

# The Radial Acceleration Relation within the $\Lambda$ CDM Model

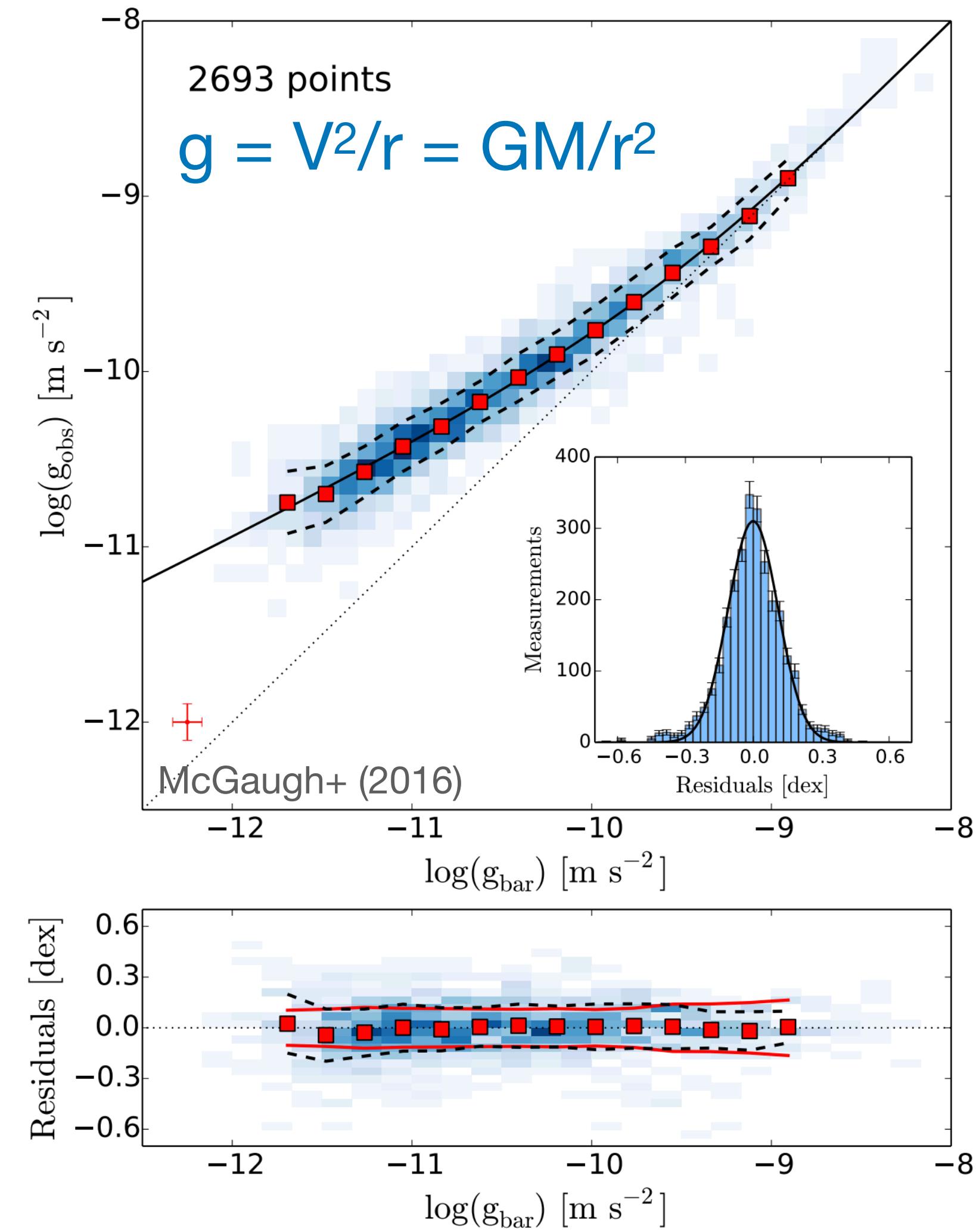
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UC Irvine

# The Radial Acceleration Relation (RAR)

Observed acceleration  
determined from rotation curves



Some have pointed to this as potential  
evidence in support of an alternative  
law of gravity (MOND)



Acceleration due to baryons  
within the same radius

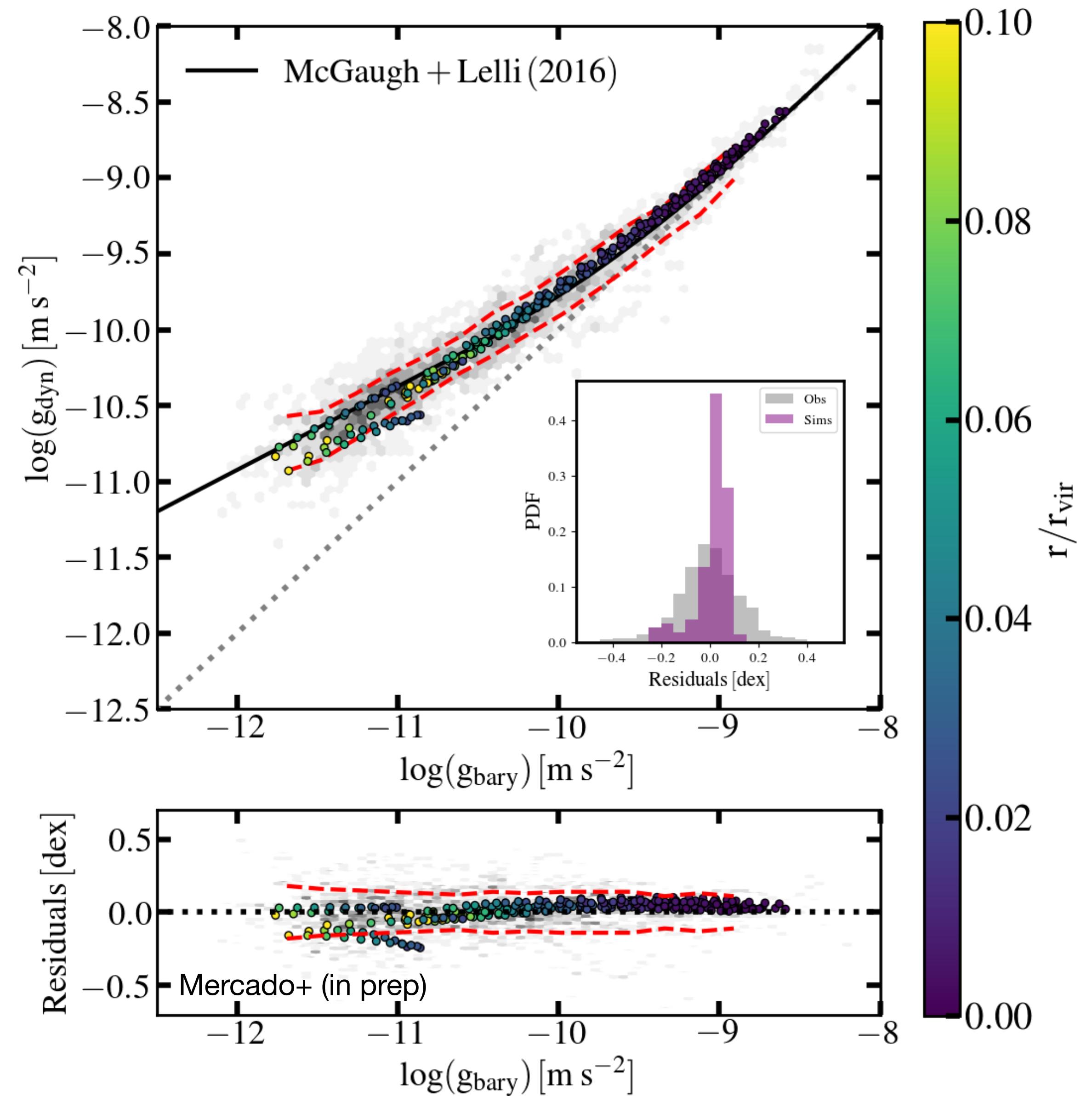




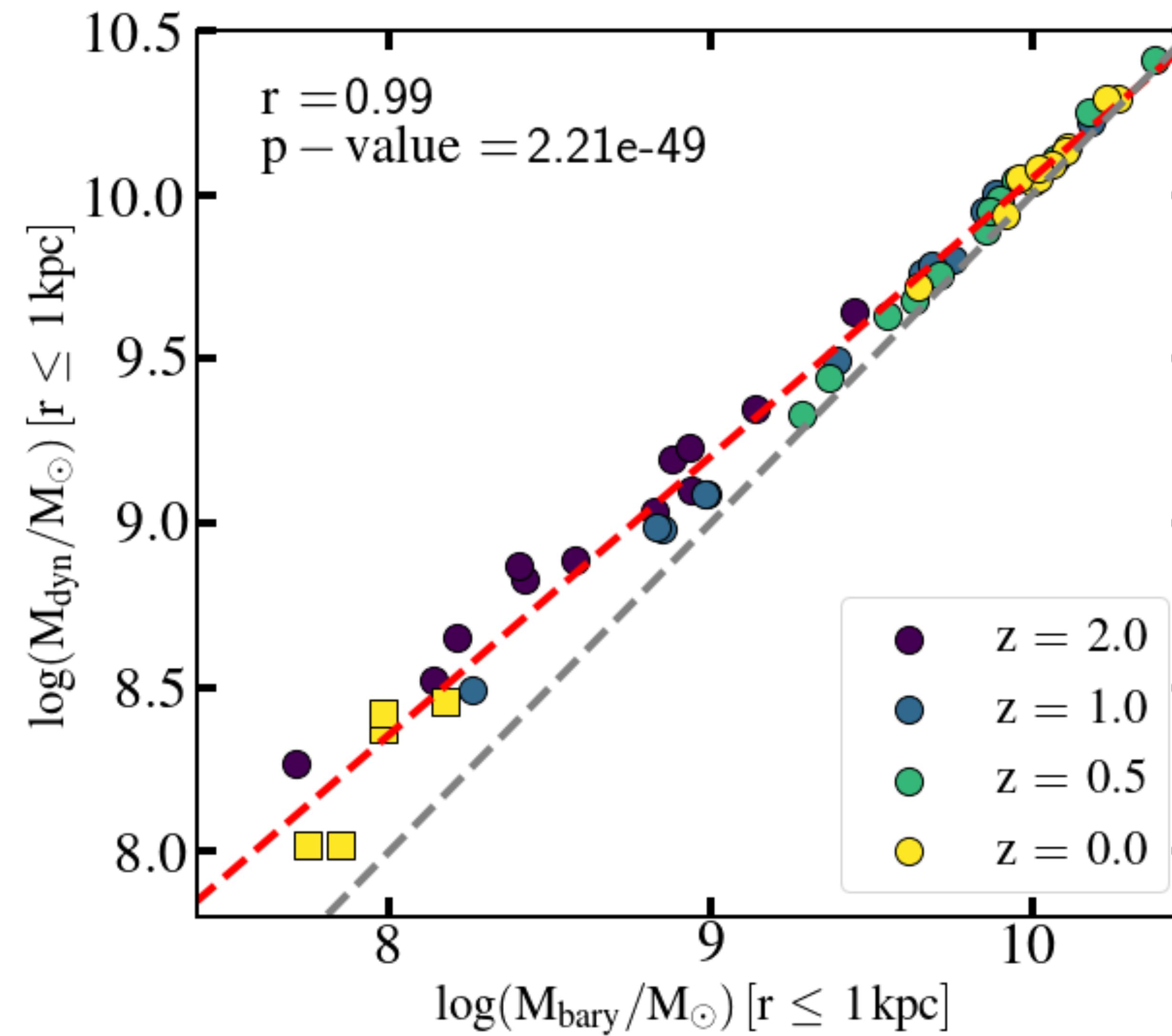
- We use a sample of FIRE-2 galaxies
  - 12 m12s (Latte + Elvis) and 5 m11s at  $z = 0$
  - $M_{\text{halo}} = 10^{10.8} - 10^{12.2} M_{\odot}$
  - $M_{\text{star}} = 10^{8.8} - 10^{11.1} M_{\odot}$

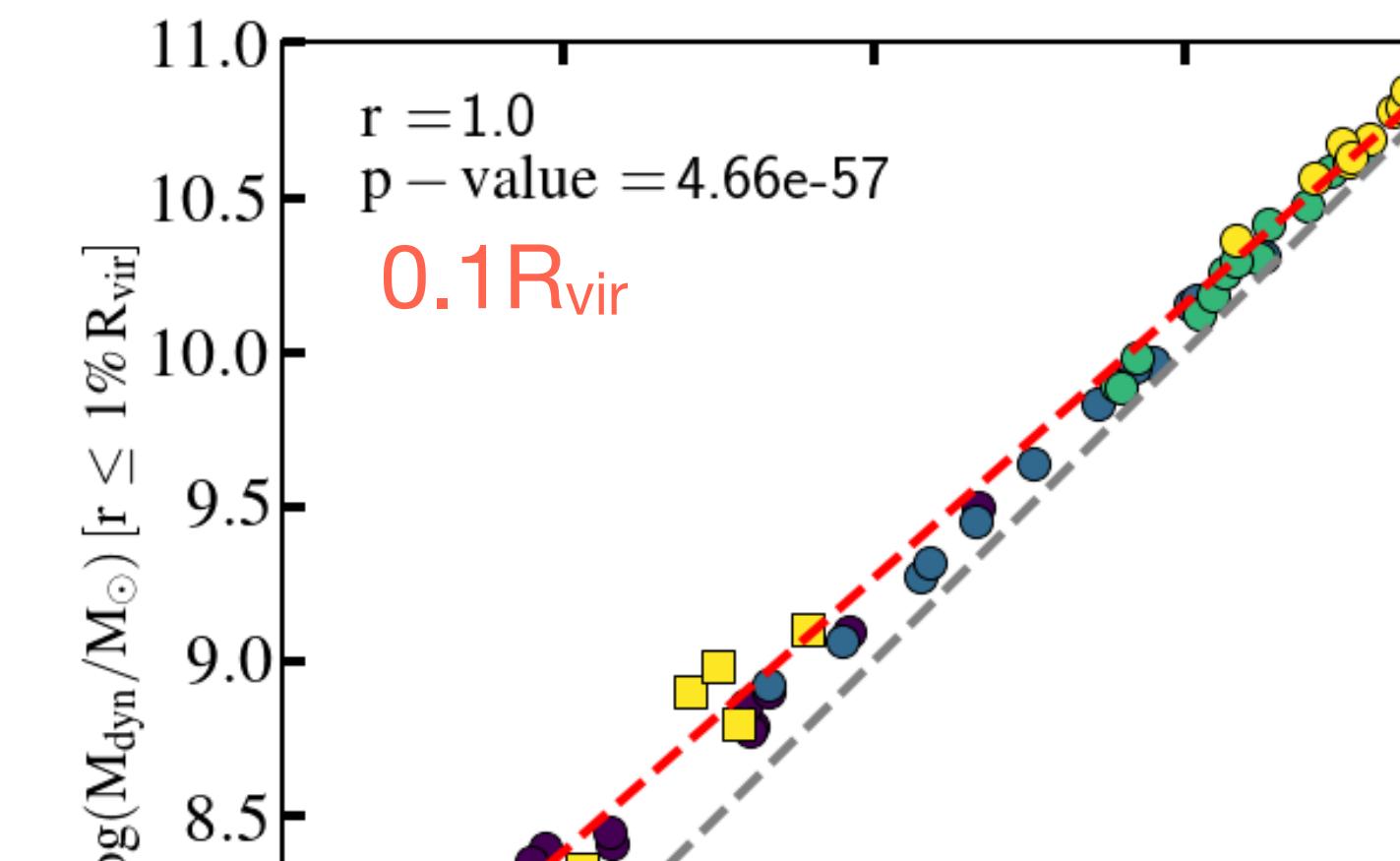
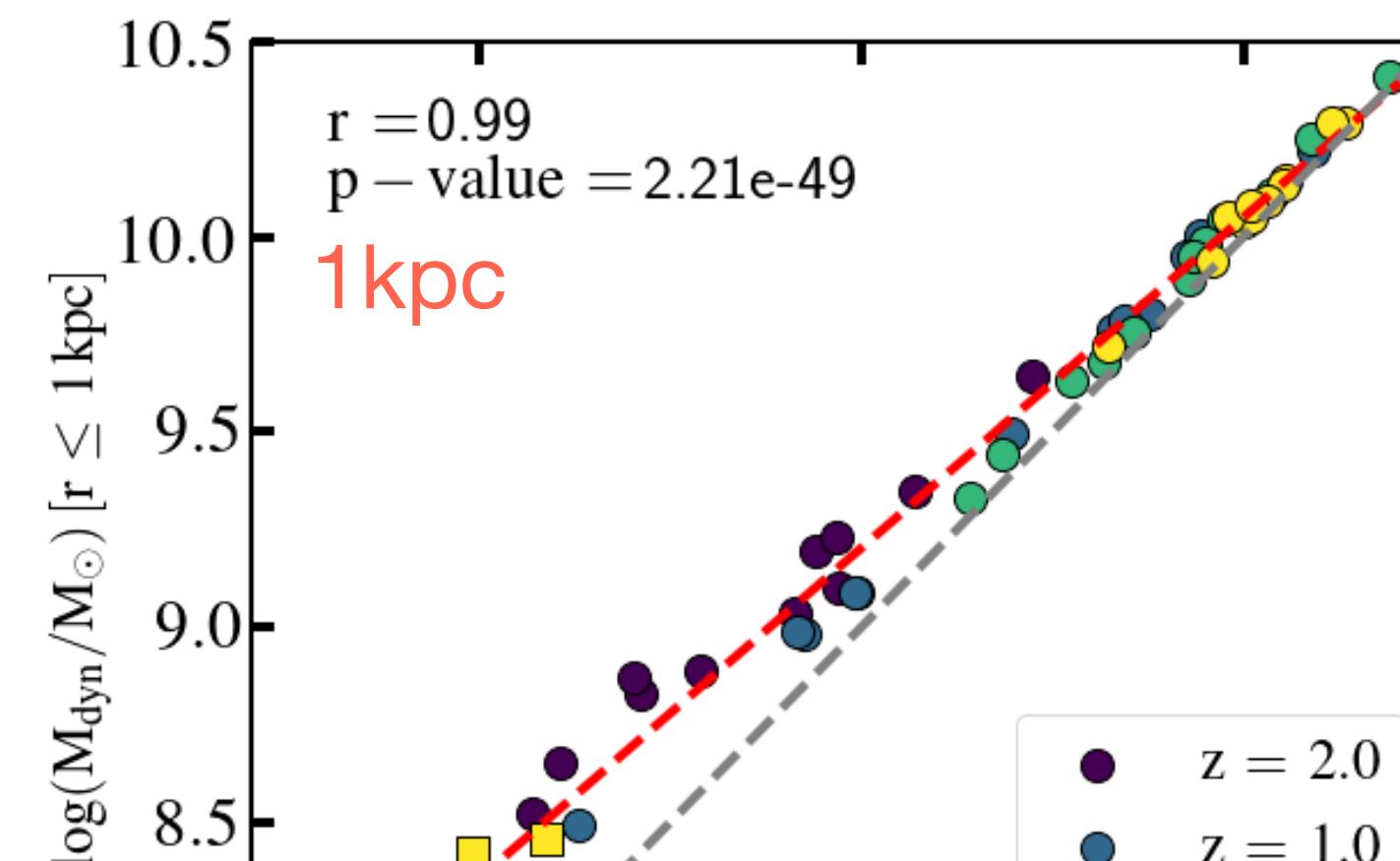


# RAR in the FIRE sims



# Why does this work? Very Tight Mass vs. Mass Relationship

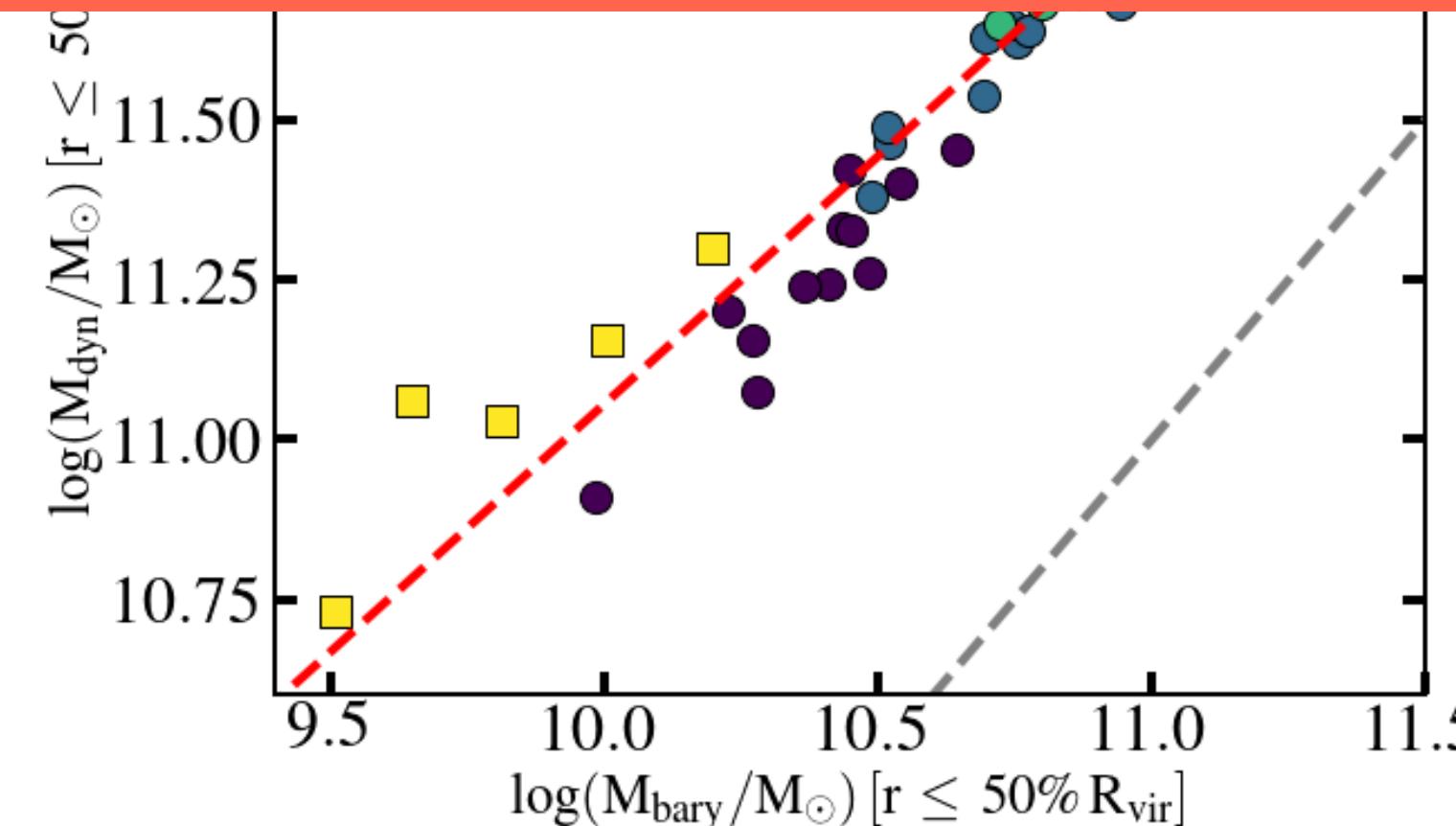
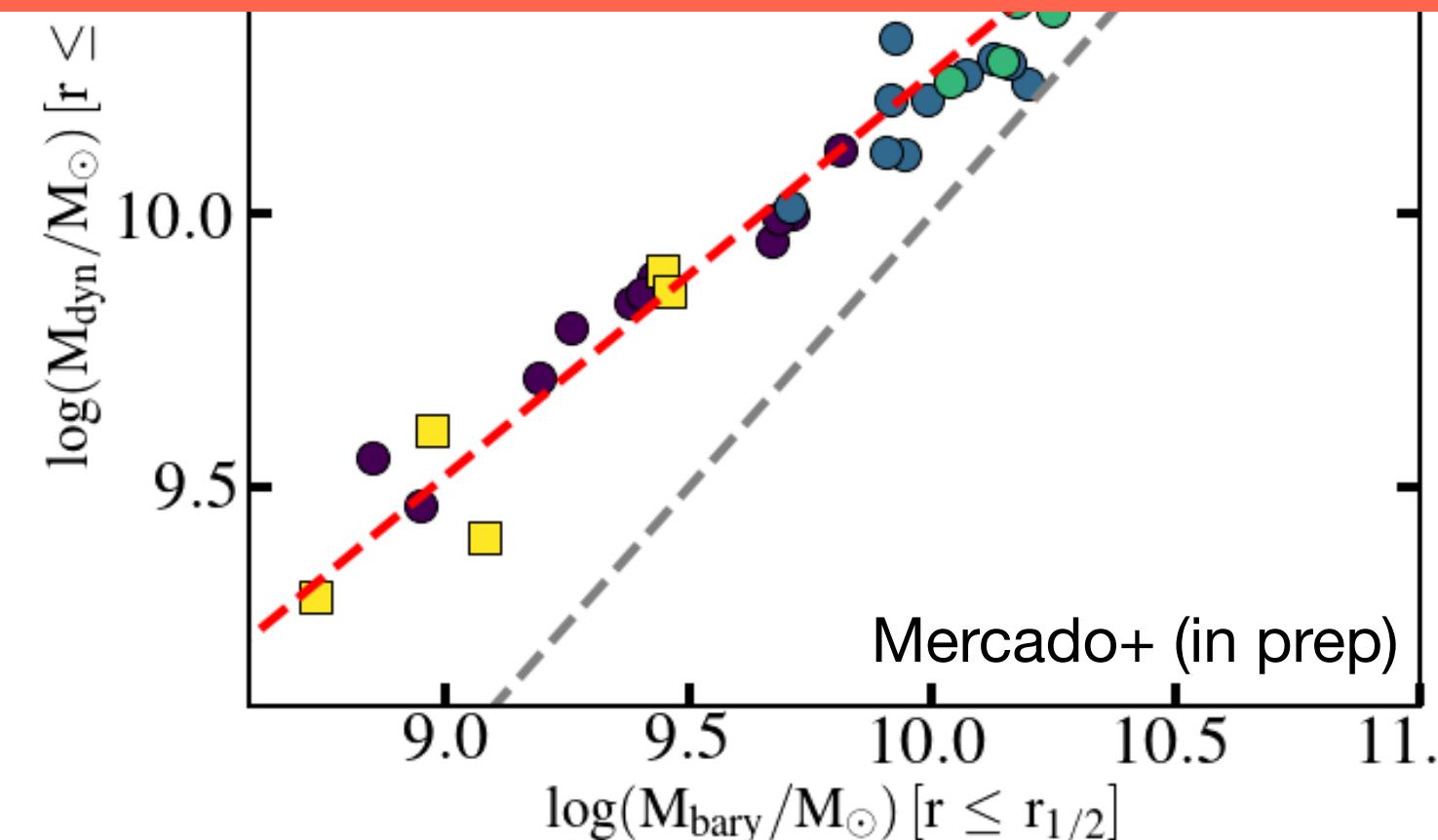




$$M_{\text{dyn}}(r) \propto M_{\text{bary}}(r)$$



$$\frac{GM_{\text{dyn}}(r)}{r^2} \propto \frac{GM_{\text{bary}}(r)}{r^2}$$

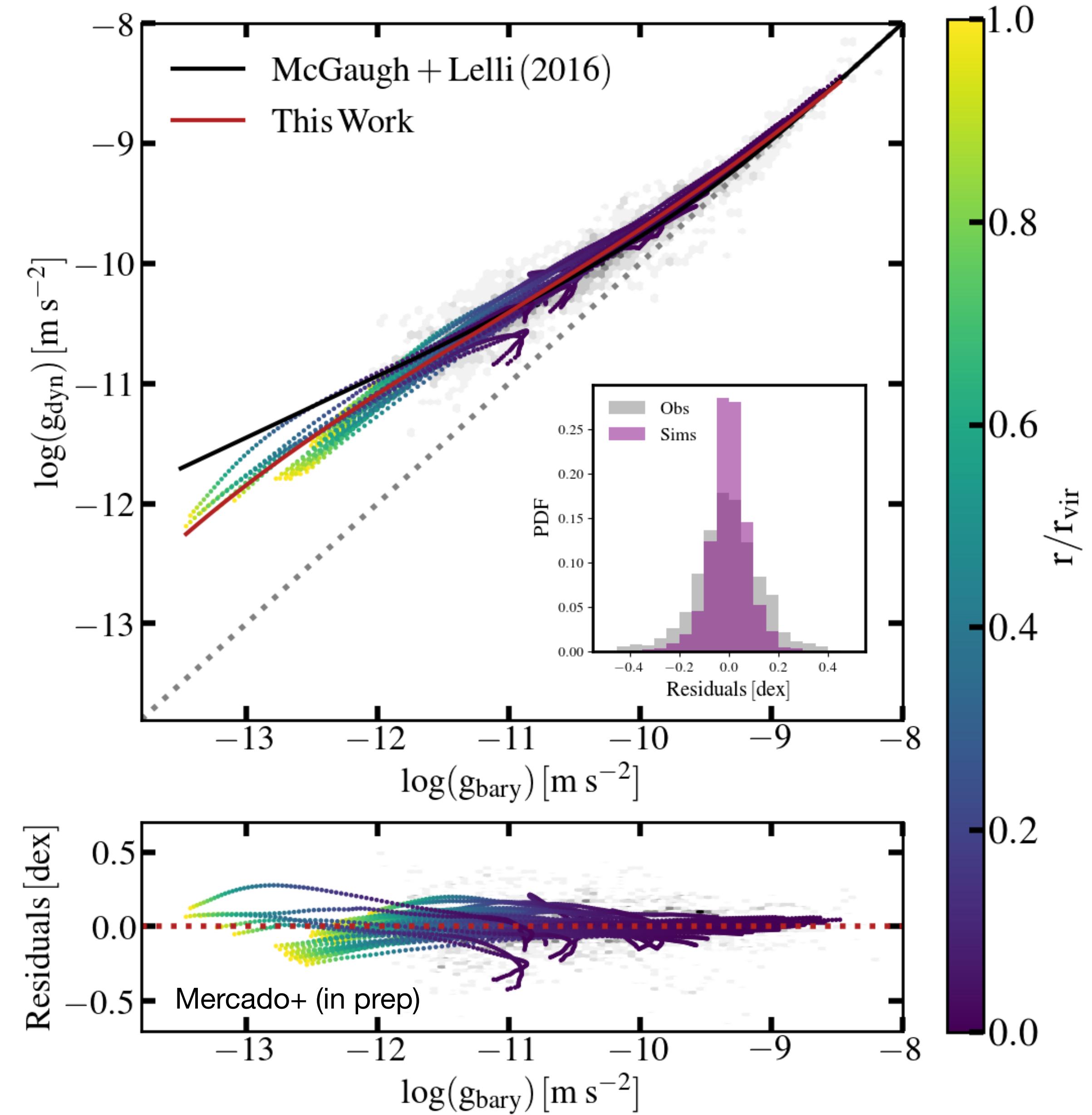




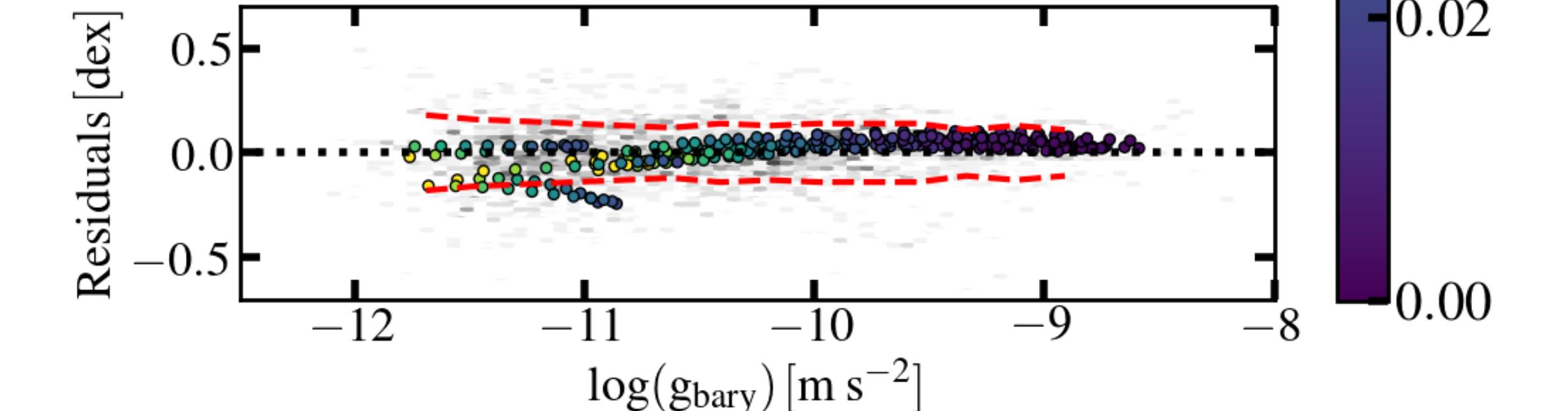
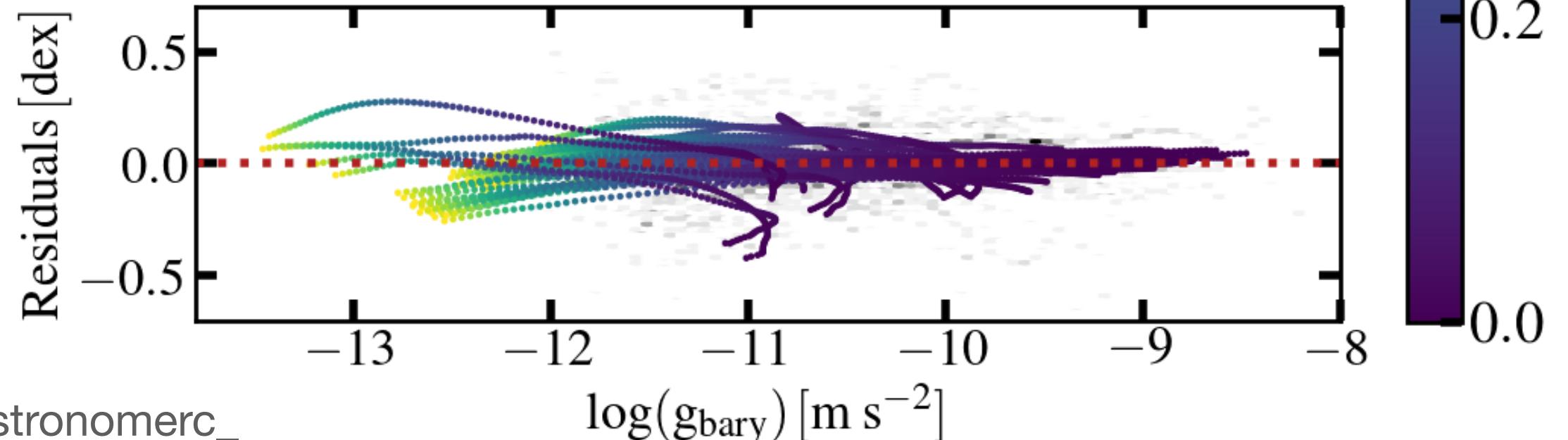
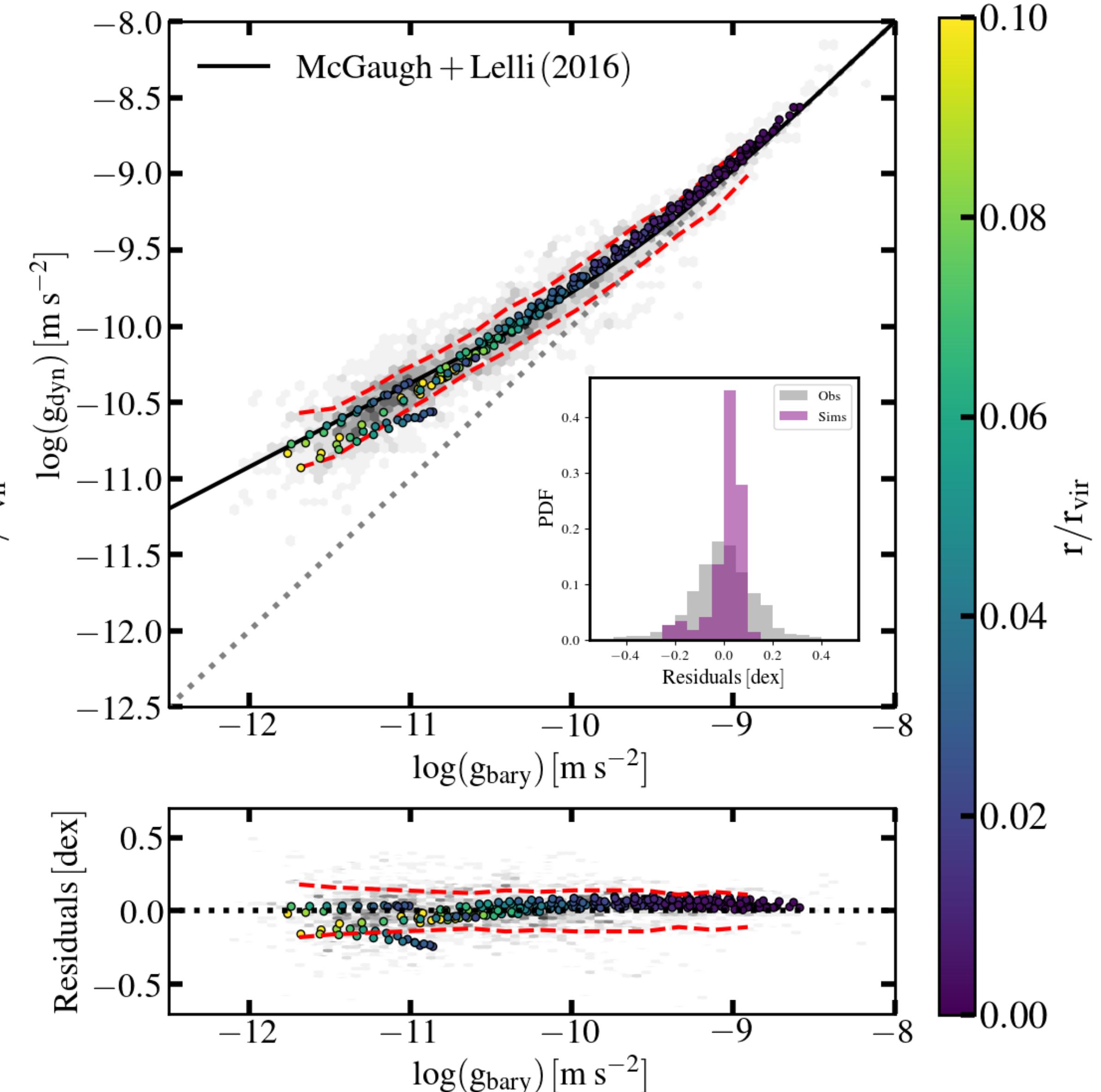
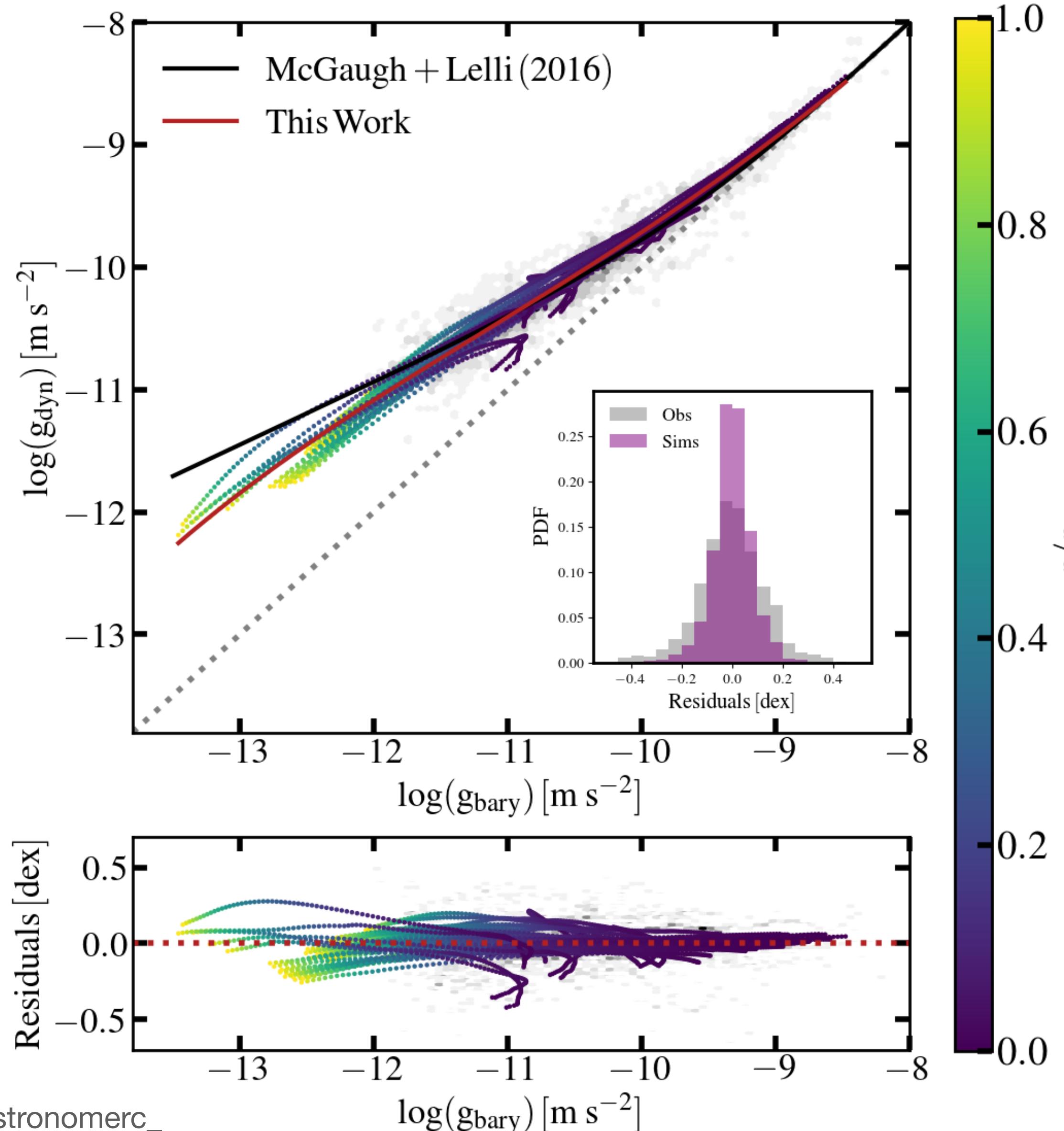
- We use a sample of FIRE-2 galaxies
  - 12 m12s (Latte + Elvis) and 5 m11s at  $z = 0$
  - Treat m12 progenitors at  $z = 0.5, 1, 2$  as separate galaxies
  - Sample of  $N = 53$  simulated galaxies



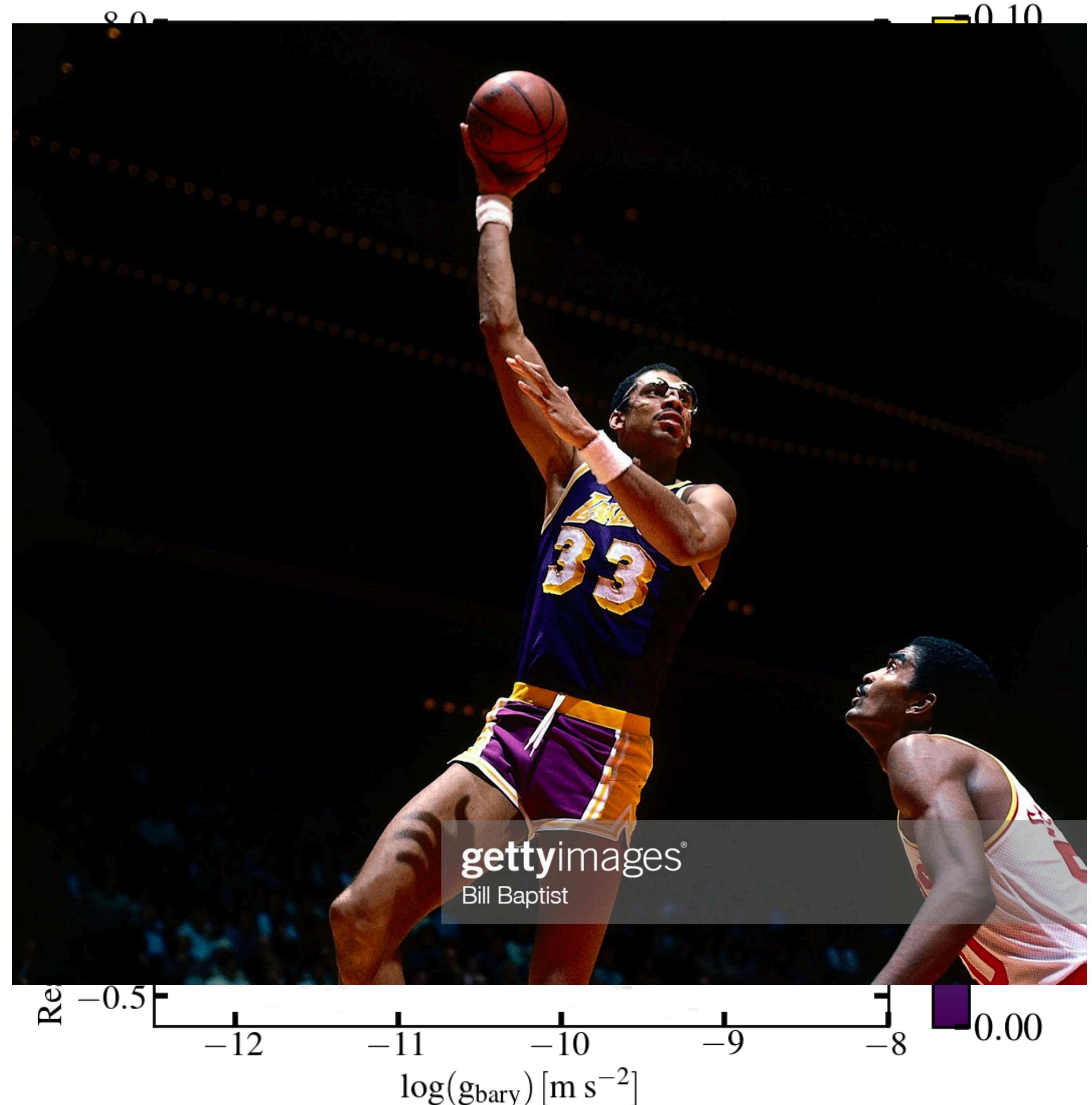
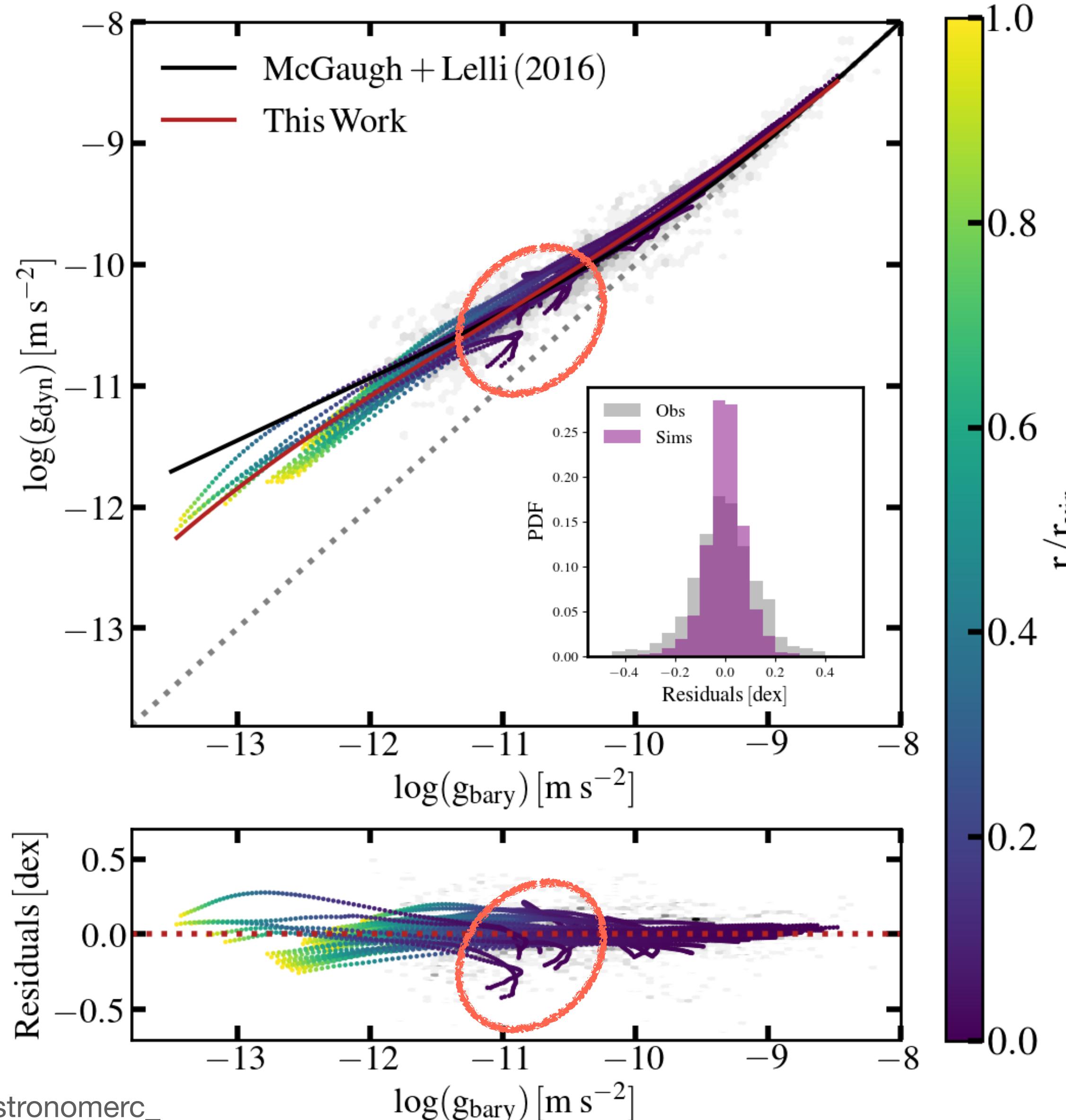
# RAR in the FIRE sims



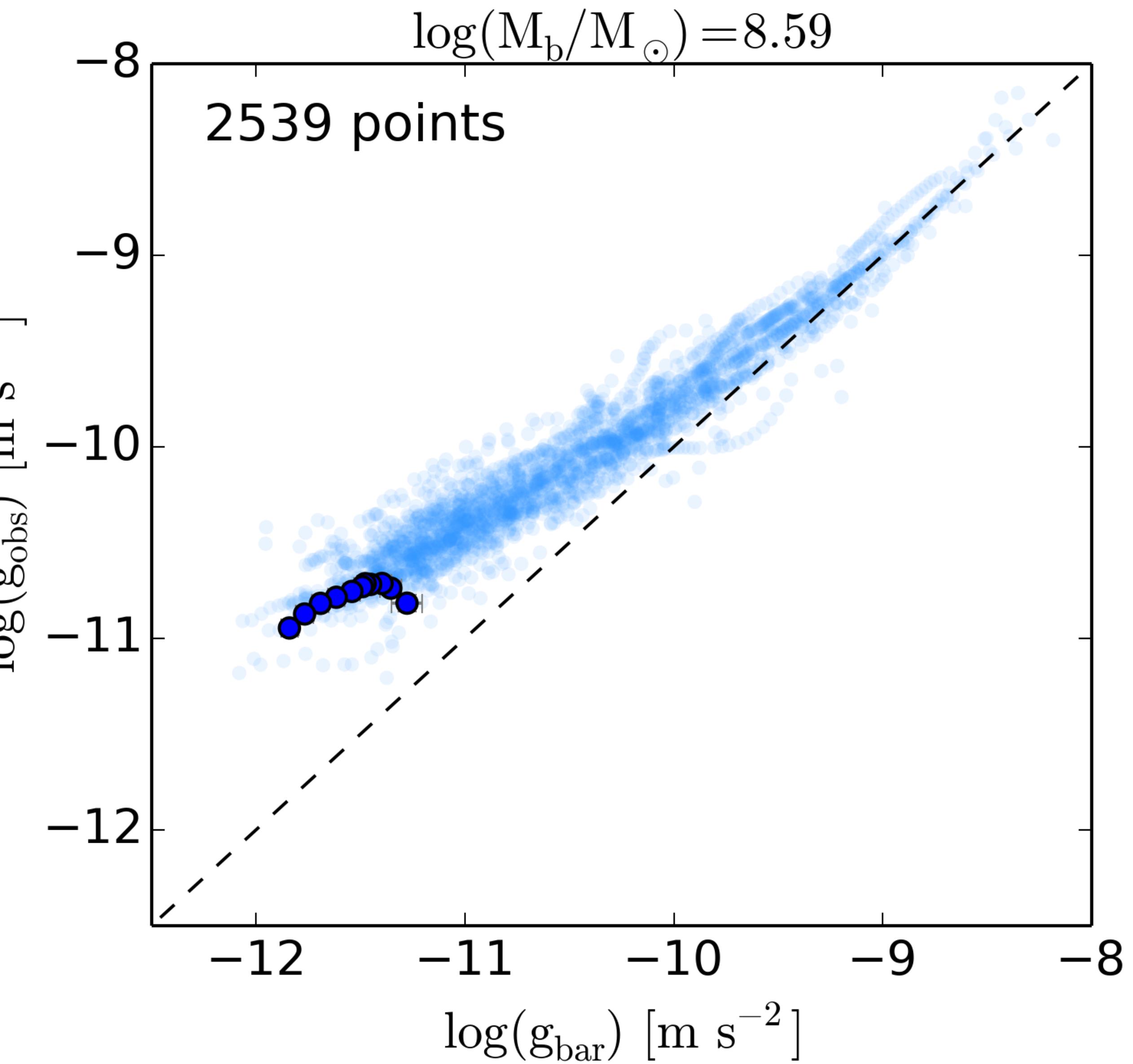
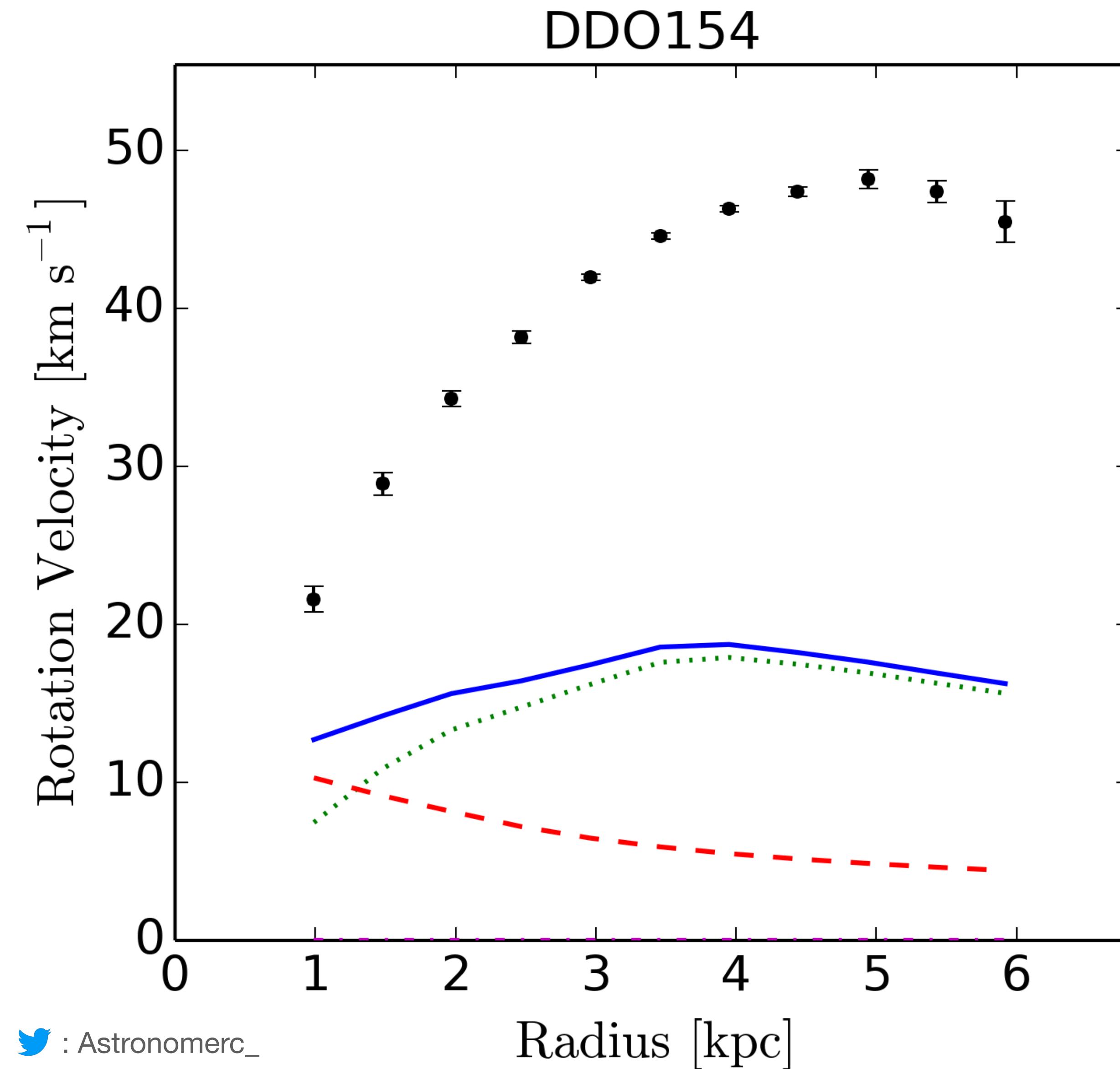
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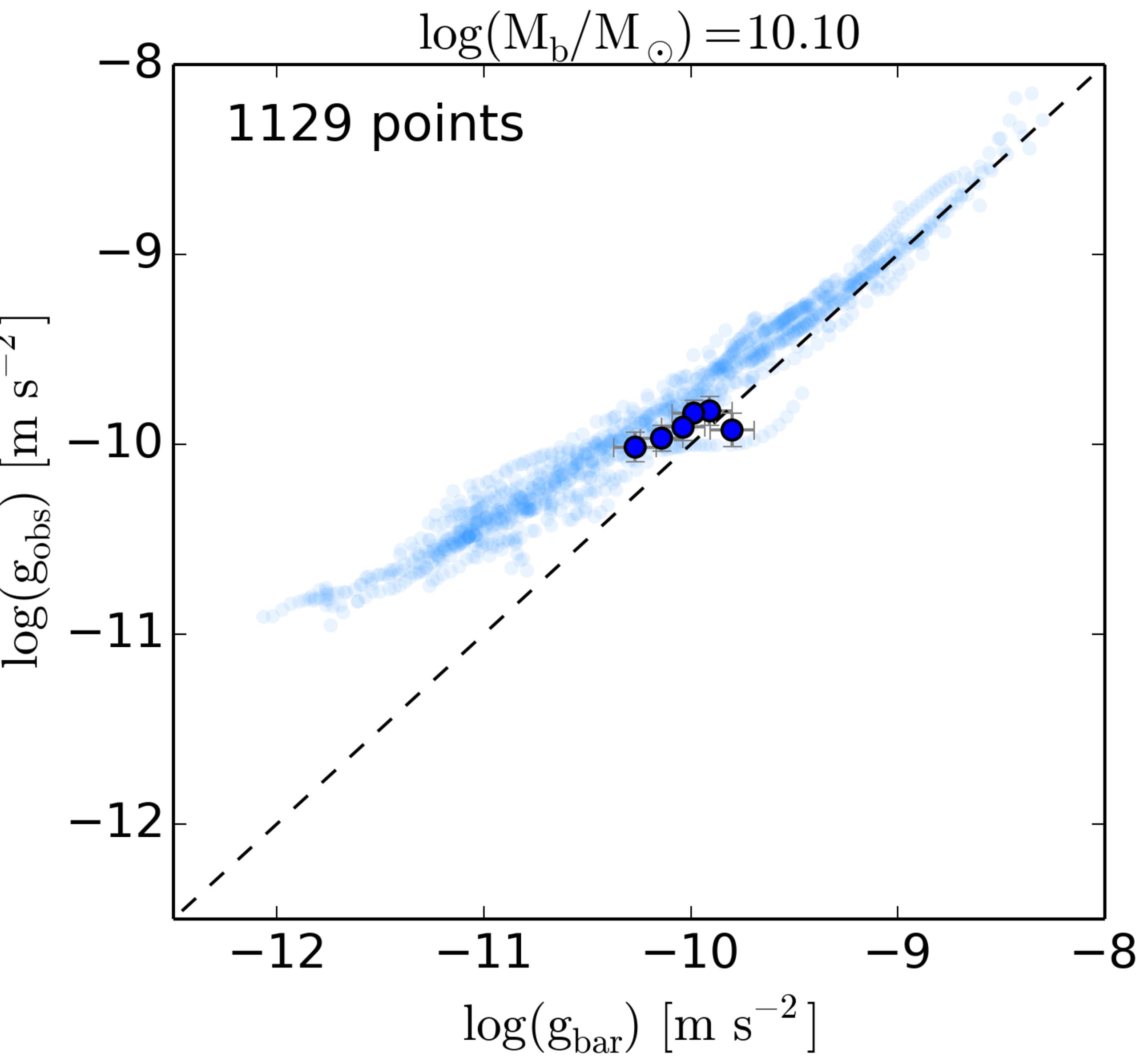
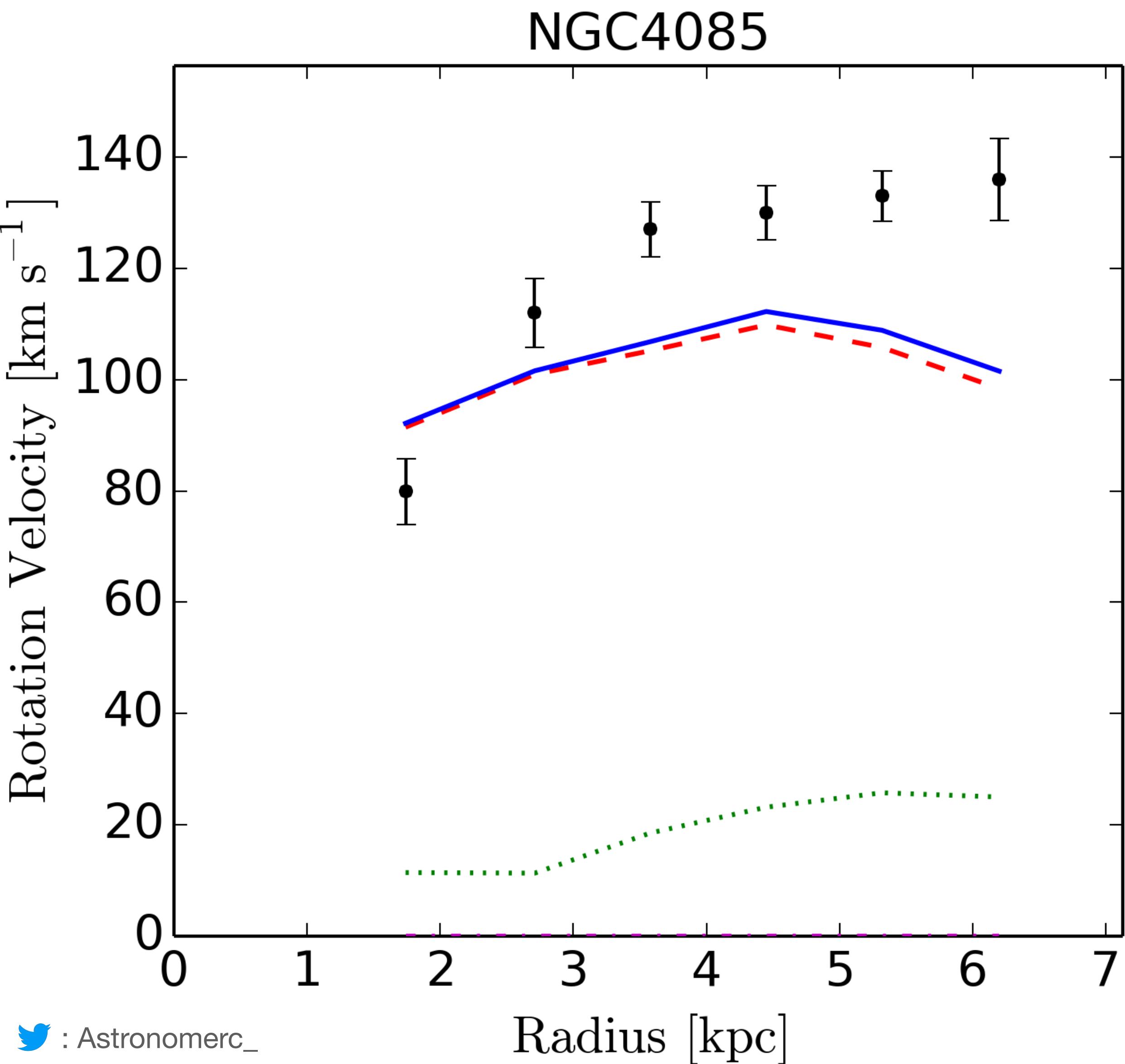
# What's up with those hooks?!



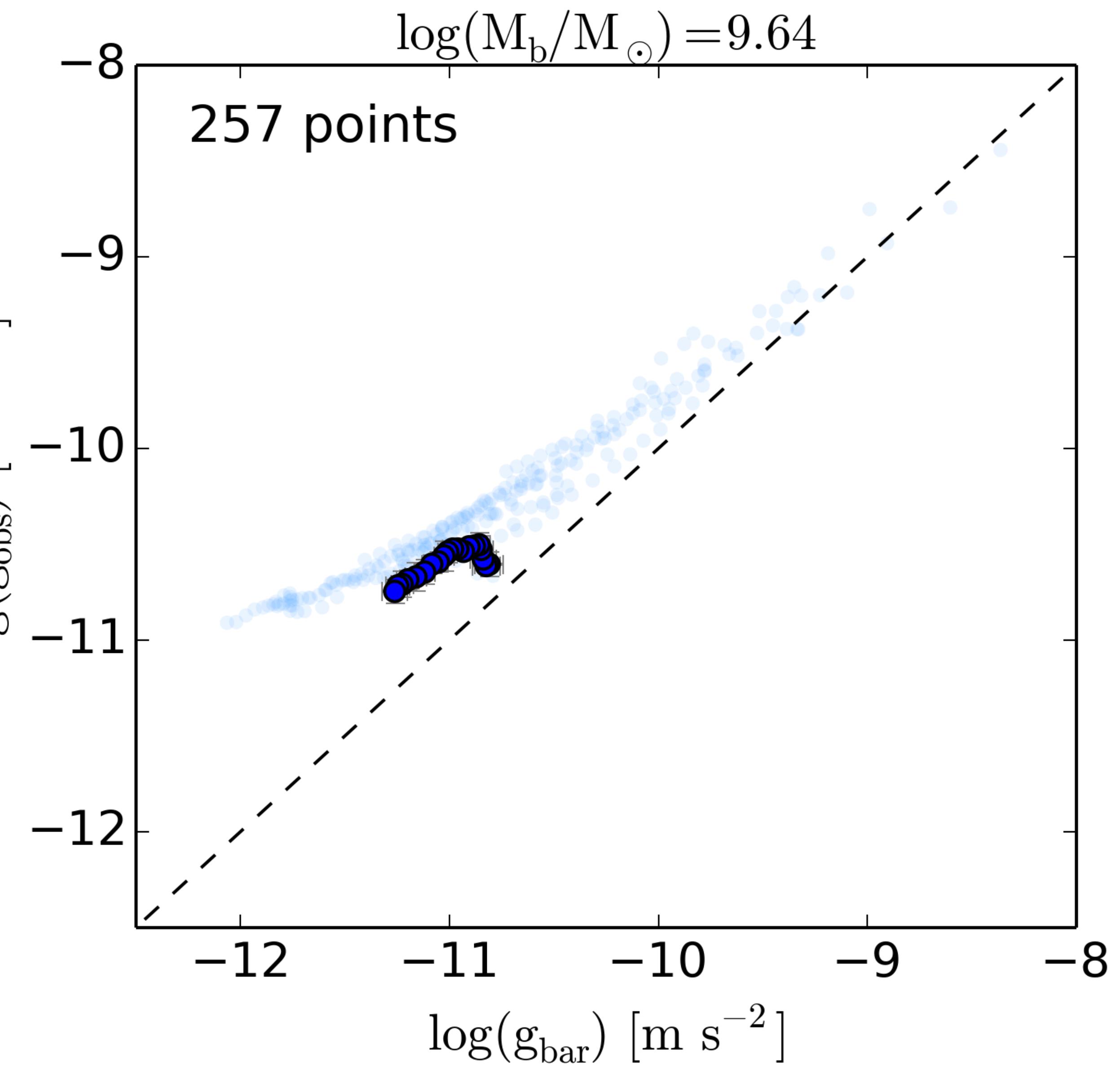
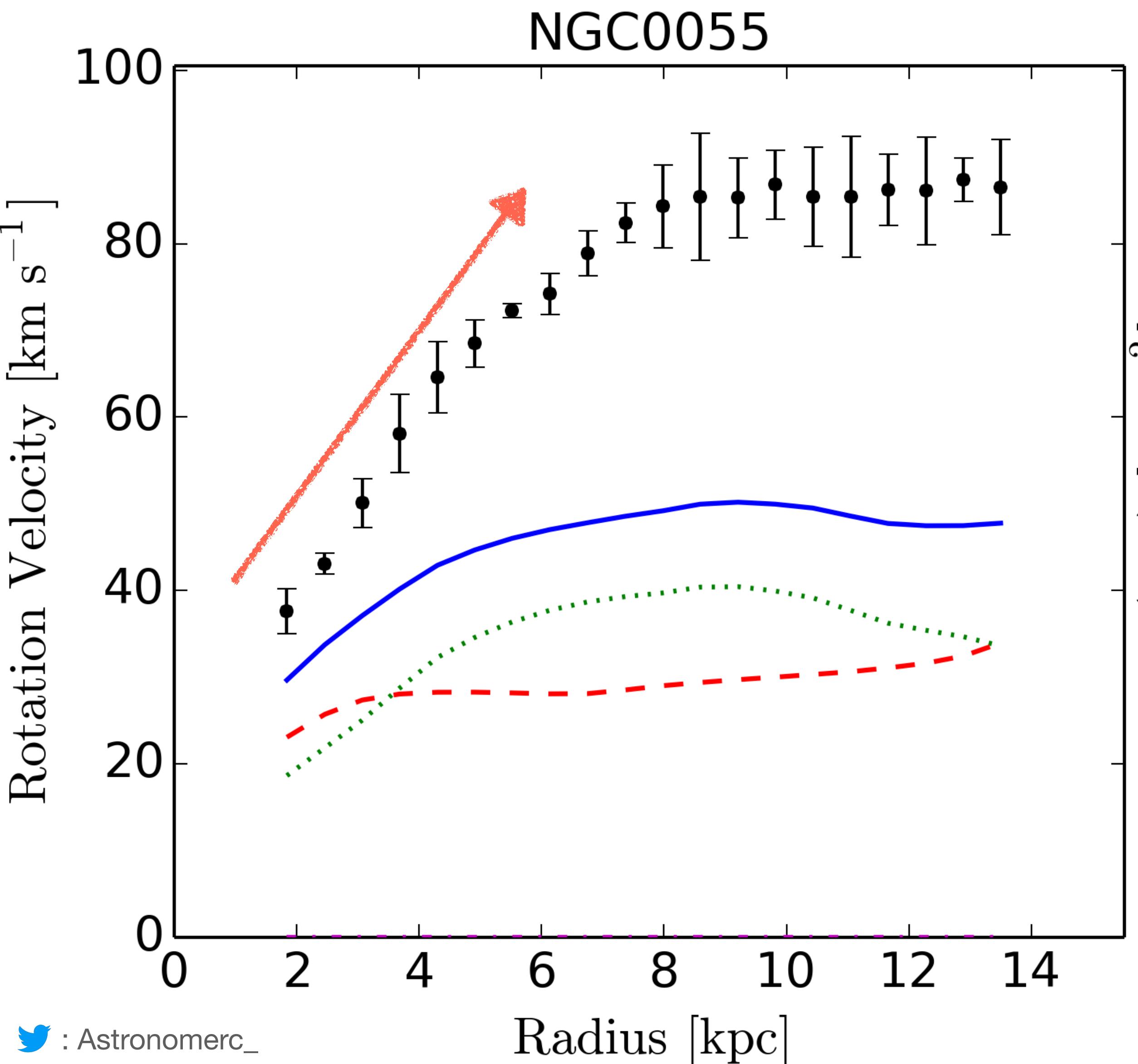
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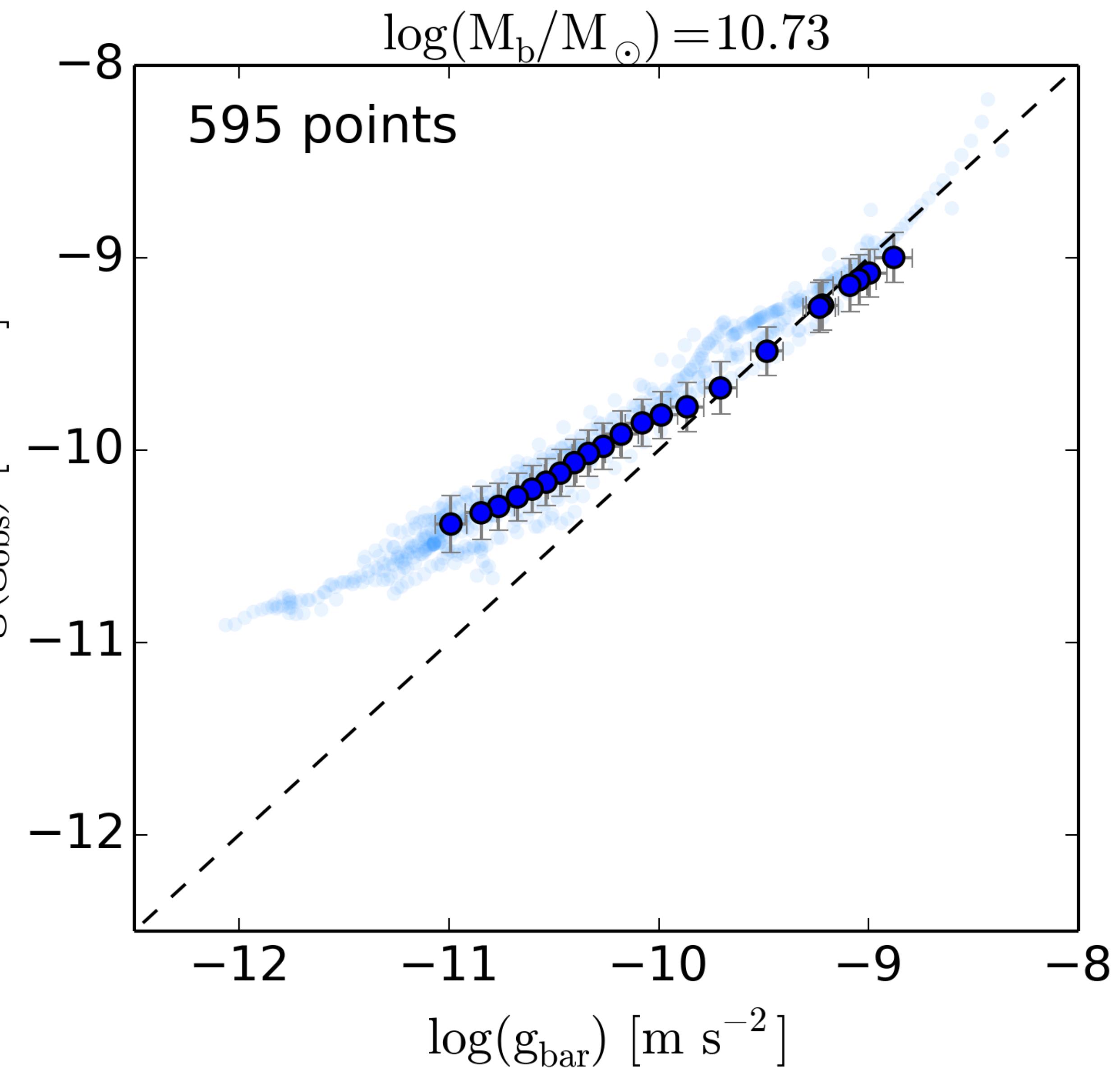
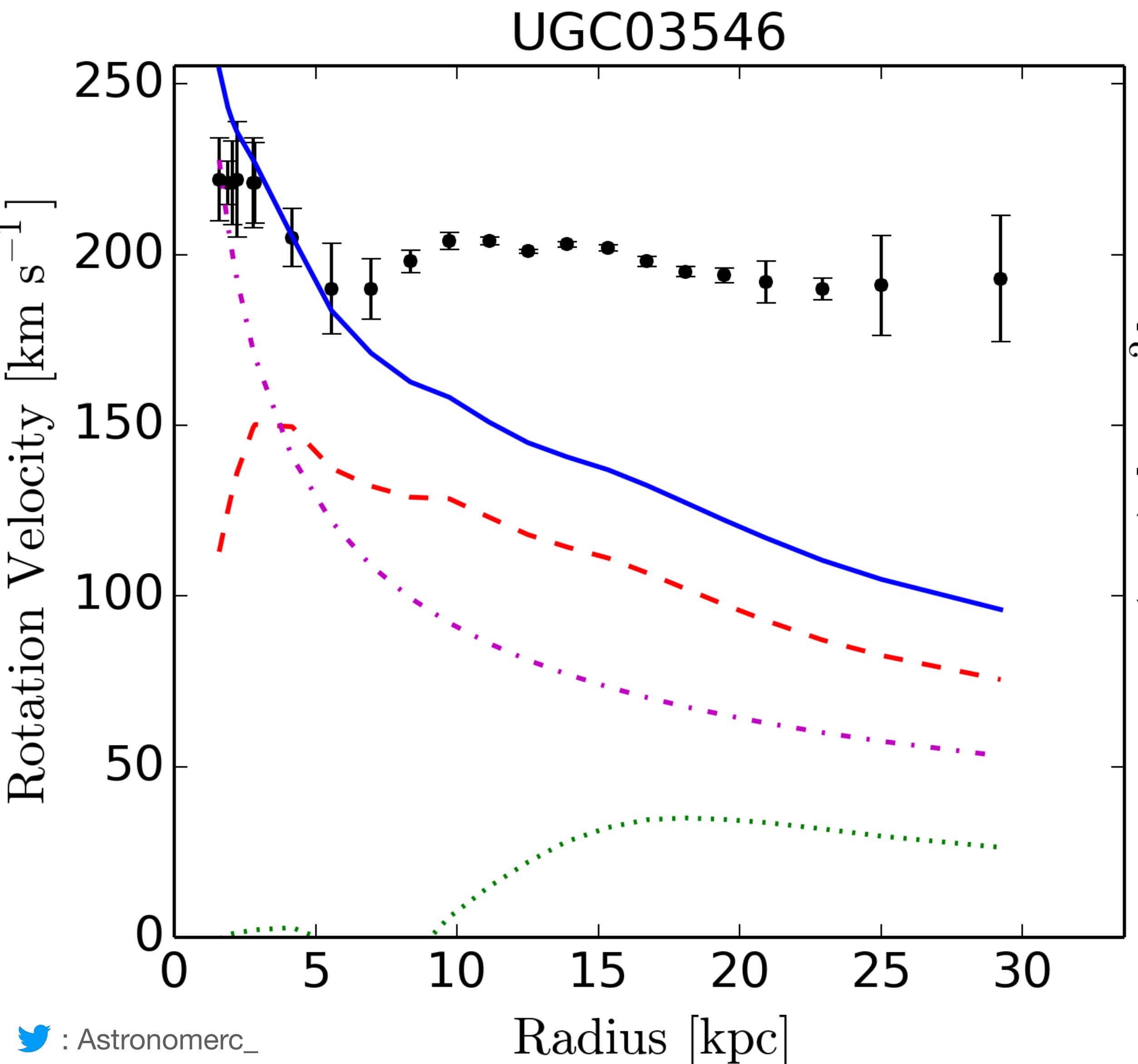
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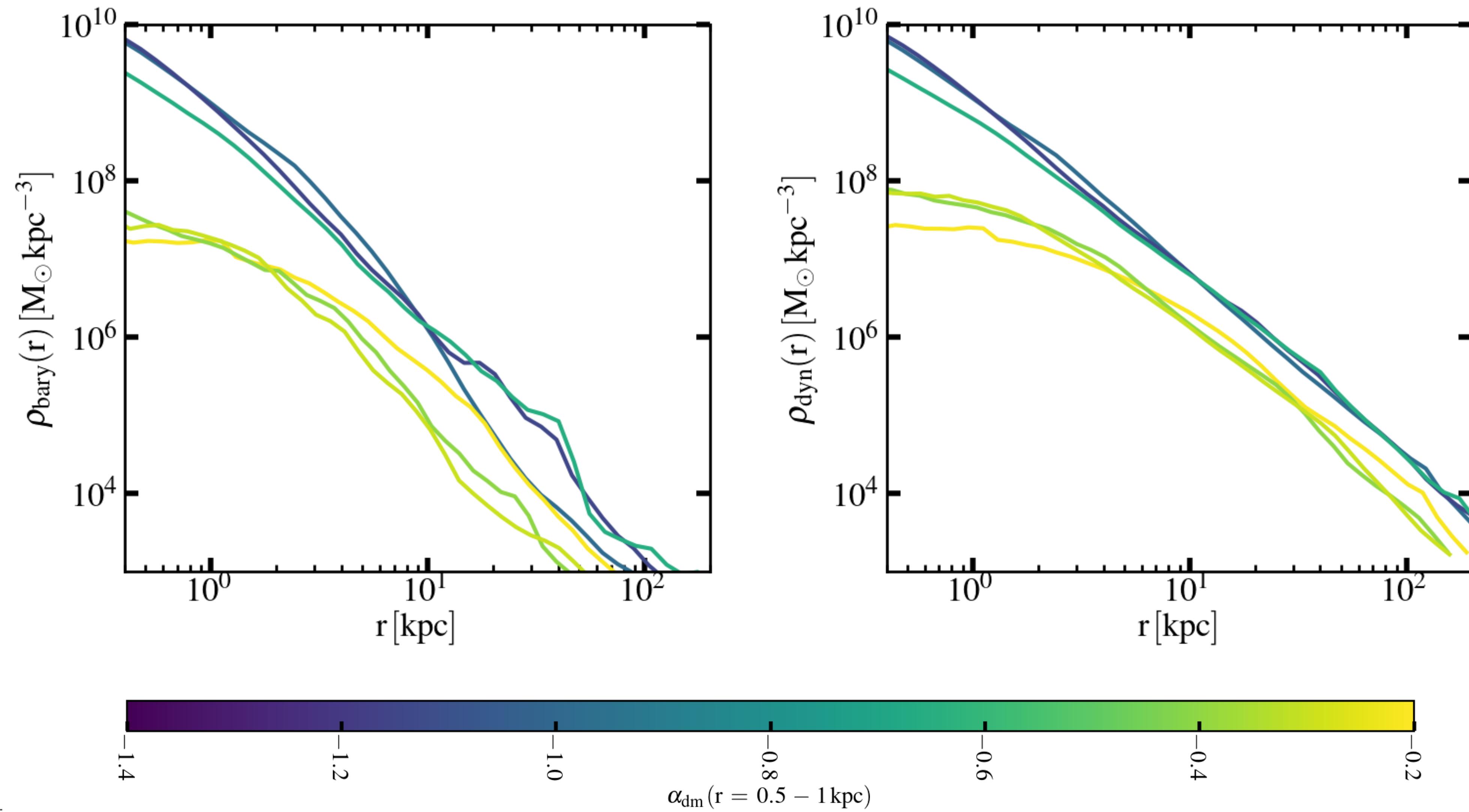
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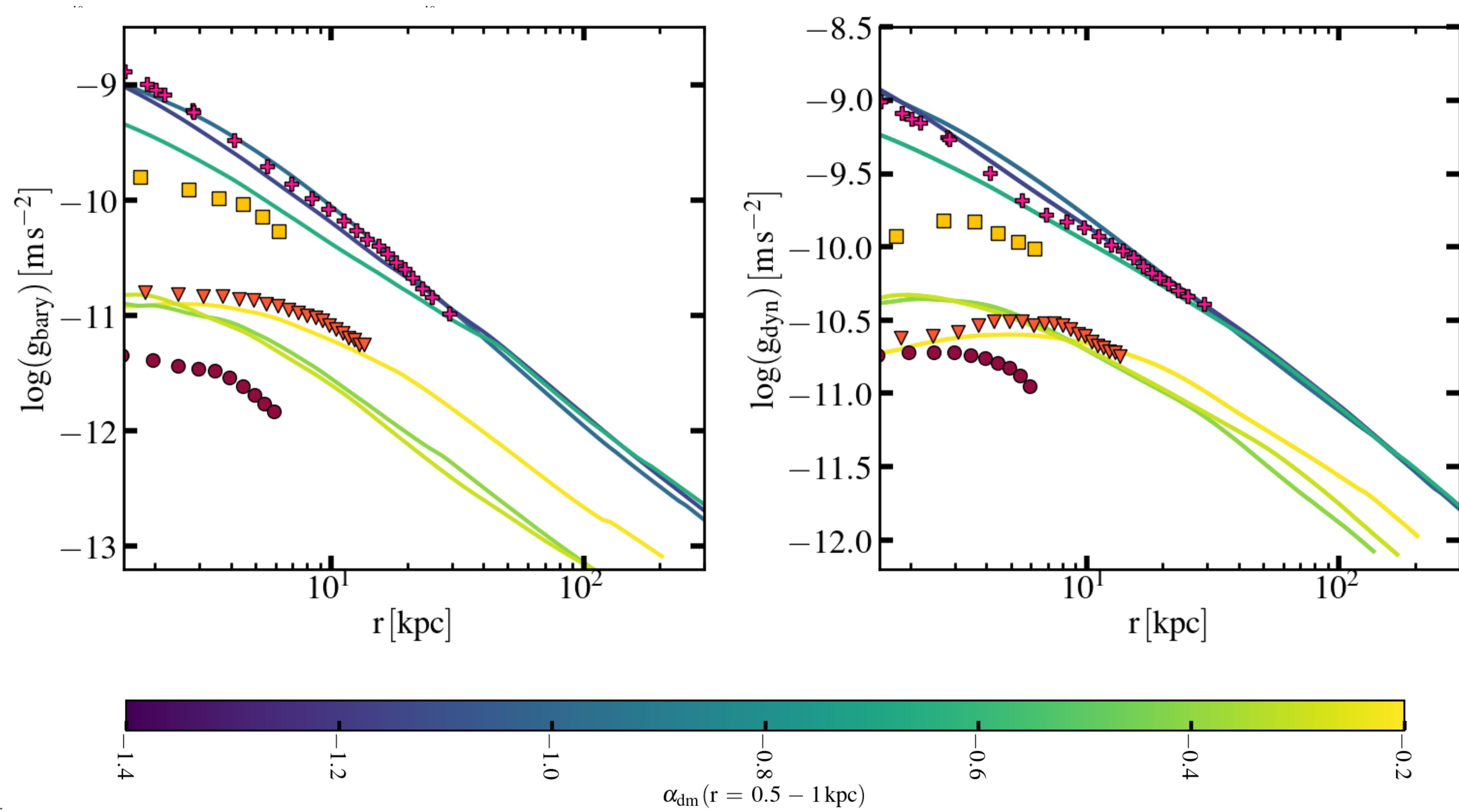
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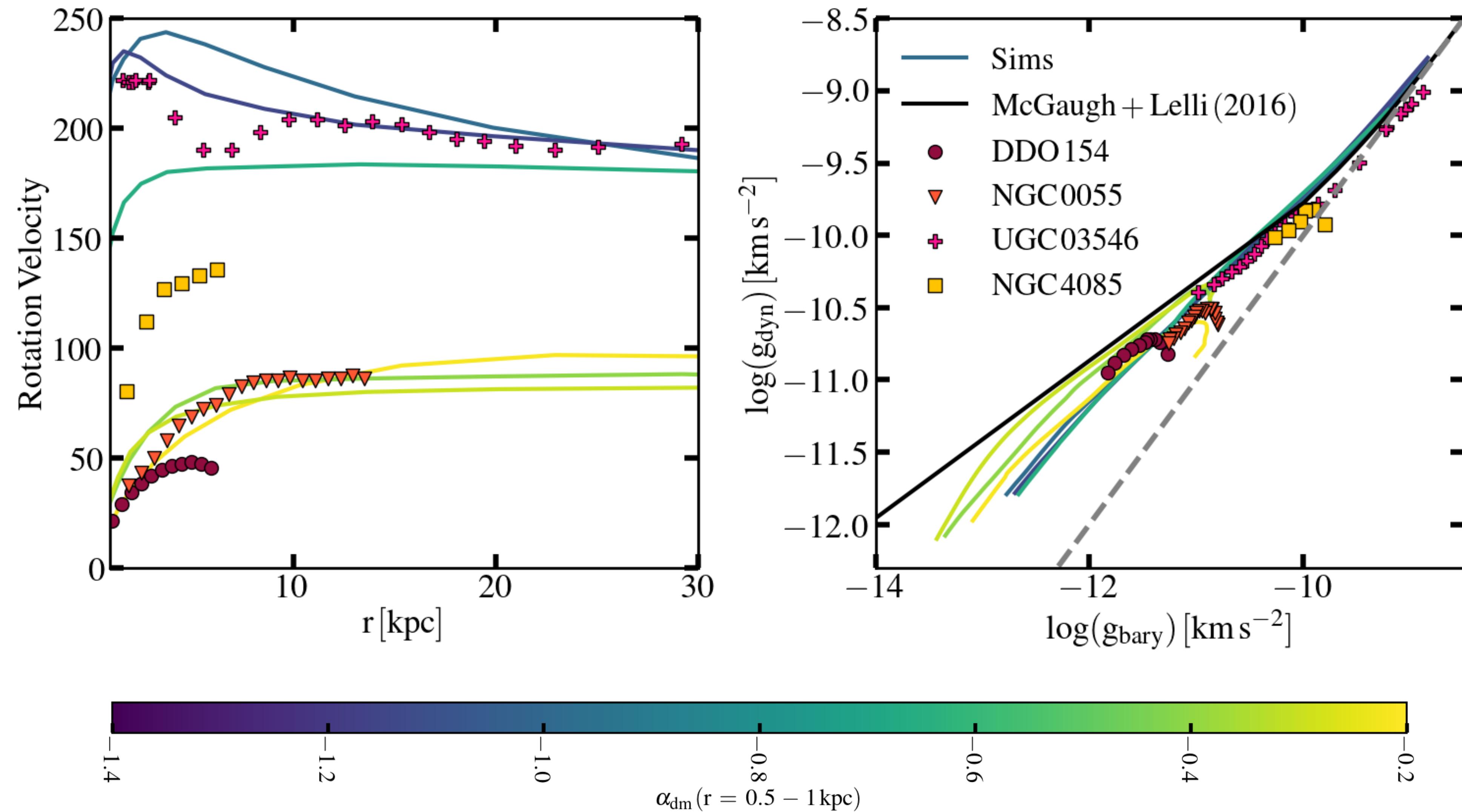
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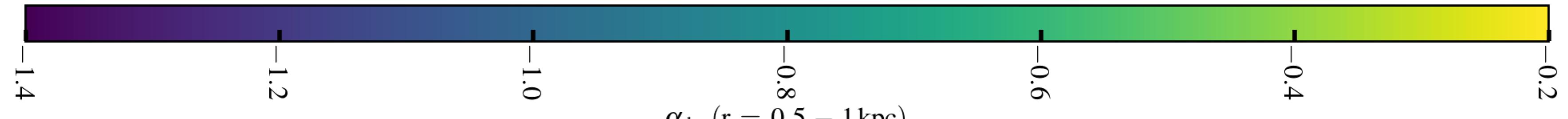
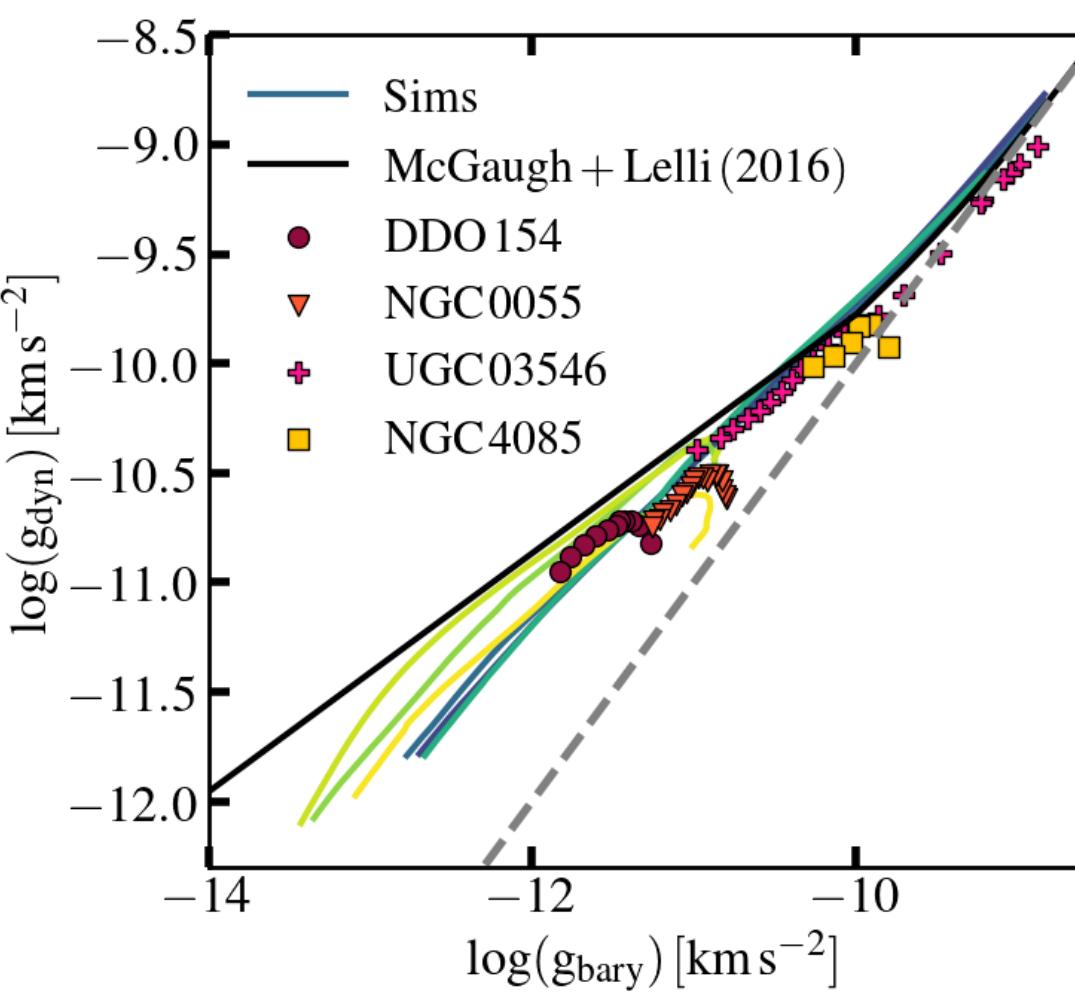
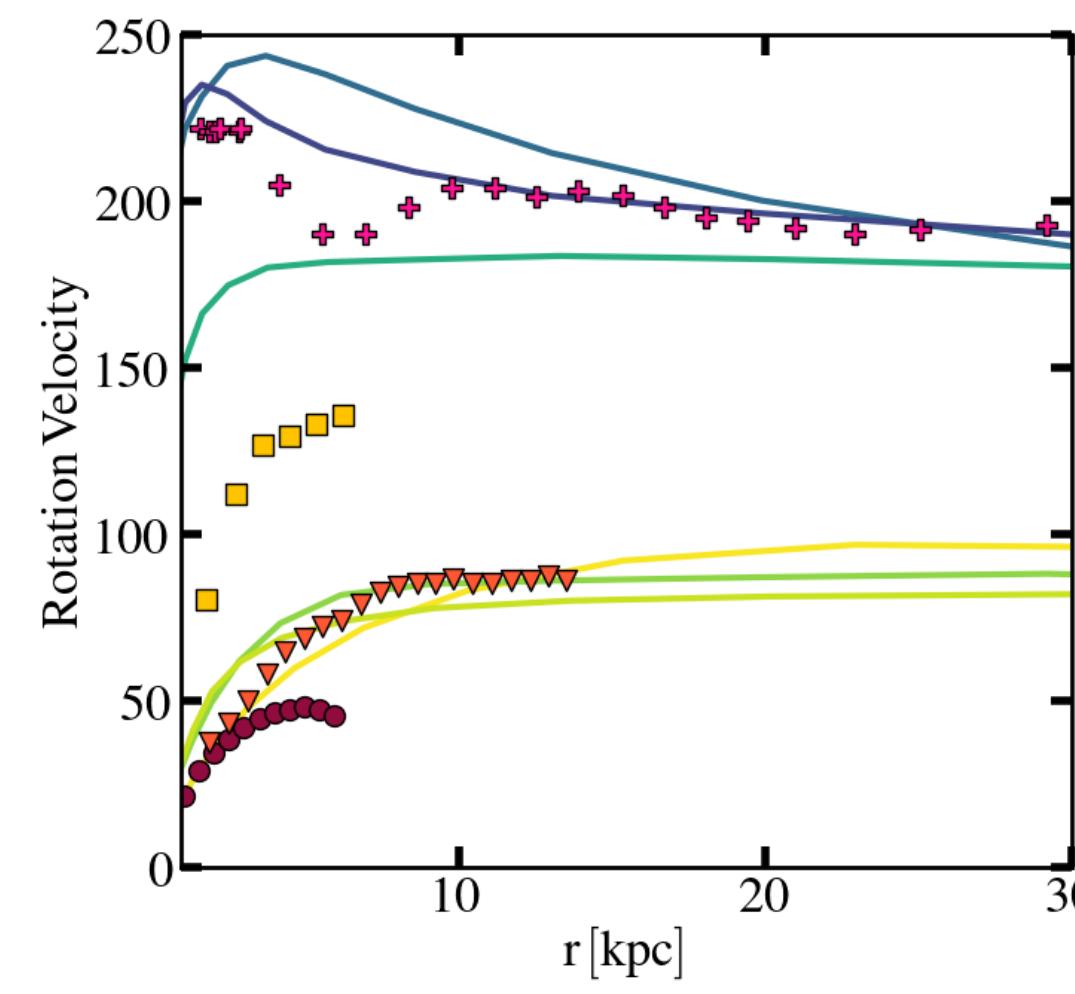
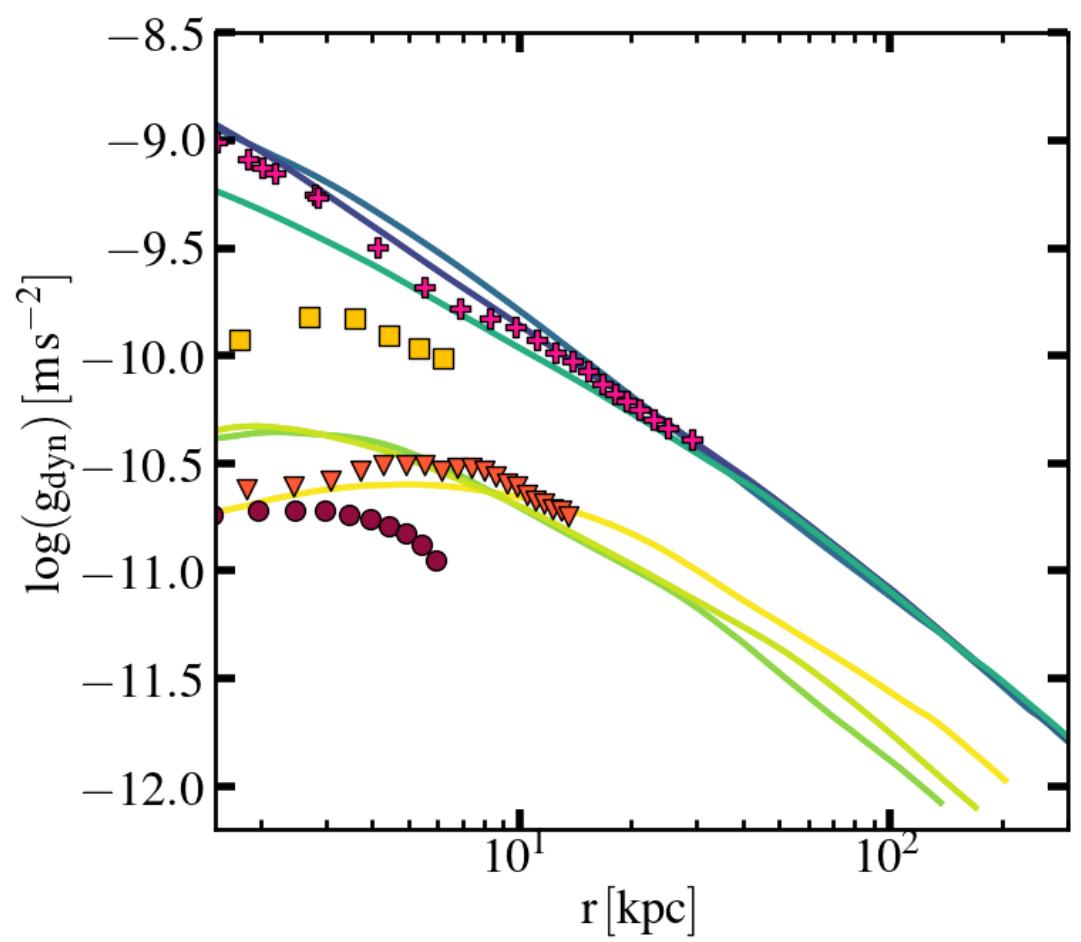
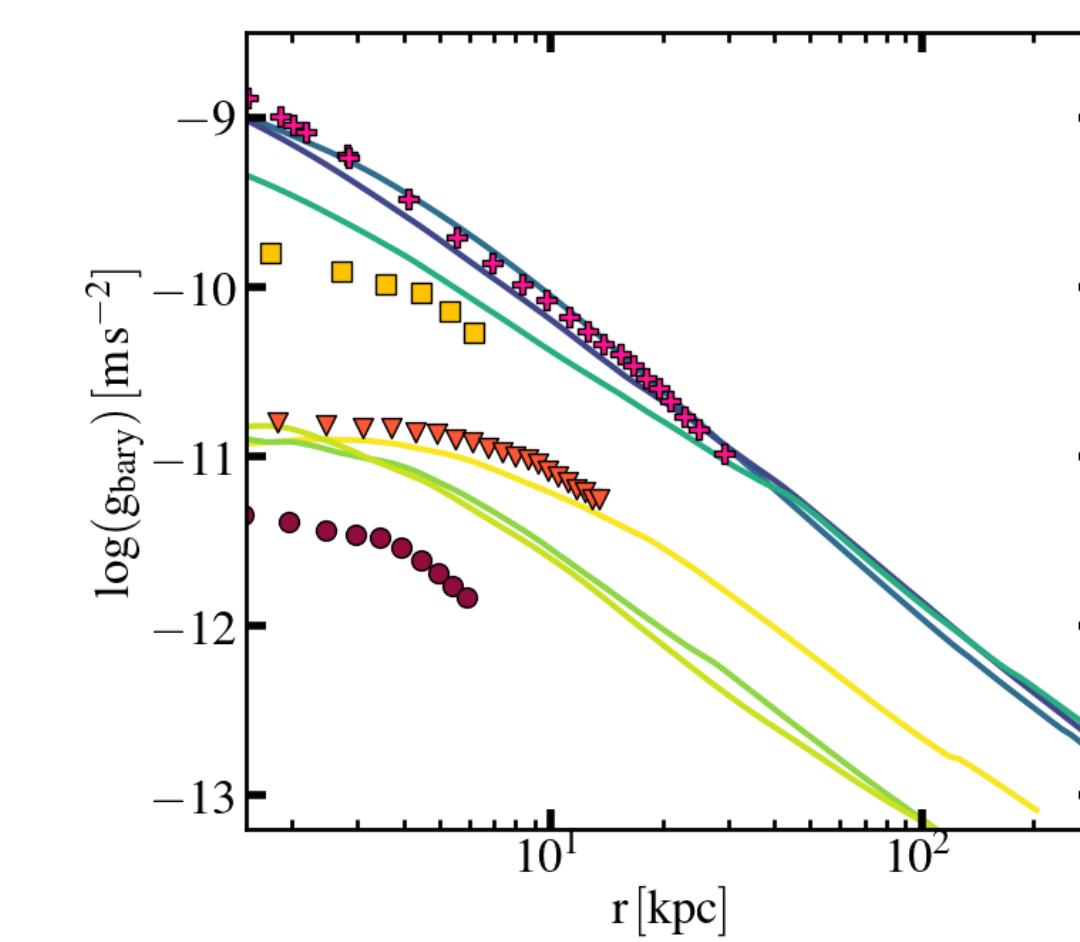
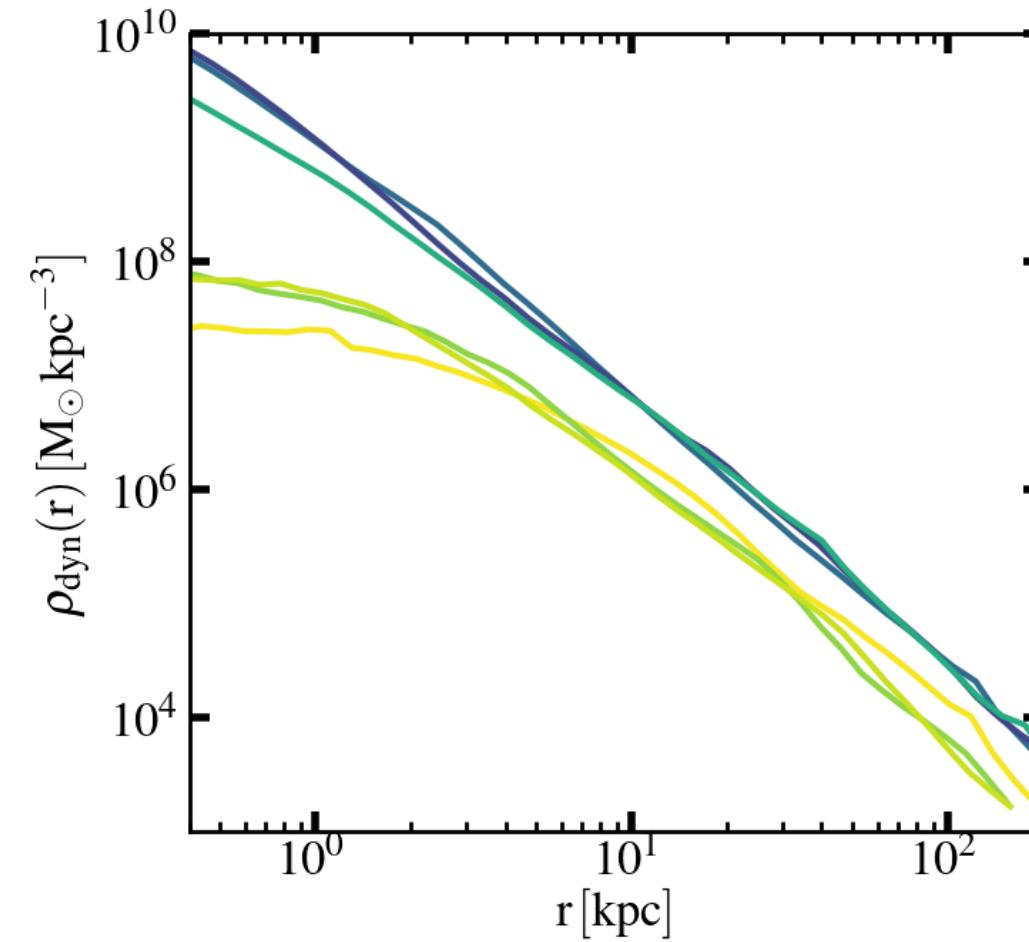
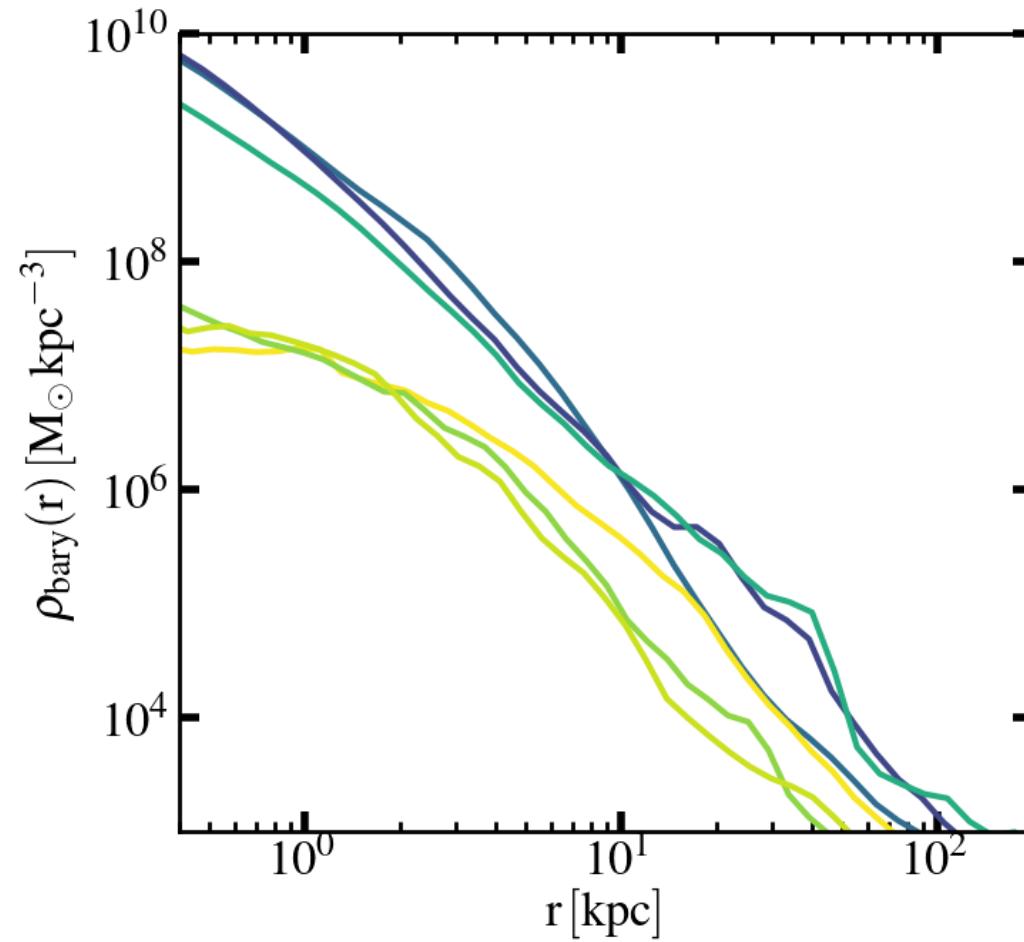
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# What's up with those hooks?!



# Conclusions

- RAR is a natural consequence of  $\Lambda$ CDM
  - This come straight out of measuring  $g_{\text{dyn}}$  and  $g_{\text{bary}}$  from FIRE-2 sims
  - Agrees extremely well with McGaugh's data with roughly similar scatter
  - Relationship persists when measuring acceleration as far out as  $R_{\text{vir}}$
  - Chan 2017; Keller & Wadsley 2017; Ludlow+ 2017; Navarro+ 2017; Wheeler+ 2019;
- Possible due to a tight relationship between baryonic mass and dynamical mass (within the same radius)
  - More work to be done to understand this
- We confirm and explain the existence of “hook” features on the RAR for the simulations
  - These hooks exist in observational data
  - We expect for galaxies with cored inner density profiles

# Thanks!

Coming soon to an Arxiv near you!



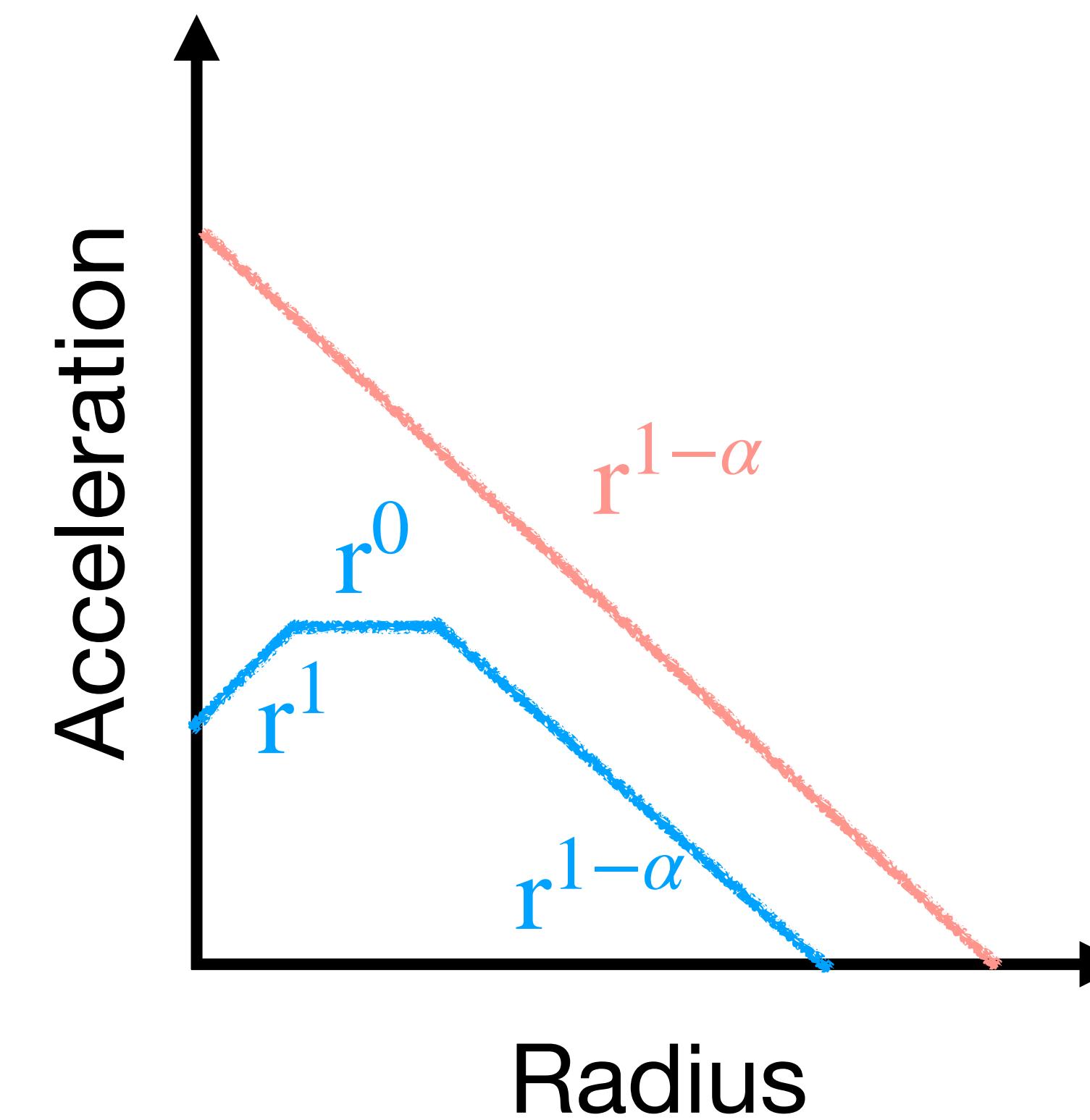
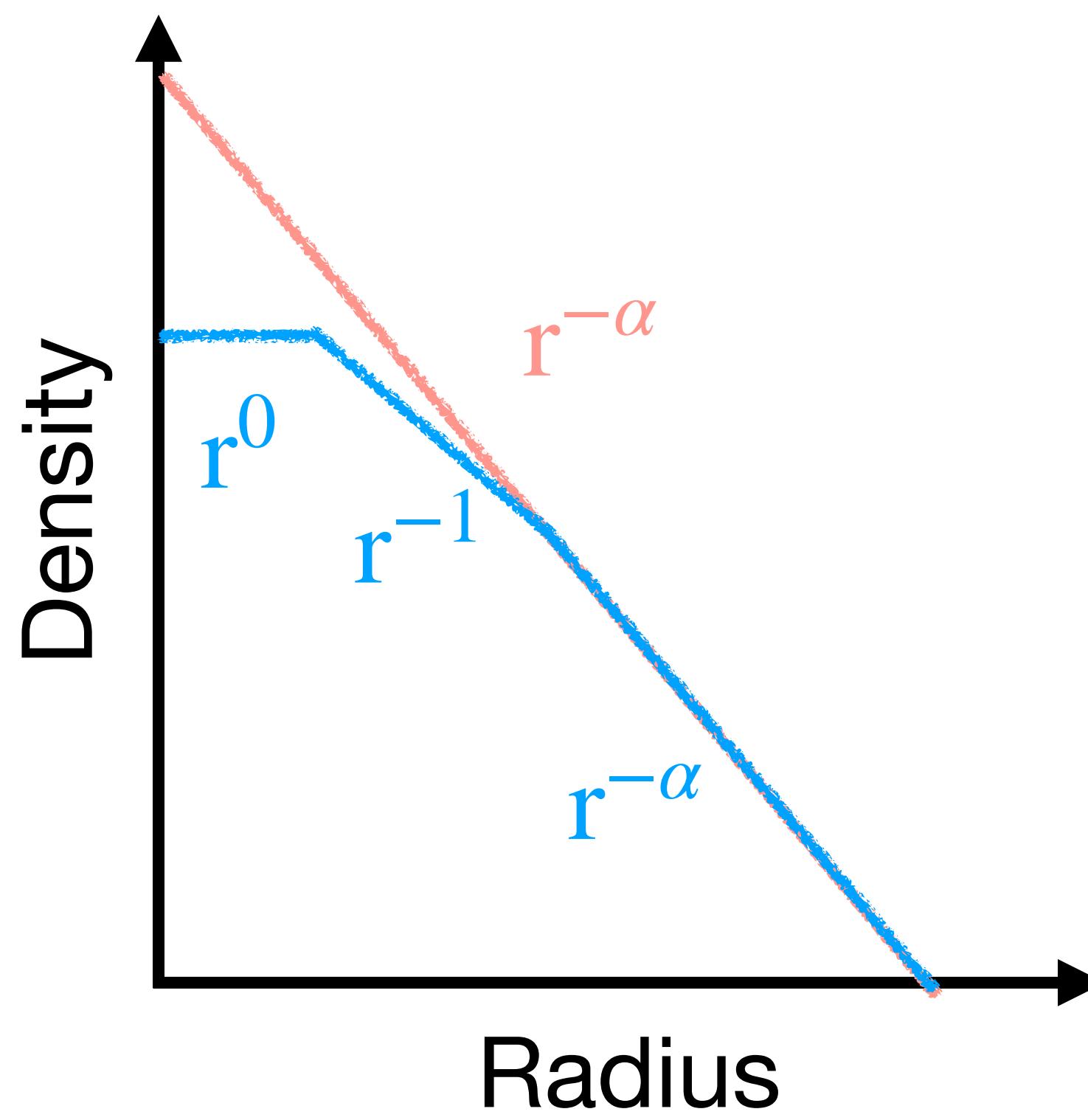
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Email: [mercadf1@uci.edu](mailto:mercadf1@uci.edu)

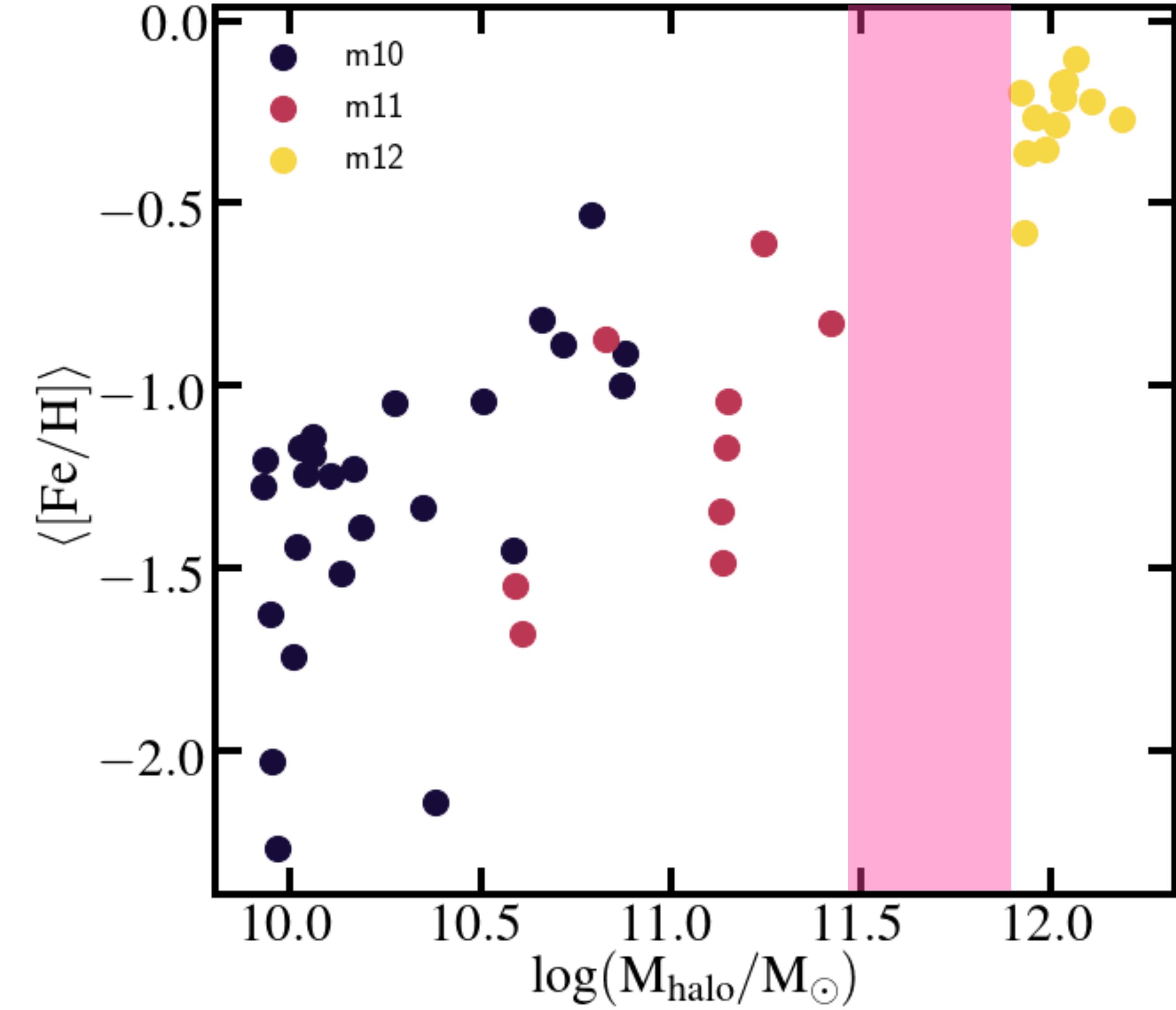
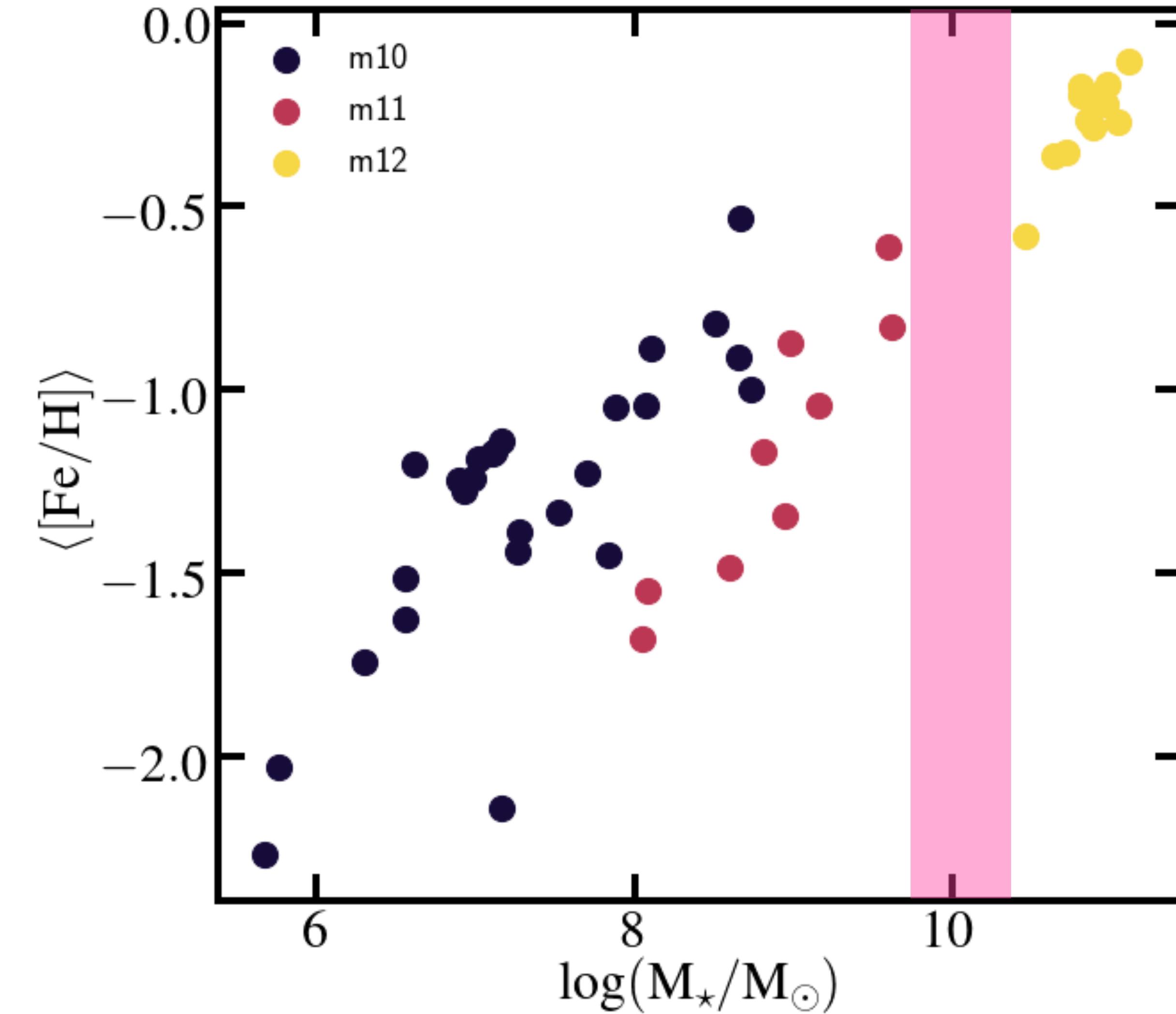
# We should expect these hooks!

$$\rho \propto r^{-\alpha} \quad M = V\rho \propto r^{3-\alpha}$$

$$g \propto \frac{M}{r^2} \propto r^{1-\alpha}$$



# Gap in FIRE-2 sims



# Behavior of galaxies on the RAR

