

*comparing 3D spectroscopic observations
with
cosmological hydrodynamical simulations*

Jesse van de Sande

Sydney Institute for Astronomy

*In Collaboration with Claudia Lagos, Charlotte Welker, Felix Schulze
& Rhea-Silvia Remus, Joss Bland-Hawthorn and the SAMI-Team*



THE UNIVERSITY OF
SYDNEY



Linking Galaxies
Australia-ESO
Conference Feb-19

Comparing 3D spectroscopic observations with cosmological hydrodynamical simulations

DISCLAIMER:

This is **not** a contest to see which simulation is “the best”; simulations have different philosophies: ‘made to match’ vs ‘made to bridge’

Aim is to identifying key areas of success and tension.



GalaxyDundee
@RealAussie



Follow

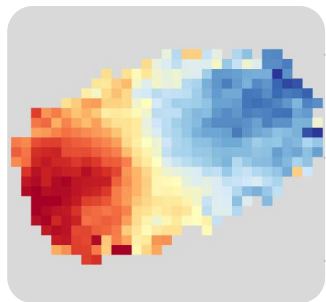
Strewth! These blokes and sheilas are agro like a pair of dingoes! If you ask me, they have a few roos loose in their top paddock! I reckon this needs a fair dinkum comp. Too easy!

[← Reply](#) [↻ Retweet](#) [★ Favorite](#) [⋮ More](#)

2:43 PM - 21 Feb 19 · [Embed this Tweet](#)



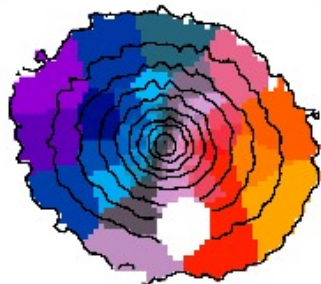
Comparing 3D spectroscopic observations with cosmological hydrodynamical simulations



SAMI

$N_{gal} = 1558$

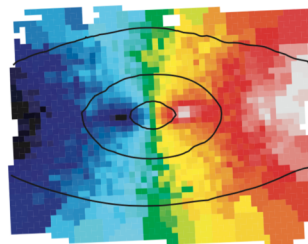
Croom+12
Bryant+15
van de Sande+ 17a,b
Scott+17



CALIFA

$N_{gal} = 257$

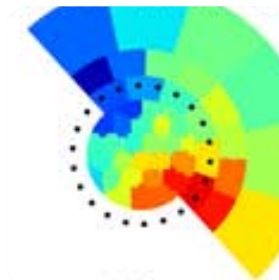
Sanchez+12
Walcher+14
Gonzalez Delgado+15
Falcon-Barroso+17



ATLAS^{3D}

$N_{gal} = 240$

Cappellari+11; 13a,b
Emsellem+11
Krajnovic+11
McDermid+15

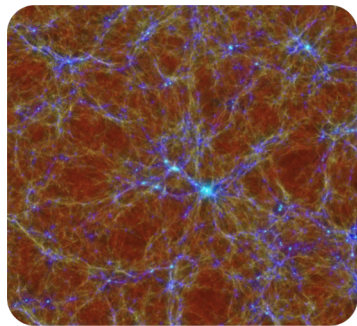


MASSIVE

$N_{gal} = 85$

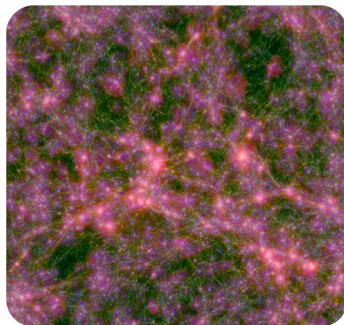
Ma+14
Veale+17a,b,18

Comparing 3D spectroscopic observations with cosmological hydrodynamical simulations



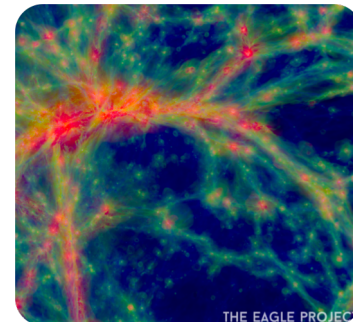
**Magneticum
Pathfinder**
(59 Mpc)³ co-moving

Dolag+ in prep
Hirschmann+14
Schulze+18



Horizon-AGN
(142 Mpc)³ co-moving

Dubois+14, 16
Chisari+15
Welker+19 in prep



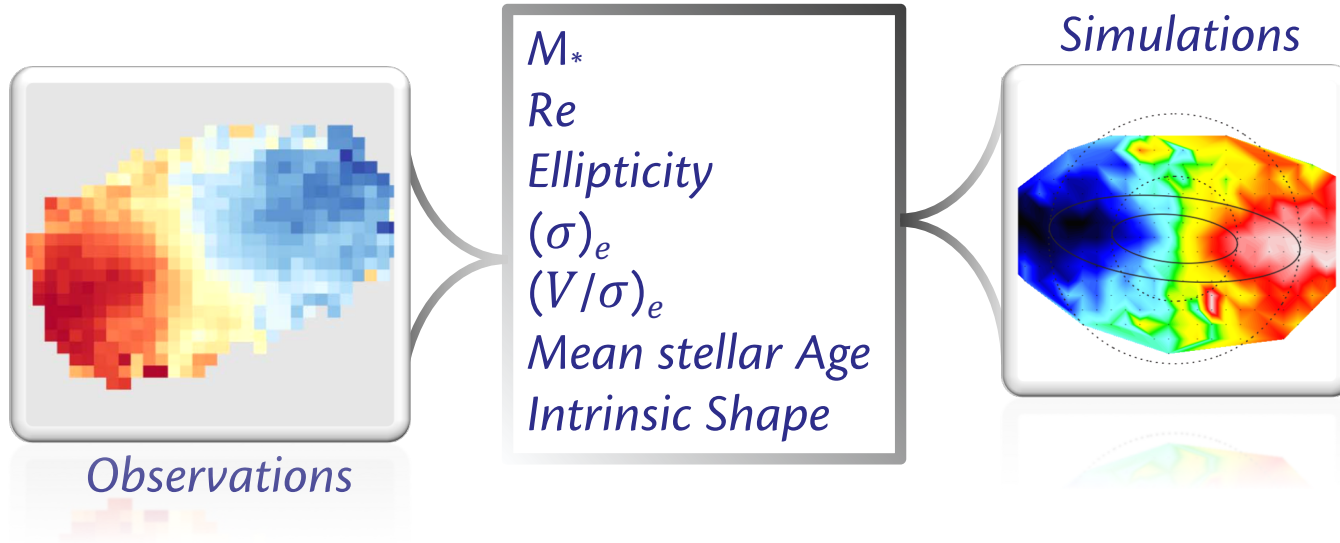
EAGLE & Hydrangea
(100 Mpc)³ co-moving
+ 24 Cluster Zoom-In

Schaye+2015
Crain+2015
McAlpine+2016
Barnes+17
Bahe+17
Lagos+18

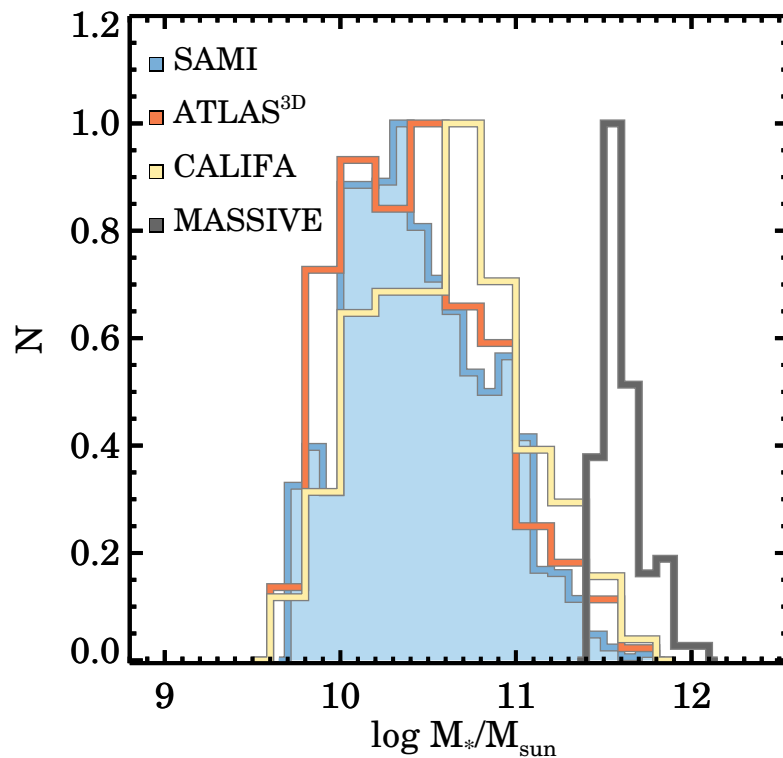
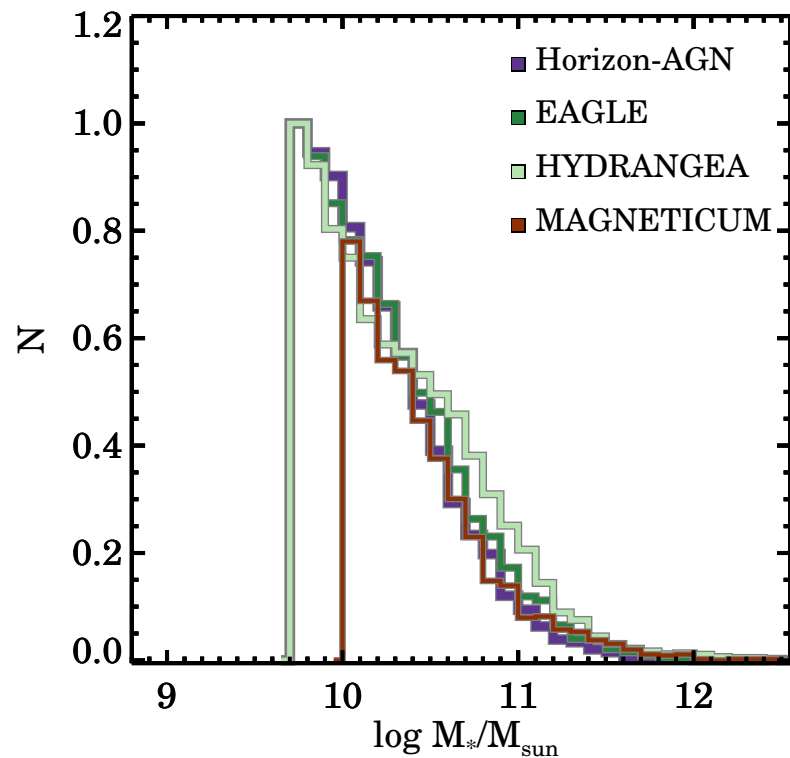
Huge thanks to: Claudia Lagos, Charlotte Welker, Felix Schulze & Rhea-Silvia Remus

Comparing 3D spectroscopic observations with cosmological hydrodynamical simulations

- It's crucial to do the measurements in (*nearly*) identical ways
- Use luminosity-weighted measurements rather than mass-weighted
- Extract mass-matched sample from simulations to avoid biases due to trends with M_*

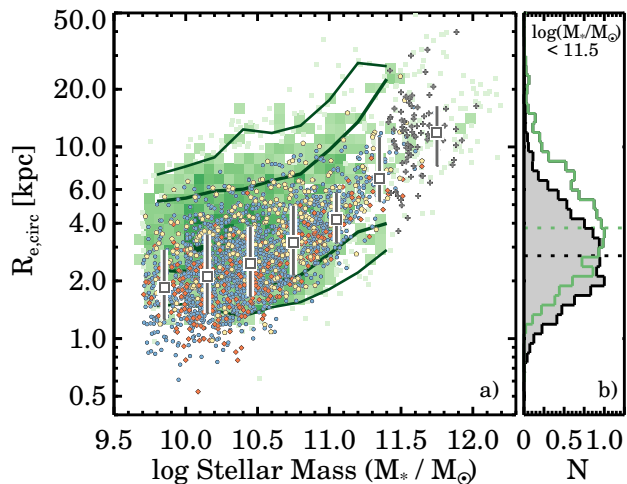


Biases with M_* require mass-matching of simulations with obs.

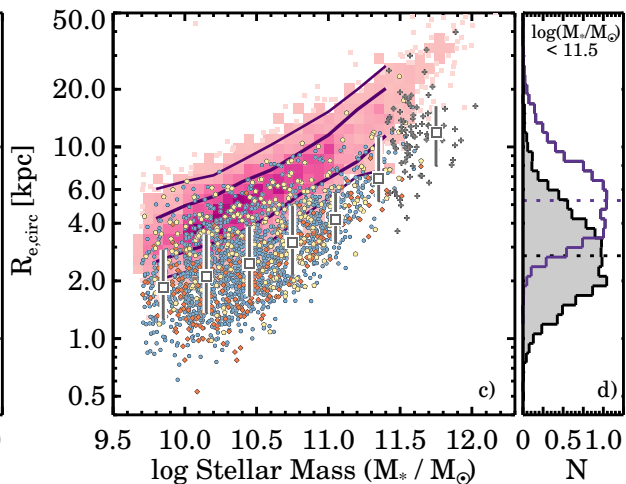


Shape of size-mass relation well recovered, but median size of simulated galaxies too large

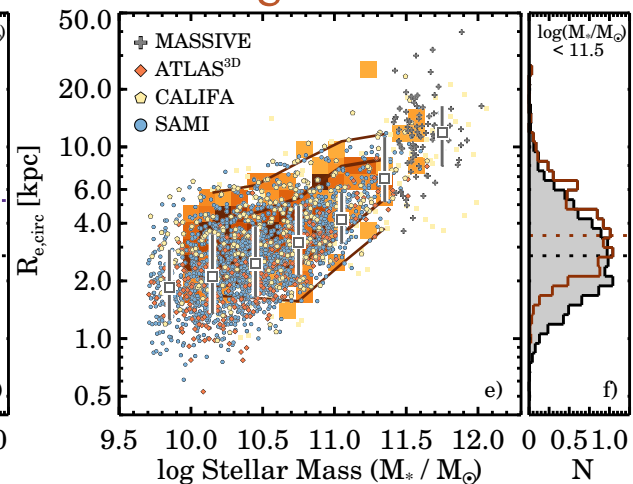
EAGLE



Horizon-AGN

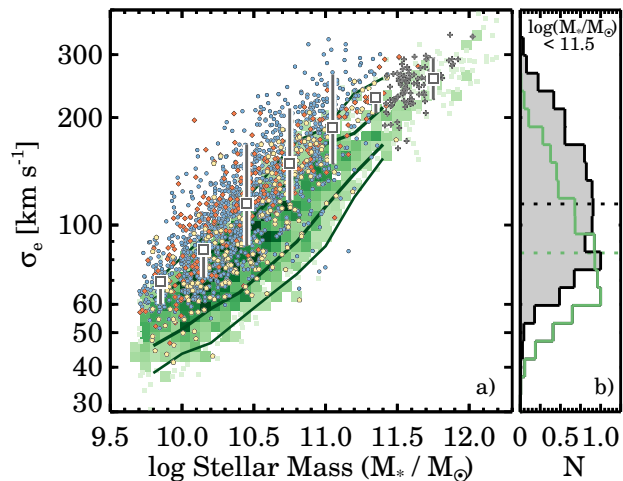


Magneticum

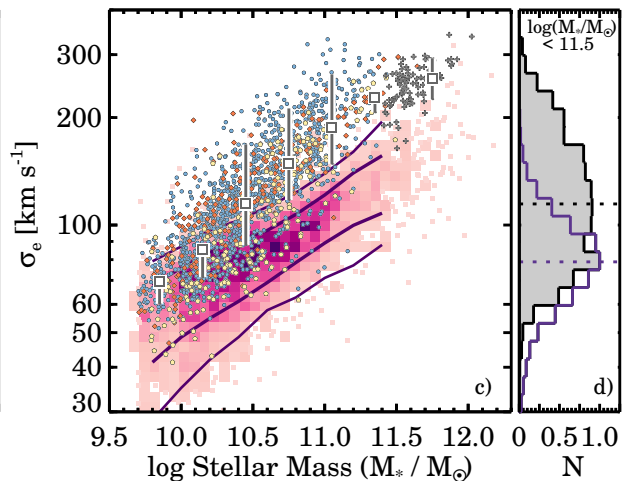


Velocity dispersion-mass relation well recovered, but median of sigma values too low

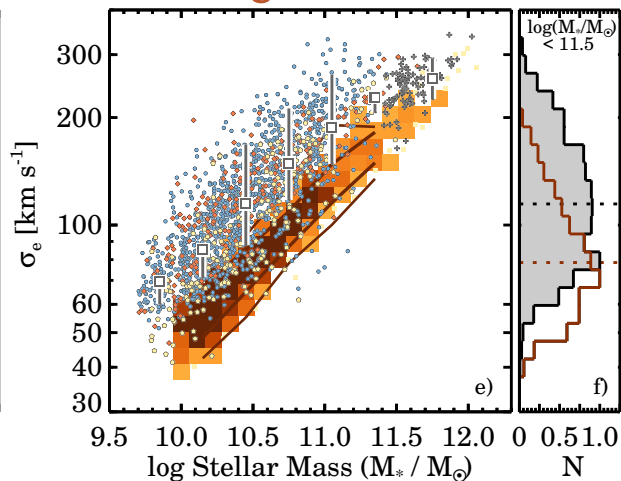
EAGLE



Horizon-AGN

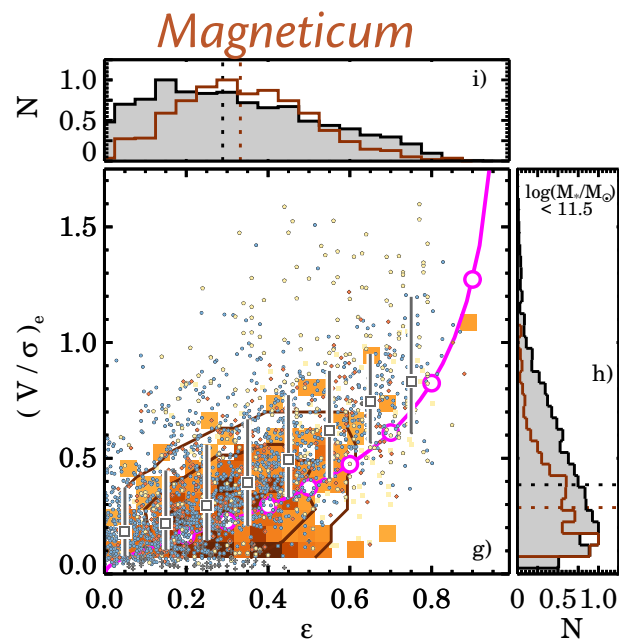
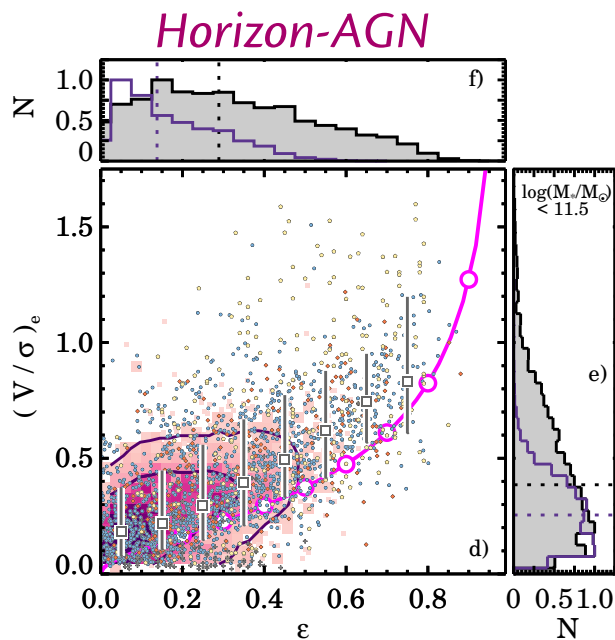
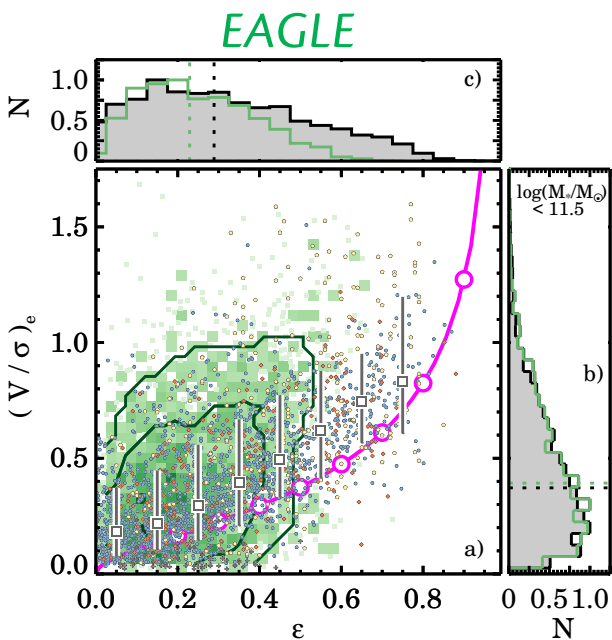


Magneticum

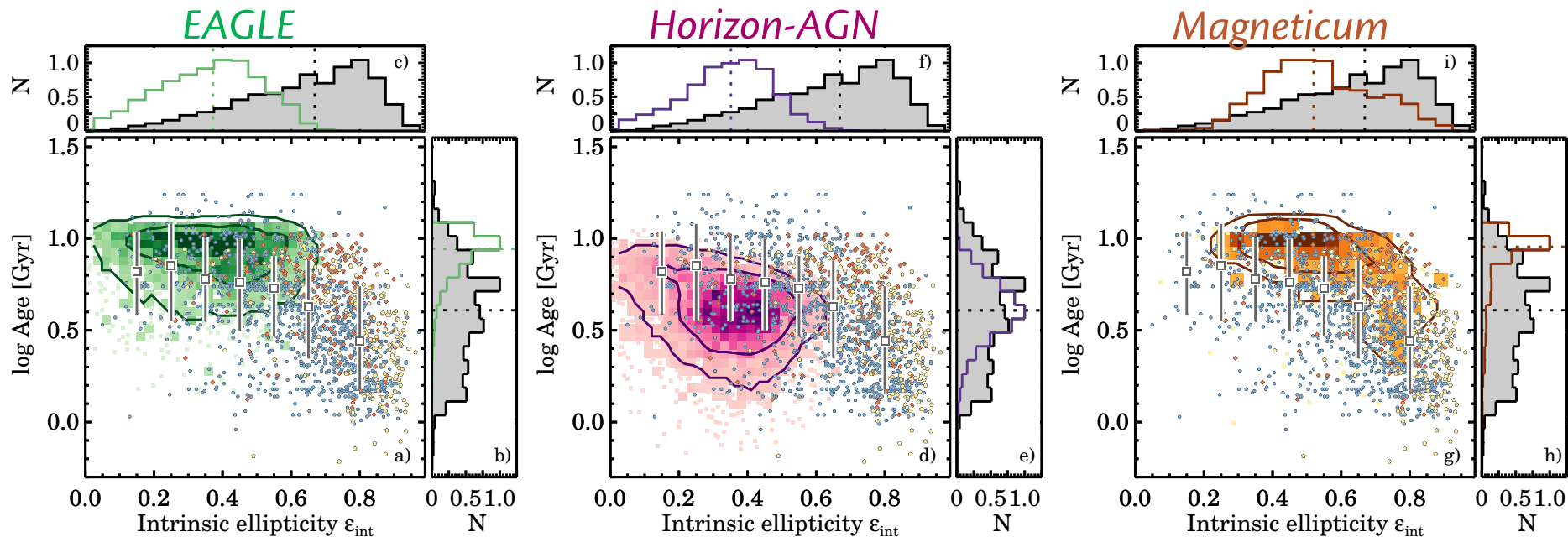


$\left(\frac{V}{\sigma}\right)_e - \epsilon$ diagram not well sampled by simulations;
 dearth of flattened, fast-rotating galaxies

$$\left(\frac{V}{\sigma}\right)^2 \equiv \frac{\langle V^2 \rangle}{\langle \sigma^2 \rangle} = \frac{\sum_{i=0}^{N_{spX}} F_i V_i^2}{\sum_{i=0}^{N_{spX}} F_i \sigma_i^2}$$



Mild trend between age and intrinsic ellipticity found in simulations, but trend is offsets, and young flattened galaxies absent.



Take Home Message

- Comparison between simulations and observational data has highlighted several areas for improvement (*van de Sande et al. 2019*)
 - *EAGLE+Hydrangea*: R_e (+), ε (-), σ_e (-), and mean stellar age (+)
 - *Horizon-AGN*: R_e (+), ε (-), σ_e (-) and $(V/\sigma)_e$ (-)
 - *Magneticum*: σ_e (-), $(V/\sigma)_e$ (-), and mean stellar age (+)
- Our results demonstrate the vast improvement of cosmological simulations in recent years.