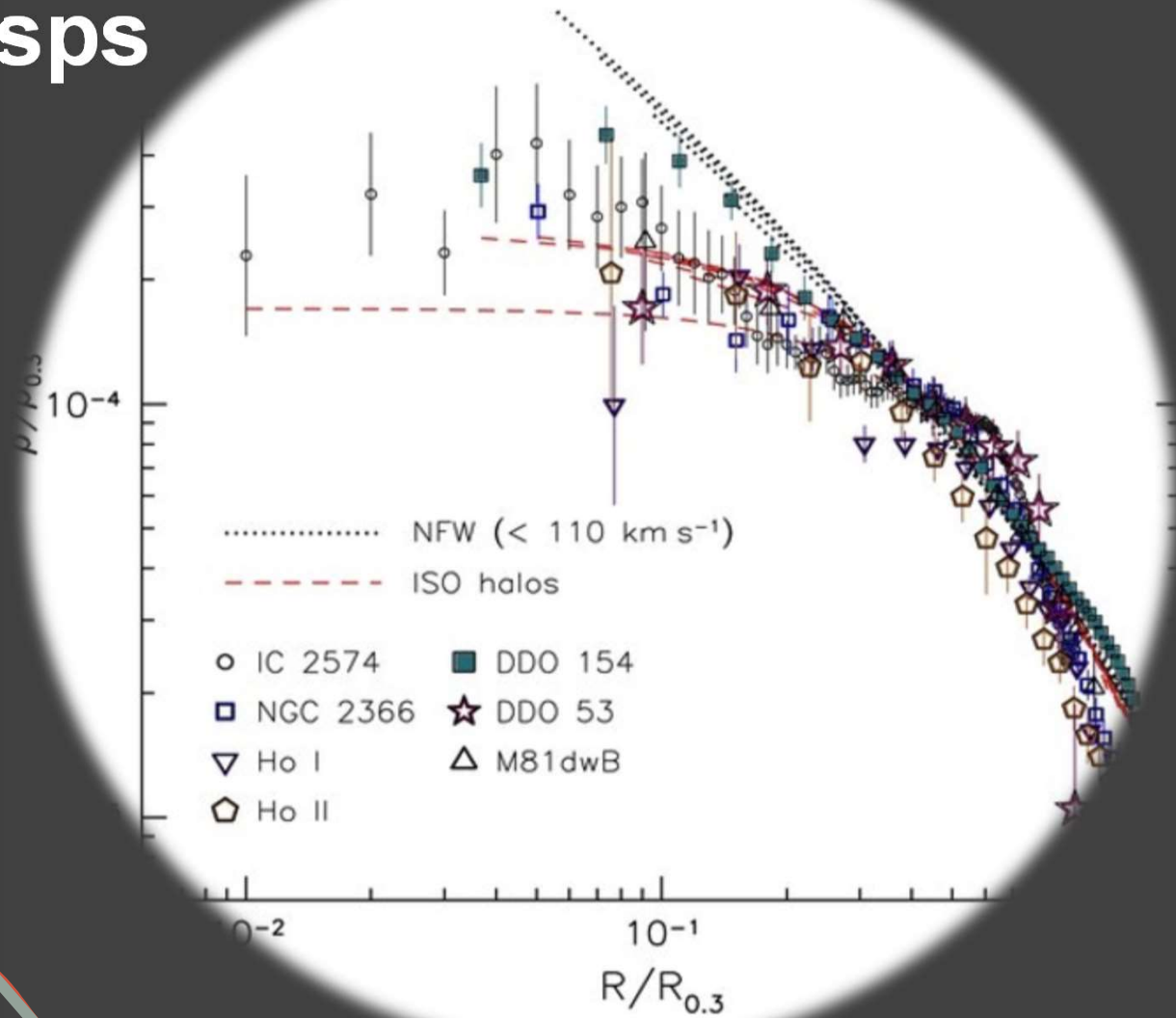
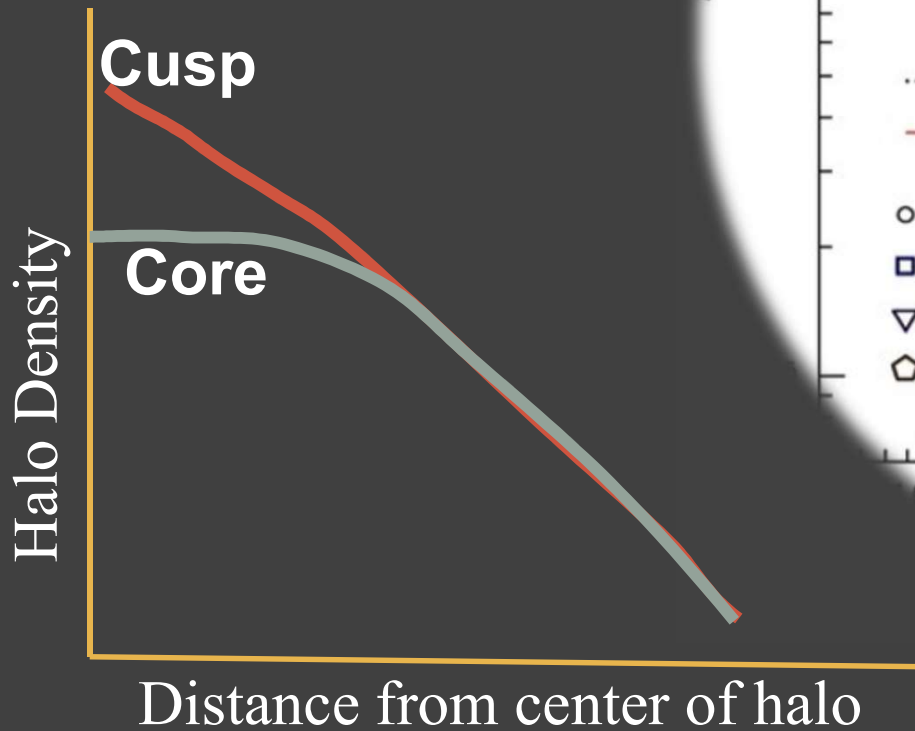


The Self-Interacting Dark Matter (SIDM) paradigm

Particle dark matter within a six parameter cosmological model is a good explanation for the observed dark matter densities on 10 kpc scales or larger.

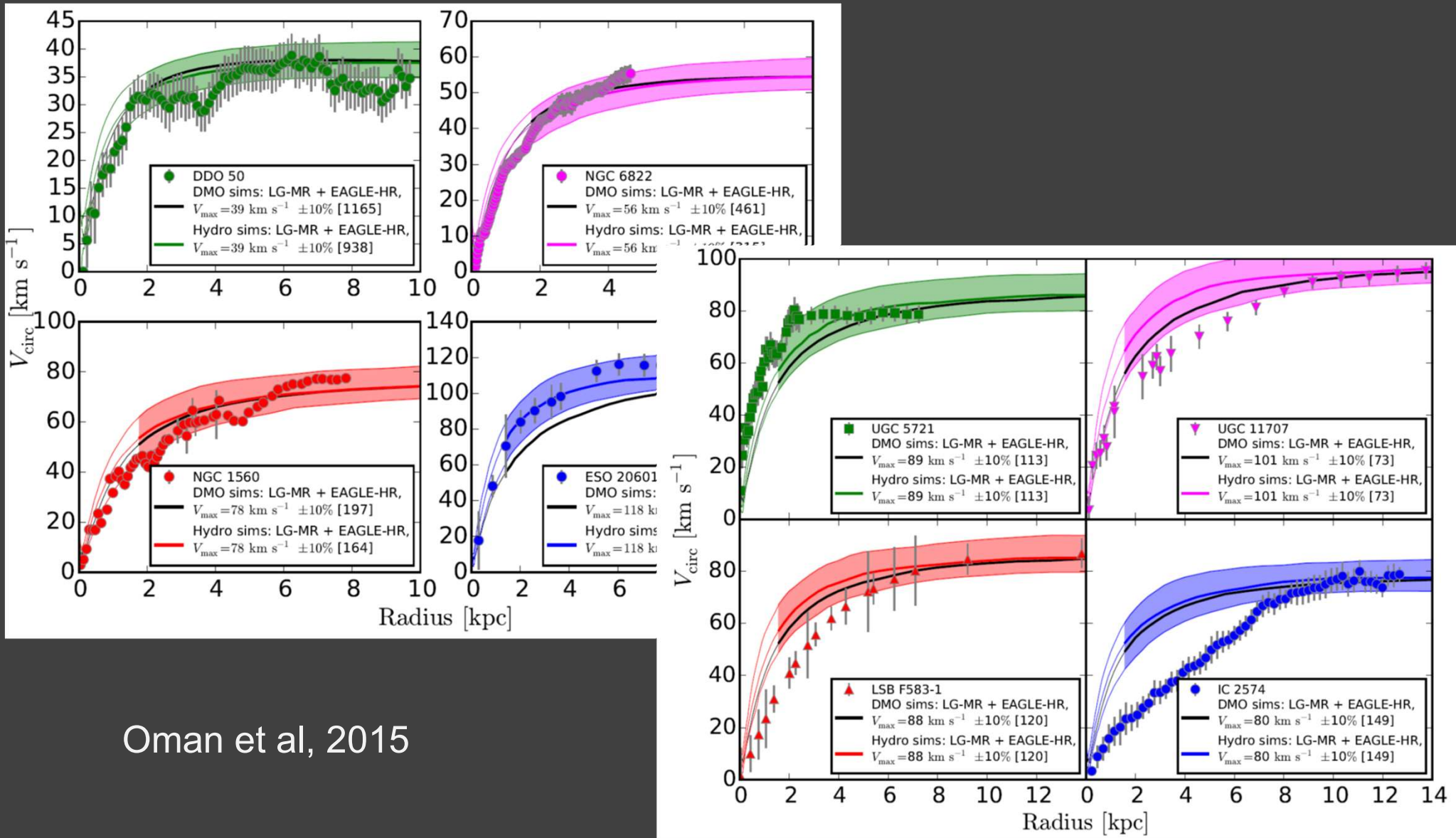
However, there are unexplained puzzles.

Cores AND cusps



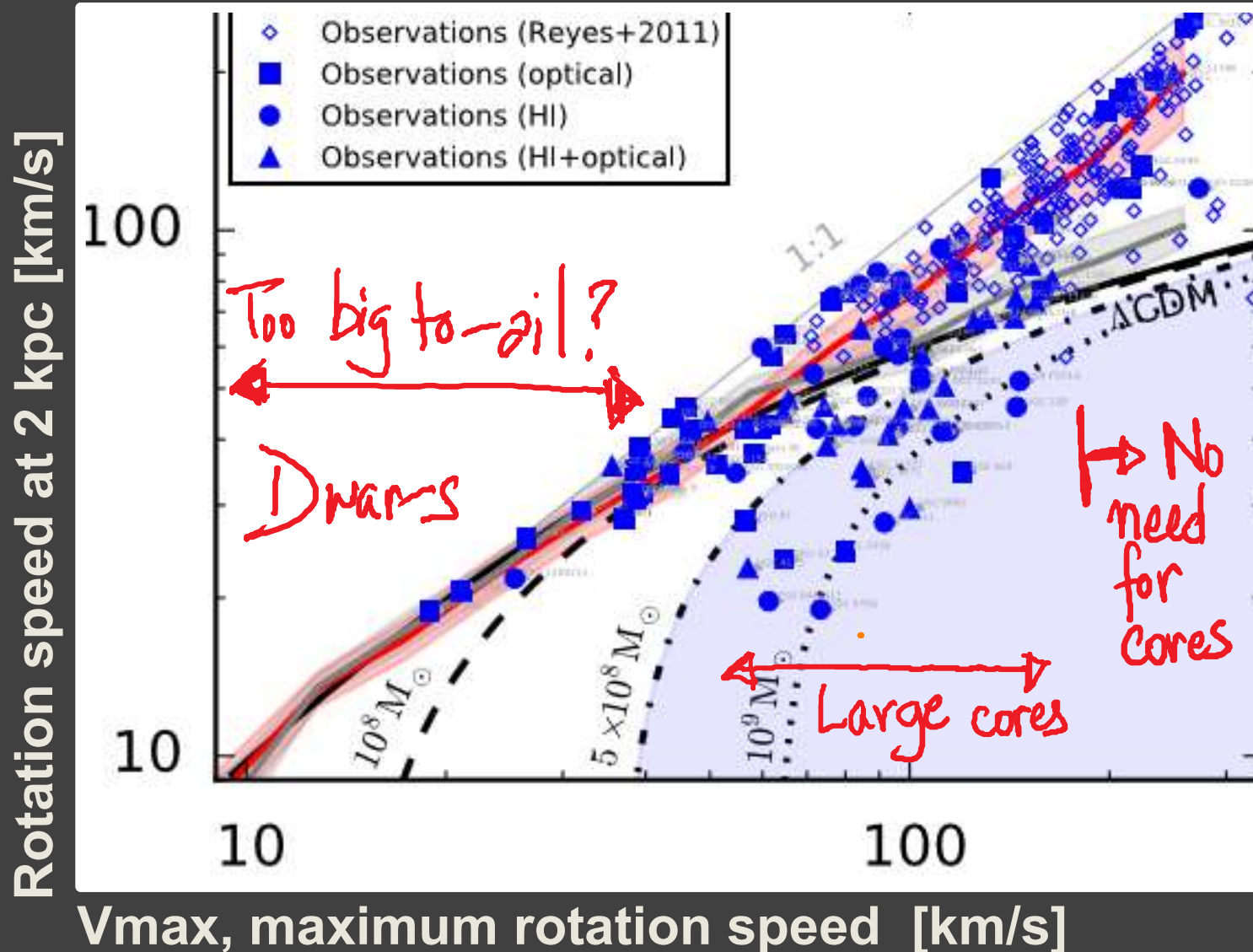
Oh et al 2015

Cores AND cusps



Oman et al, 2015

The puzzling diversity in rotation curves



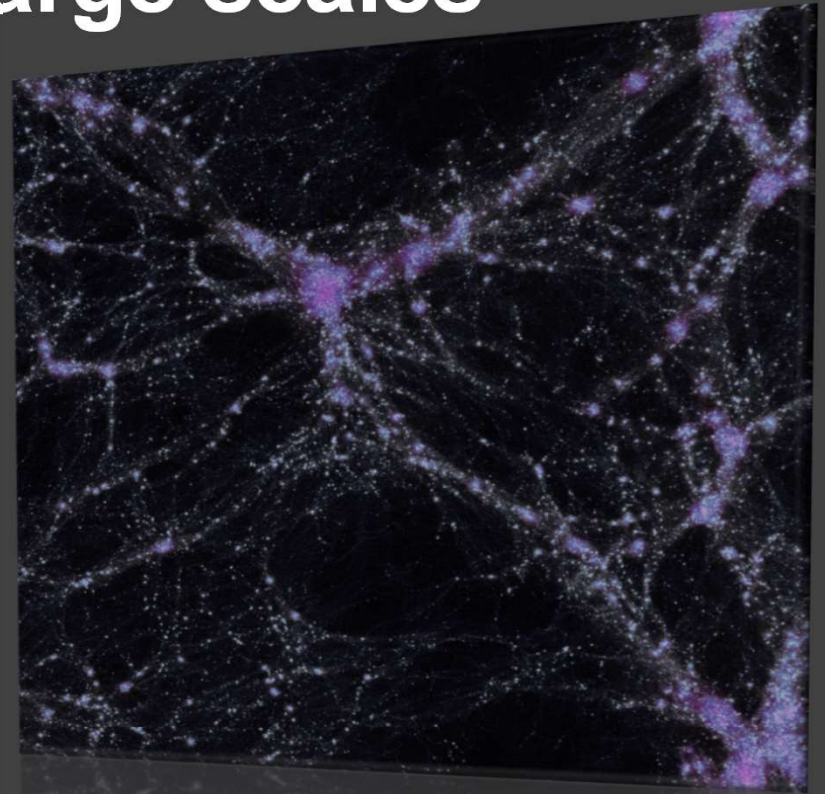
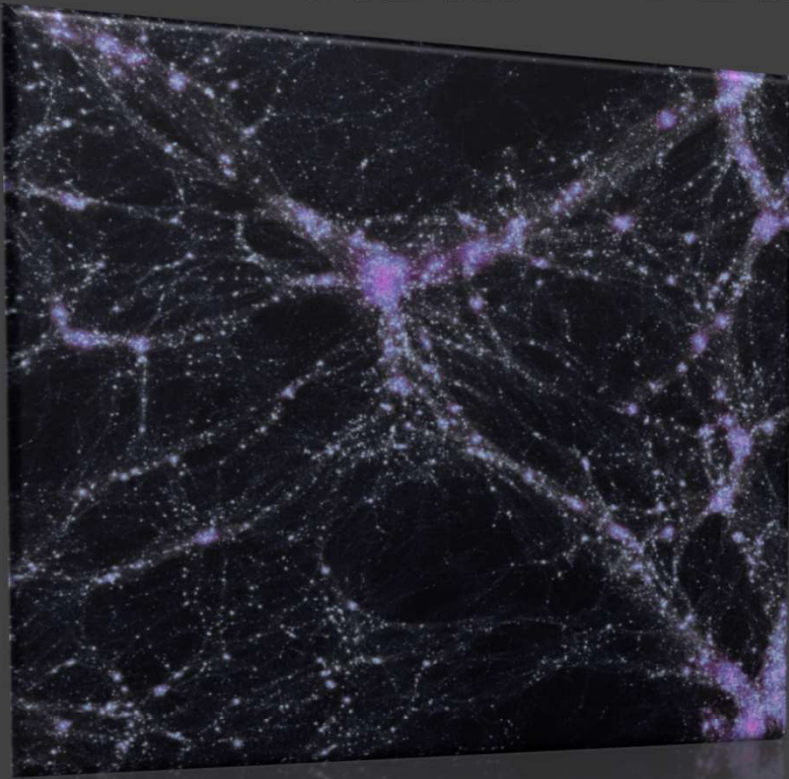
▶ Similar V_{max}
⇒ Similar halo masses
And
Similar total baryon masses

What is SIDM?

Particle dark matter with self-interaction (elastic and inelastic collisions) that allows for significant energy transport in galaxies and clusters.

Cross section over mass > 0.1 barn/GeV.

SIDM = CDM on large scales

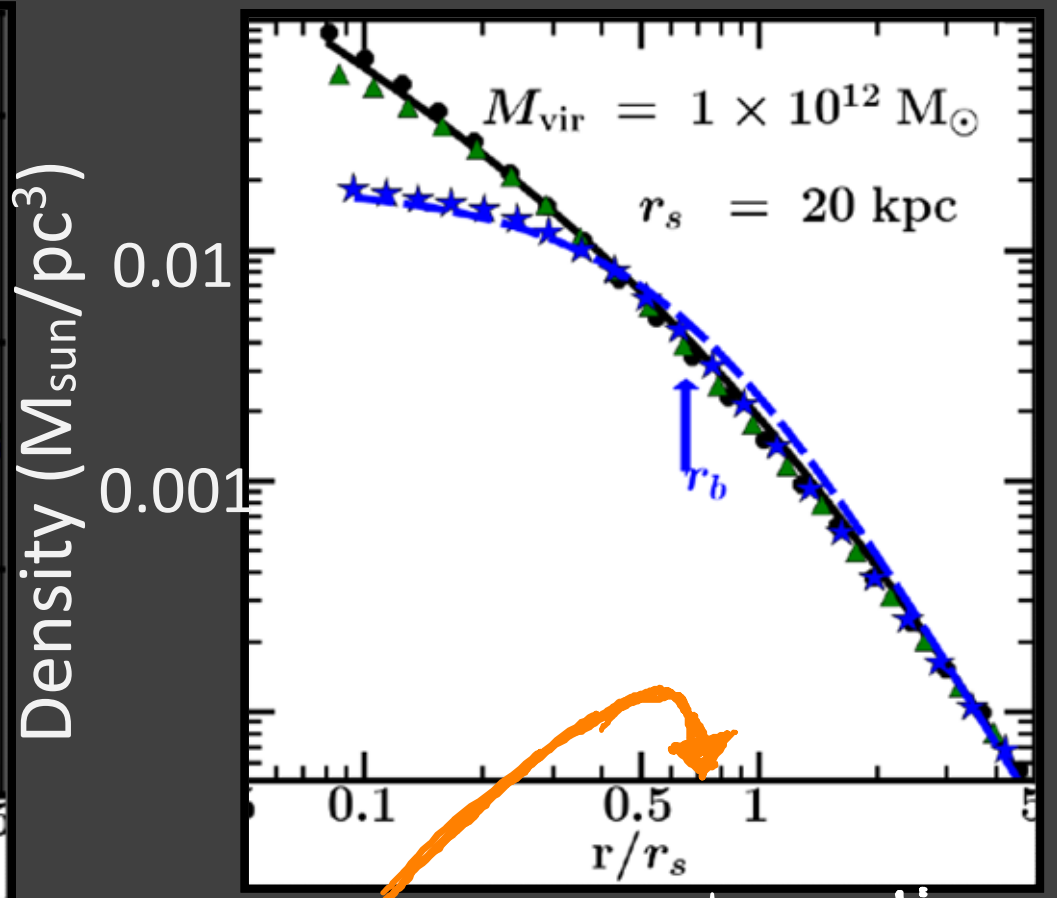
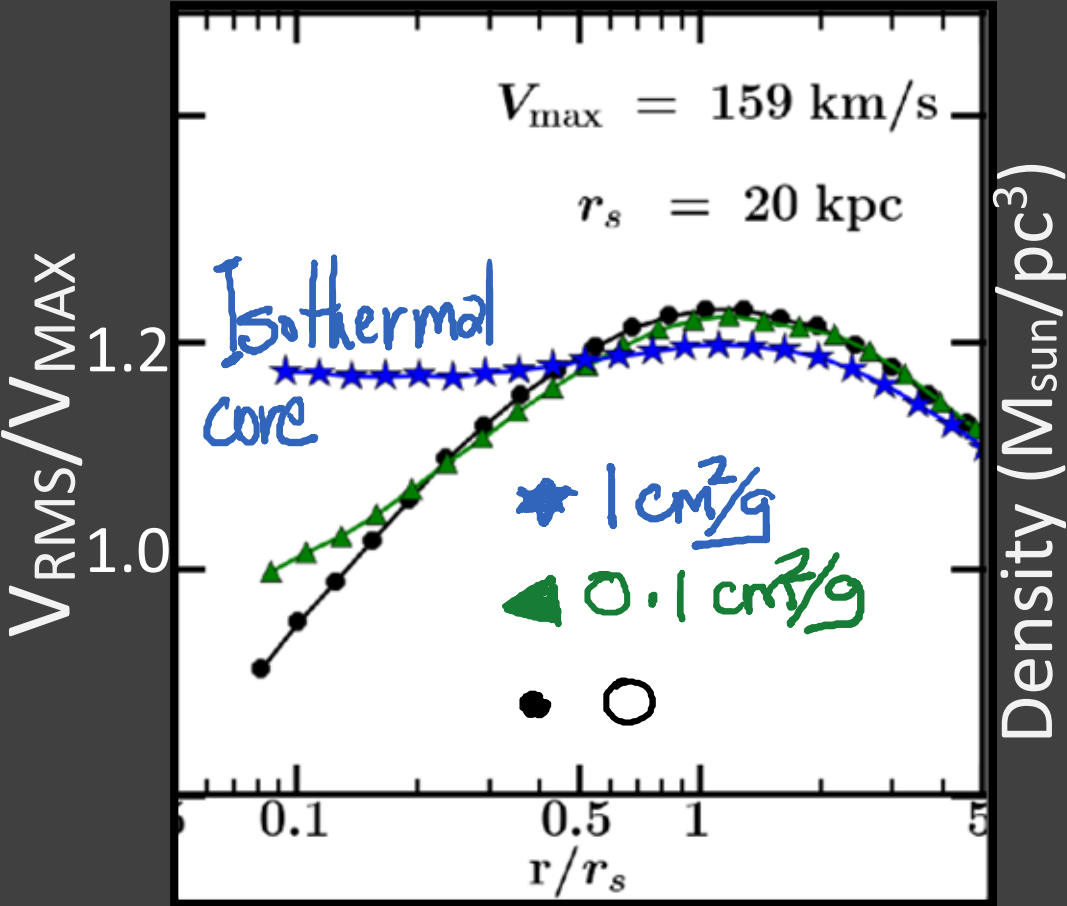


With James Bullock, Miguel Rocha, Annika Peter (2013)

SIDM and CDM predictions deviate in the inner part of galaxies.

Spergel and Steinhardt 2000

SIDM: thermalization of the inner halo



r_b : one interaction on average over age of halo

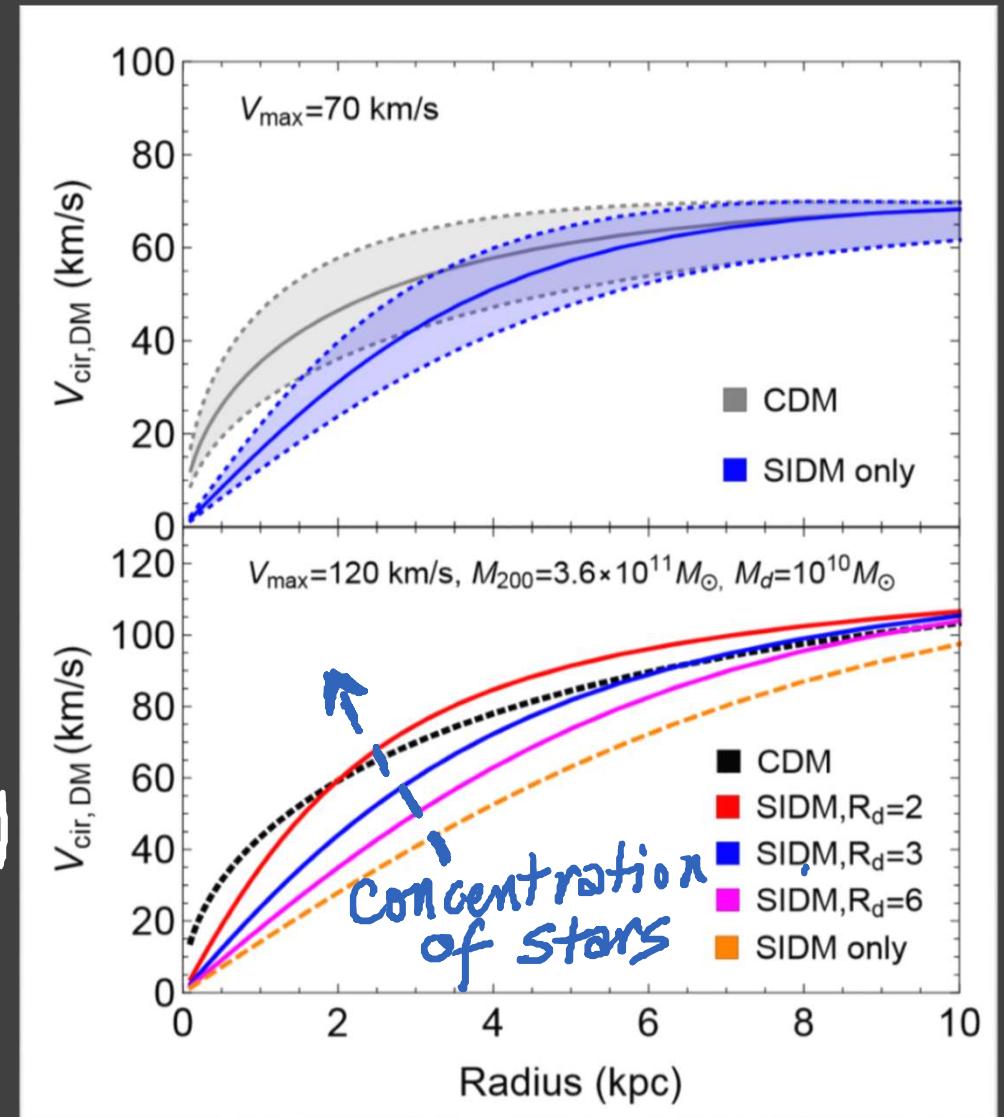
With James Bullock, Miguel Rocha, Annika Peter (2013)

SIDM halo profile is almost uniquely determined

$$\rho_{\text{SIDM}}(r) = \begin{cases} \rho_{\text{iso}}(r), & r < r_1 \\ \rho_{\text{CDM}}(r), & r > r_1 \end{cases}$$

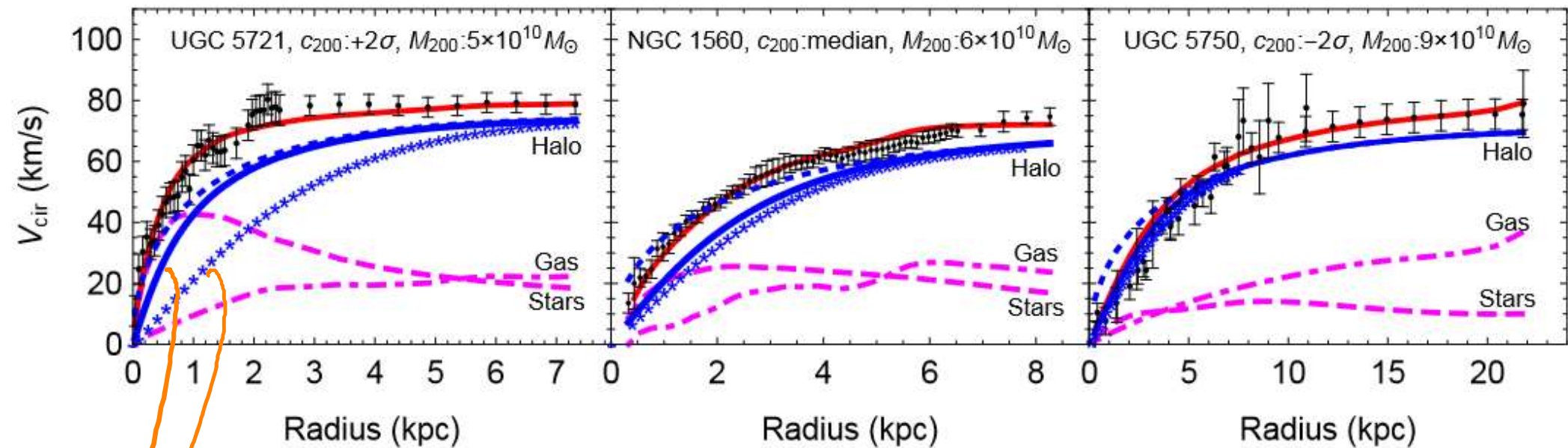
$$\rho_{\text{iso}}(r) \propto e^{-\bar{\Phi}(r)/kT}$$

↑
gravitational potential
of dark matter and baryons



With Ayuki Kamada, Andrew Pace and Hai-Bo Yu (2017)

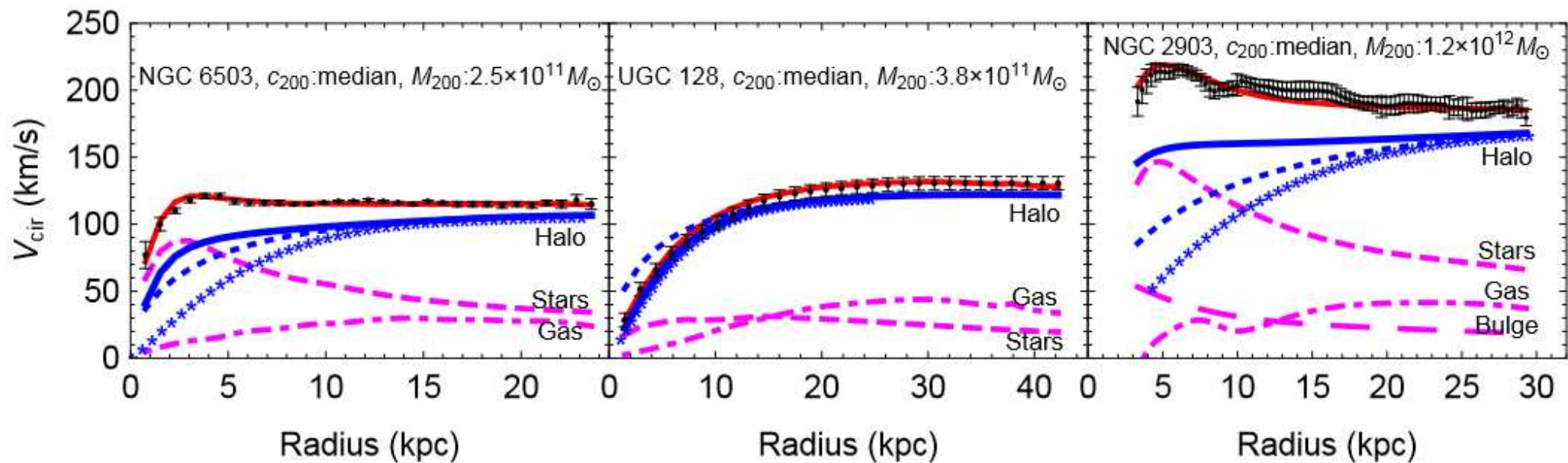
How SIDM solves the structure formation puzzles



With Ayuki Kamada, Andrew Pace and Hai-Bo Yu (2017)

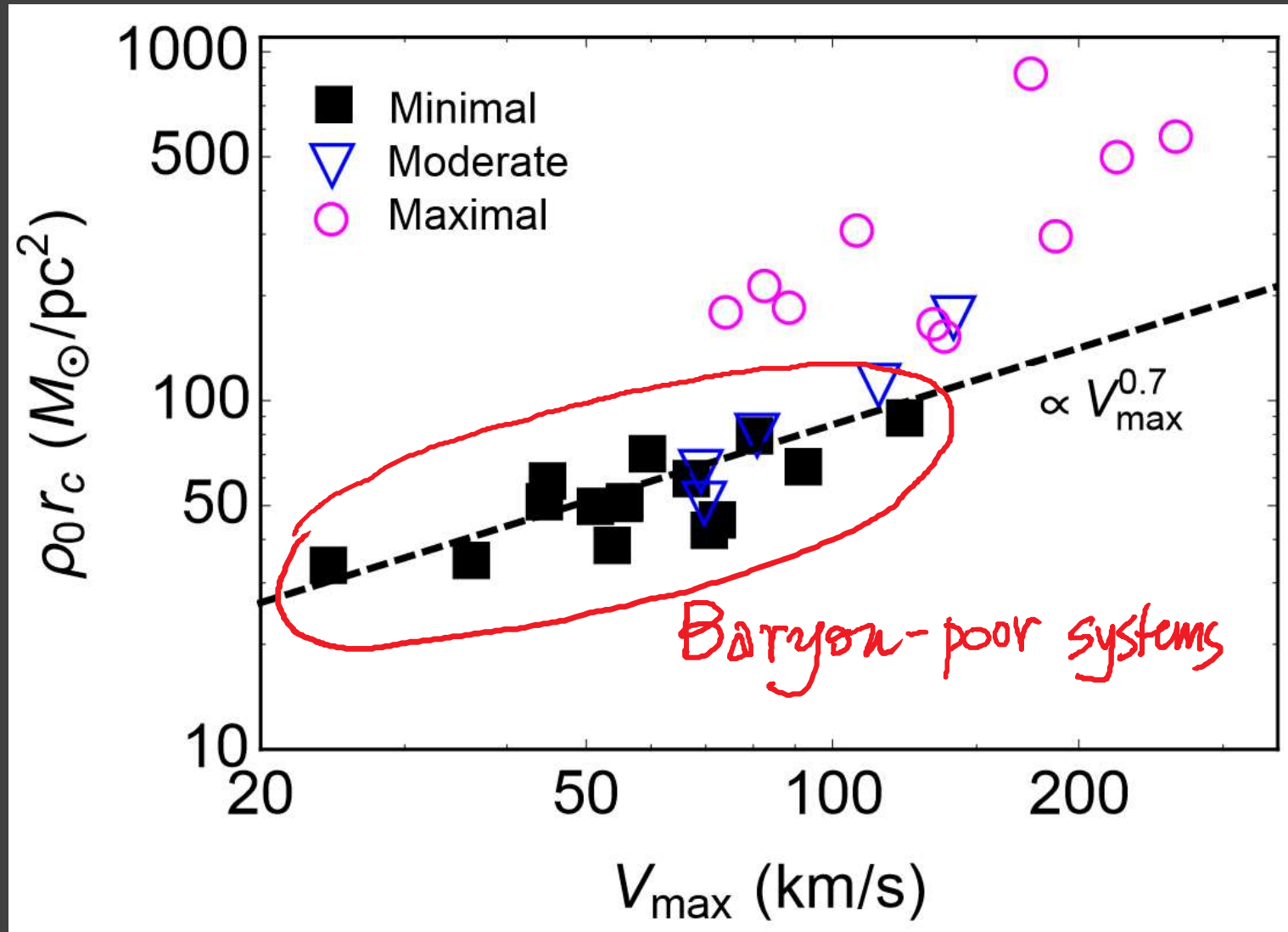
Without including the potential of stars
correct SIDM density profile

How SIDM solves the structure formation puzzles



With Ayuki Kamada, Andrew Pace and Hai-Bo Yu (2017)

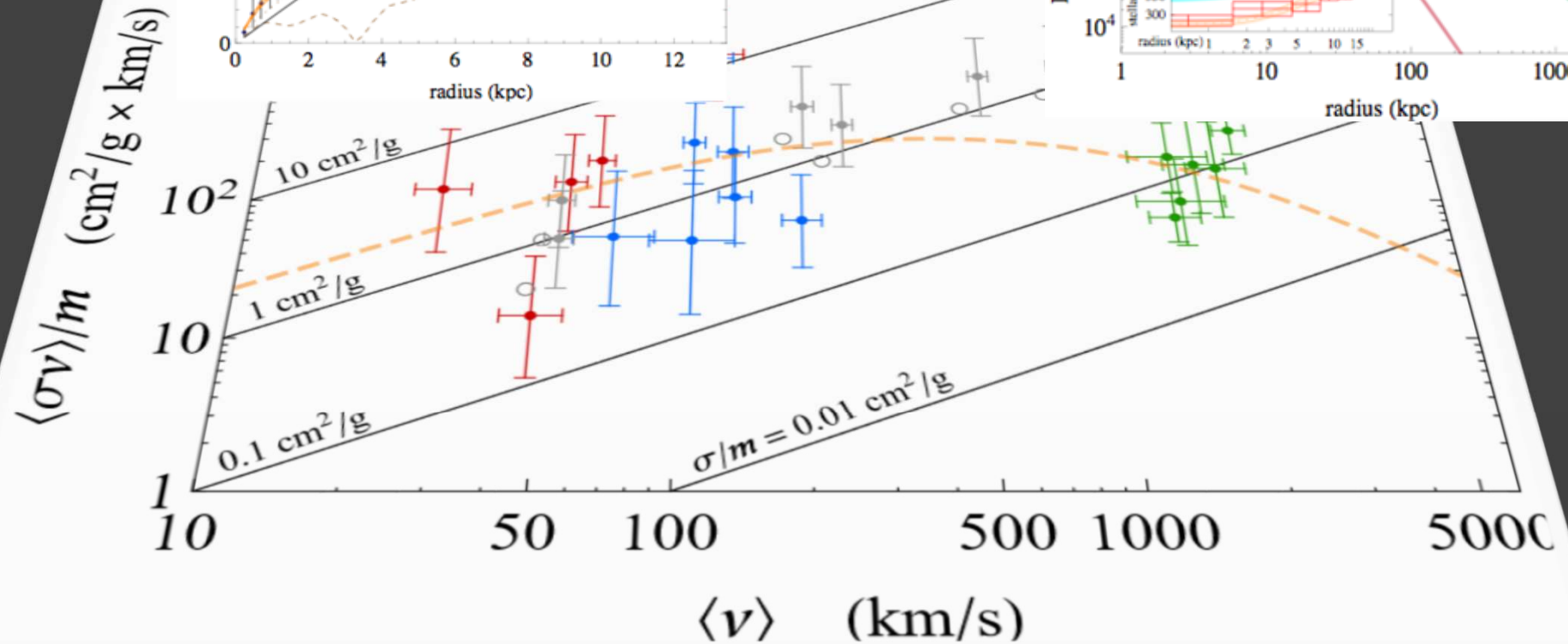
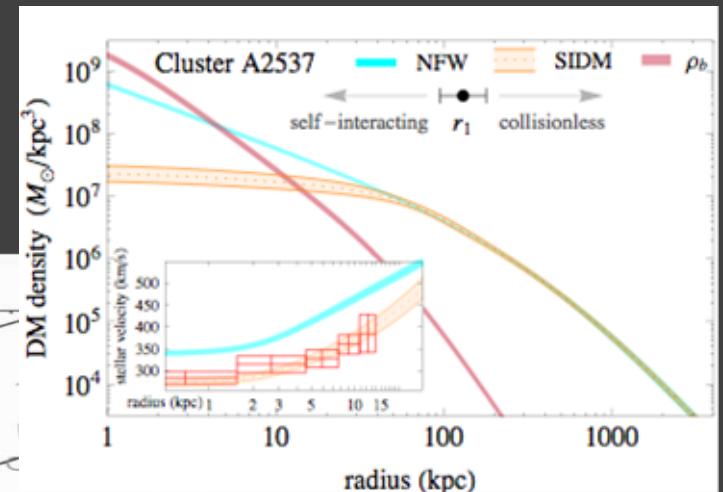
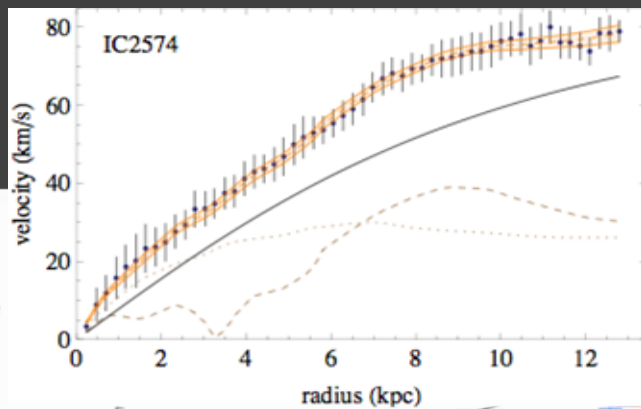
Uniformity of SIDM profiles



With Ayuki Kamada, Andrew Pace and Hai-Bo Yu (2017)

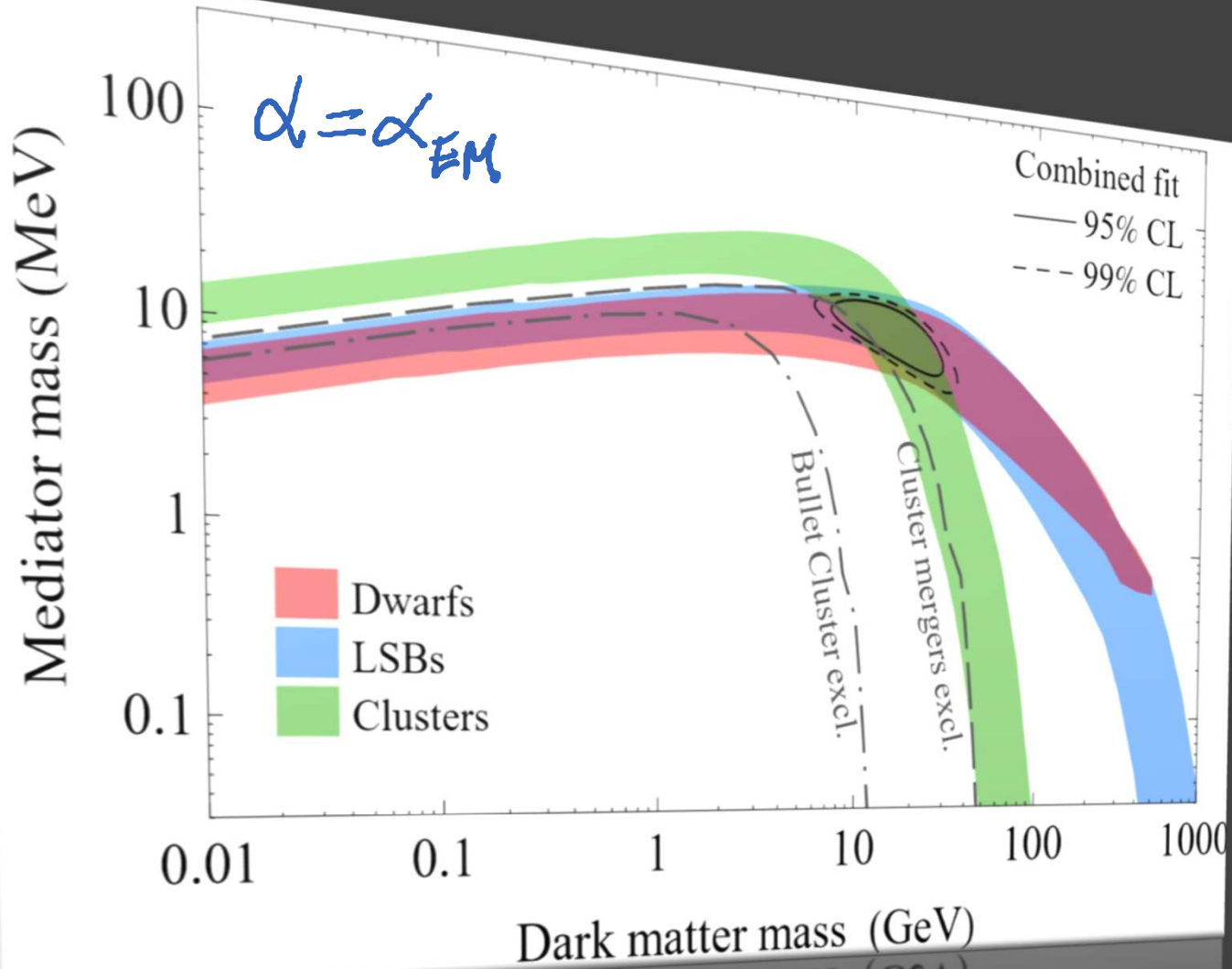
Also, Lin and Loeb (2016)

The self-interaction cross section must decrease at high collision speeds



With Sean Tulin and Hai-Bo Yu (2015)

SIDM particle properties: Yukawa interaction



$$V = \frac{t}{r} \alpha e^{-m_\phi r}$$

Tulin, Yu, Zurek 2012

Non-abelian sector
 Boddy et al (2014) papers

With Sean Tulin and Hai-Bo Yu (2015)

Direct search constraints are strong

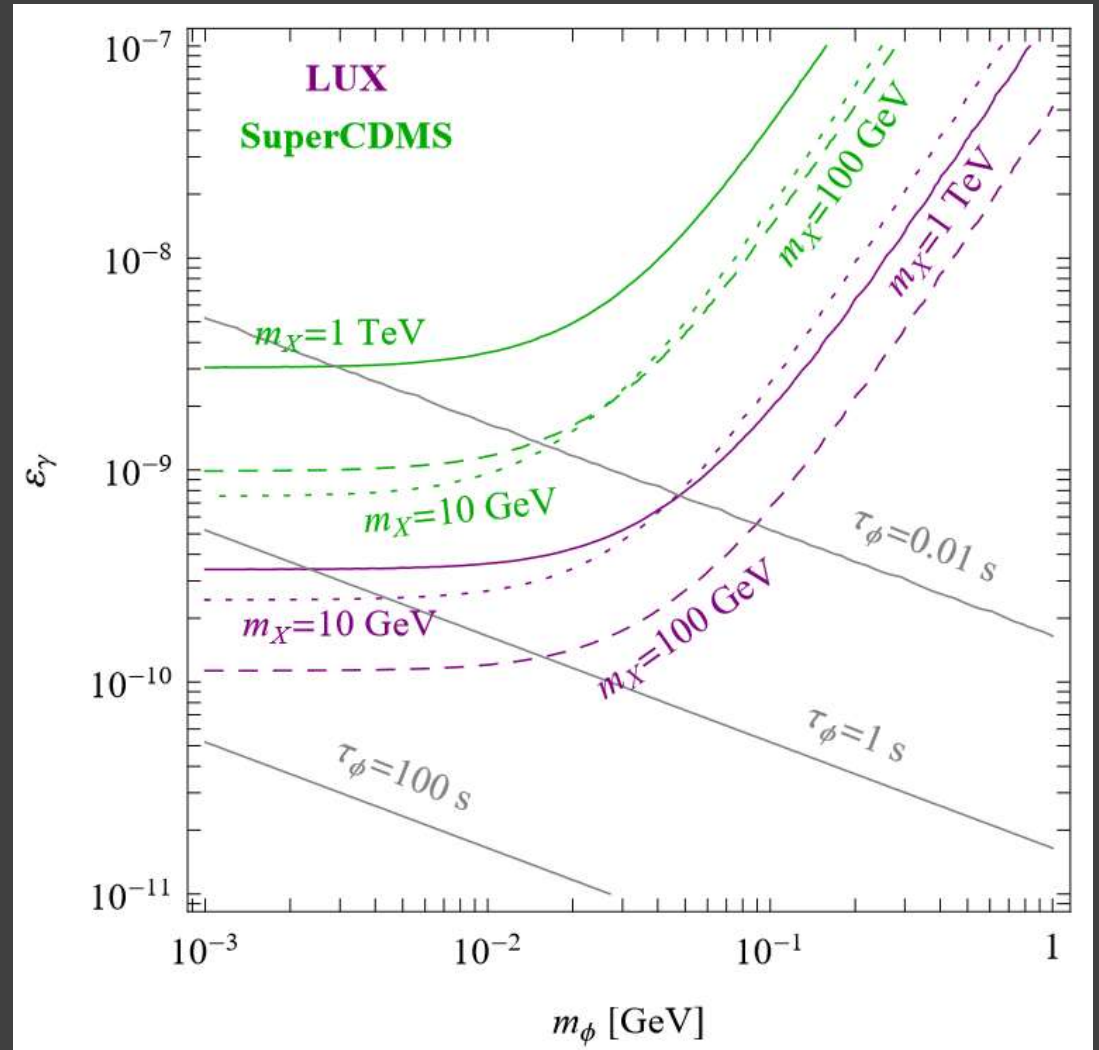
ϕ must decay!

$$\mathcal{L} > \frac{\epsilon_\gamma F F_\phi}{2}$$

Direct Searches

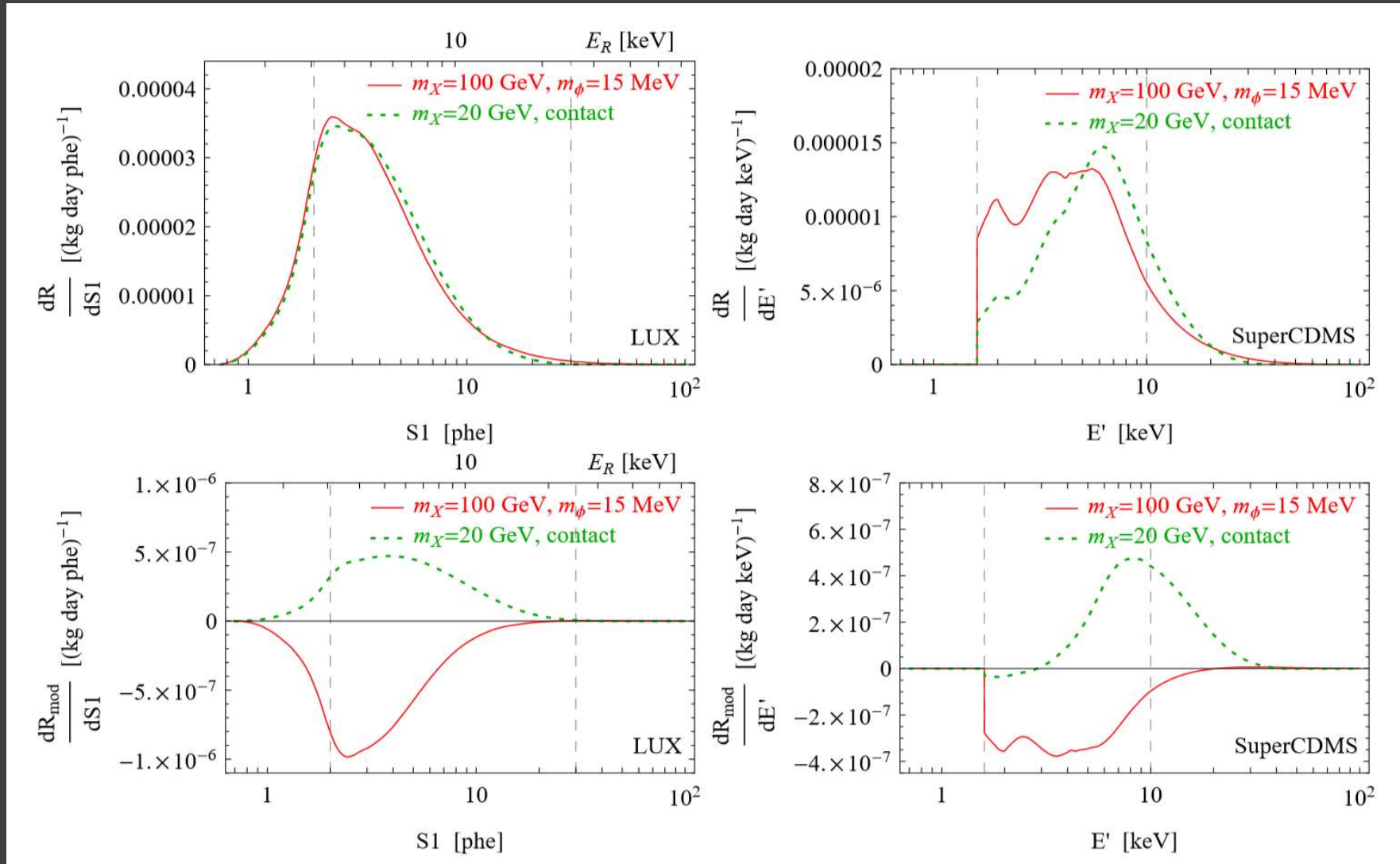
Tulin, Yu and Kaplinghat (2013)

Momentum dependent scattering for SIDM:
Multiple targets and annual modulation can distinguish WIMPs and SIDM



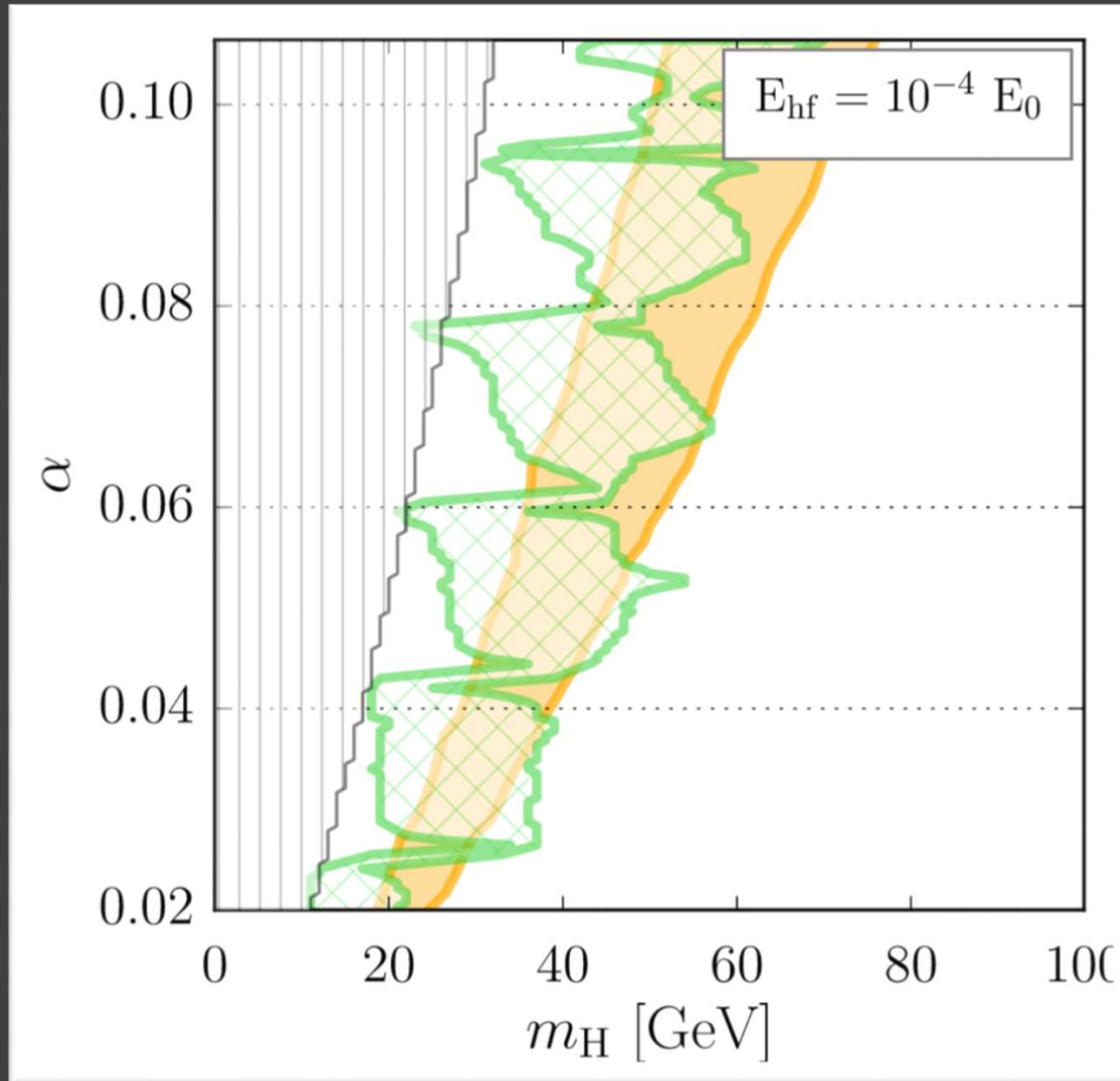
With Eugenio Del Nobile and Hai-Bo Yu (2015)

WIMPs or SIDM: Multiple targets and annual modulation can tell



With Eugenio Del Nobile and Hai-Bo Yu (2015)

SIDM particle properties: Dark Hydrogen



with Kim Boddy, Anna Kwa, Annika Peter (2016)

Model independent tests of the SIDM paradigm

SIDM tracks the stellar potential where stars dominate. *Strong lenses and elliptical galaxies in X-rays.*

SIDM predicts cores in satellite galaxies. *Multiple population chemo-dynamics in the MW satellites.*

