Inferring the Structure & Orbit of MW Satellites with Semi-analytics

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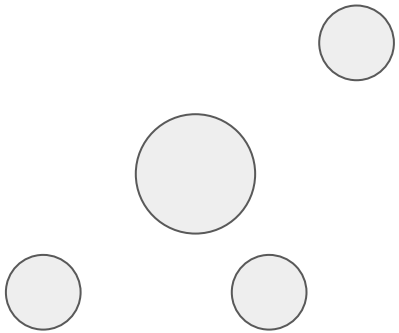
Driving Idea

- Want to understand satellite galaxies, but this is hard
- Many models for the relevant processes
  - Source of systematic uncertainties

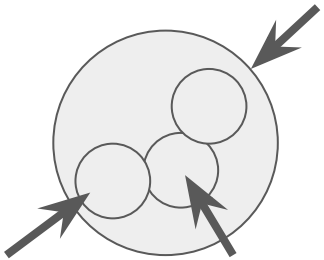
Want to infer properties of MW satellites and how (e.g.) baryons change the story


DSS, via STScI

Galaxy Formation & Evolution: a primer



Galaxy Formation & Evolution: a primer



Galaxy Formation & Evolution: a primer

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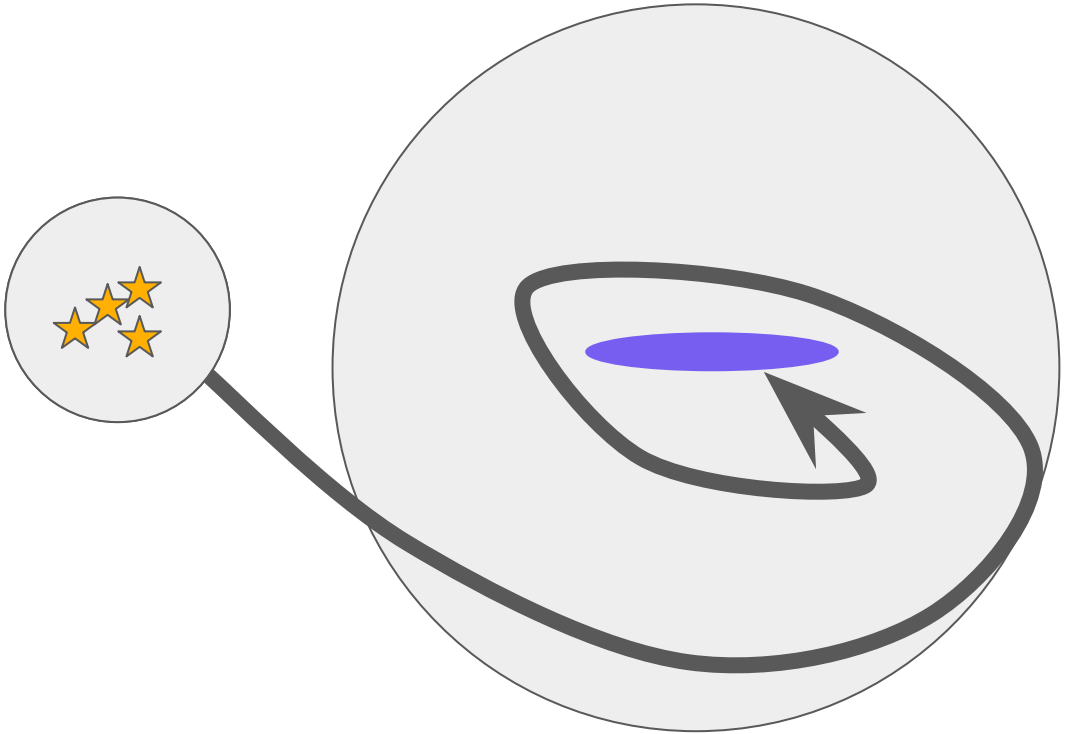

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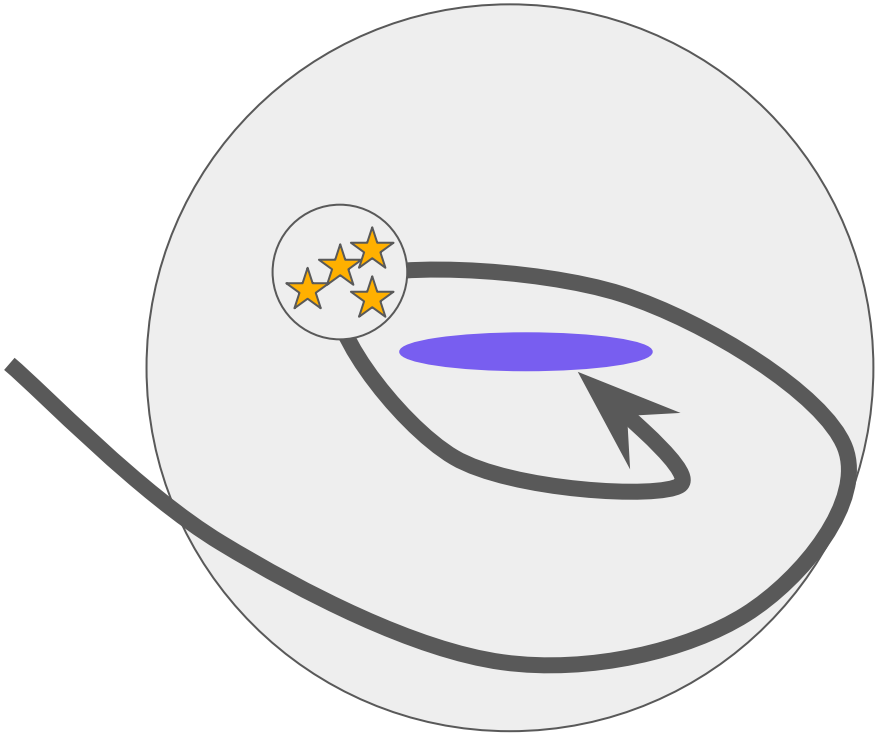

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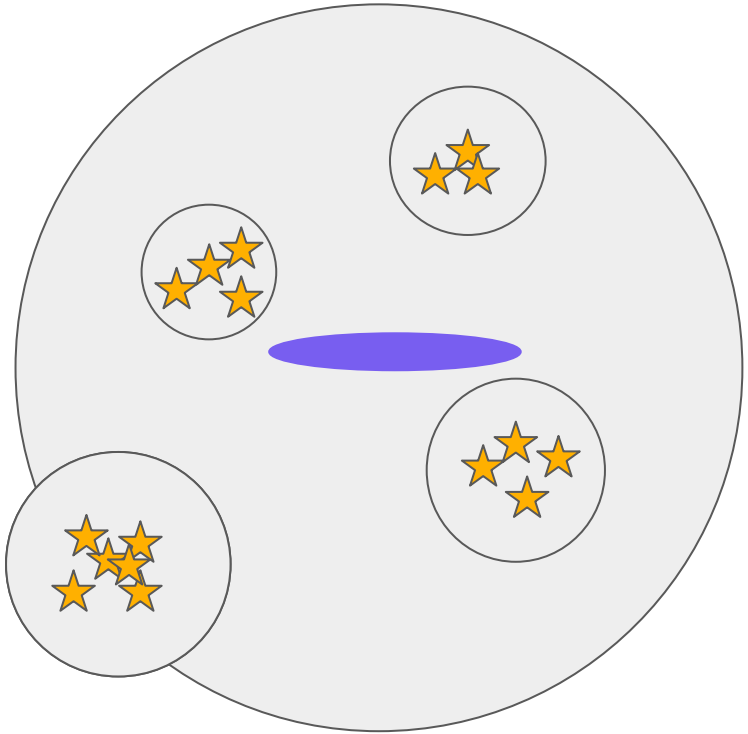
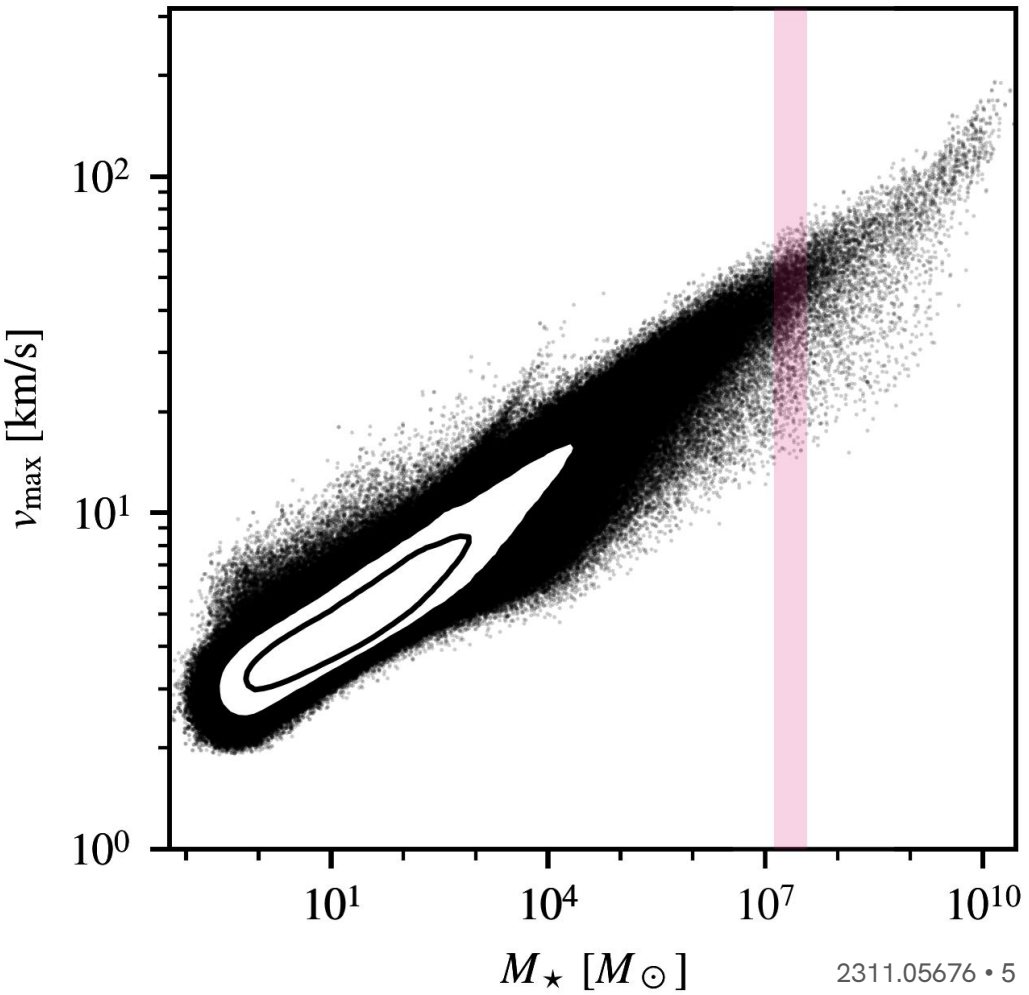


Semi-Analytics: SatGen

- Calibrated initial conditions & orbit integrator
- Efficient to run: not particle-based
  - Captures halo-to-halo variance
- Many knobs to tweak, including feedback
  - Emulate hydro sims to form cores or cusps

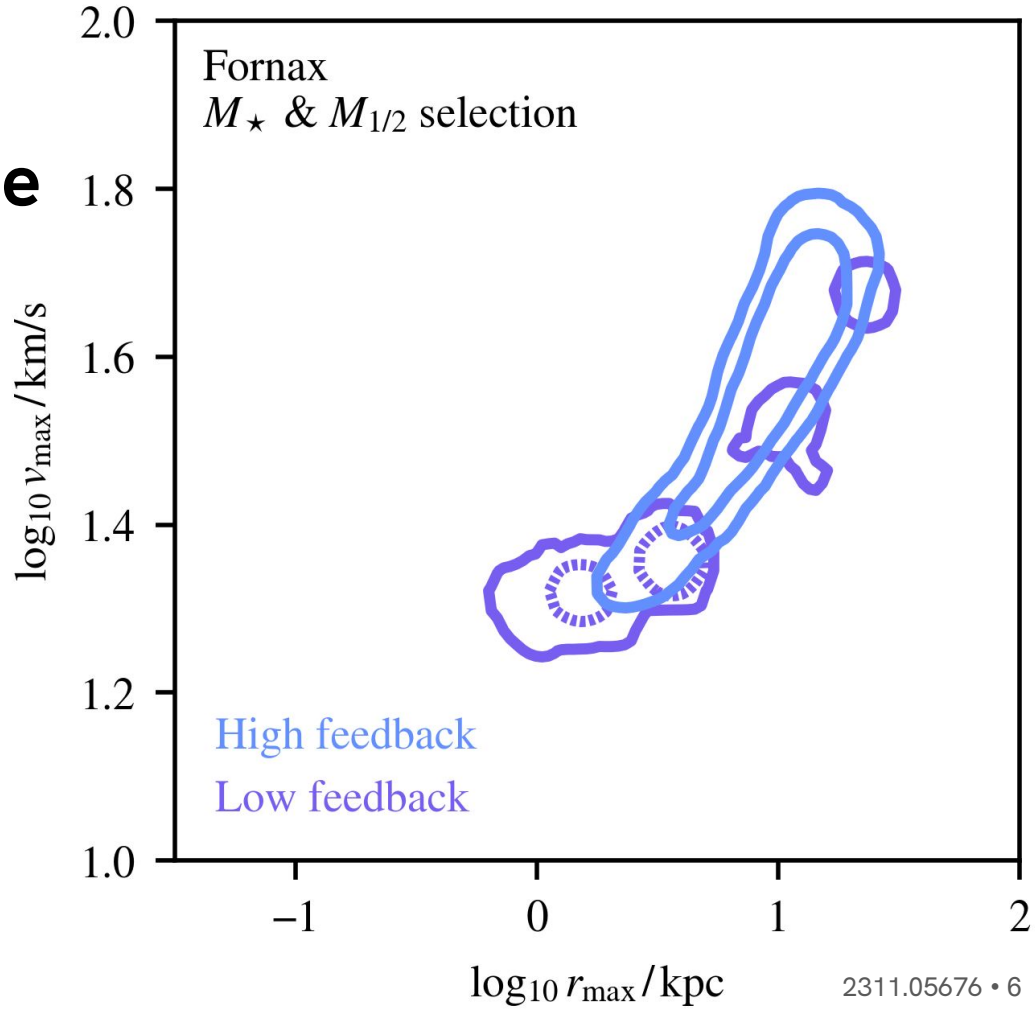
Methods

- Find satellites that match **observed properties**
- **Key assumption:** these galaxies live in realistic halos
- Infer halo properties!



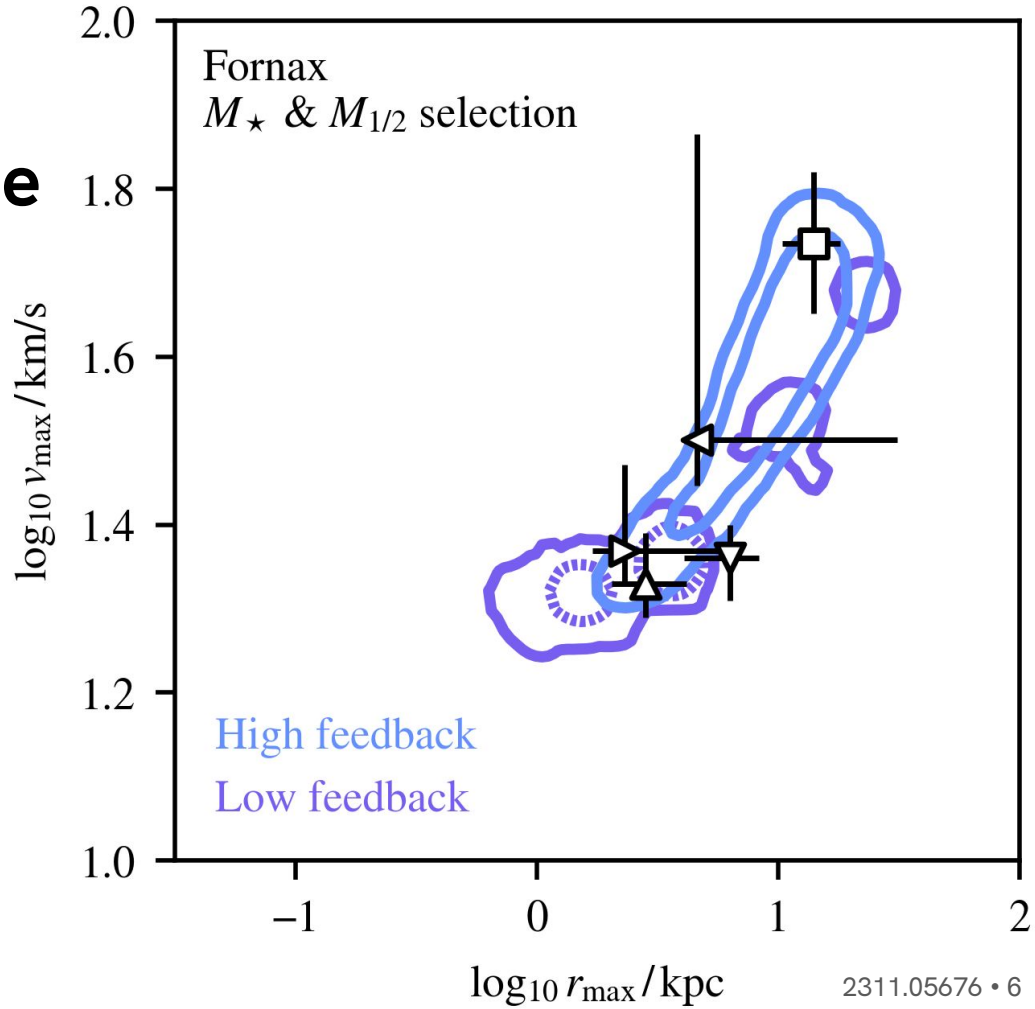
Fornax Profile Inference

- Many stars, but not much inner mass
- **This is hard to do with low feedback**



Fornax Profile Inference

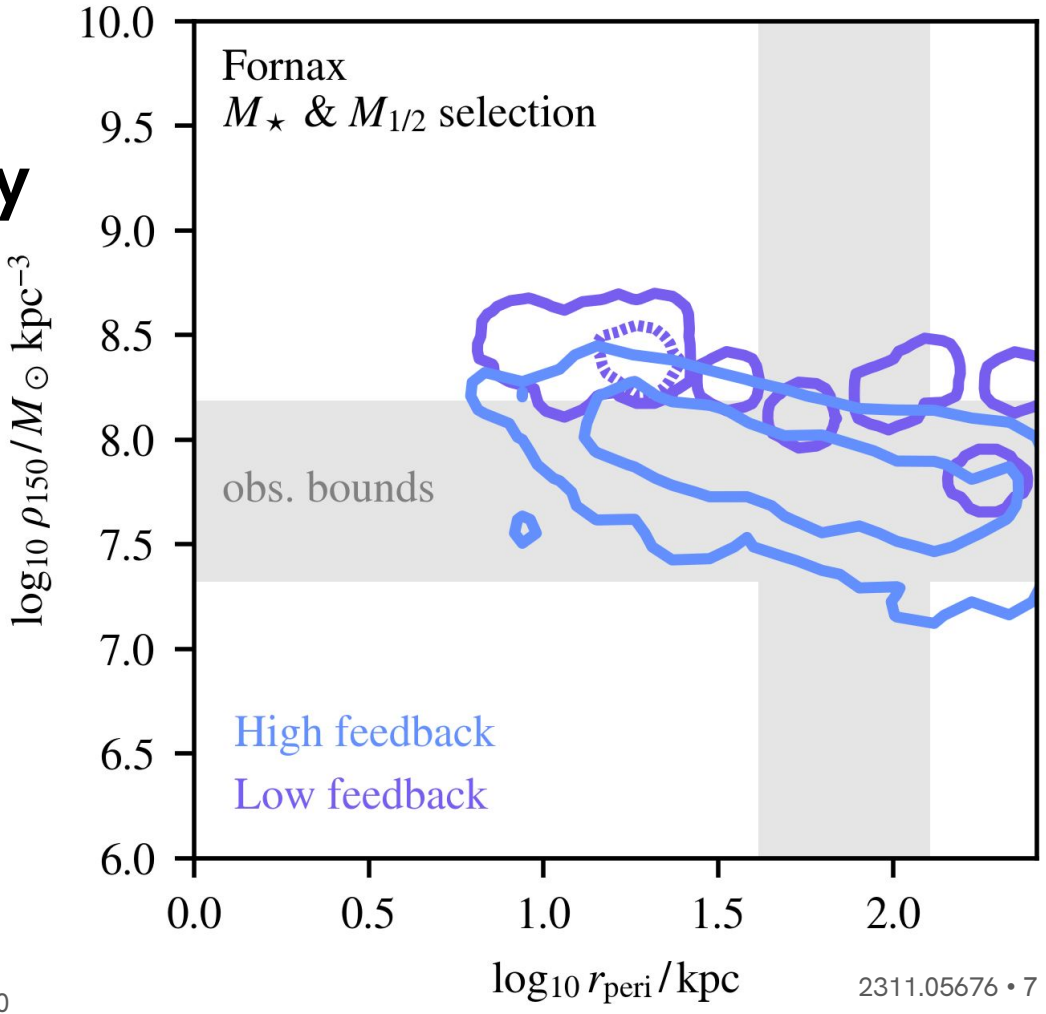
- Many stars, but not much inner mass
- **This is hard to do with low feedback,** but kinematics vary



Errani+18, Kaplinghat+19, Andrade+23

Fornax Central Density

- **Low-feedback** halos are in tension with other observations
- **Feedback models can be constrained with these analyses**

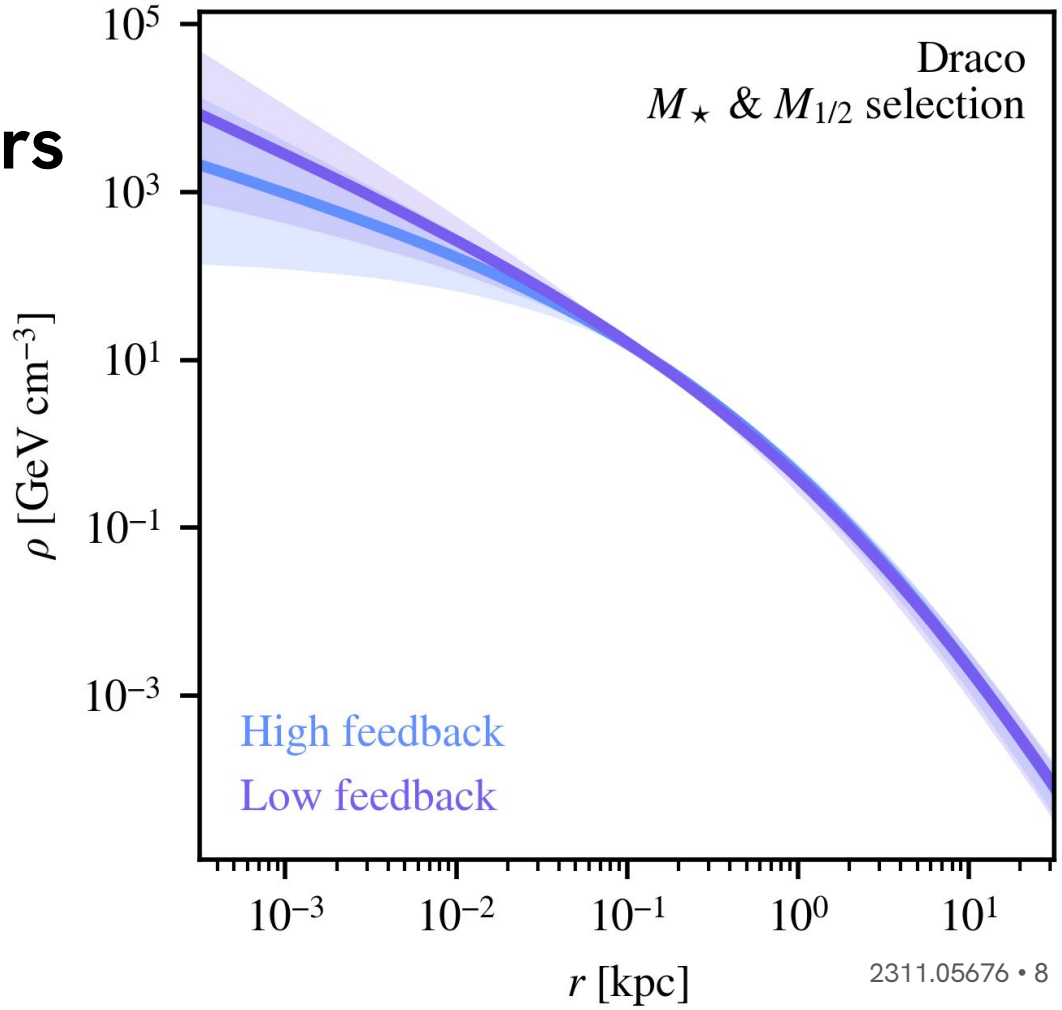


Fritz+18, Battaglia+22, Pace+22; Read+19, Kaplinghat+19, Hayashi+20

Ongoing work: *J* factors

M. Kaplinghat, M. Lisanti,
Y. Park, K. Raman, B. Safdi

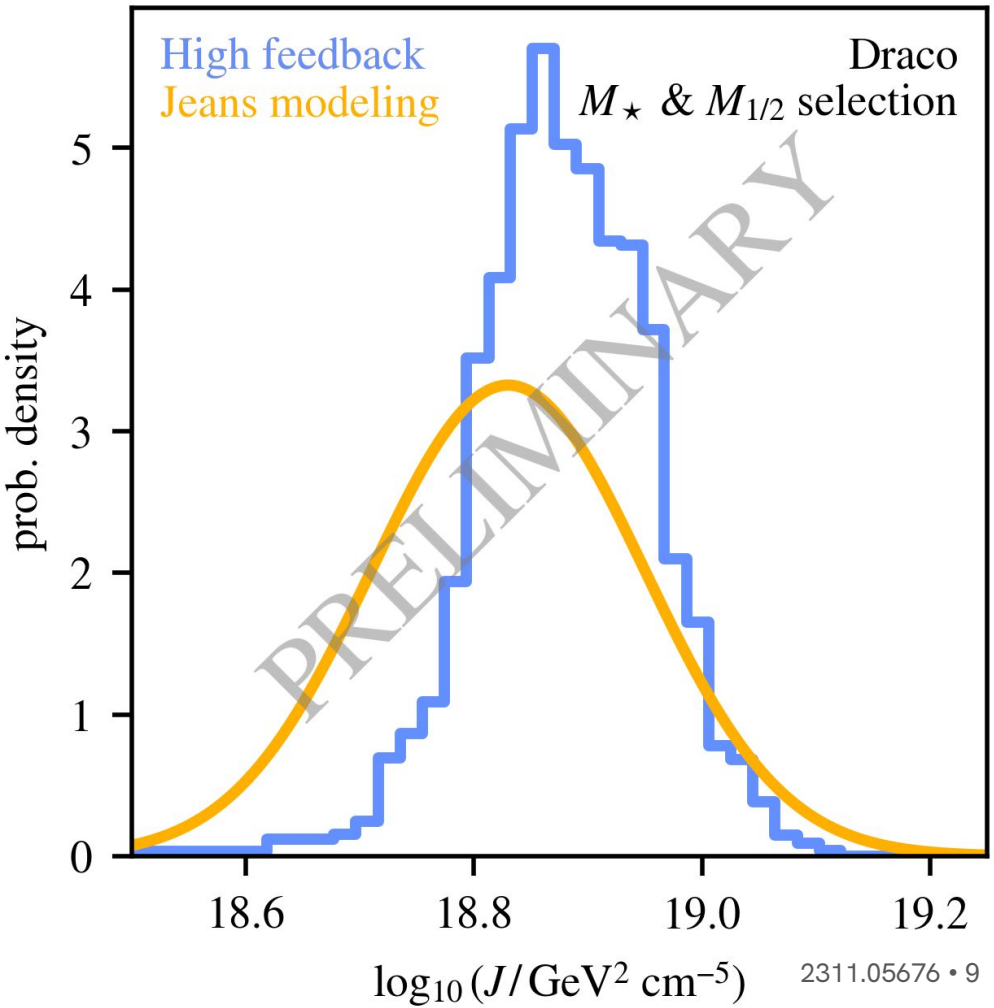
- Infer DM density



Ongoing work: *J* factors

M. Kaplinghat, M. Lisanti,
Y. Park, K. Raman, B. Safdi

- Infer DM density
- *J* factor can be conditioned on, e.g., orbital properties or MW host properties



Pace & Strigari 18

Thank you!

2311.05676

Benefits of this framework:

- Easy to get large statistics
- Calibrated uncertainties, vary over systematics
- Easily extensible (see my GitHub, link in paper)

Backup: Methods

$$f(v_{\max}) = \int f_{\mathrm{model}}(v_{\max} \mid \log M_\star)\, f(\log M_\star)\, \mathrm{d}\log M_\star$$

- Assumes that **the SatGen model** accurately recovers the conditional probability distribution term
- Choose the region of M_* space via **observation**