Learning about Dark Matter distribution in Galaxies

Goal: *infer the DM profile of real Galaxies over a large range of masses*

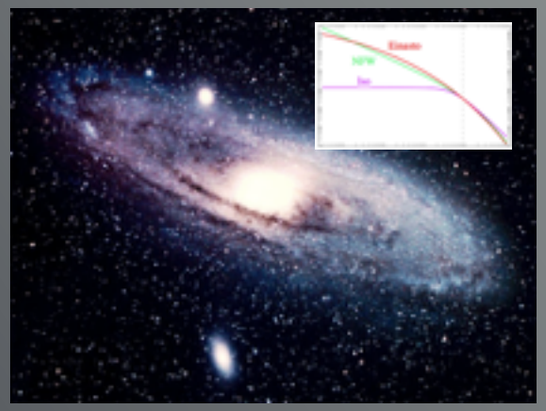
Tool: *training machines to apply (and correct) well-known astrophysical methods with state-of-art sims*

Coordinators: F. Calore, F. Iocco

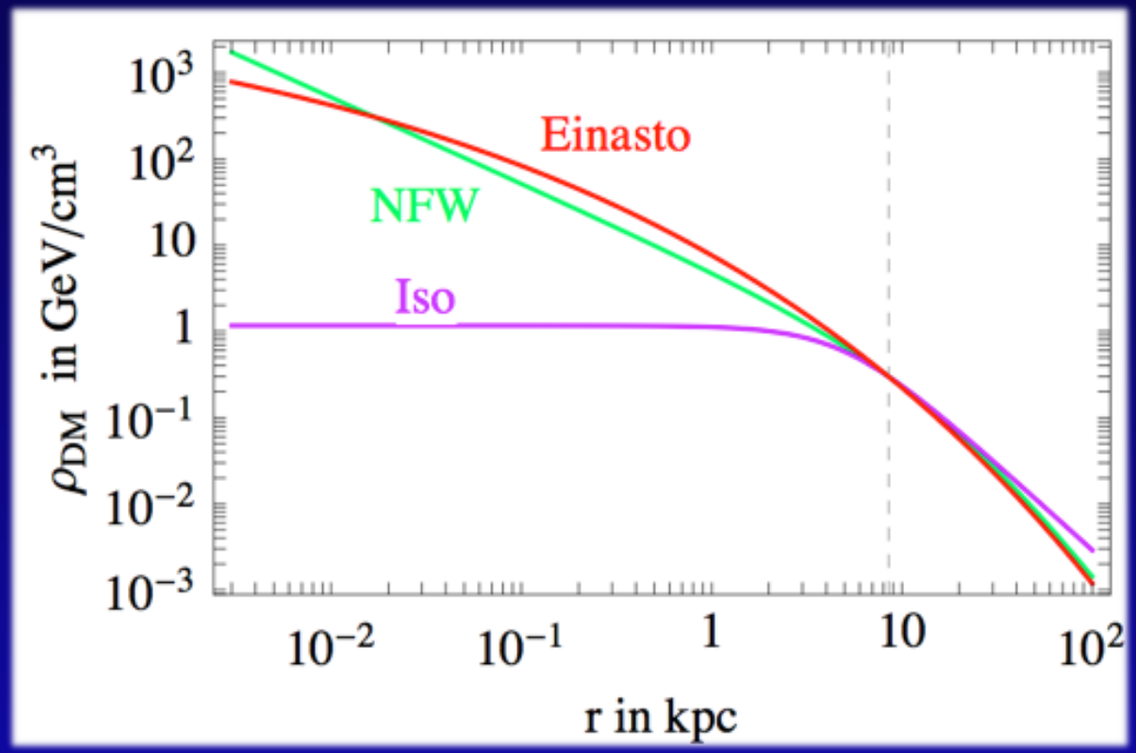
Dark Machines
kickoff meeting
June 19th, 2018

The single halo profile: a changing paradigm

A "universal" DM profile?



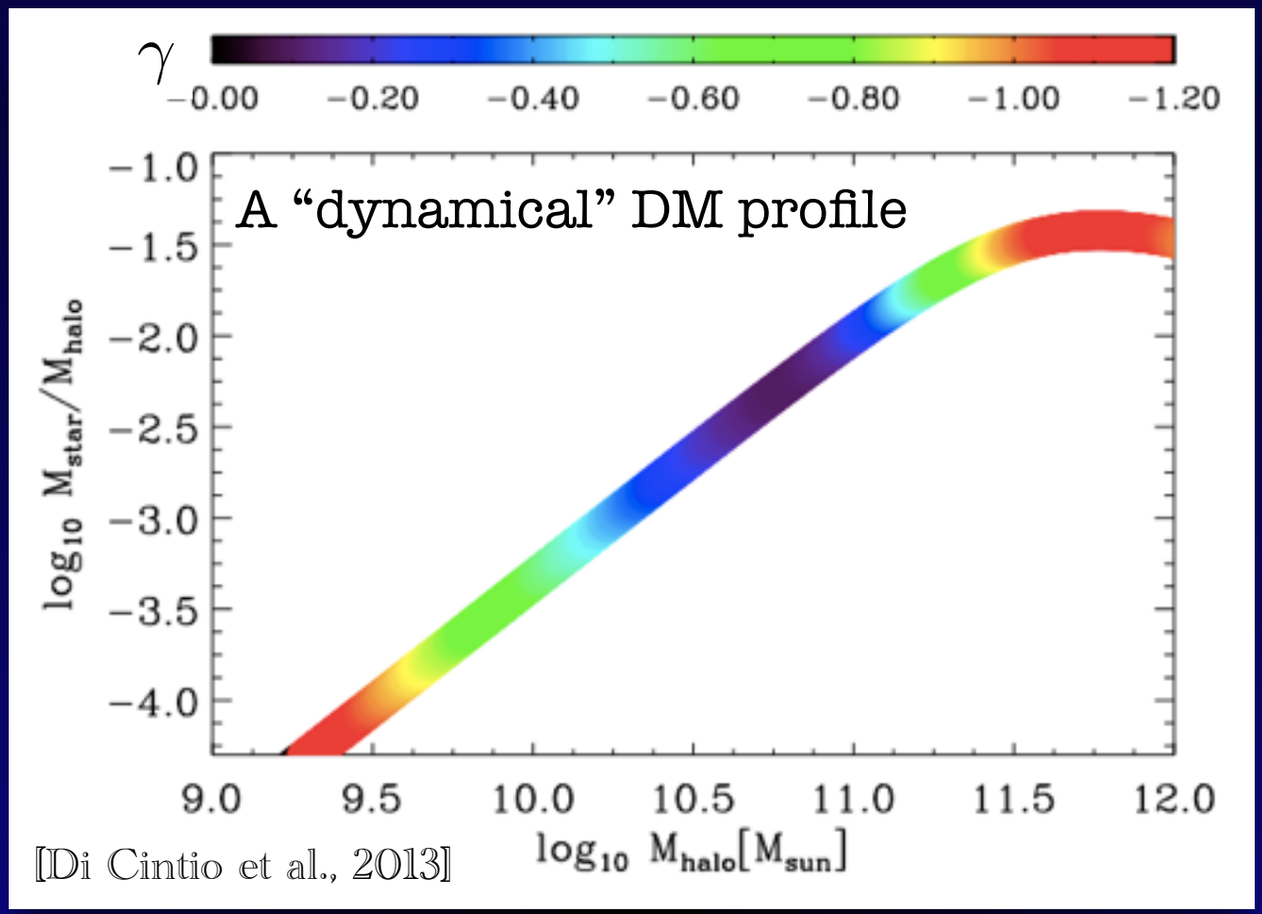
(not in scale!)



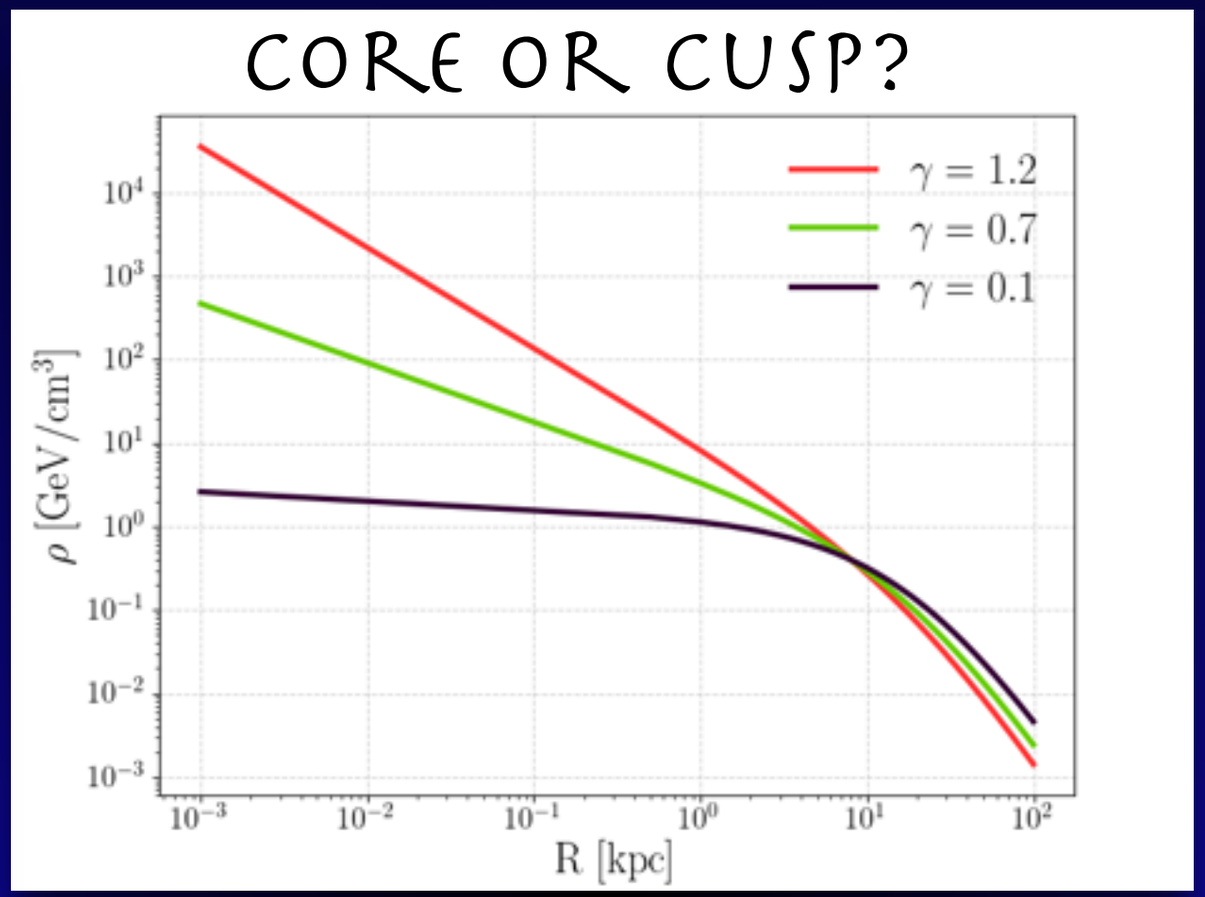
NAVARRO-FRENK-WHITE

$$\rho(R) \propto \frac{R_s}{R}\left(1+\frac{R}{R_s}\right)^{-2}$$

The single halo profile: a changing paradigm



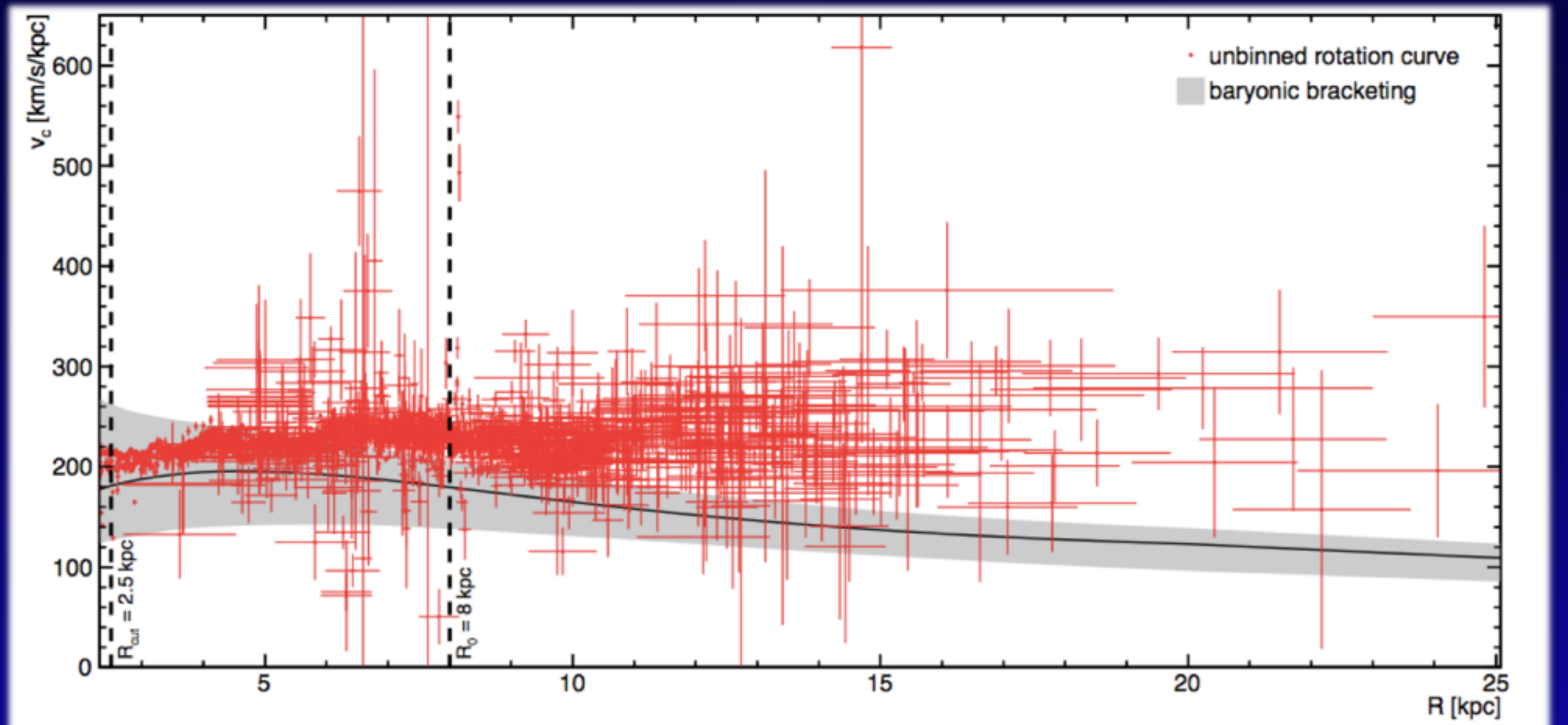
[Di Cintio et al., 2013]



generalized NFW

$$\rho_{DM}(R) \propto \rho_0 \left(\frac{R}{R_s}\right)^{-\gamma} \left(1+\frac{R}{R_s}\right)^{-3+\gamma}$$

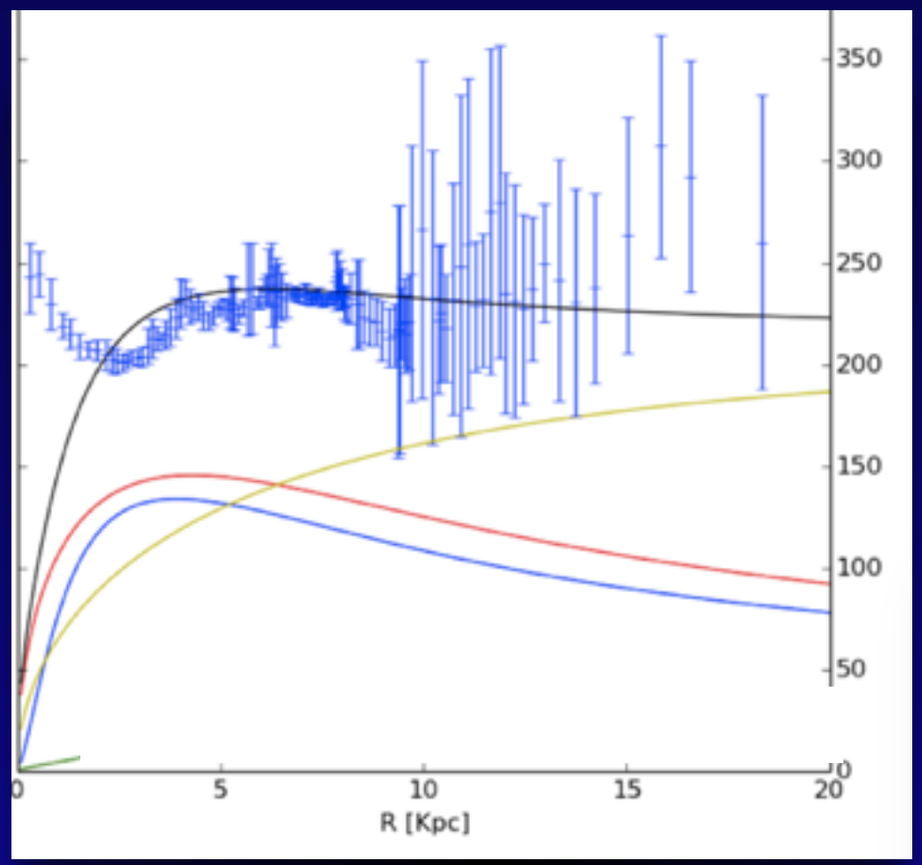
An example: the Milky Way



[Iocco, Pato, Bertone, Nature Physics 2015]

Inferring the DM density structure

Fitting a pre-assigned shape on top of luminous

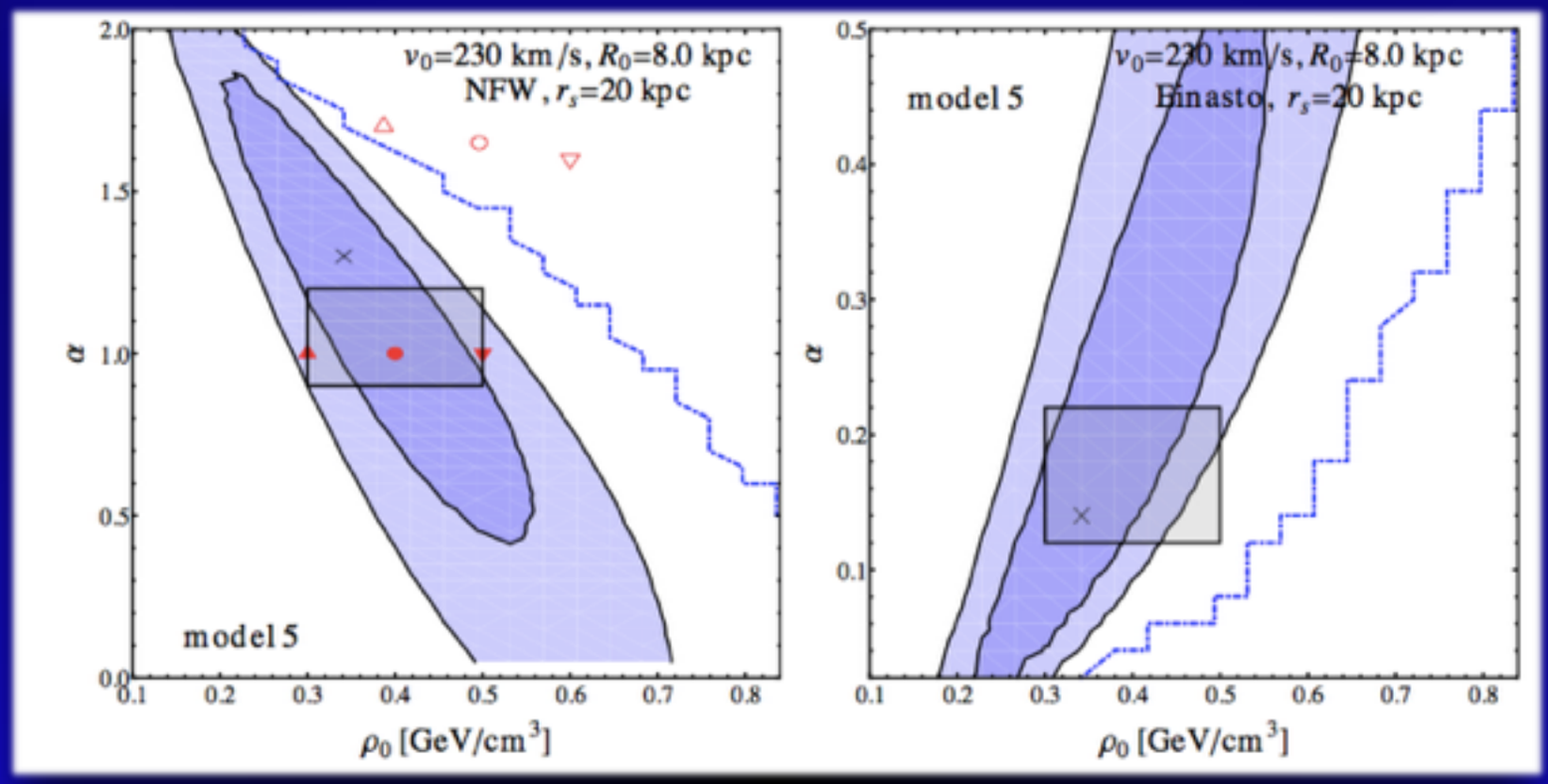


gNFW

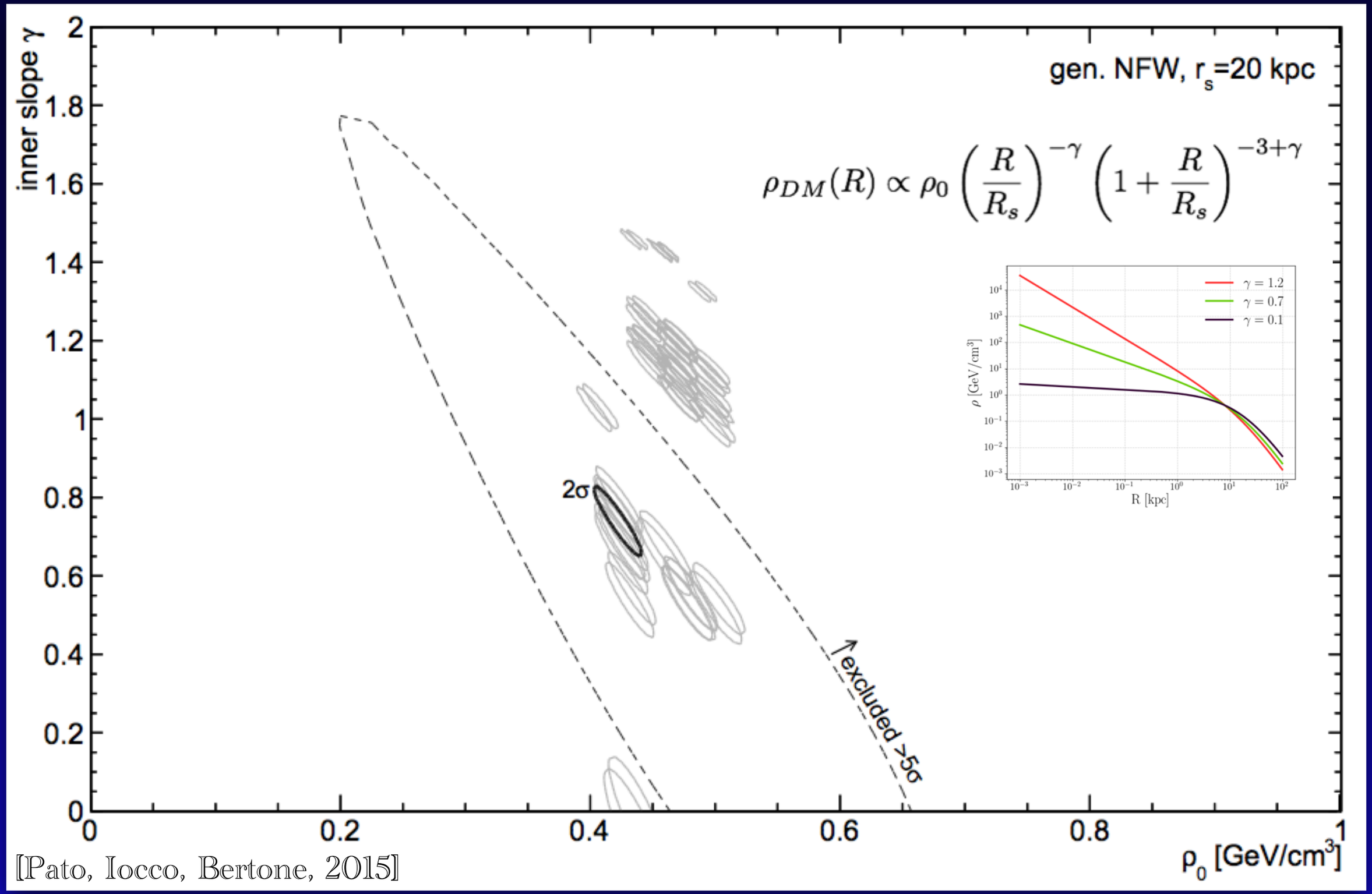
$$\rho_{DM}(R) \propto \rho_0 \left(\frac{R}{R_s}\right)^{-\gamma} \left(1+\frac{R}{R_s}\right)^{-3+\gamma}$$

Einasto

$$\rho_{DM}(R) \propto \rho_0 \exp\left[-\frac{2}{\gamma}\left(\left(\frac{R}{R_s}\right)^{\gamma}-1\right)\right]$$

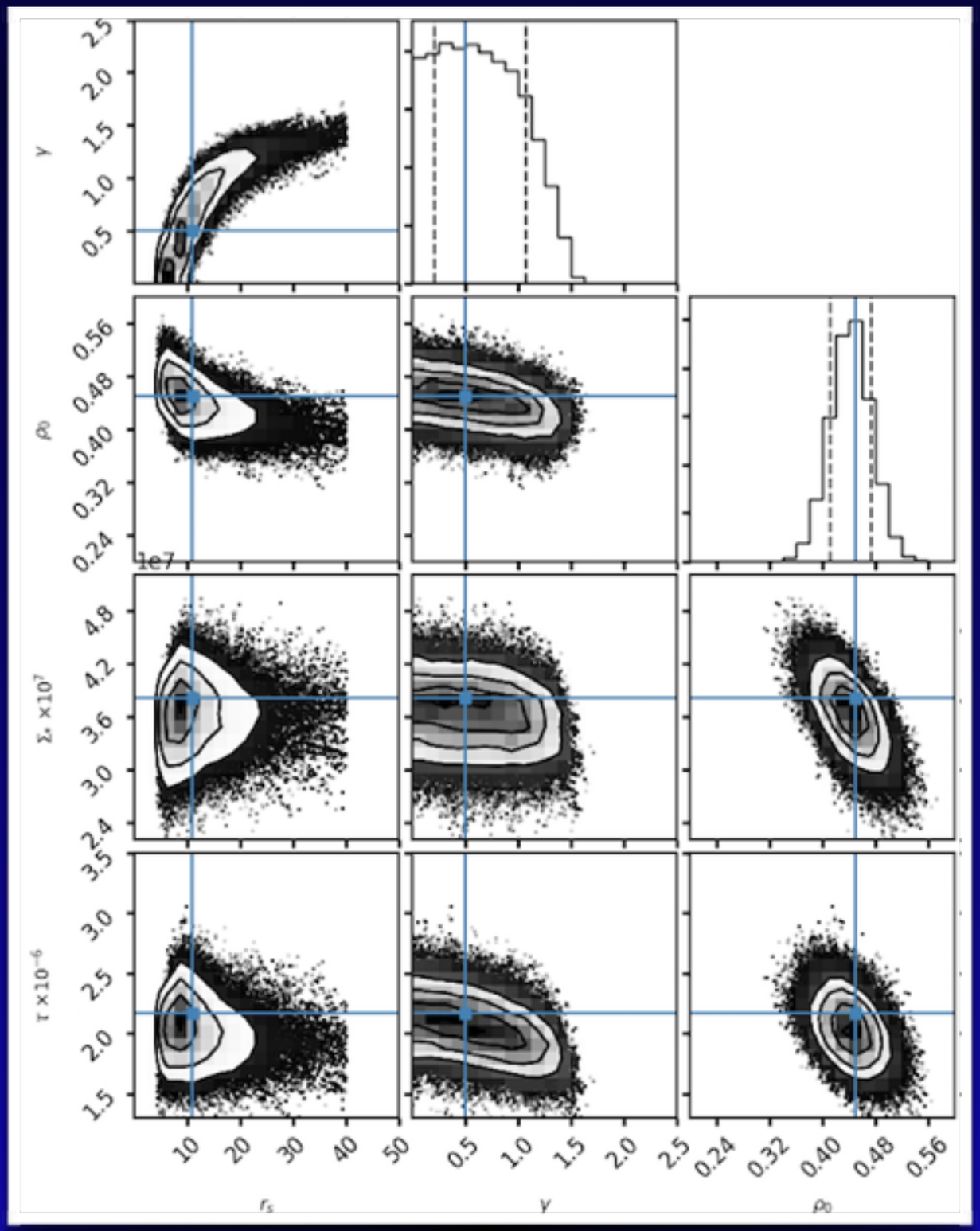


Extracting the DM density structure



[Pato, Iocco, Bertone, 2015]

Tuning the machinery, I.



Do the results correspond to physical reality?

Testing the method with mock data

Generalize to other “nuisance”: ellipticity, generic profiles, etc

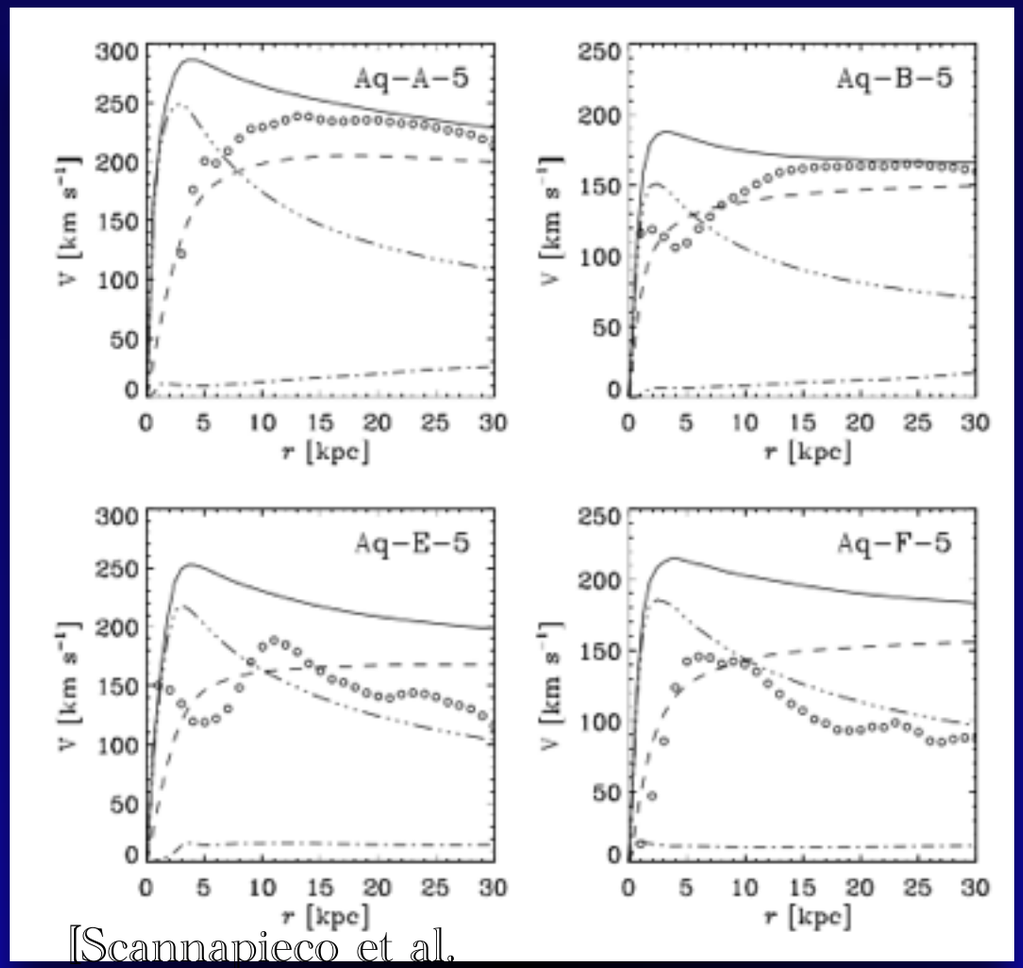
Application of method to theoretical benchmarks

E. Karukes, M. Benito, A. Geringer-Sameth, F. Iocco, R. Trotta

work in progress

Tuning the machinery, II

Calibrate method on simulation
(physical reality known)



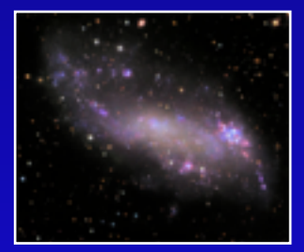
[Scannapieco et al.

Mass

Disc spirals

Rotation supported

Dwarf Spheroidal



Pressure supported

Tuning the machinery, III

What's needed?

- Reconstruction algorithms (in progress)
- "Data" from simulations + mock-ization of sim output (getting them)
- Expertise on ML
- A catalogue of real data (at the very end)

Who's in (so far)

- Francesca Calore
- Fabio Iocco (ICTP-SAIFR, exp: MW dynamics,)
- Ekaterina Karukes (postdoc ICTP, exp: Galaxies and reconstr.)
- Beatriz Tucci (tbc, USP student, keen on ML)
- You?