre of DM with gravitational lensing
- Find stellar and x-ray peaks using peak-finders

Do full analysis on actual observational data?

Analytical model



Harvey et al. (2014)