

# SELF-INTERACTING DARK MATTER (SIDM)

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# DARK MATTER: THE PARTICLE

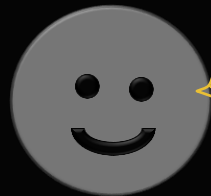
Theory of everything

**W,Z,h, $\gamma$**

Dark matter particle

Quarks/Leptons

Dark matter particle(s)?



# DARK MATTER: THE PARTICLE

Theory of everything

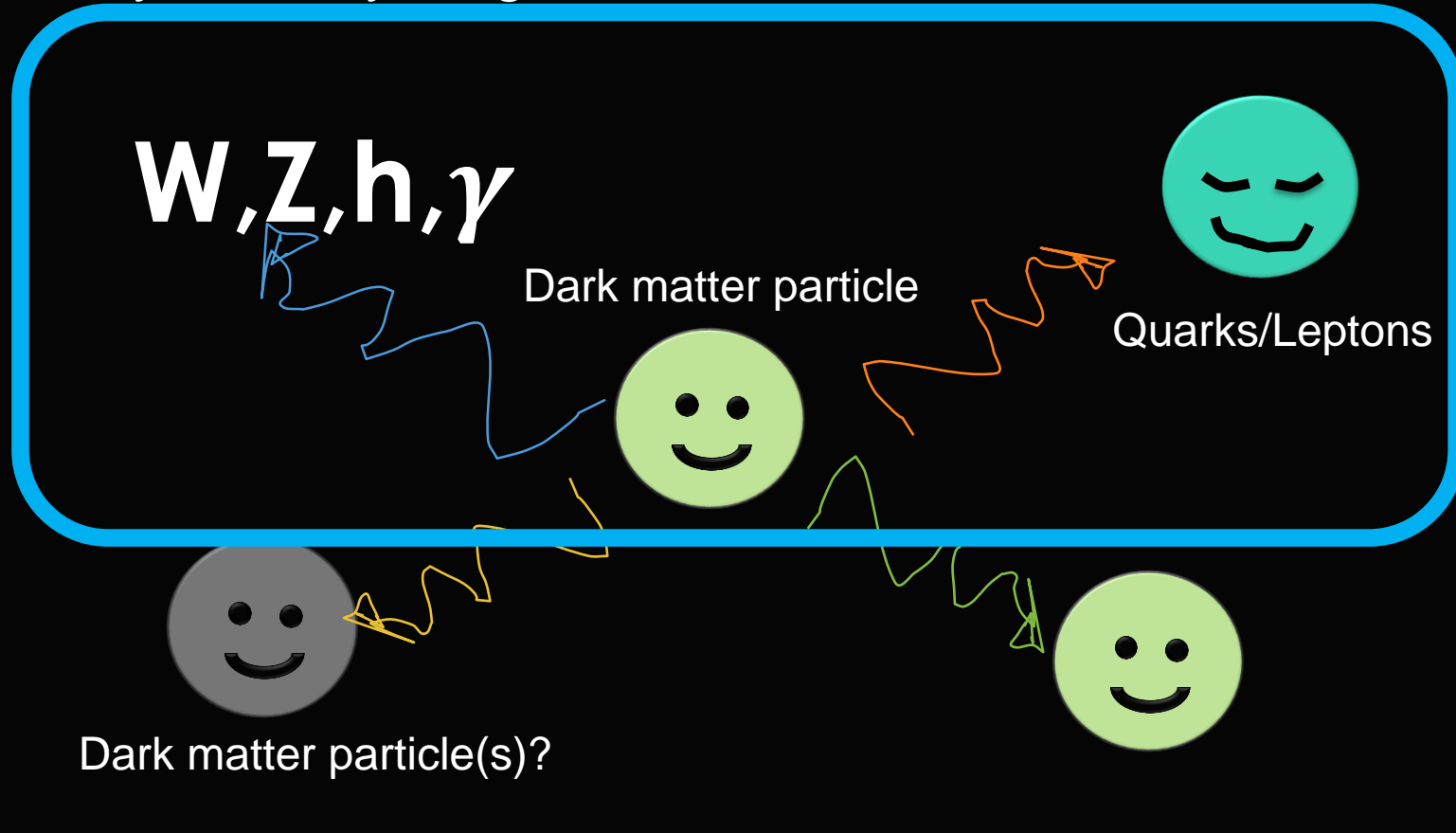
Standard Particle Searches

$W, Z, h, \gamma$

Dark matter particle

Quarks/Leptons

Dark matter particle(s)?



# DARK MATTER: THE PARTICLE

Theory of everything

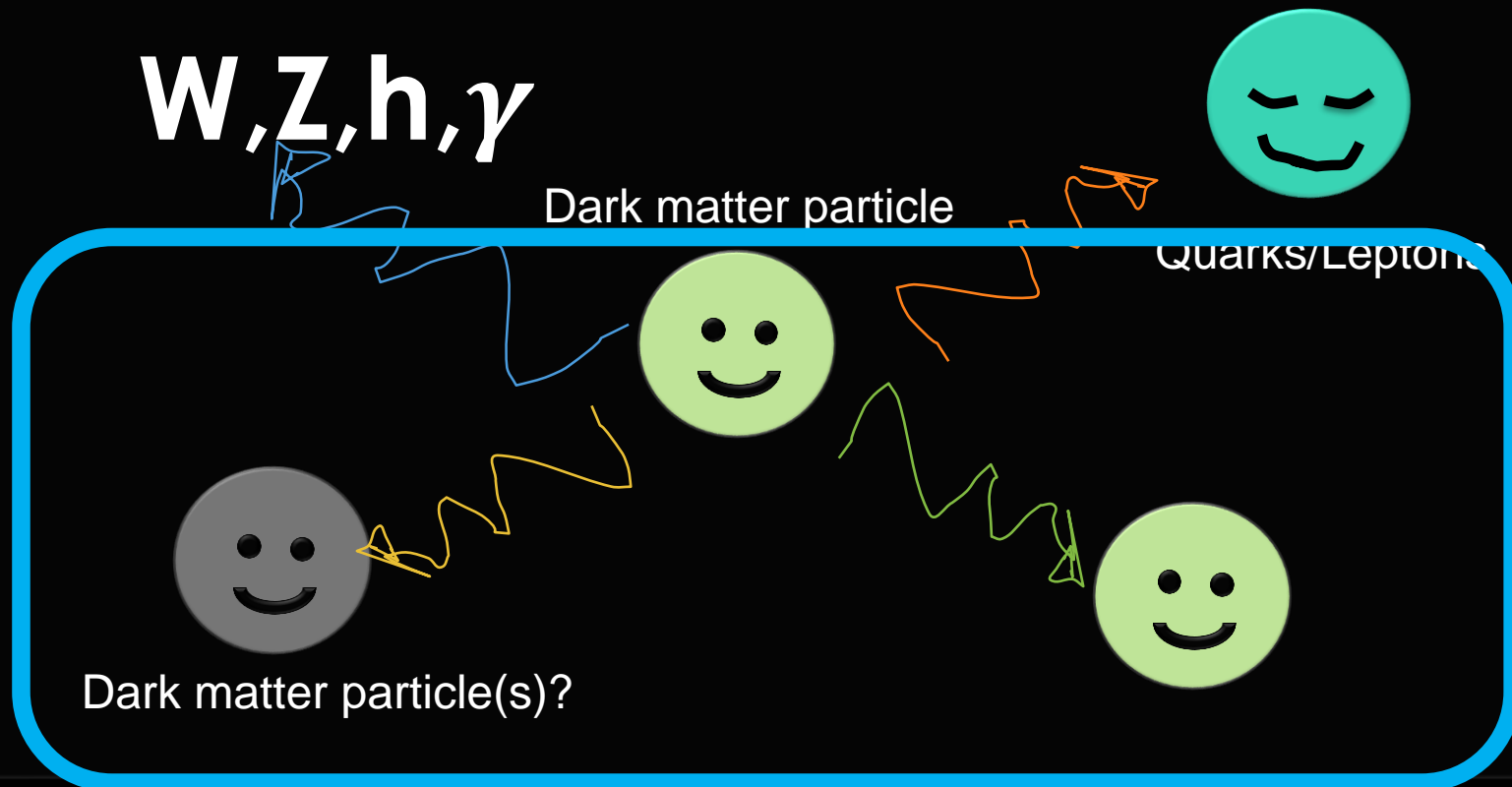
Astronomical searches

$W, Z, h, \gamma$

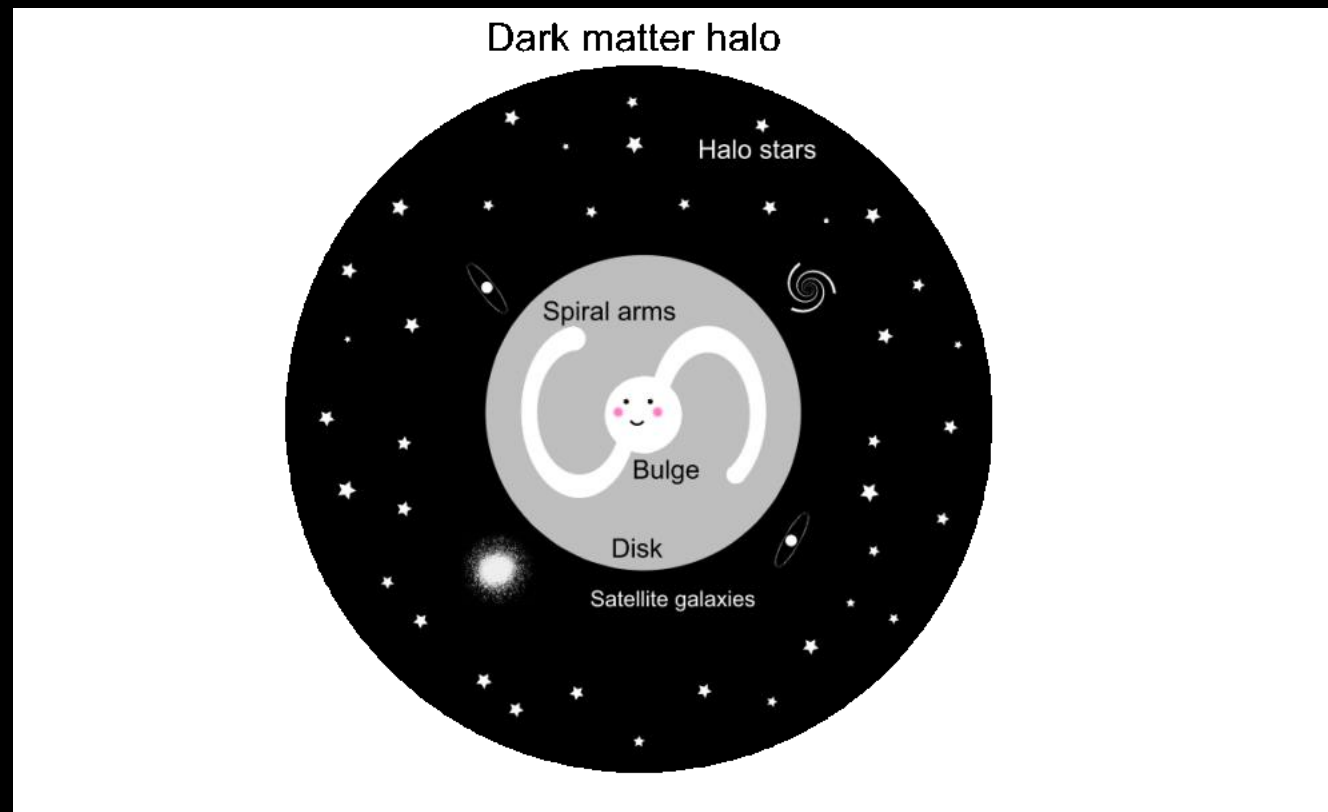
Dark matter particle

Quarks/Leptons

Dark matter particle(s)?

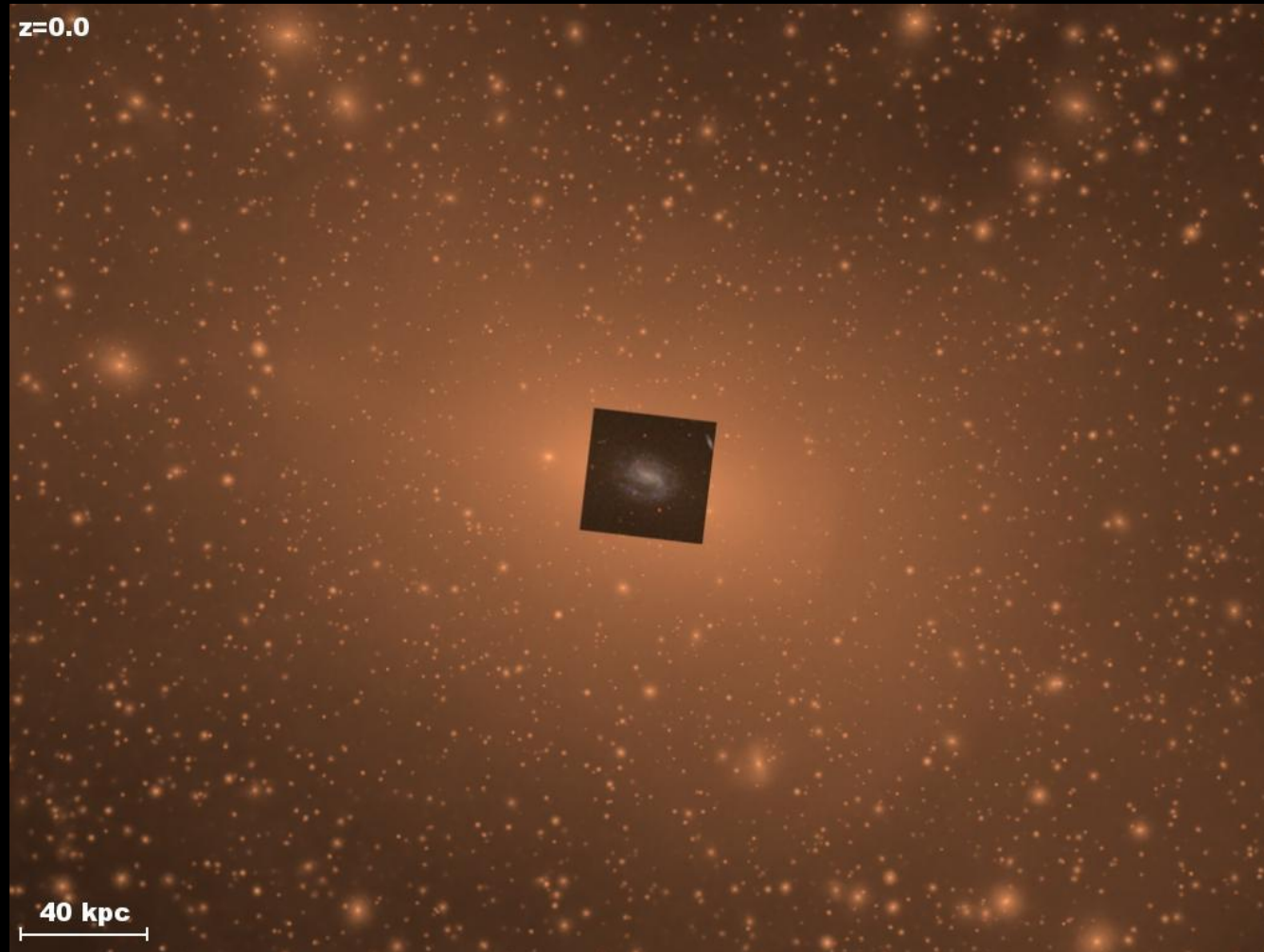


# DARK MATTER: GALACTIC GLUE



Credit: Aishwarya Srivastava, my CS-major SURP student @OSU

# DARK MATTER: GALACTIC GLUE

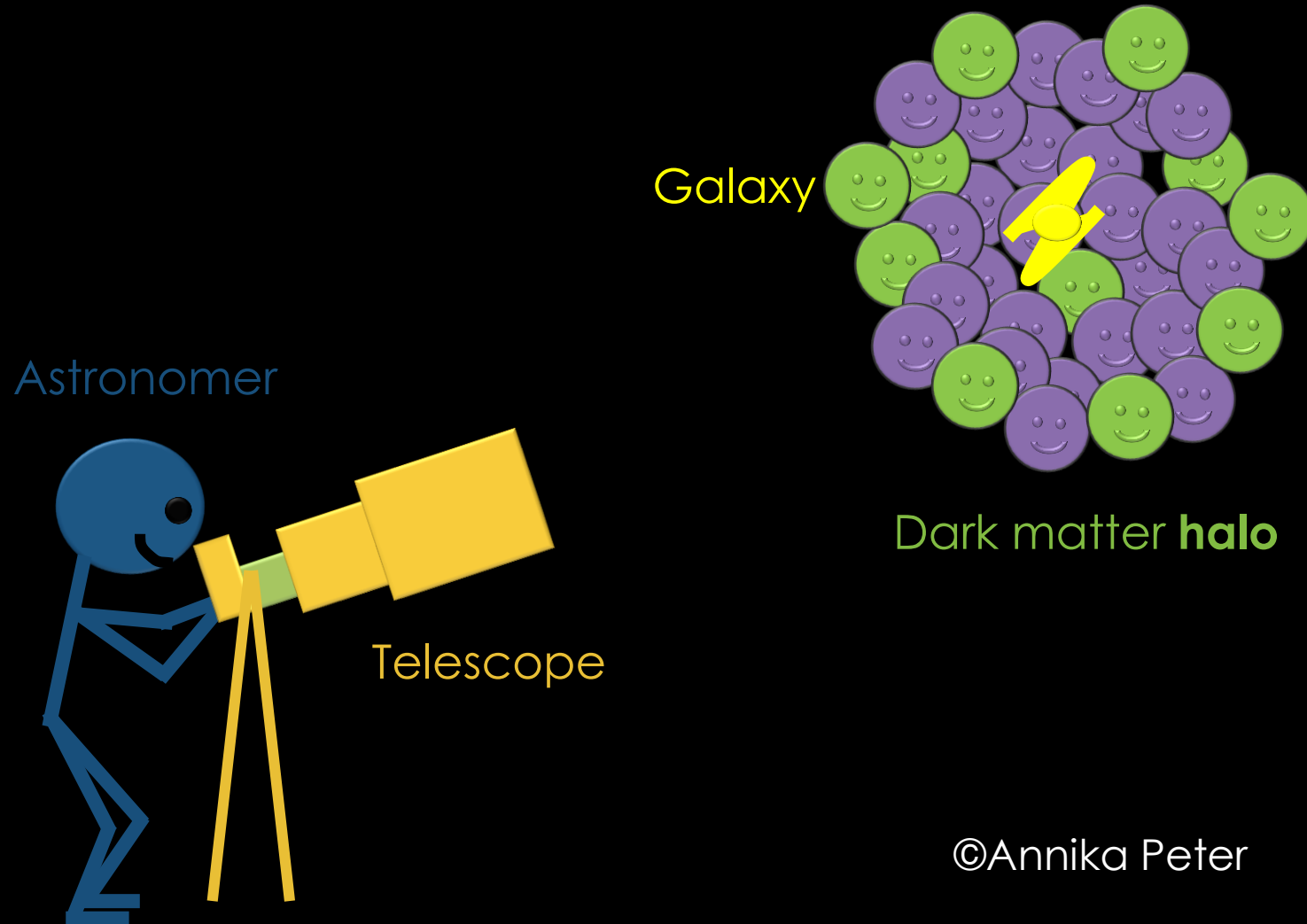


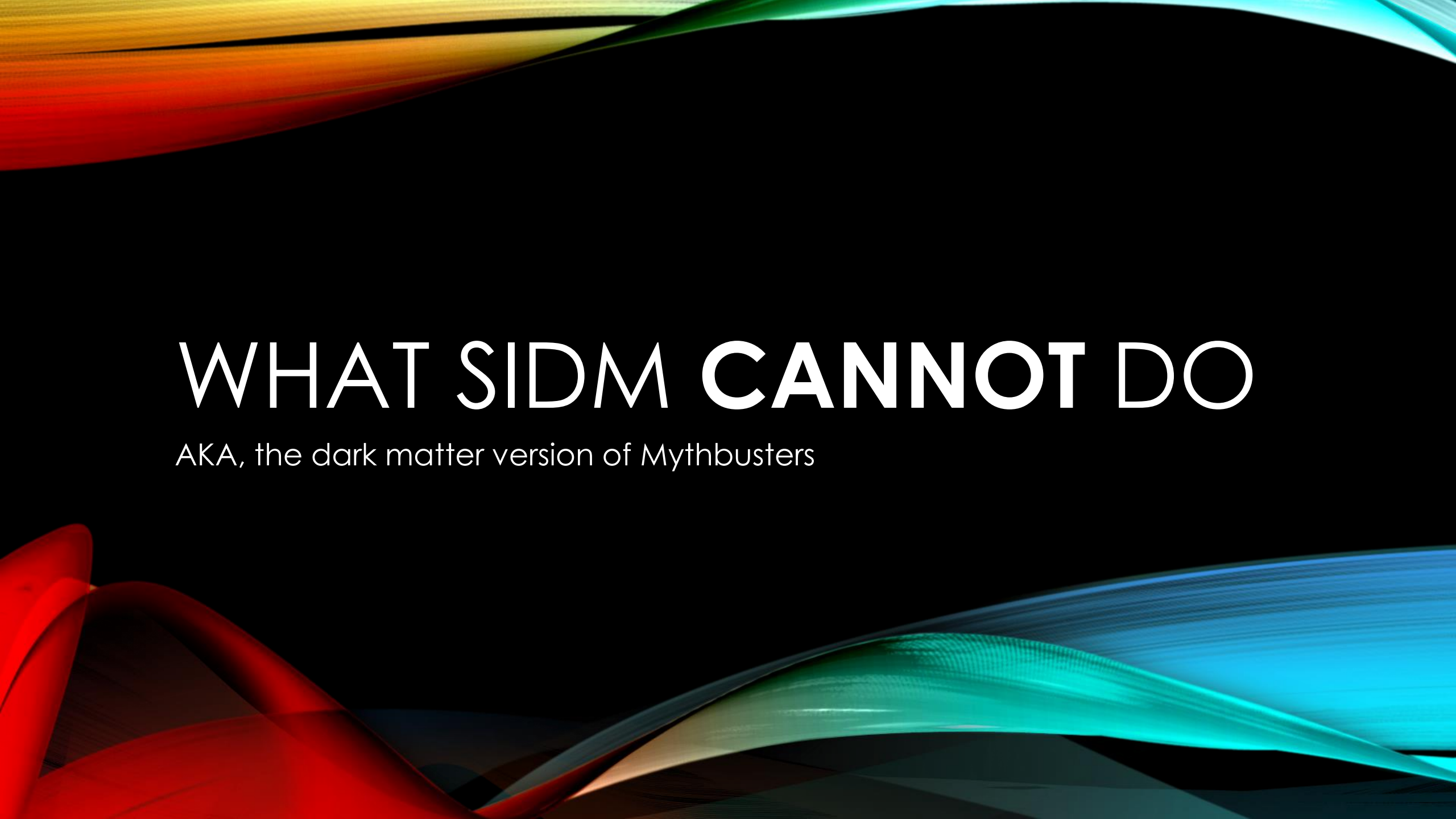
Closer to scale...

Weinberg+  
1306.0913



# DARK MATTER: GALACTIC GLUE





# WHAT SIDM CANNOT DO

AKA, the dark matter version of Mythbusters

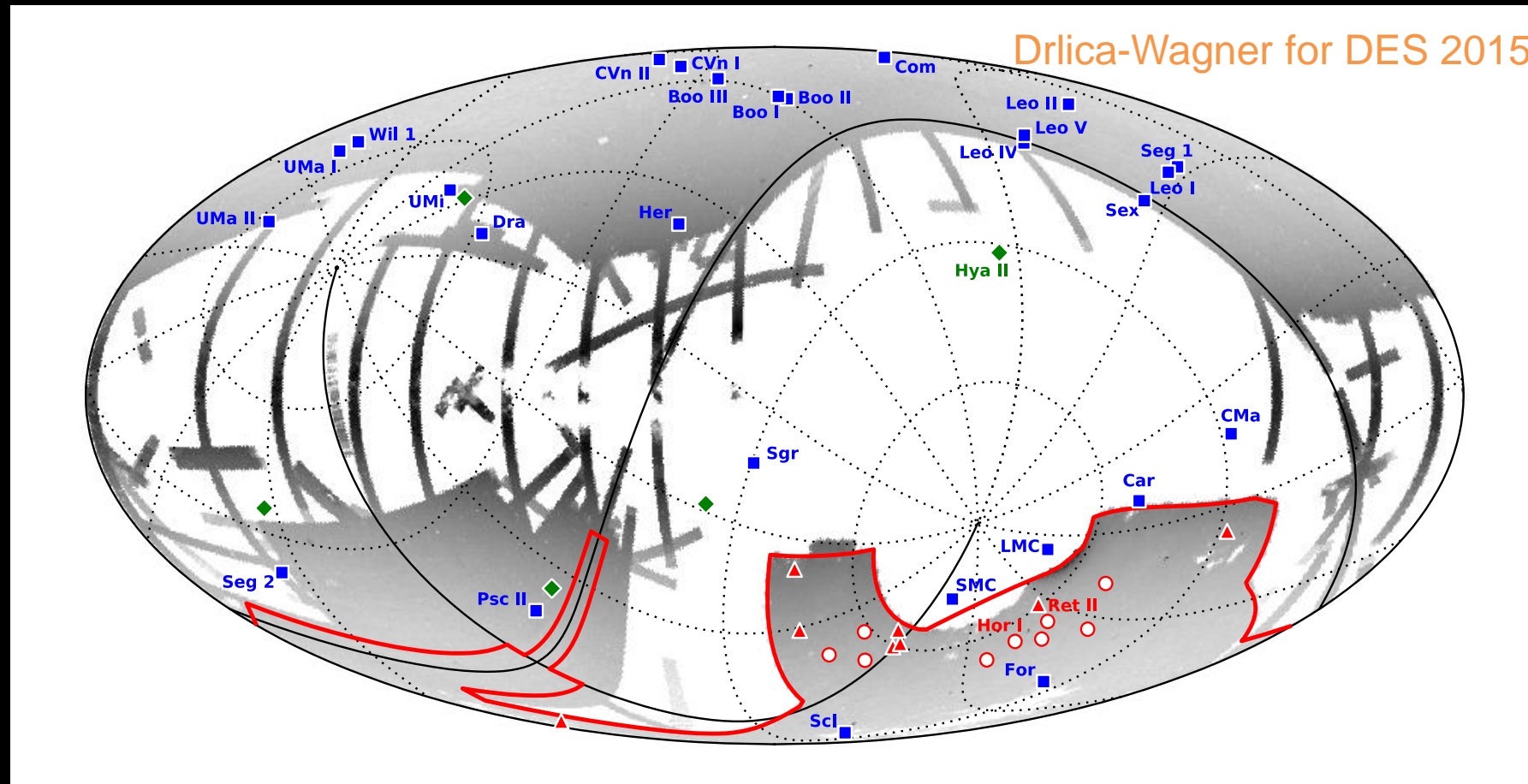




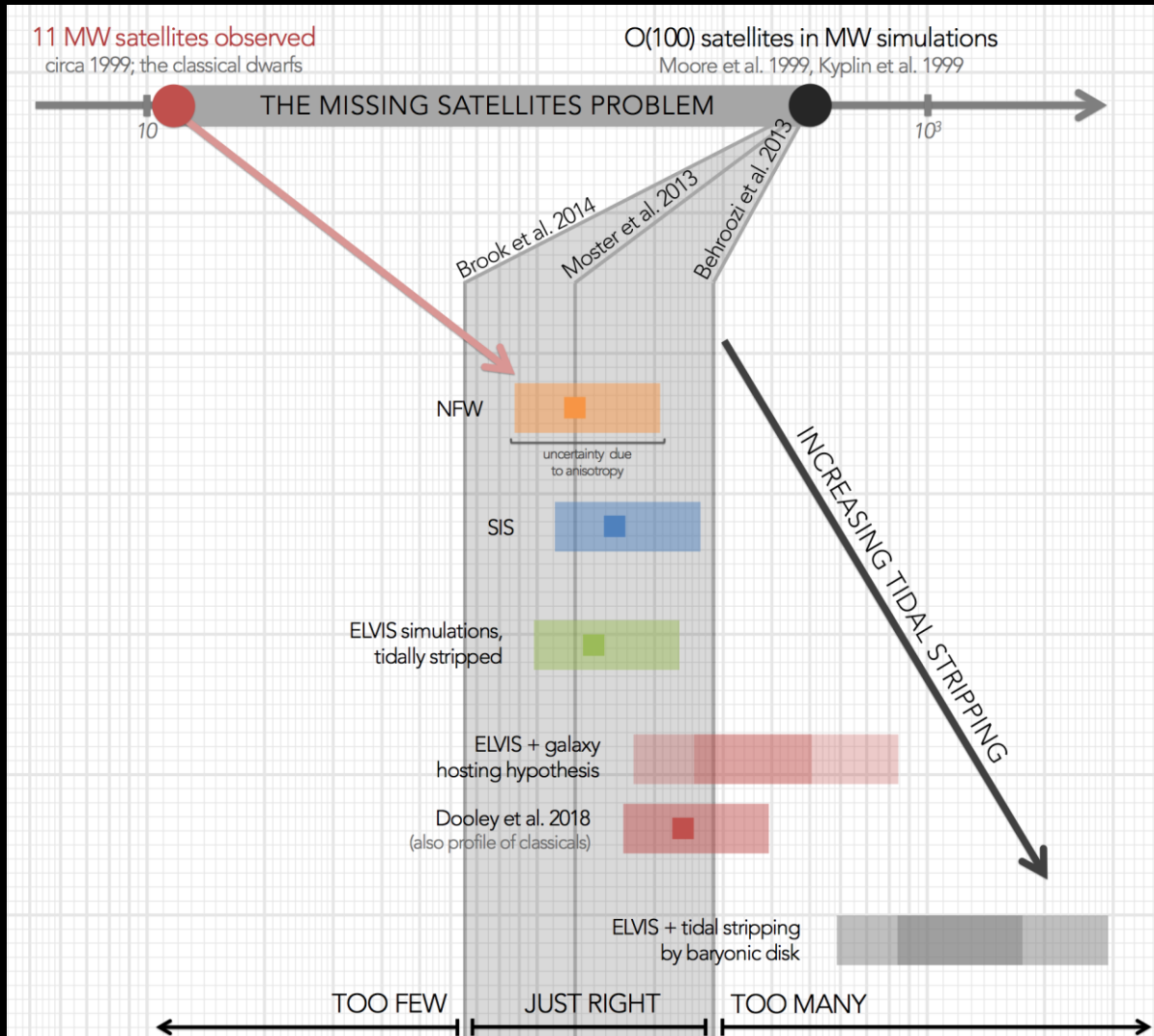
# WHAT SIDM **CANNOT** DO

1. Solve the "missing satellites" (actually not a) problem.

# MORE SATELLITES...



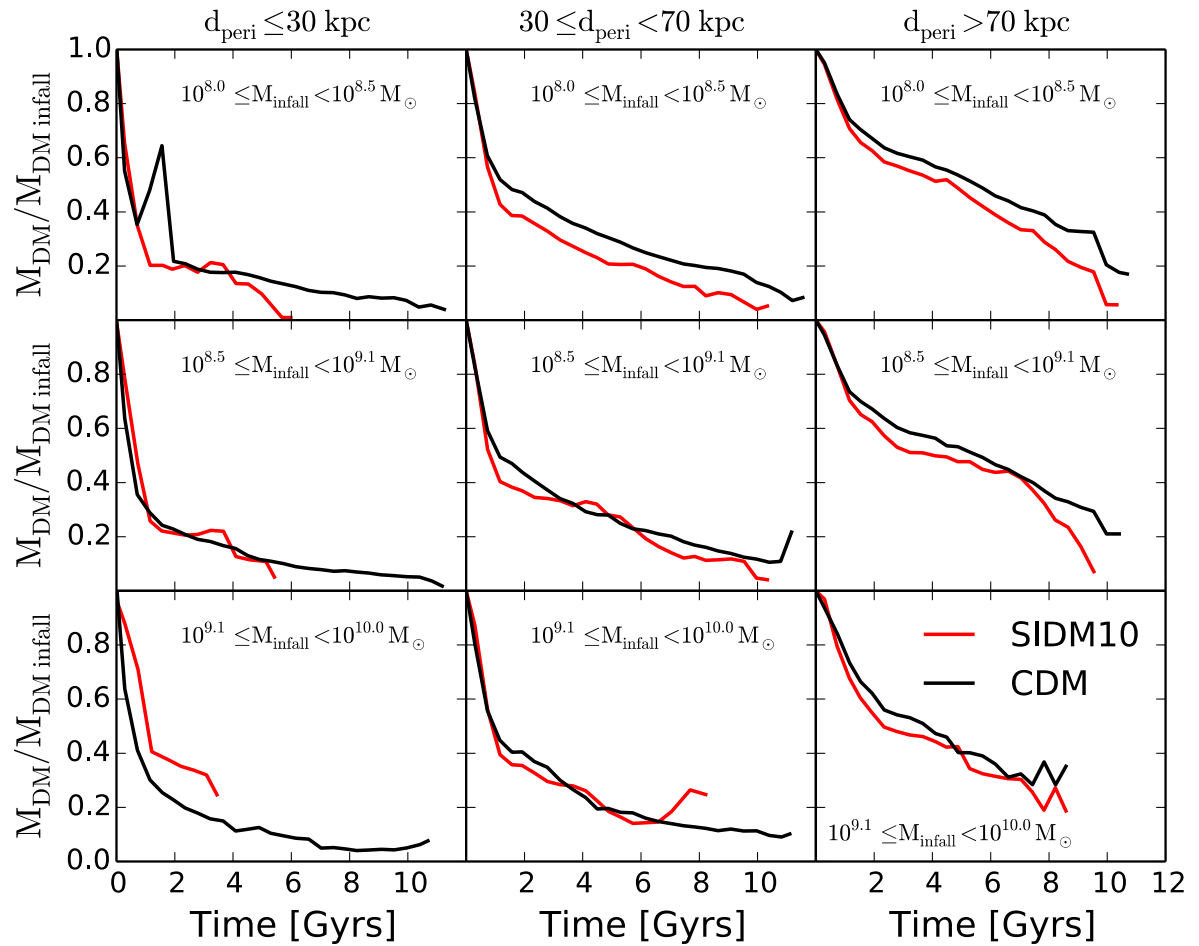
# ...NO MISSING SATELLITES PROBLEM



Kim, AP & Hargis 1711.06267

# ...NO MISSING SATELLITES PROBLEM

- Dark matter subhalo stripping with a giant cross section ( $10 \text{ cm}^2/\text{g}$ ). Barely different than CDM except for plunging orbits.
- Dooley, AP+ 1603.08919



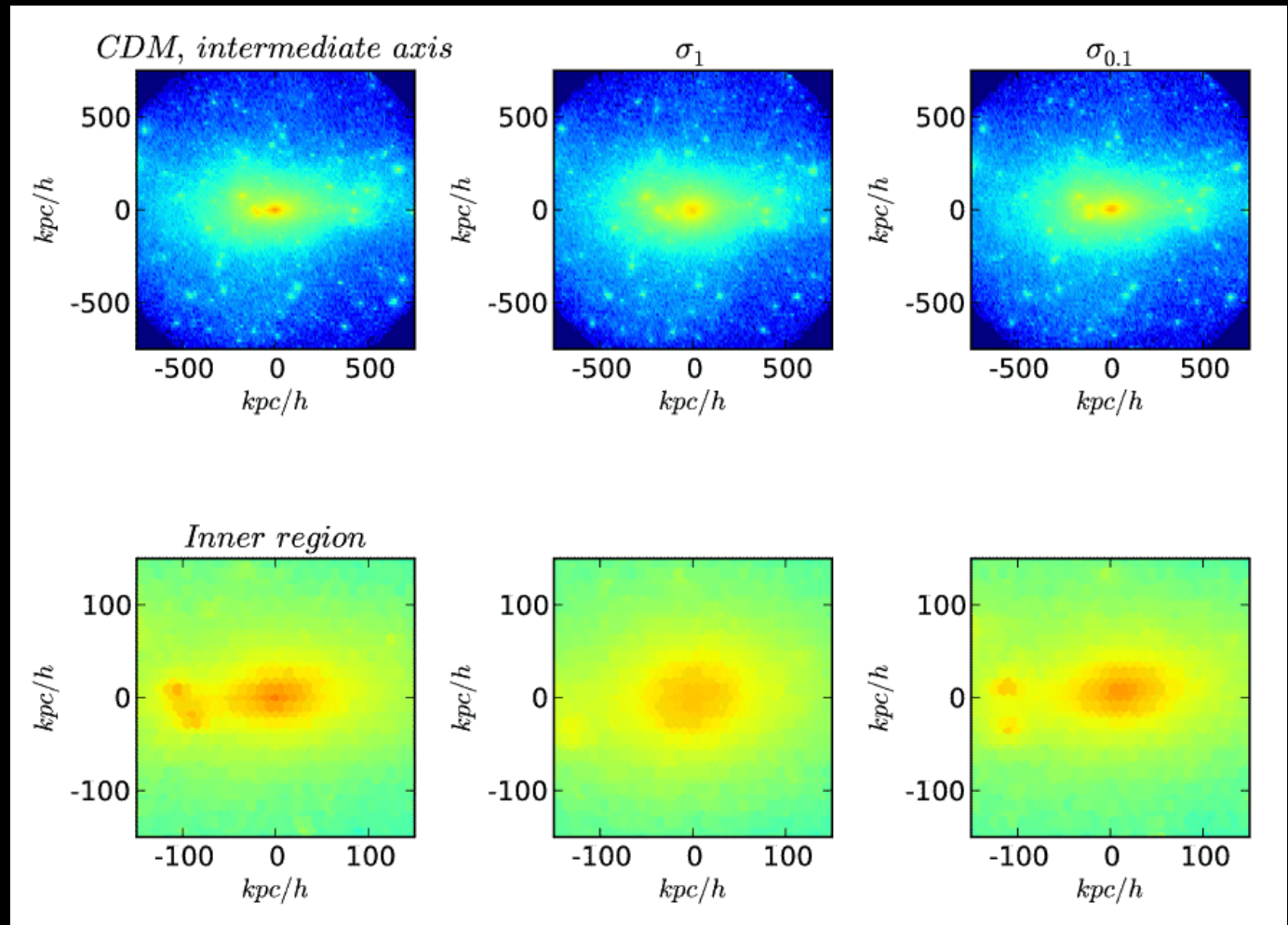
# WHAT SIDM **CANNOT** DO

1. Solve the "missing satellites" (actually not a) problem.
2. Make halos super round.



# SIDM ONLY AFFECTS THE INNER PART OF HALOS...

- AP+ 1208.3026



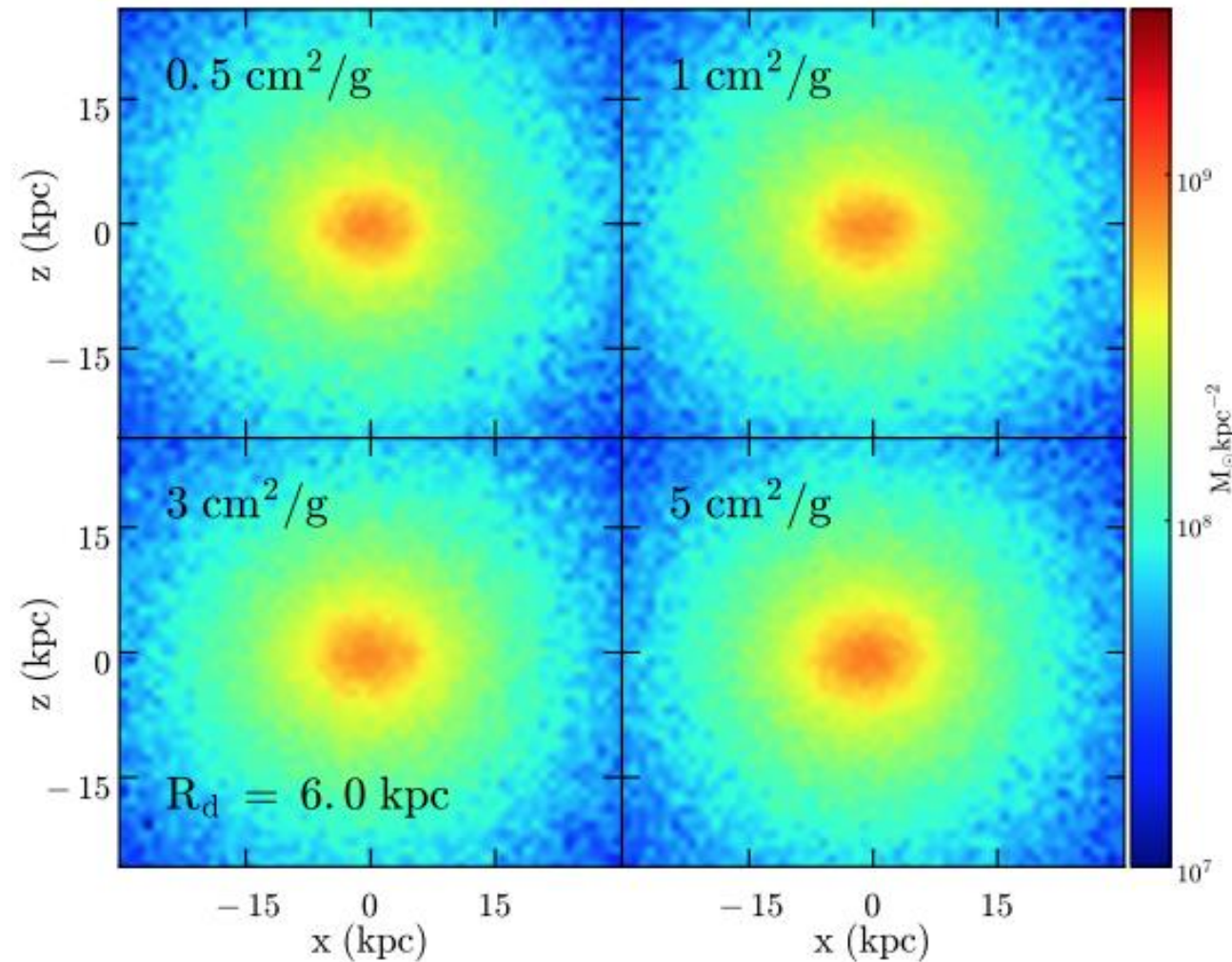
## DM halo of a disk galaxy!

### ...WHERE THEY MUST FOLLOW BARYONS' LEAD

Sameie+ 1801.09682

Original idea: Kaplinghat+ 1311.6524

See other work by Hai-Bo Yu and collaborators.



# WHAT SIDM **CANNOT** DO

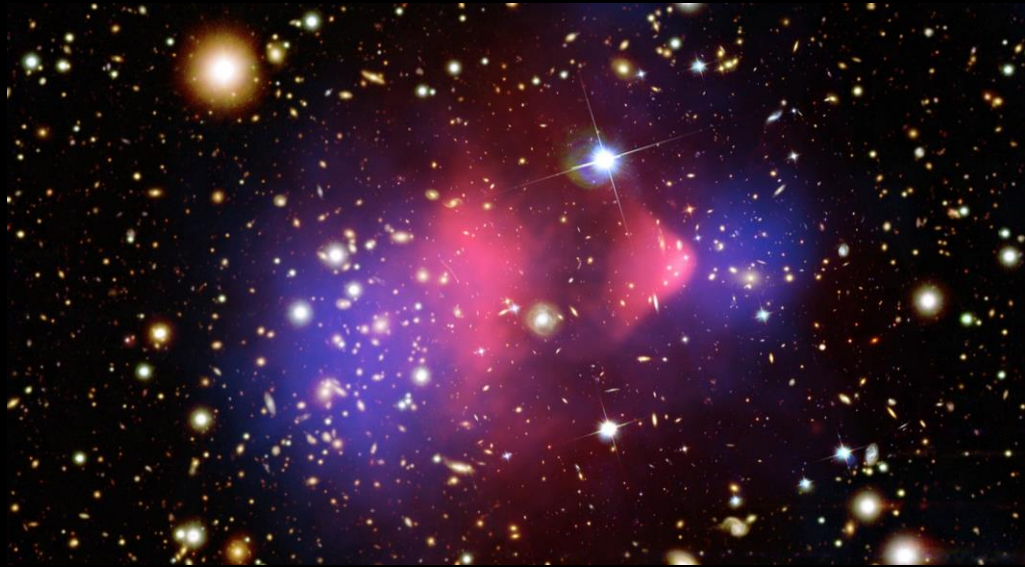
1. Solve the "missing satellites" (actually not a) problem.
2. Make halos super round.
3. Give you big offsets between halos and galaxies (bye bye Bullet).



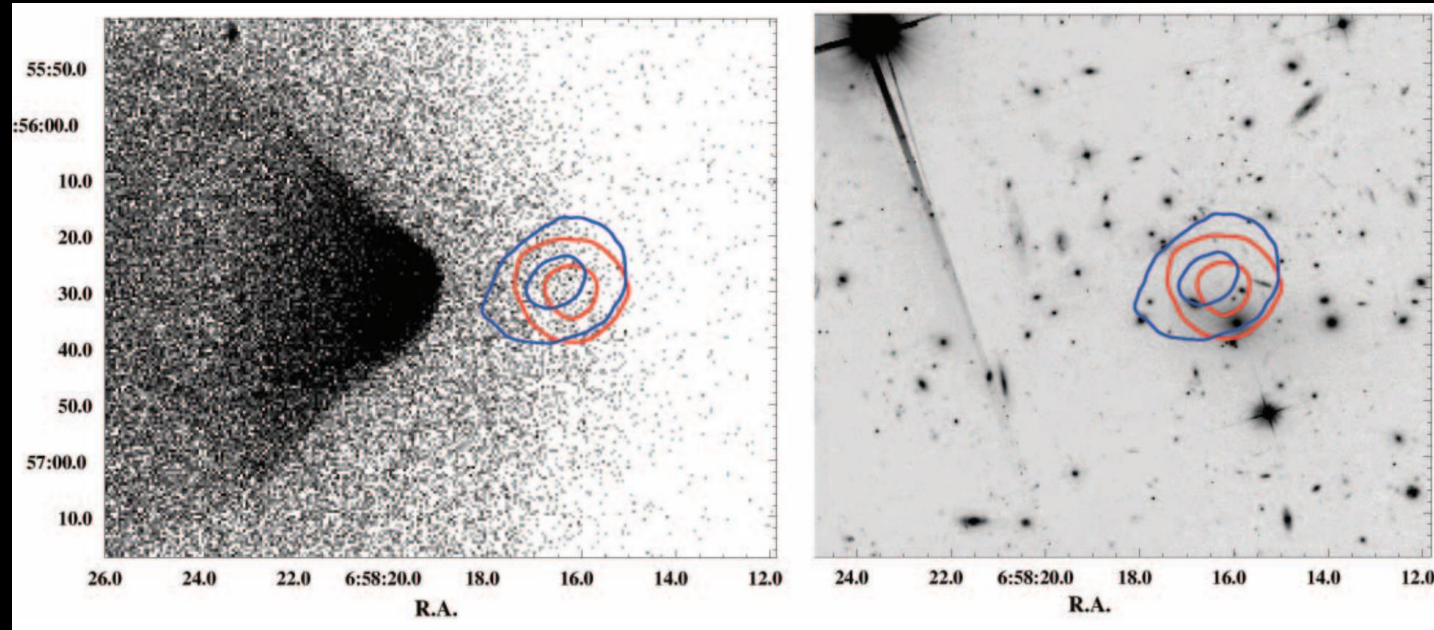
DON'T USE THIS...

## Bullet Cluster

$$\frac{\sigma}{m} < 1 \text{ cm}^2/\text{g}$$

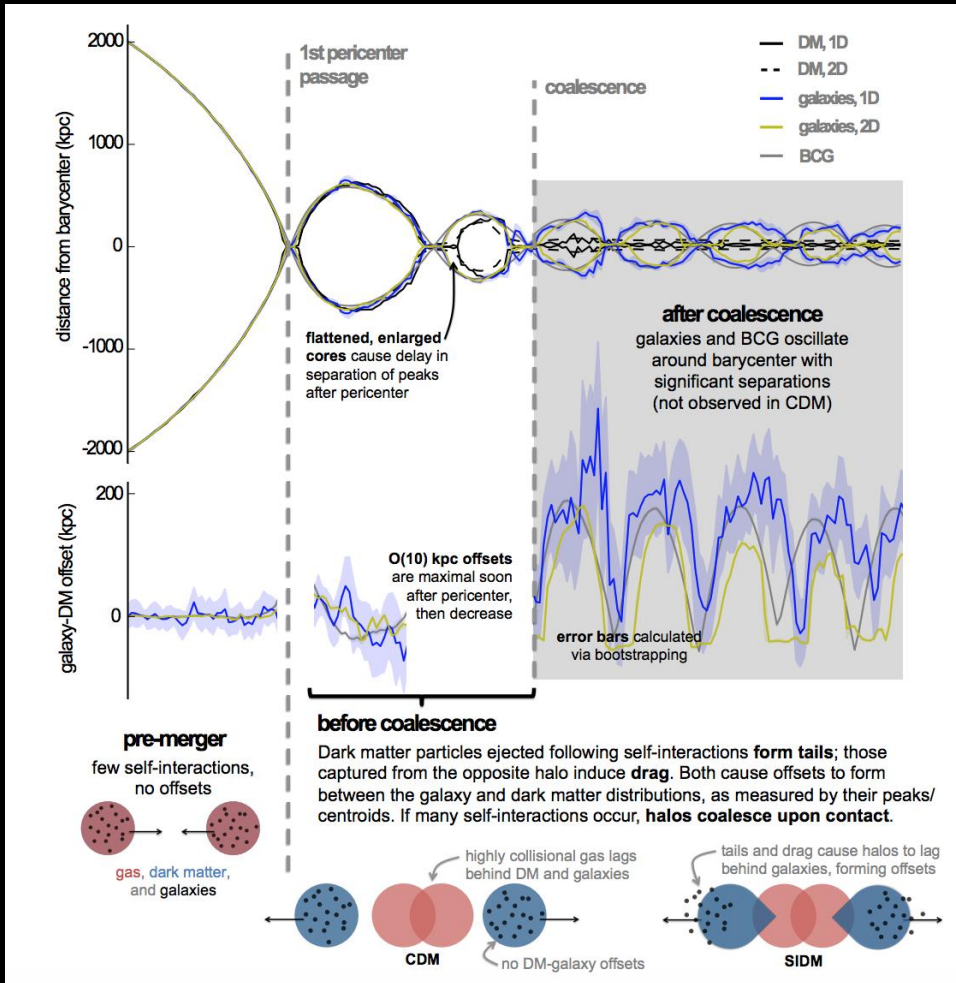


Clowe+ 2006



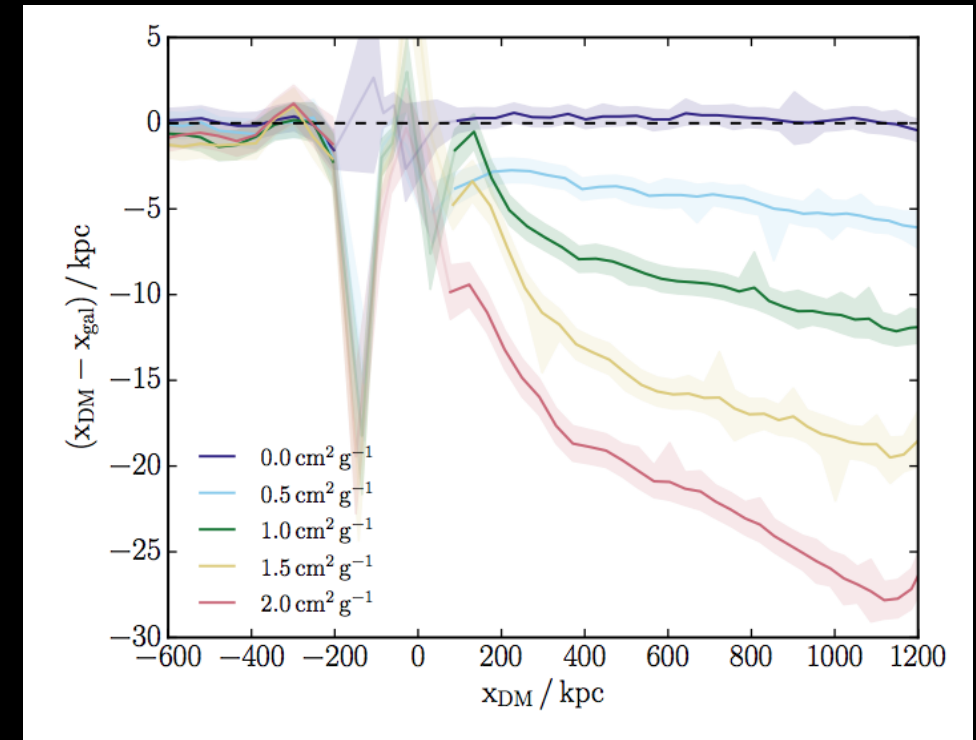
Randall+ 2008

Kim, AP & Wittman 1608.08630  
 Offsets are small and very transient



...USE THAT

$$\text{Robertson+ 1605.04307 } \frac{\sigma}{m} \sim (2 - 3) \frac{\text{cm}^2}{g} \text{ OK}$$



See also work by Kahlhoefer+colleagues





# WHAT SIDM CAN DO

Novel Probes <https://www.novelprobes.org/>

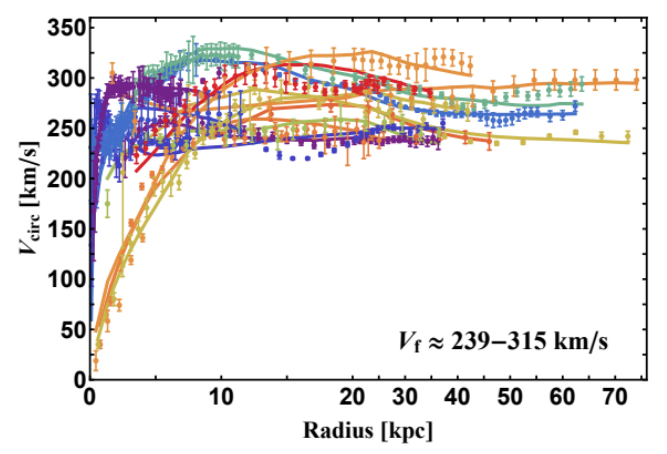
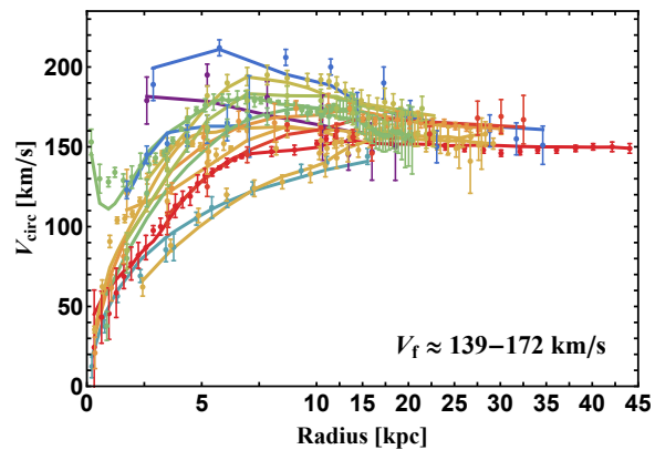
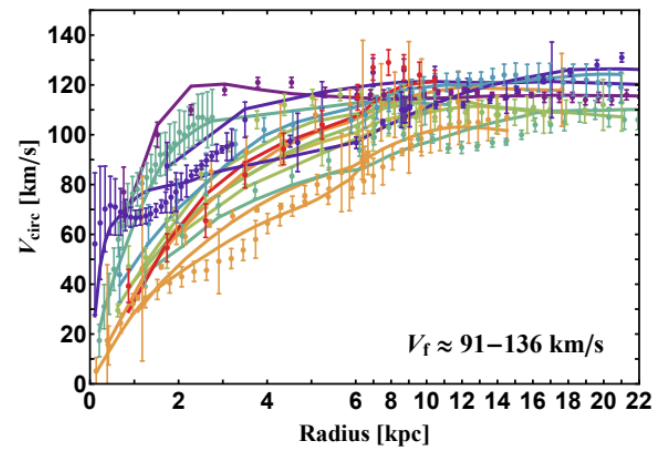
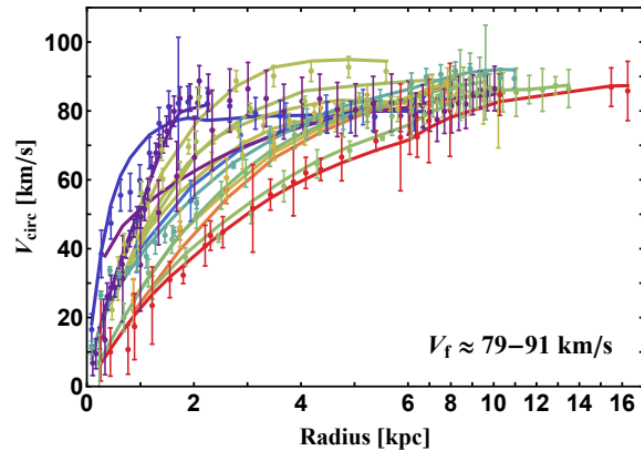


# WHAT SIDM **CAN** DO

1. Create a beautiful variety of density profiles.

# DENSITY PROFILES

- Ren+ 1808.05695



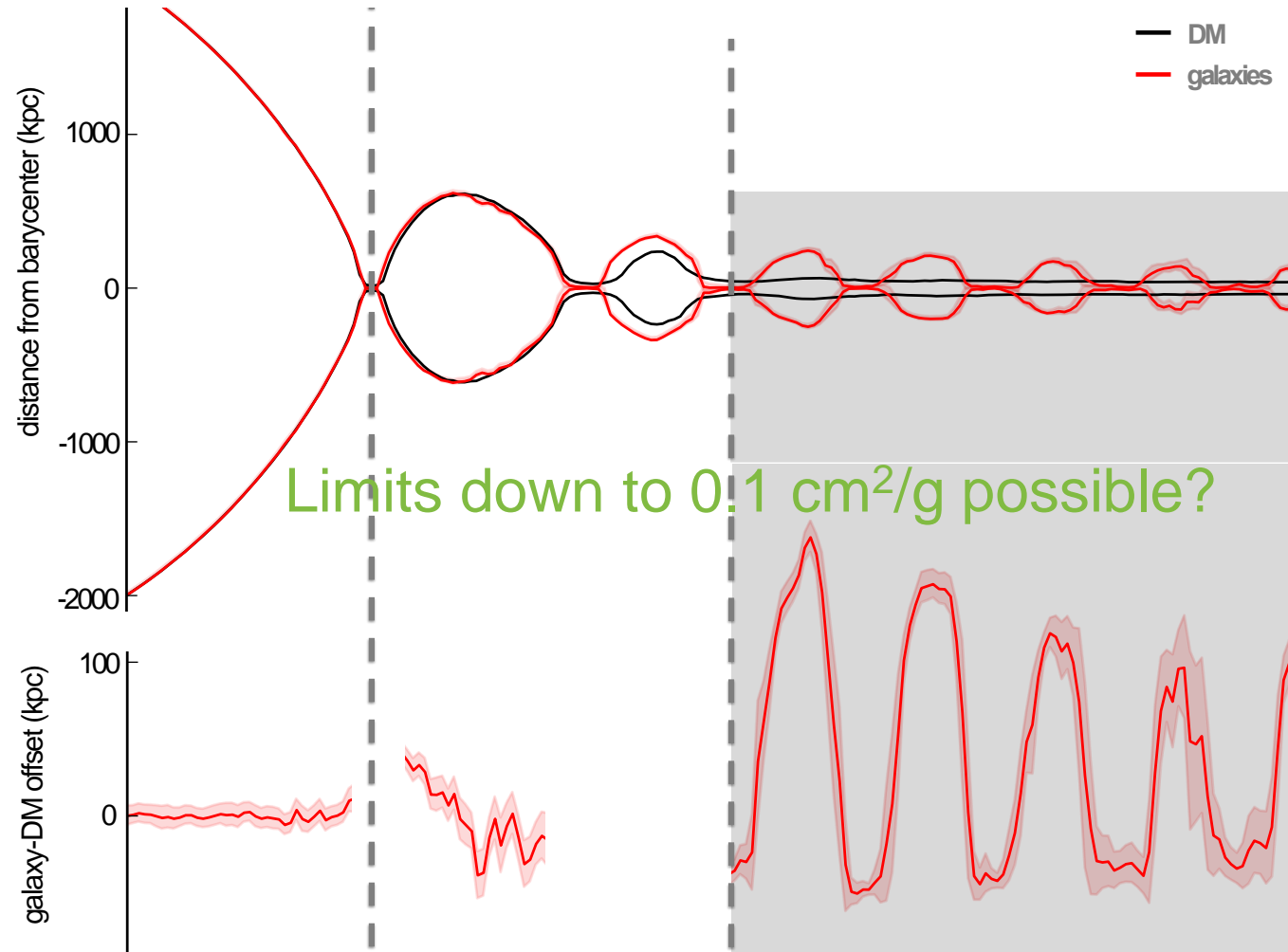


# WHAT SIDM **CAN** DO

1. Create a beautiful variety of density profiles.
2. Make galaxies ring like bells in galaxy clusters.

# SLOSHING GALAXIES IN CLUSTERS

See also work by Harvey+, Robertson+, Kahlhoefer+, Secco+ 2017



Kim, AP, Wittman 1608.08630



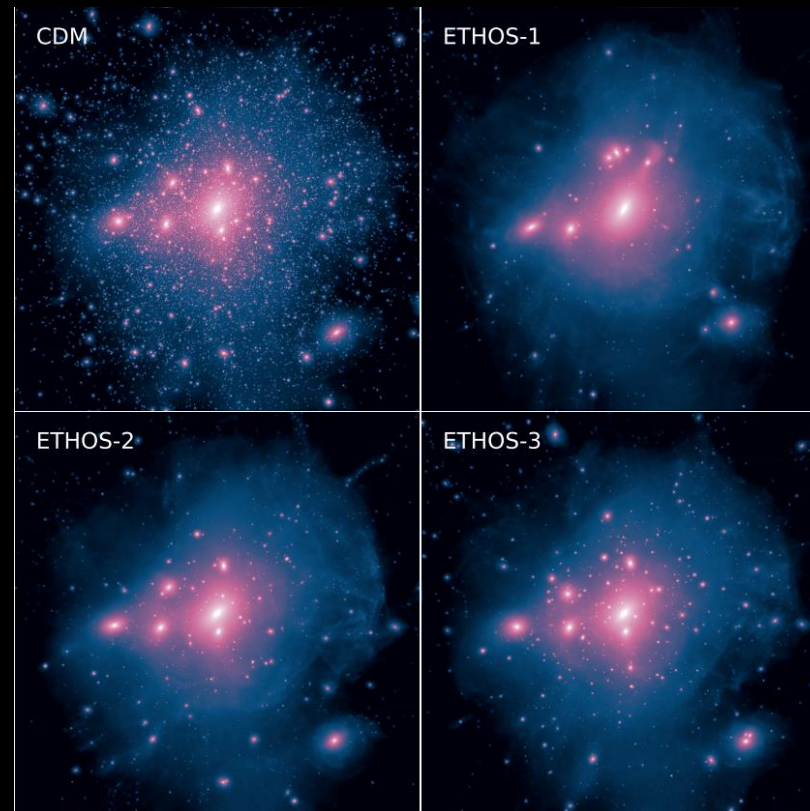
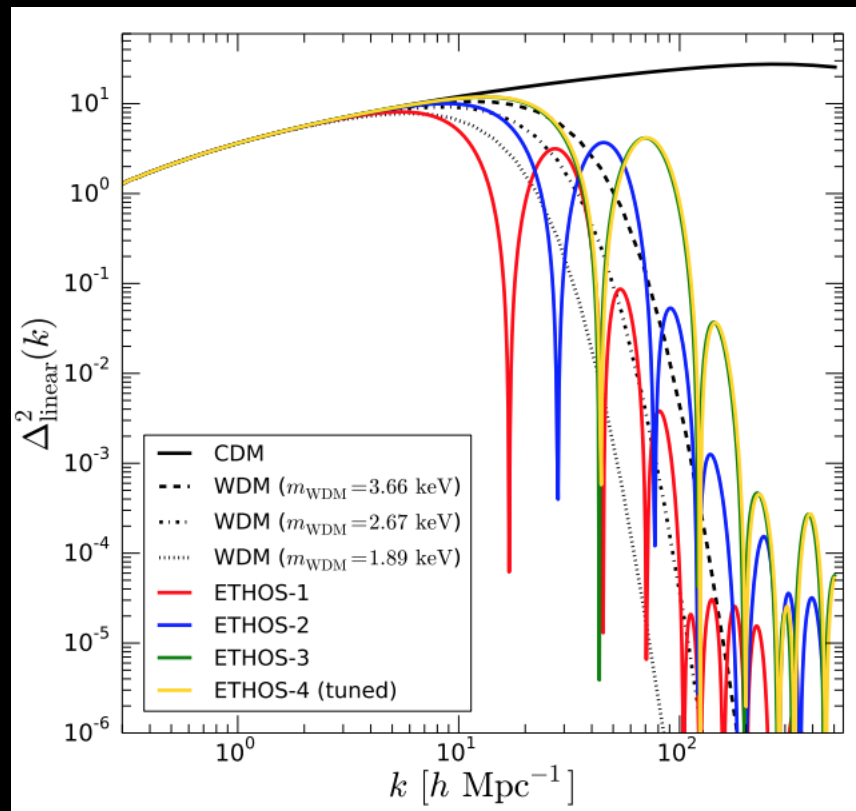
# WHAT SIDM **CAN** DO

1. Create a beautiful variety of density profiles.
2. Make galaxies ring like bells in galaxy clusters.
3. If the model is right, you can truncate the matter power spectrum.

# DARK ACOUSTIC OSCILLATIONS

Hidden photon dark matter

Vogelsberger+ 1512.05349



See papers by Cyr-Racine & collaborators

# FOR MORE

- Tulin & Yu: <https://arxiv.org/abs/1705.02358> (Published in Physics Reports)
- Buckley & Peter: <https://arxiv.org/abs/1712.06615> (ditto)
- Novel Probes (in prep): <https://www.novelprobes.org/>