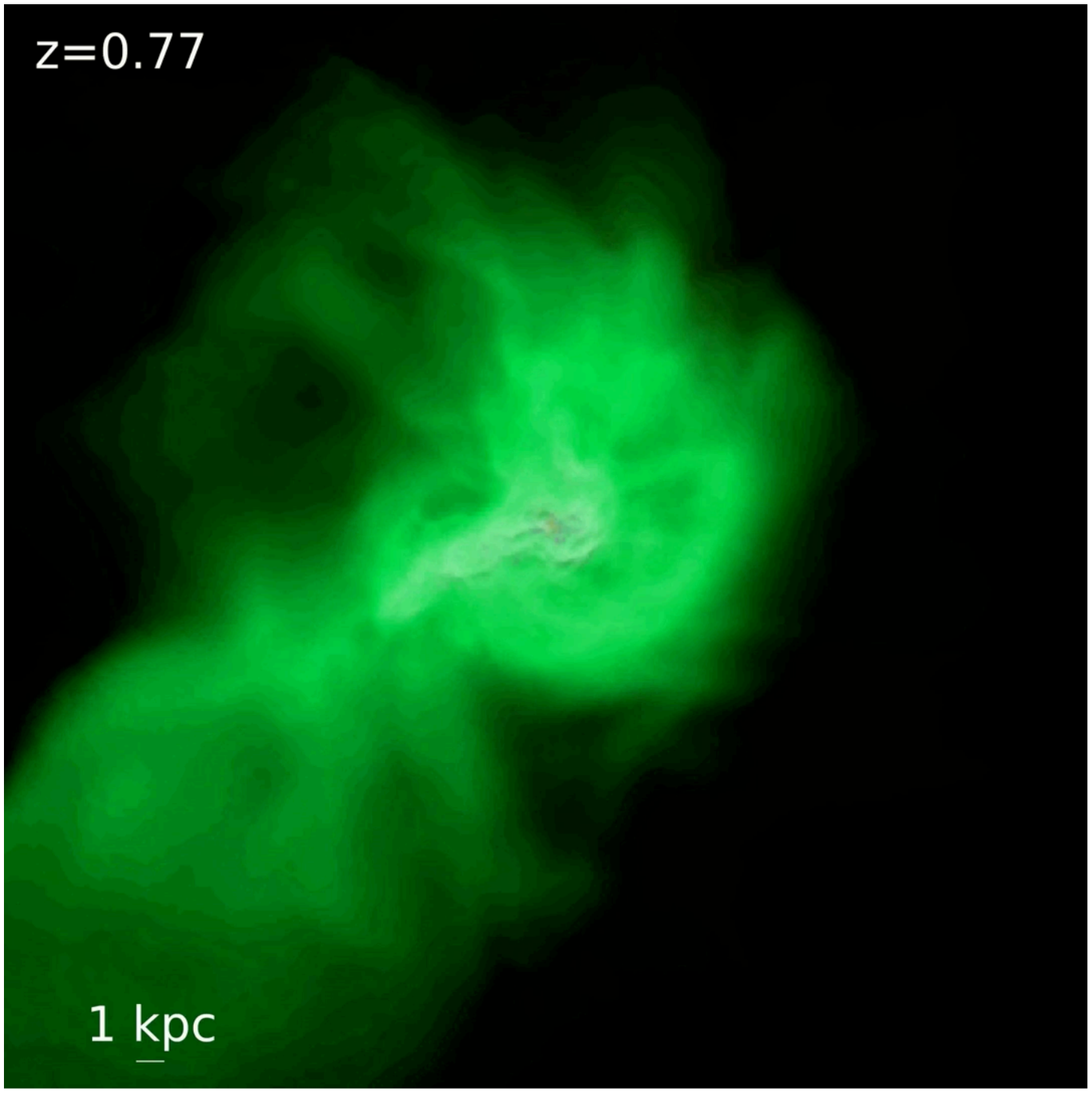
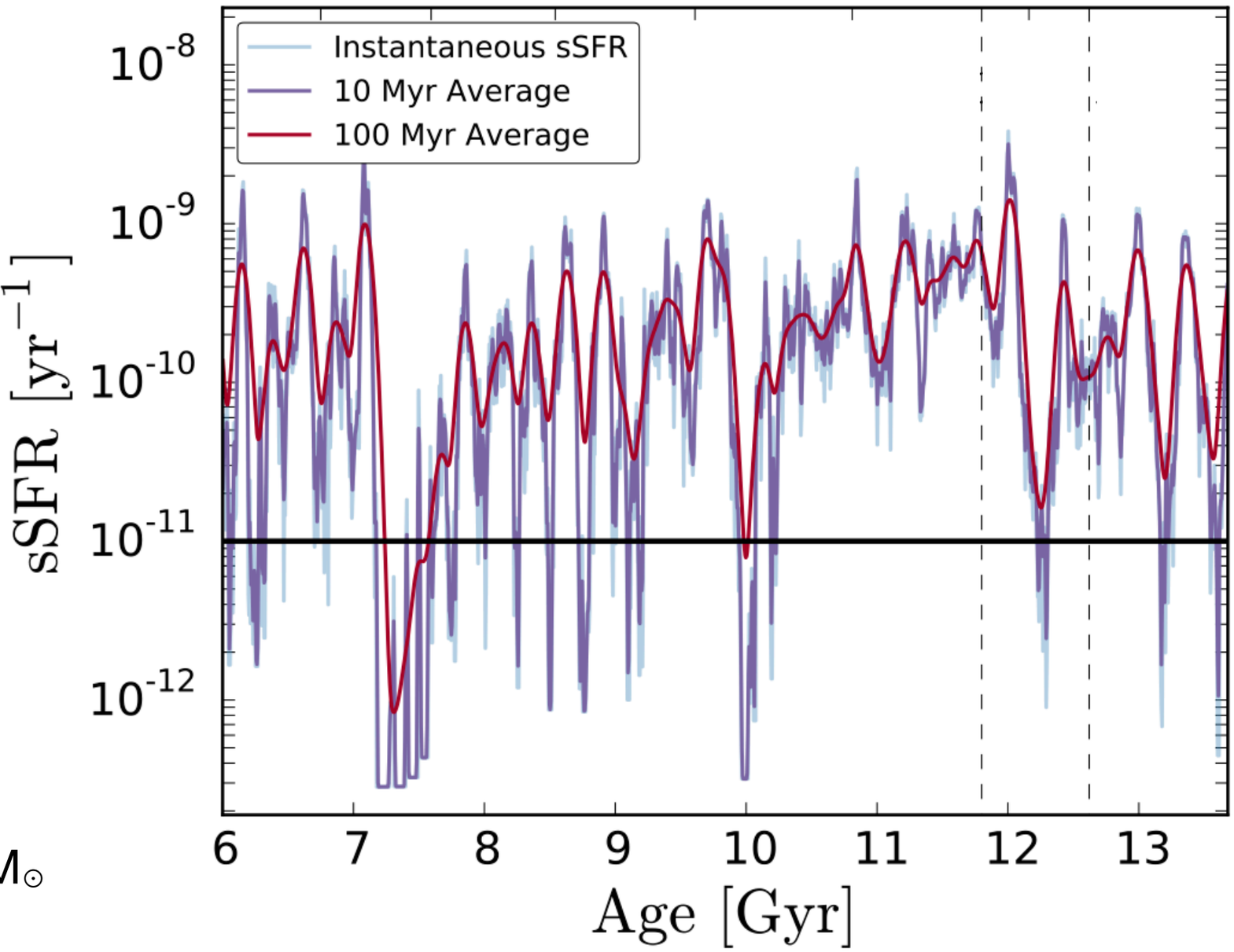
Gas kinematics and morphology of low-mass galaxies

Kareem El-Badry
(UC Berkeley)

Eliot Quataert, Andrew Wetzel, Dan Weisz, Phil Hopkins, Shea Garrison-Kimmel, TK Chan, Mike Boylan-Kolchin, Alex Fitts, ++



Feedback drives gas outflows, leads to bursty SF



M_{star} ~ 3e8 $M_\odot$

El-Badry+16

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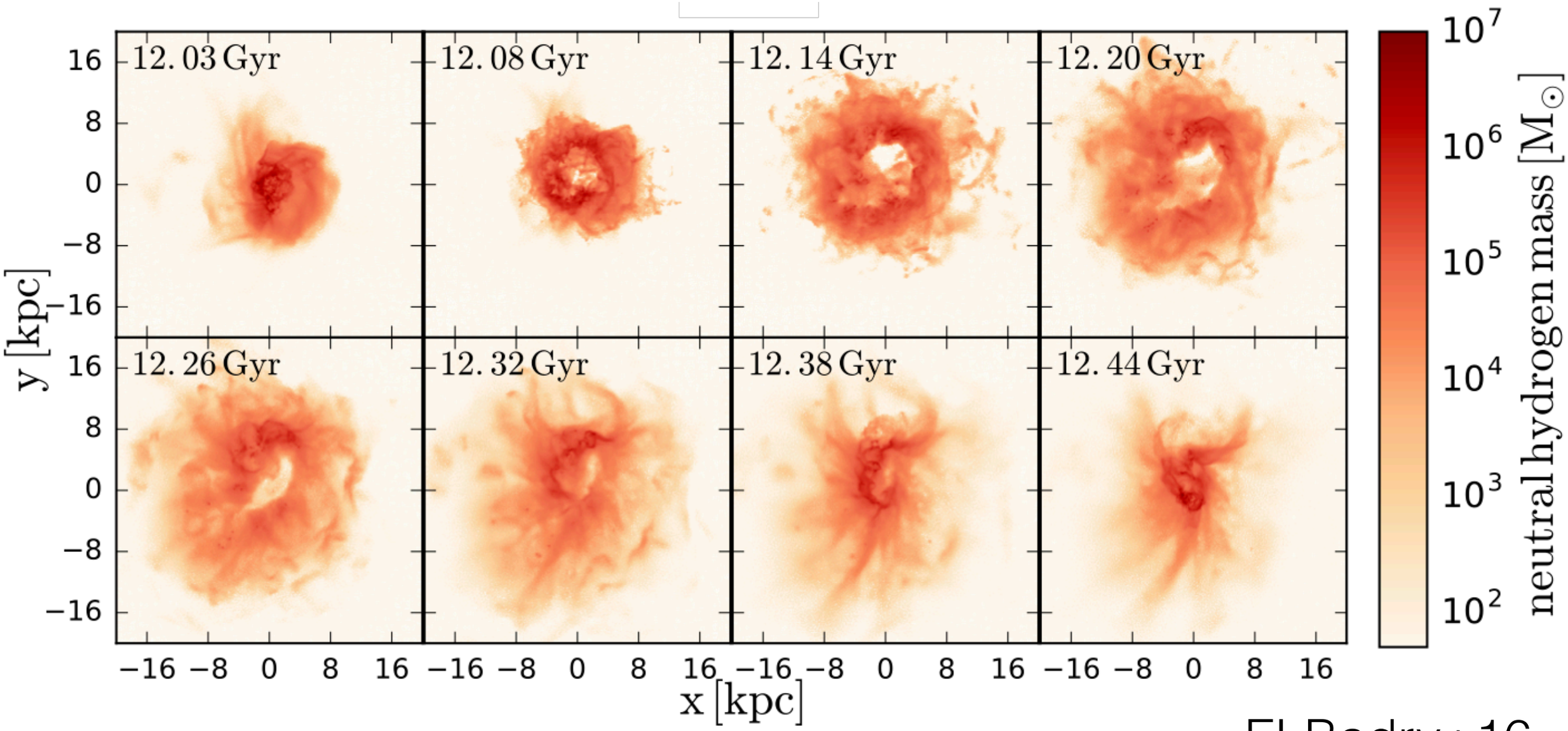
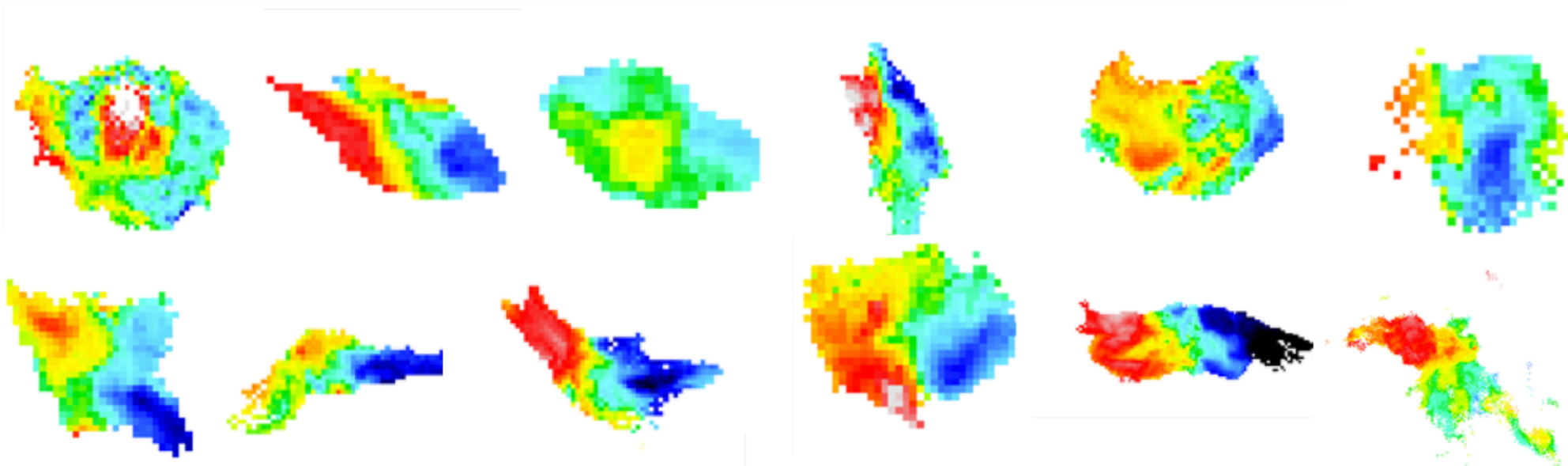


El-Badry+16

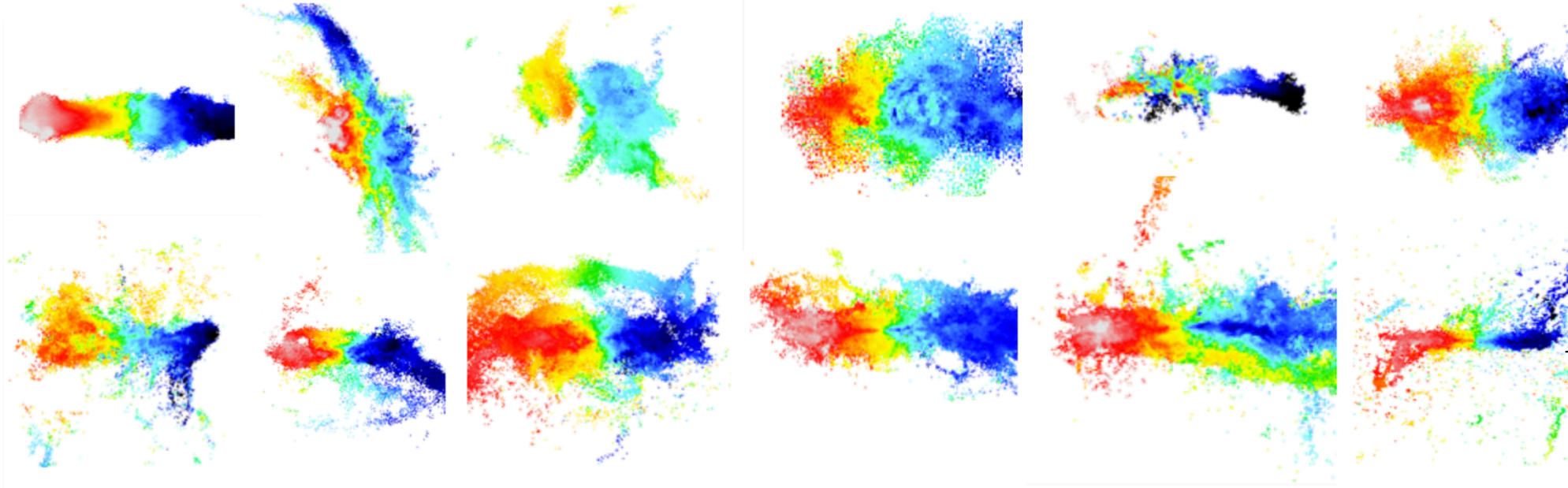
M_{star} ~ 3e8 $M_\odot$

HI mock observations



$M_{\rm star} = 10^{6-7} M_\odot$

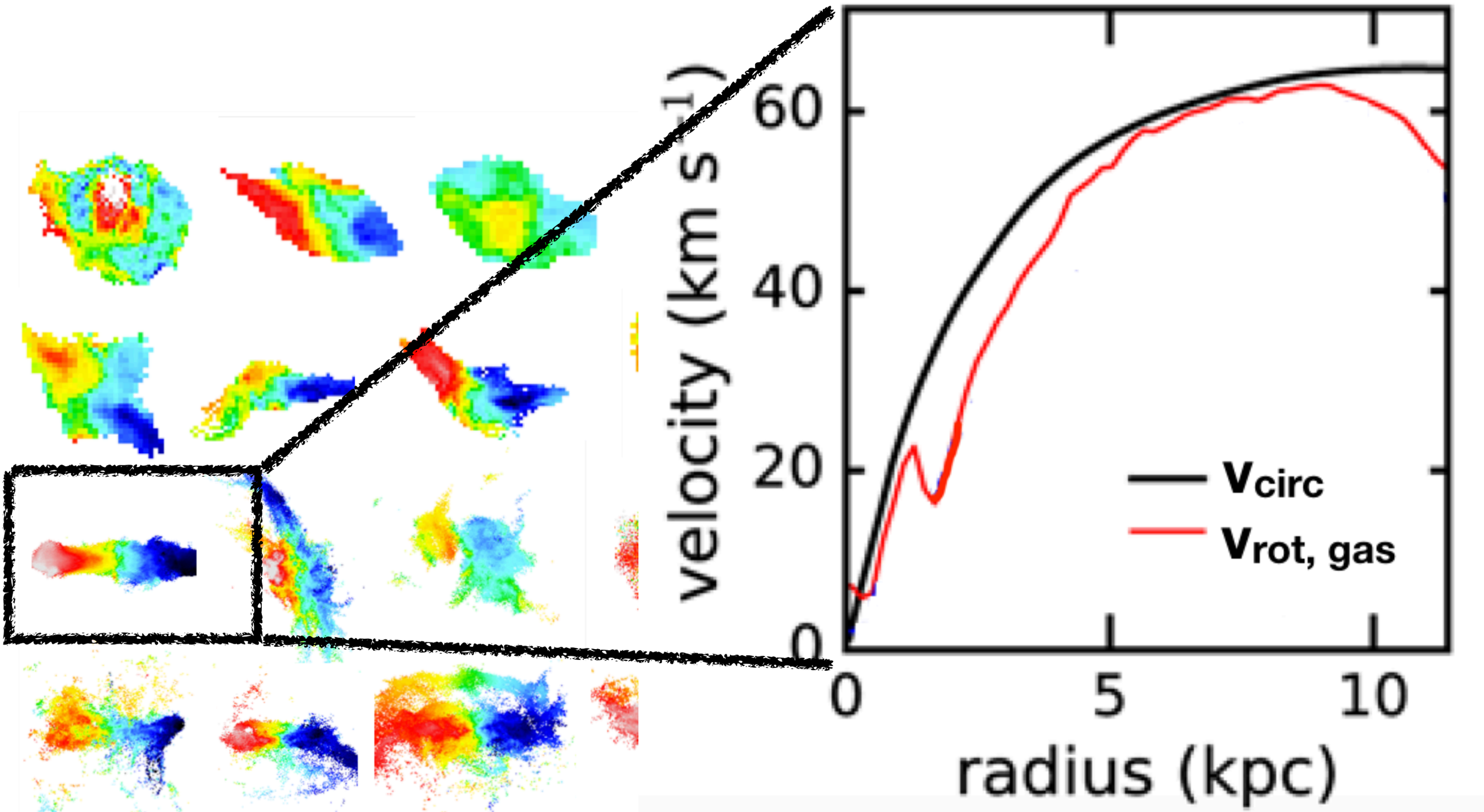
$M_{\rm star} = 10^{7-8} M_\odot$



$M_{\rm star} = 10^{8-9} M_\odot$

$M_{\rm star} = 10^{9-11} M_\odot$

all galaxies viewed “edge-on”



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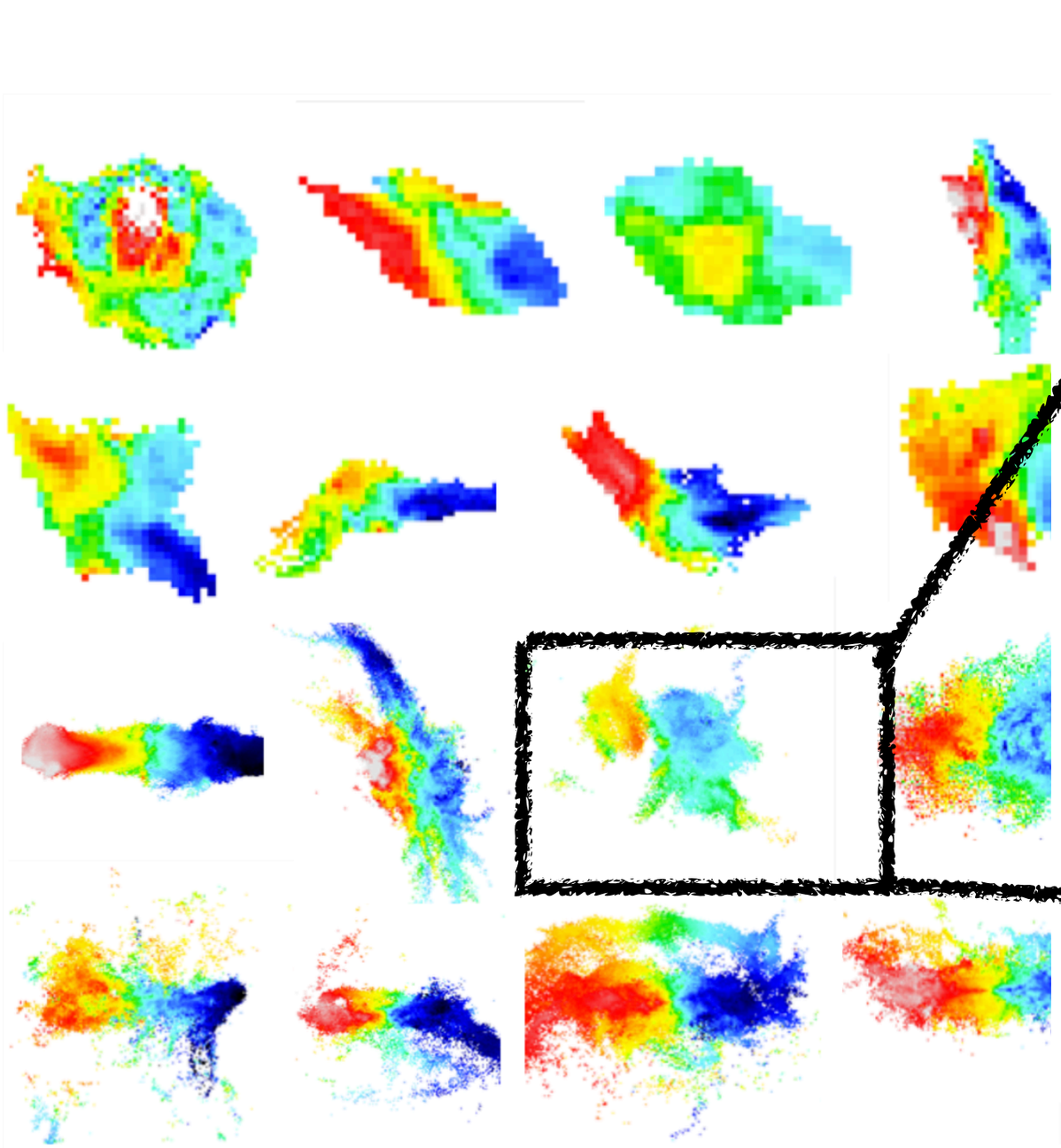
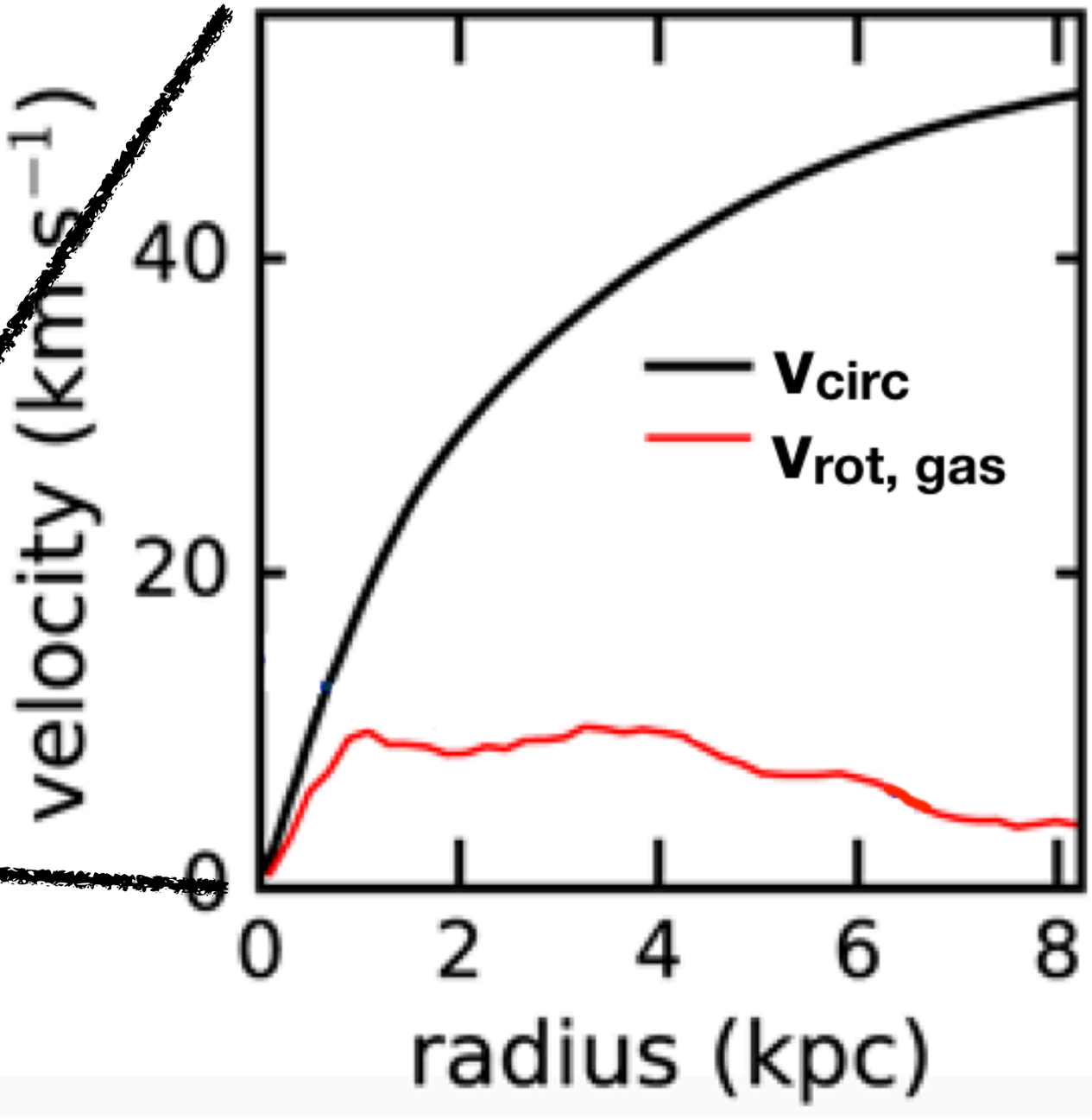
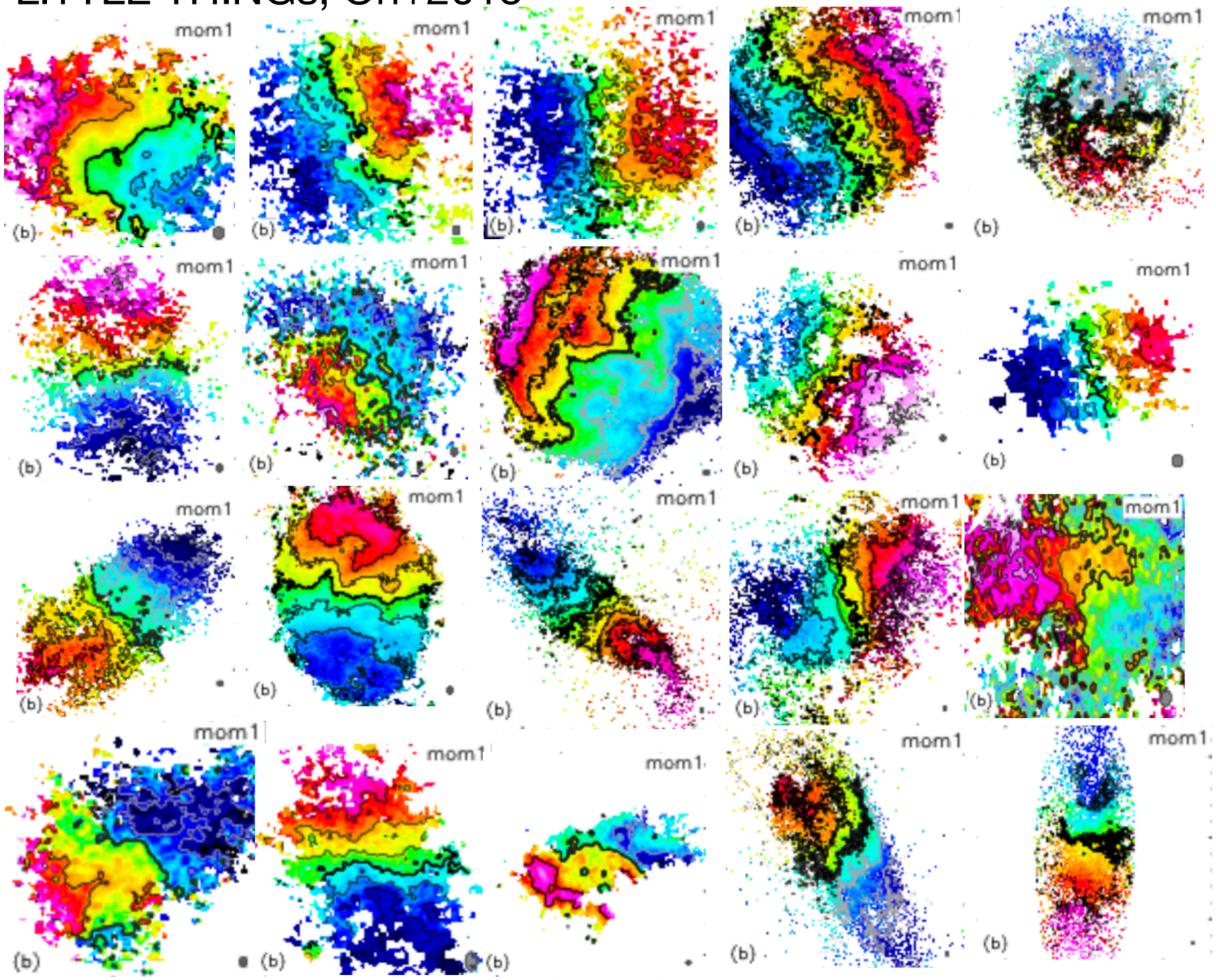



velocity (kms^{-1})
0
20
40
0
2
4
6
8
radius (kpc)
V_{circ}
$V_{rot,\ gas}$

LITTLE THINGs; Oh+2015



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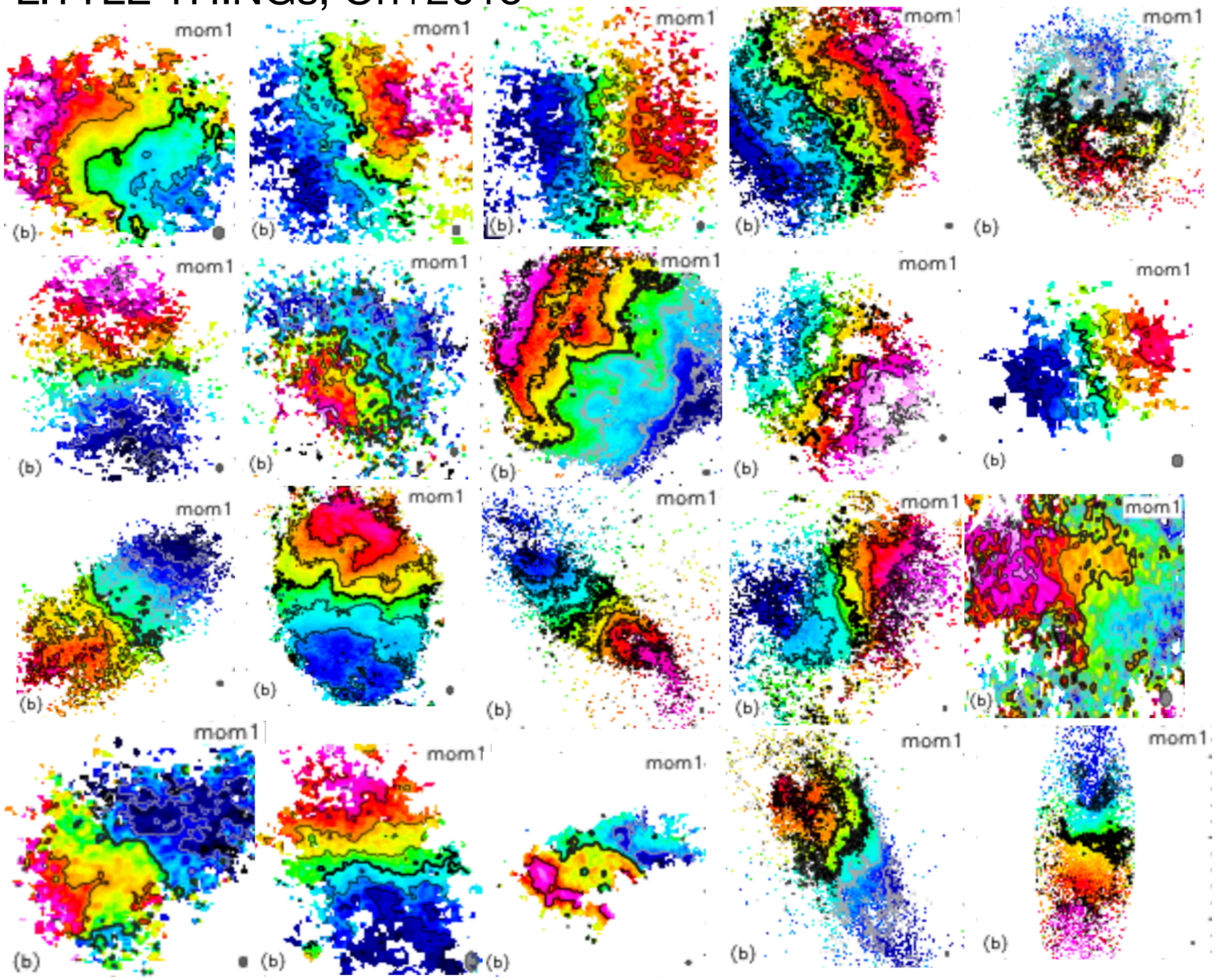

Selection function?

Quantitative comparison is hard.

Unresolved HI

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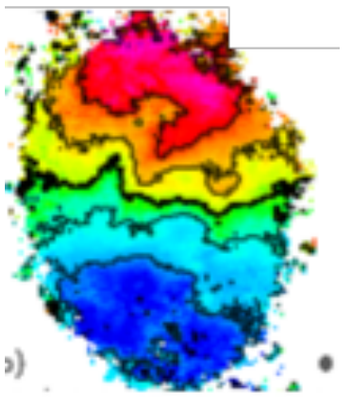
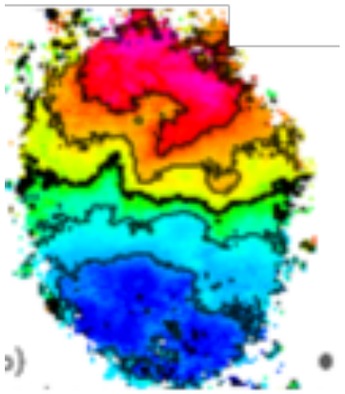
Unresolved HI



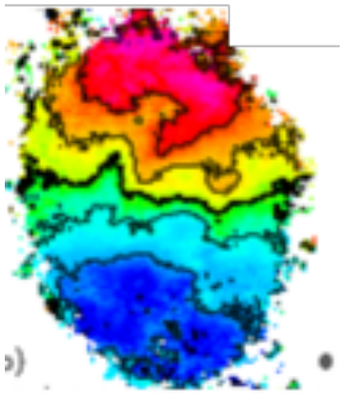
Unresolved HI

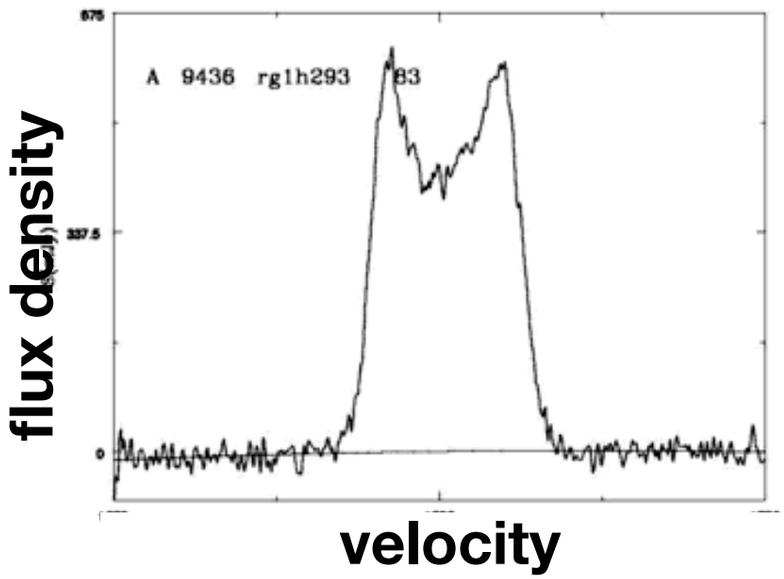
~50 kpc



Unresolved HI

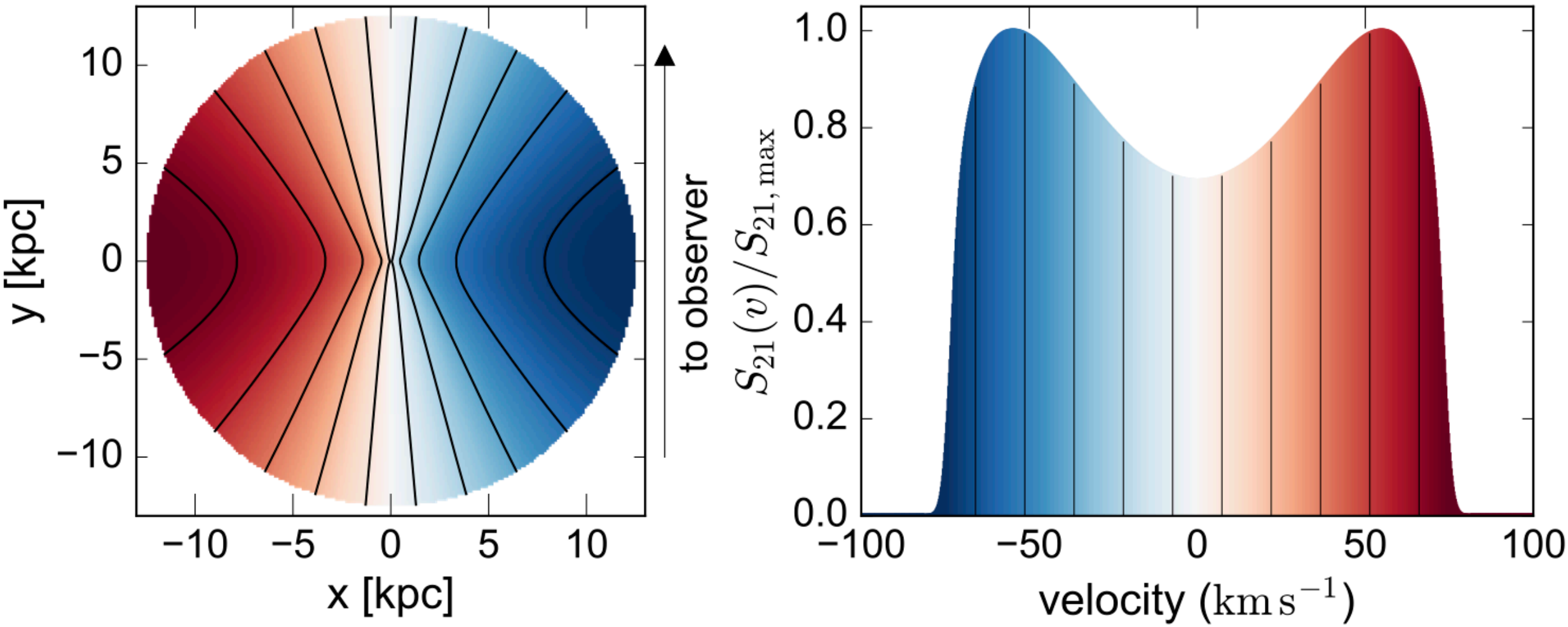
~50 kpc





available for
~50,000 galaxies;
morphologically blind

Unresolved observations contain kinematic information



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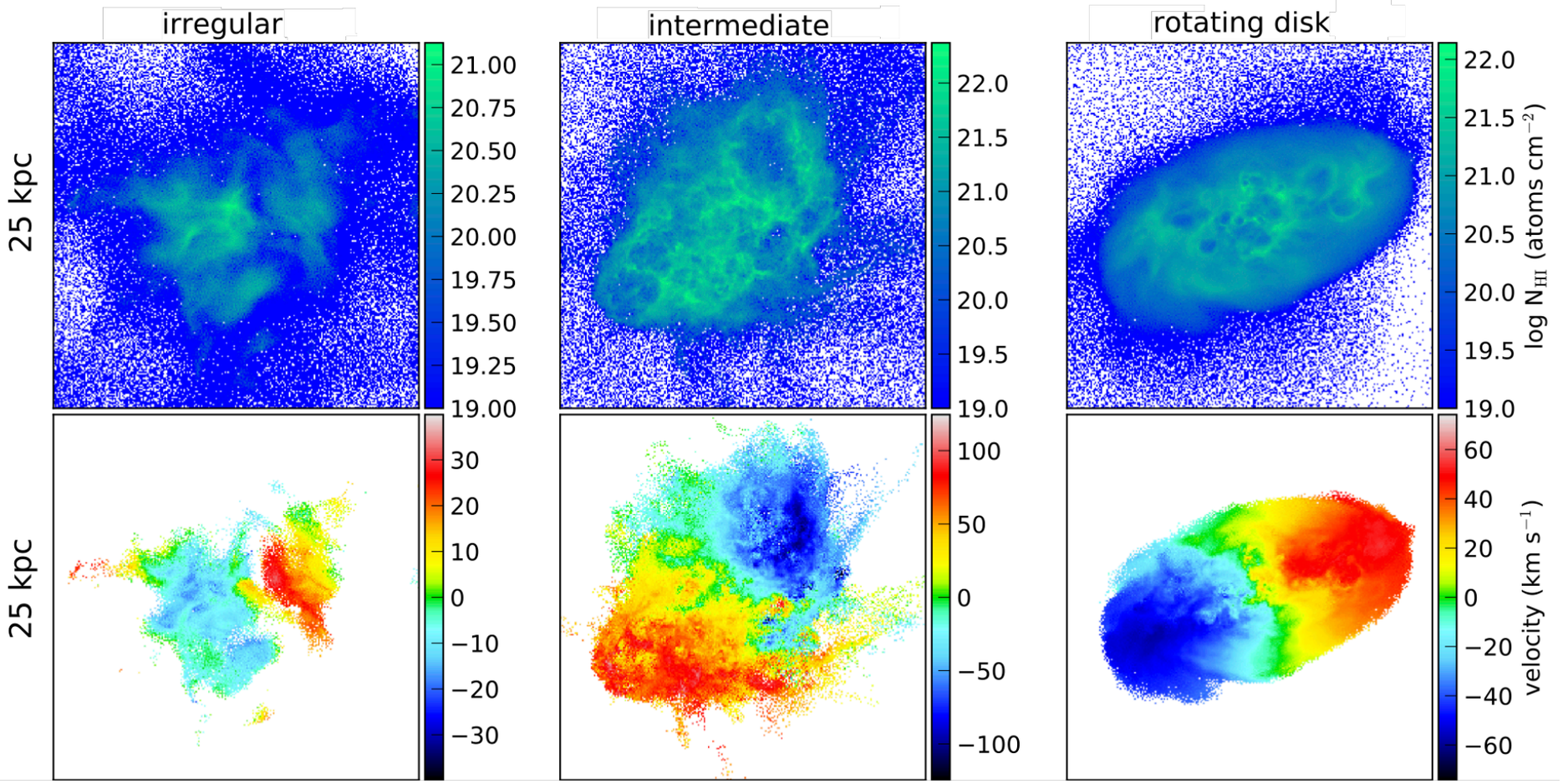

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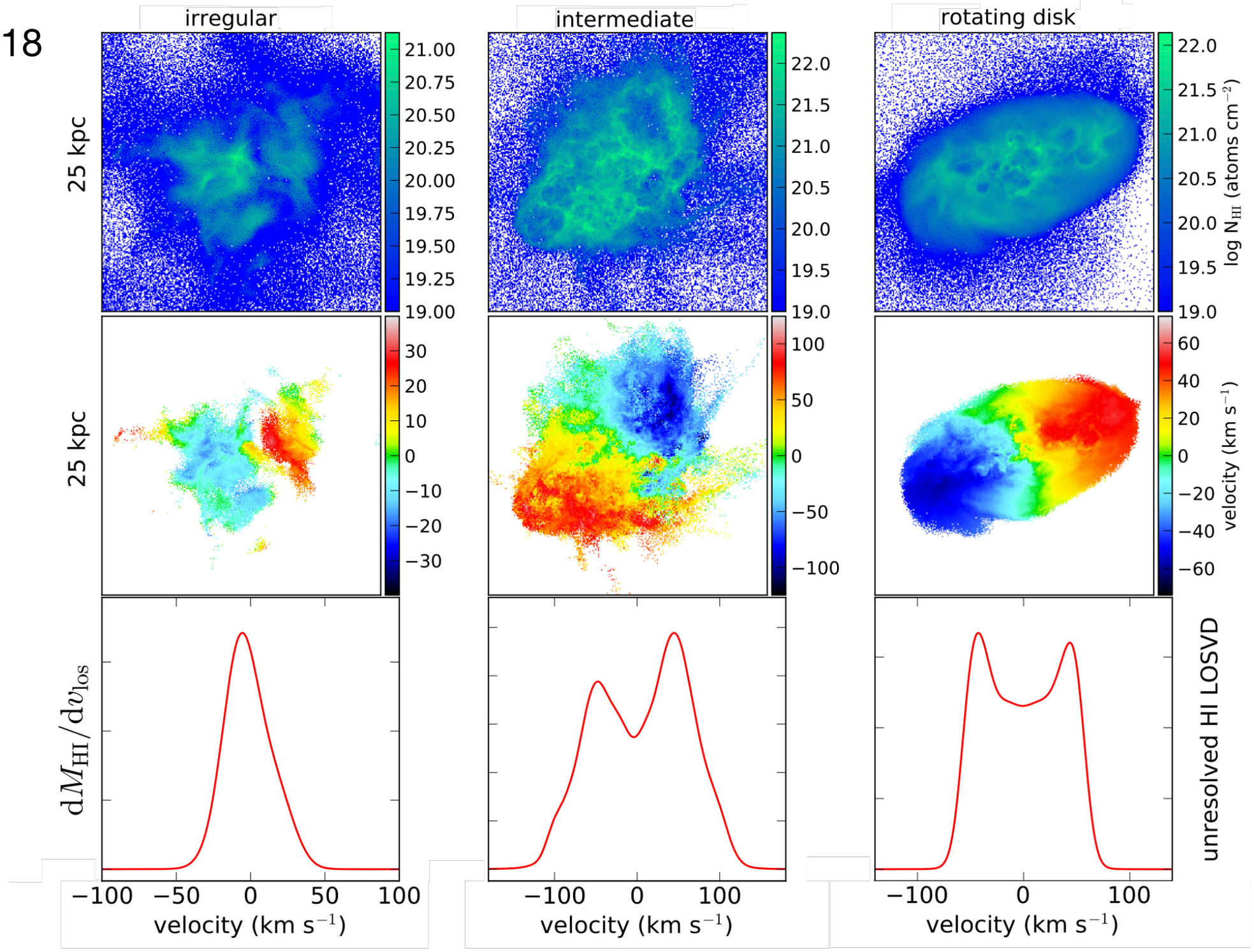
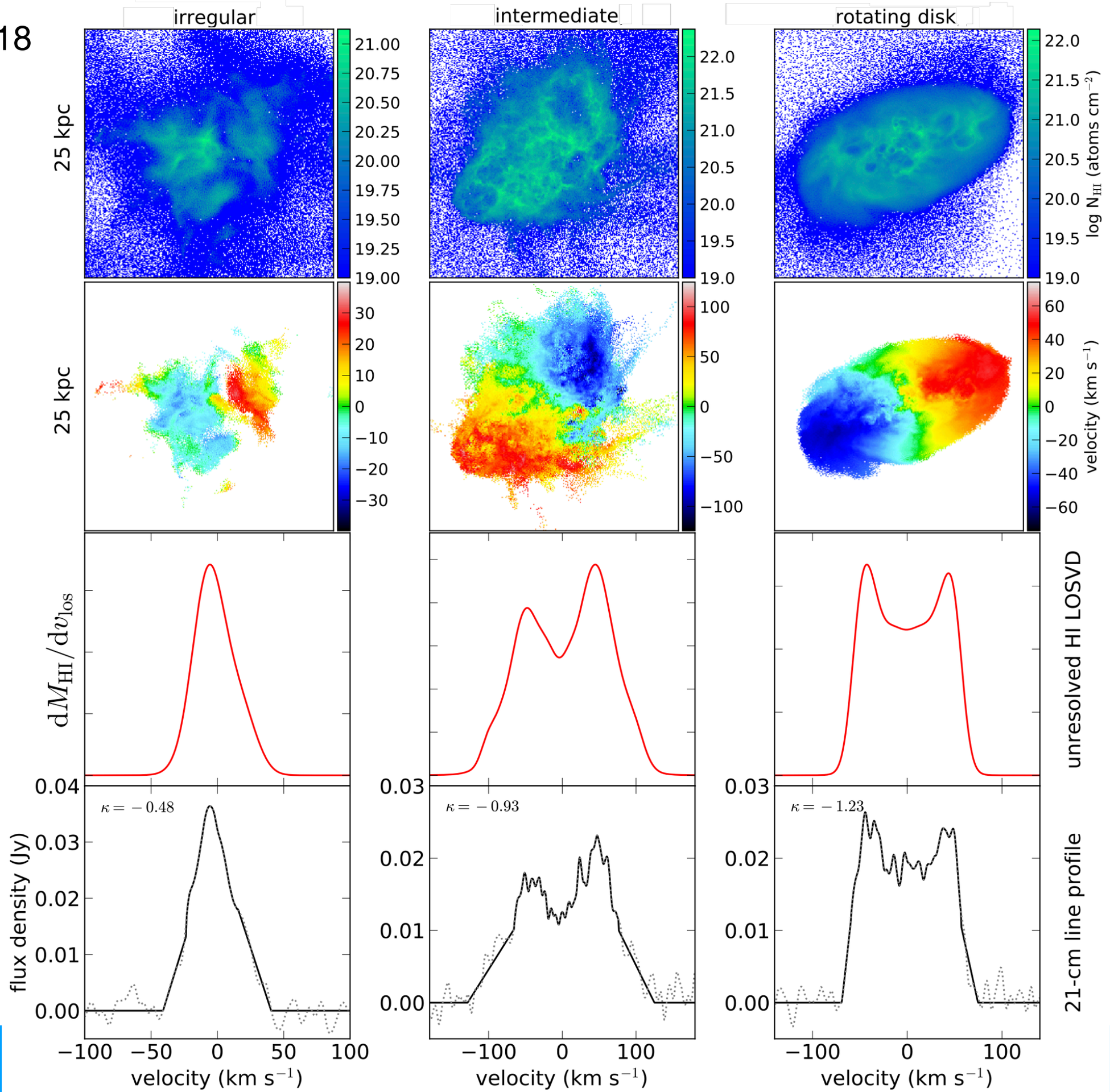
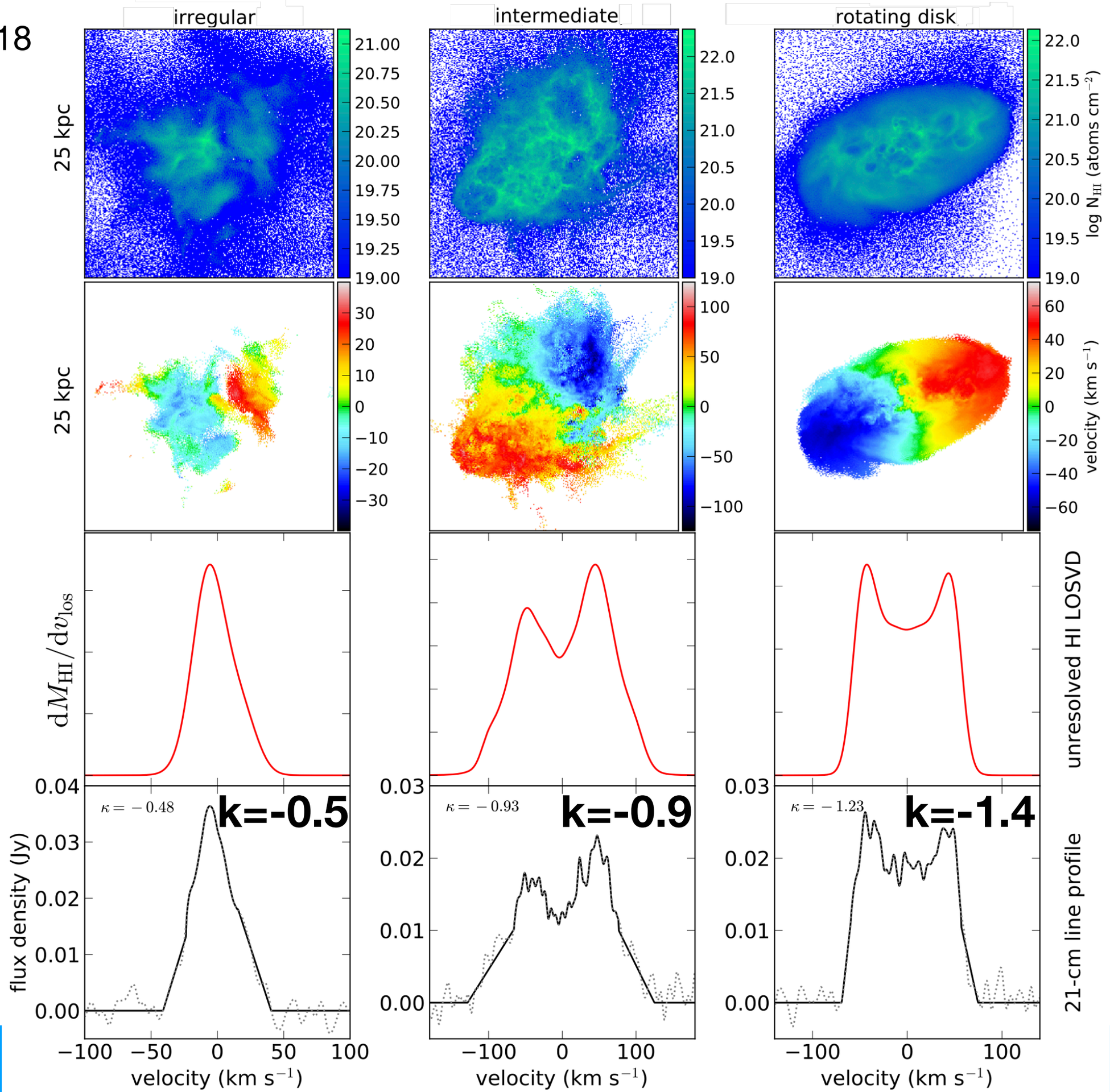

irregular
intermediate
rotating disk
25 kpc
25 kpc
21.00
20.75
20.50
20.25
20.00
19.75
19.50
19.25
19.00
22.0
21.5
21.0
20.5
20.0
19.5
19.0
22.0
21.5
21.0
20.5
20.0
19.5
19.0
log N_{HI} (atoms cm^{-2})
30
20
10
0
−10
−20
−30
100
50
0
−50
−100
60
40
20
0
−20
−40
−60
velocity (km s^{-1})
dM_{HI}/dv_{los}
−100 −50 0 50 100
velocity (km s^{-1})
−100 0 100
velocity (km s^{-1})
−100 0 100
velocity (km s^{-1})
unresolved HI LOSVD

El-Badry+18



Kareem

El-Badry+18



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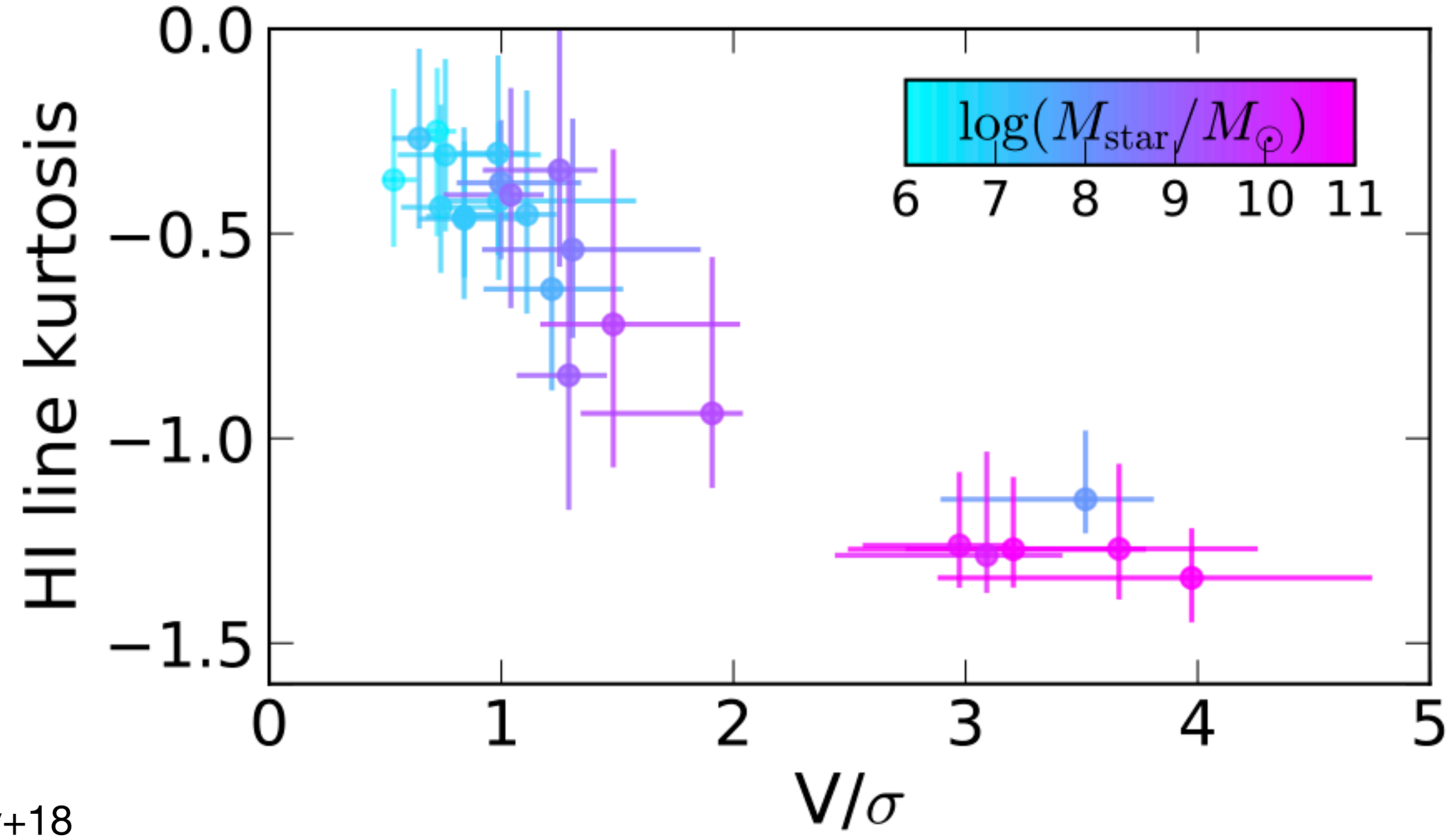
HI line kurtosis is sensitive to V/σ



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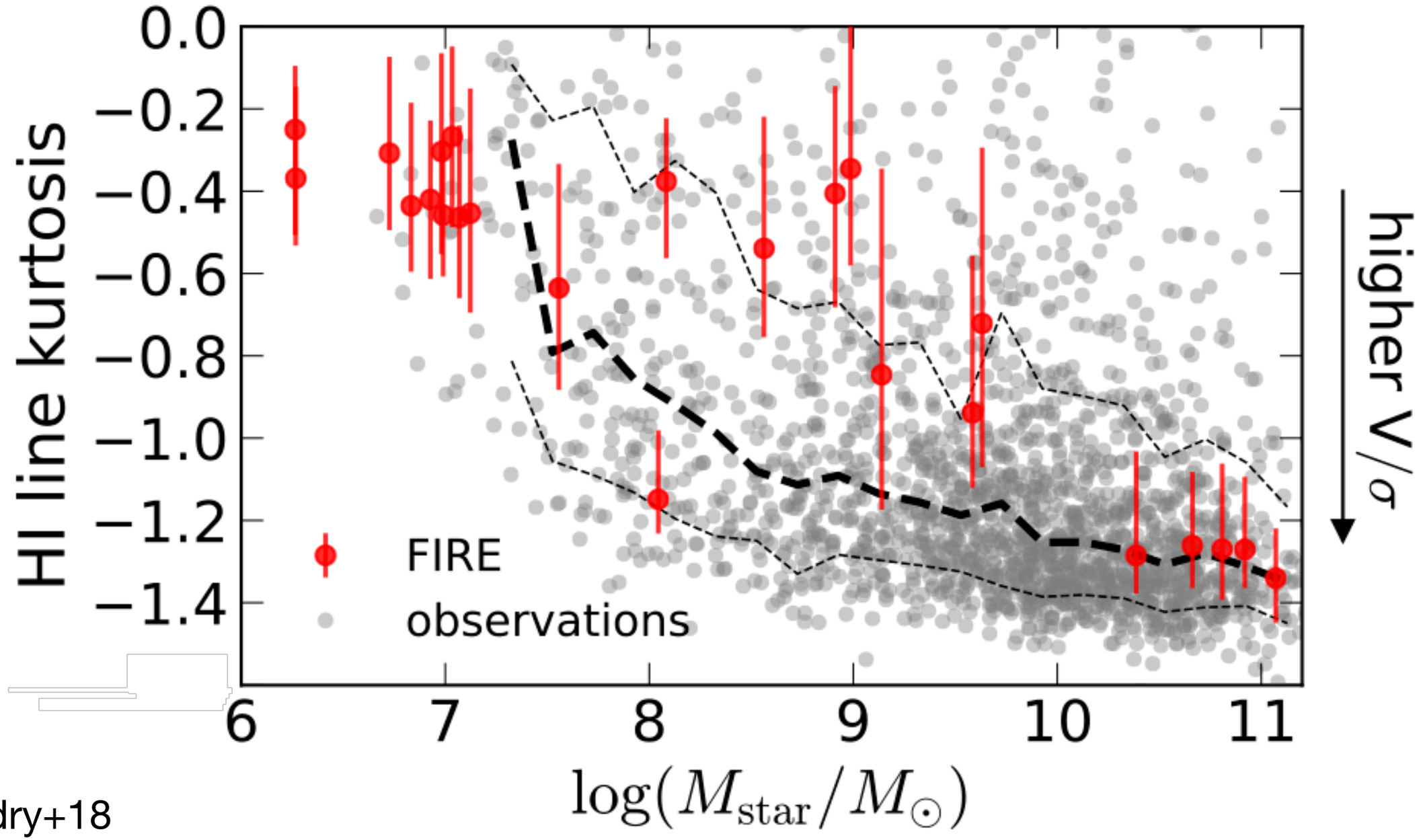
comparison to observations



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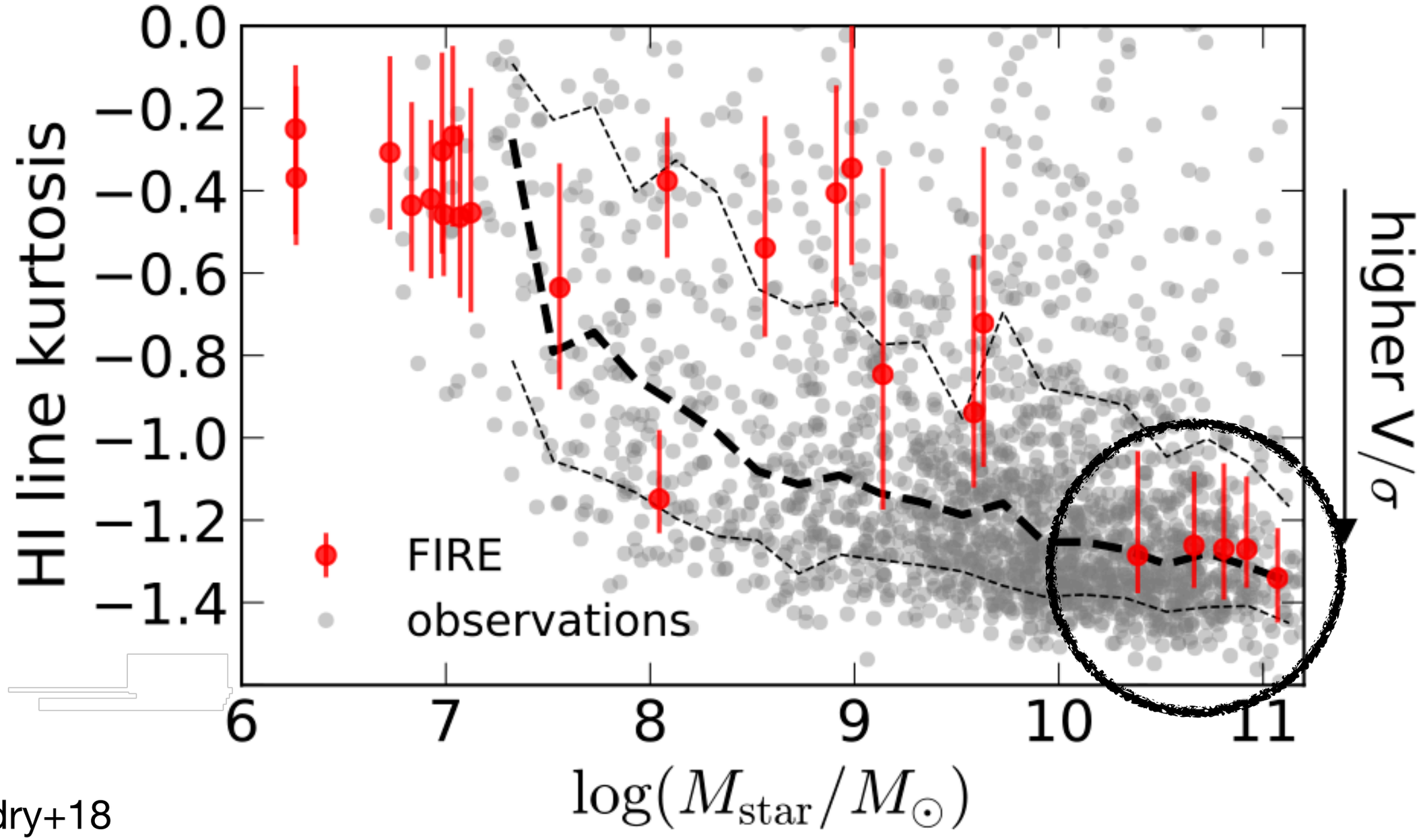
agreement at MW-masses



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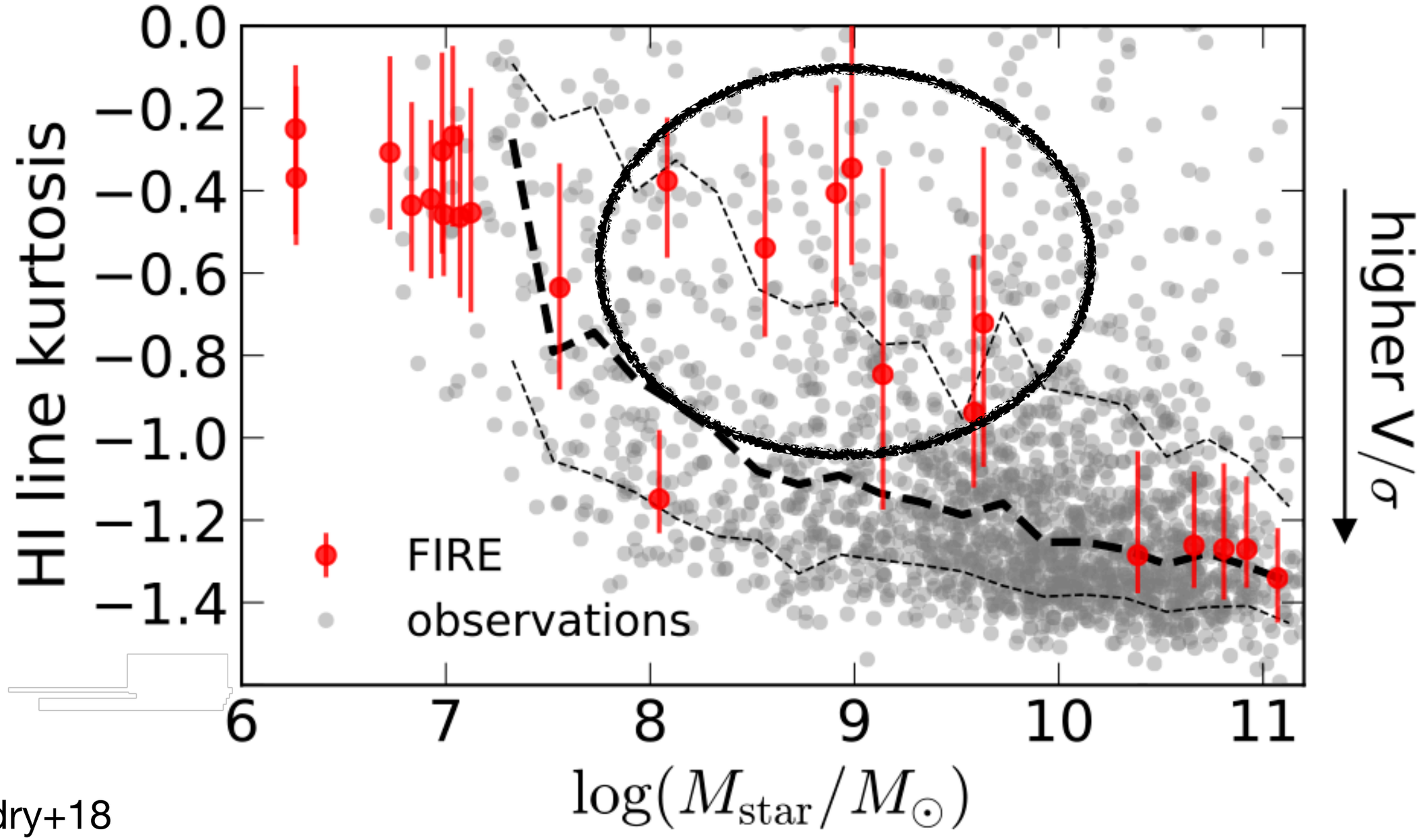
overly dispersion-supported at low/intermediate masses



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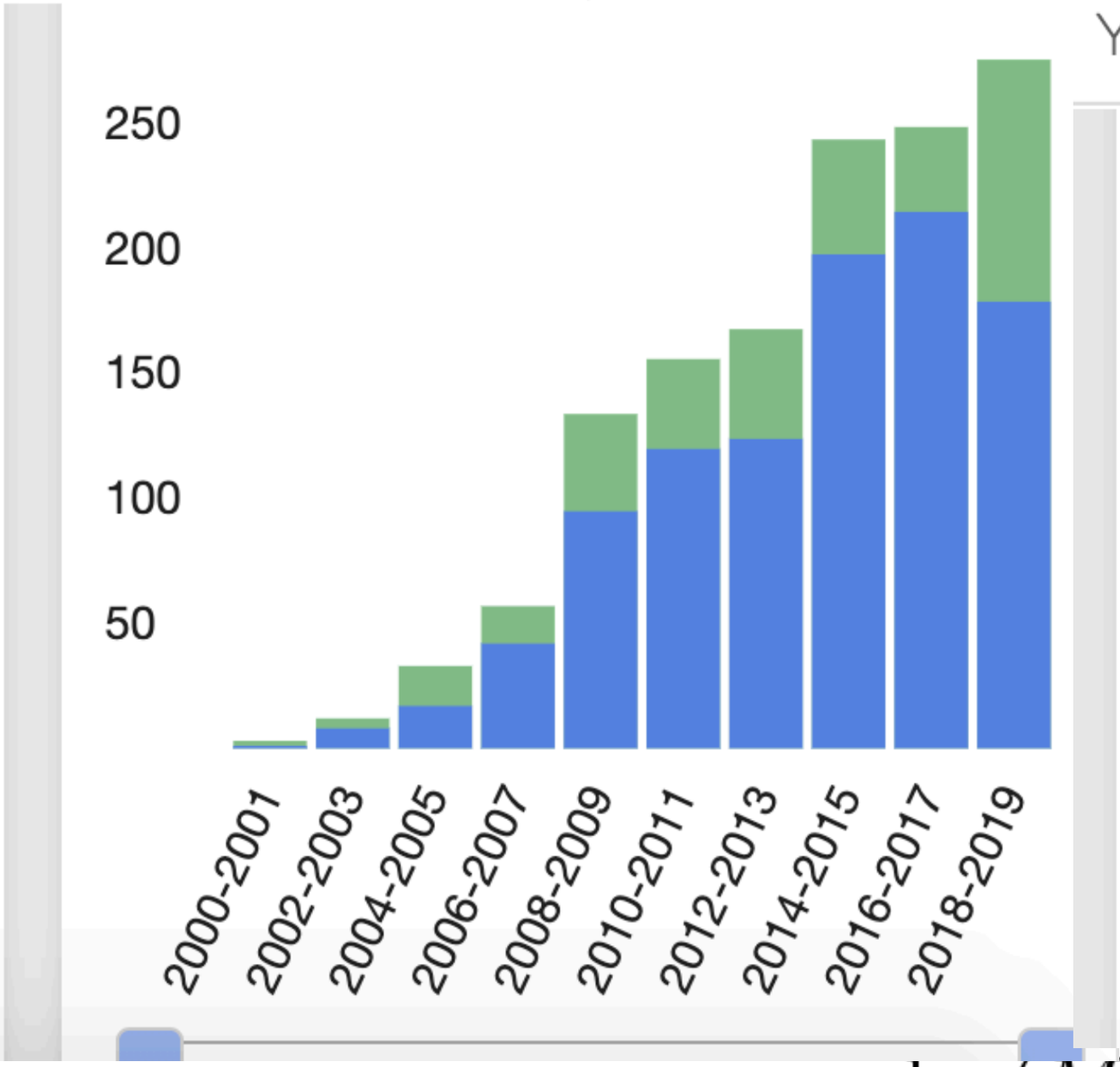
QUICK FIELD: Author First Author Abs

full:"missing satellites problem"

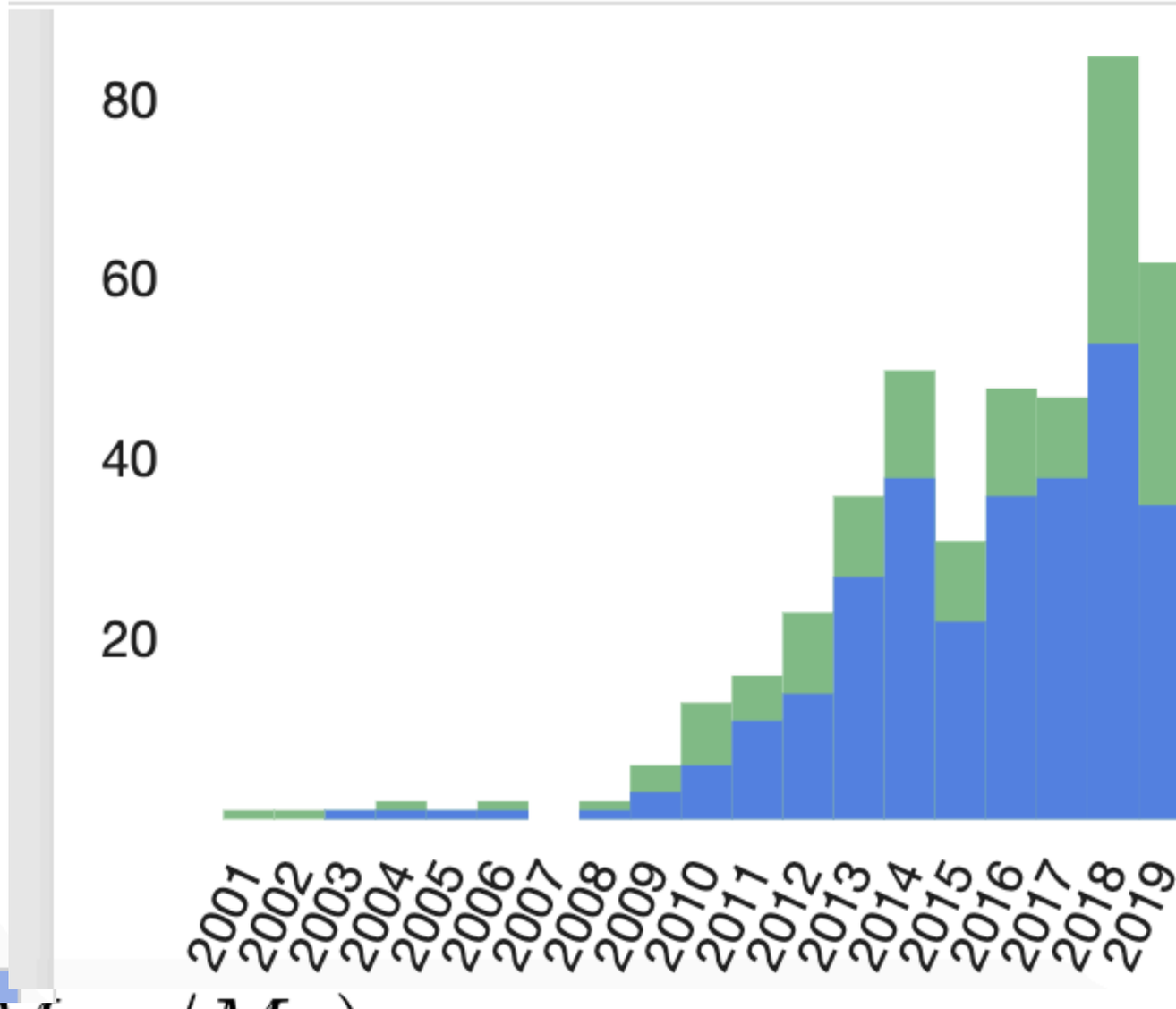
Your search returned **1,332** results



QUICK FIELD: Author First Author Abs

full:"core-cusp problem"

Your search returned **891** results



$\log(M_{\rm star}/M_\odot)$

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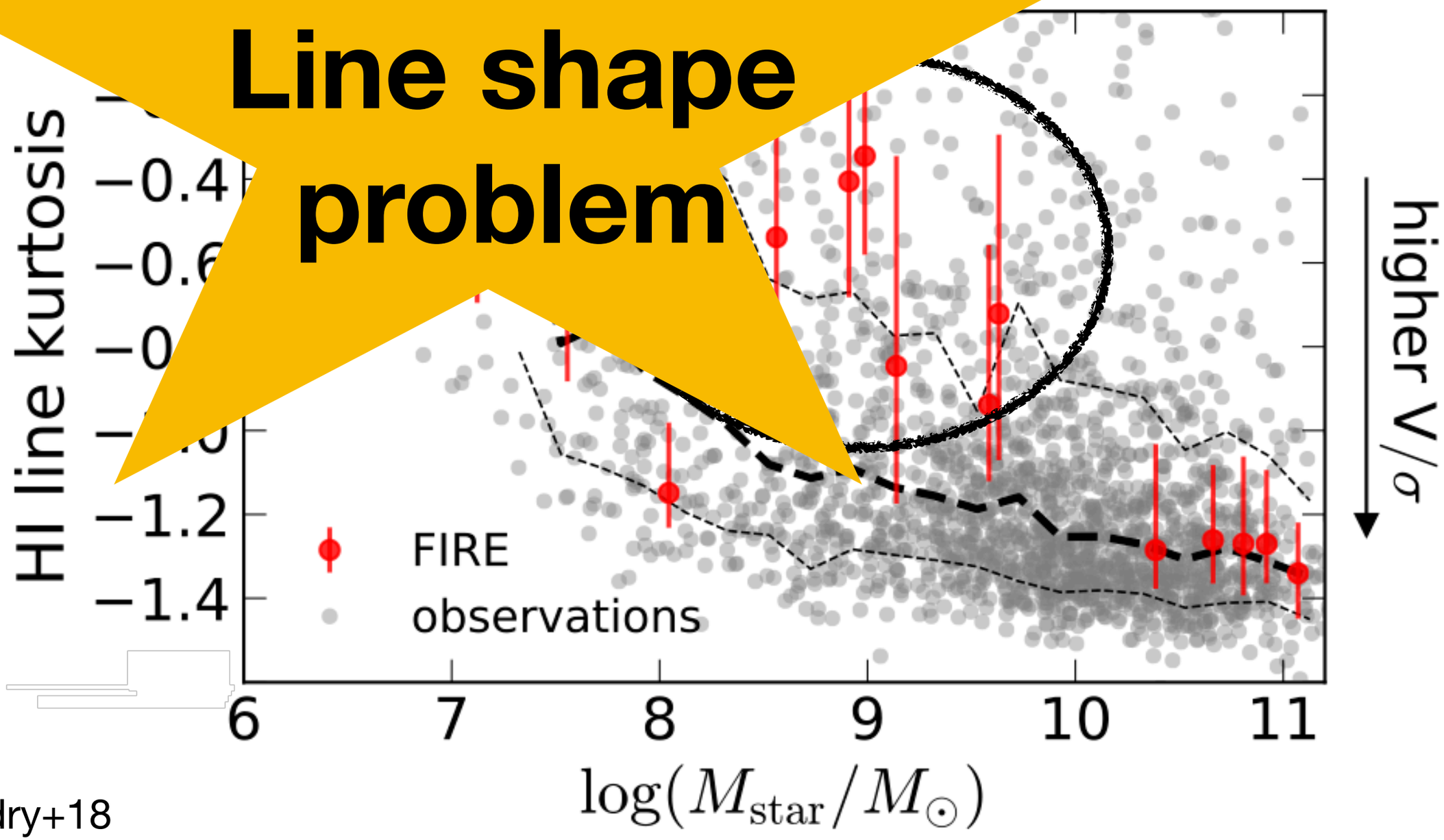
overly dispersion-supported
at low/intermediate masses

Line shape problem



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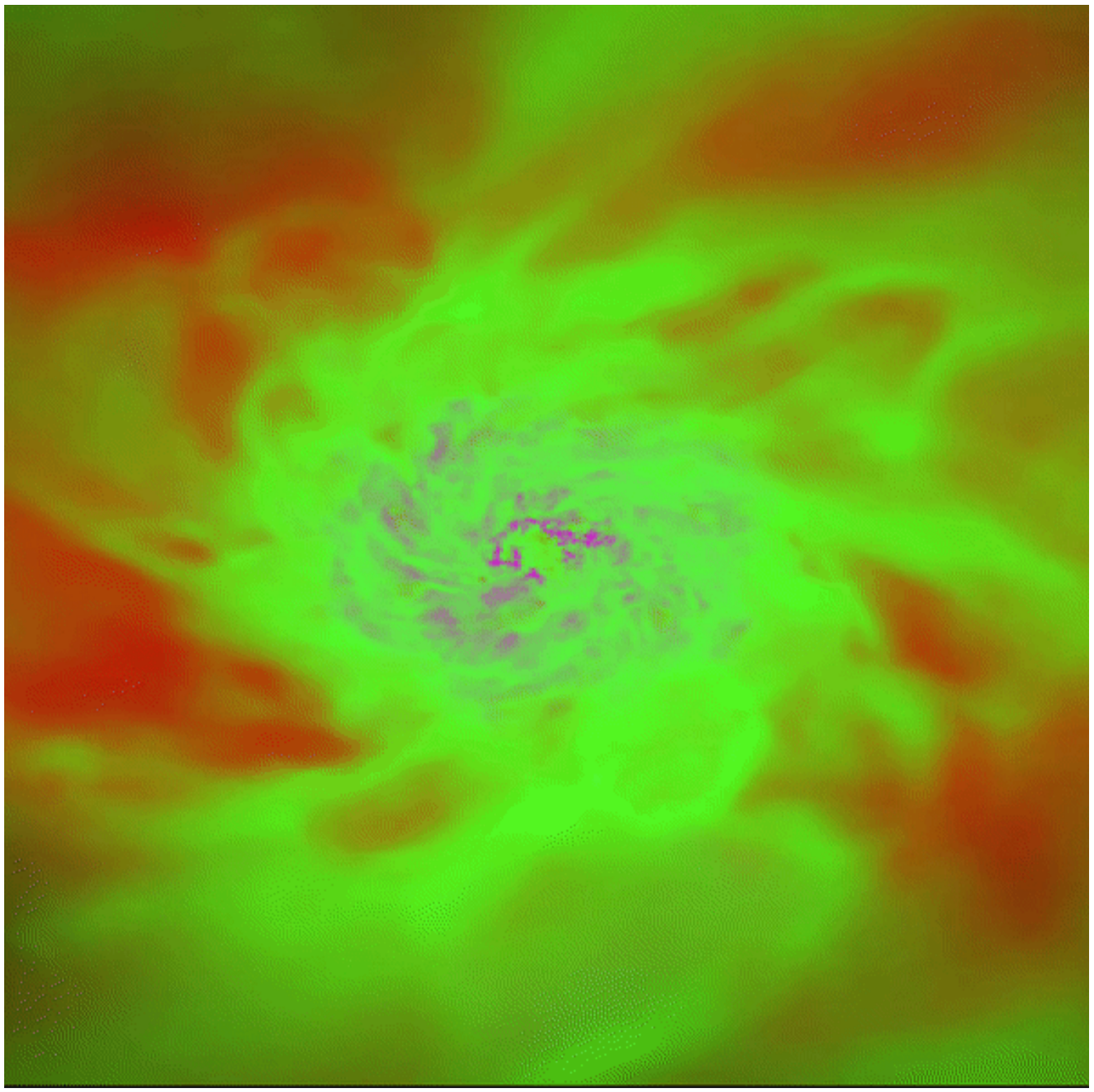
Non-cosmological simulations

- Idealized setup: NFW halo + gas in hydrostatic equilibrium
- “normal” angular momentum; $\lambda = 0.03$
- run for 10 Gyr with same physics as cosmological sims.

Non-cosmological simulations

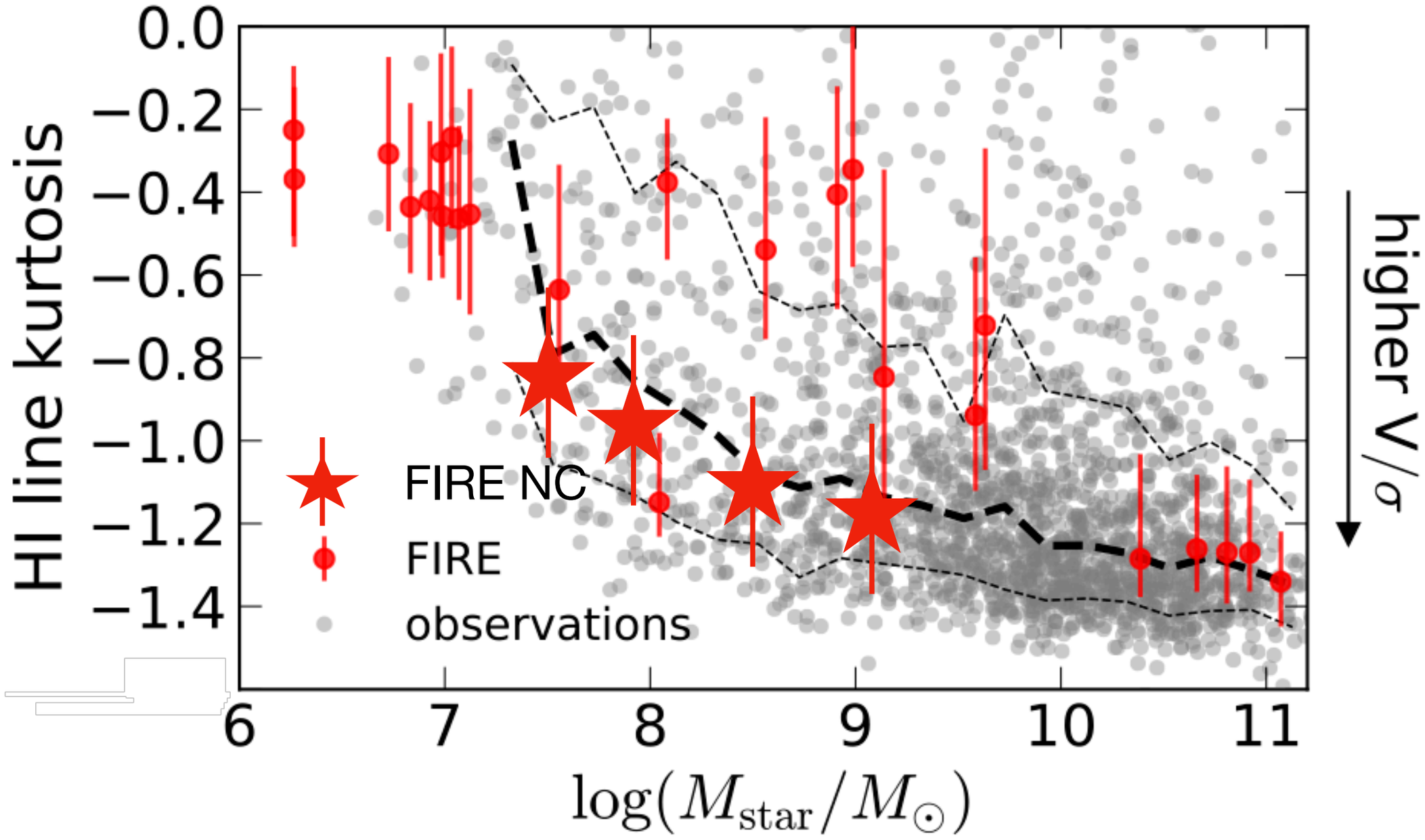


- Disks form and survive!

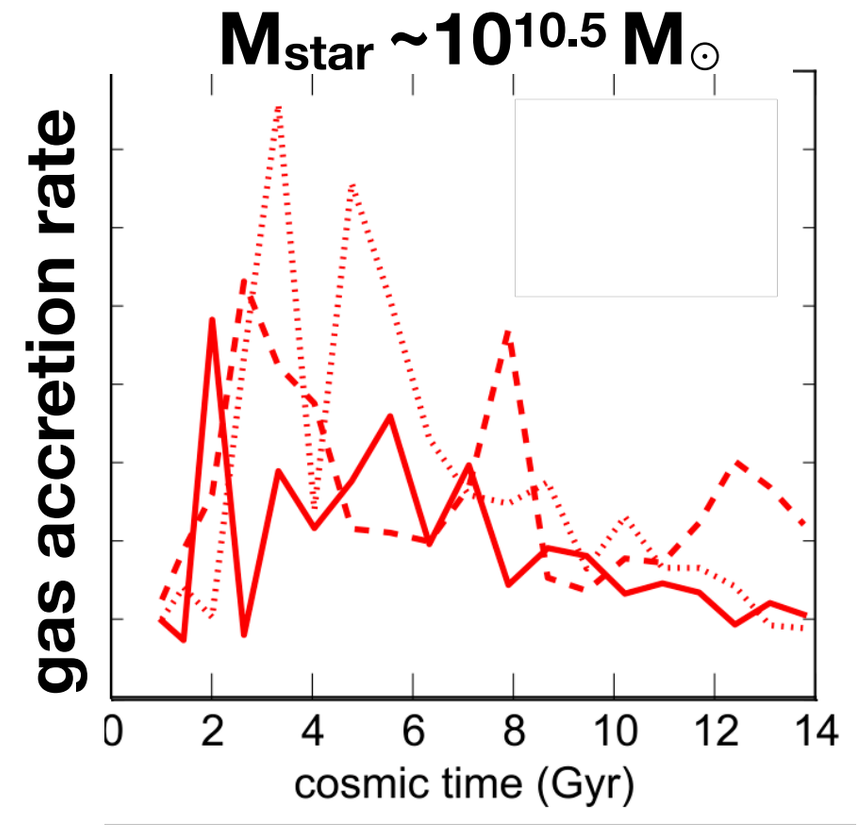
M_{star} ~ 1e8 $M_\odot$

green: T ~ 1e4 K
purple: T < 1e3 K
red: T > 1e5 K

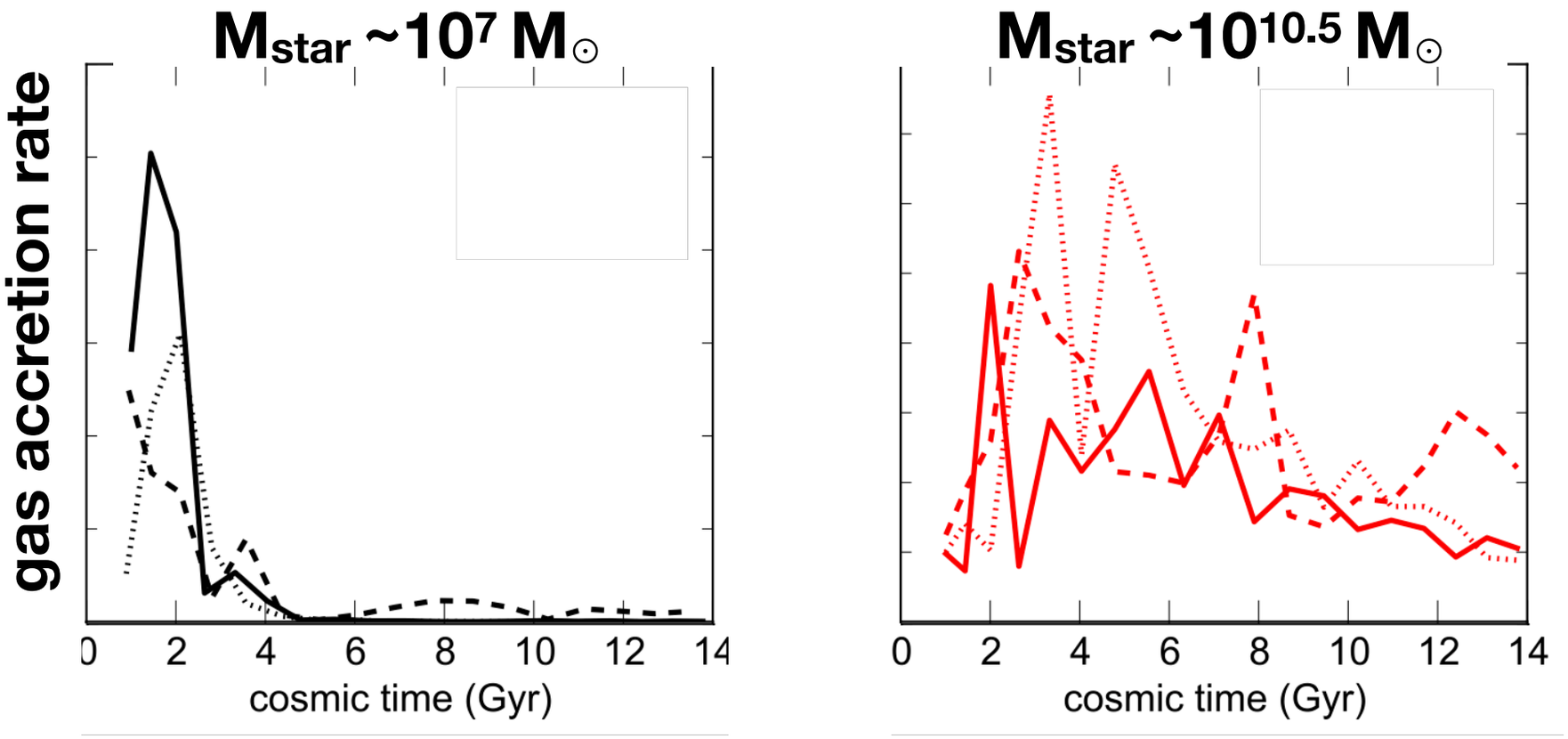
Non-cosmological sims: better agreement with observations



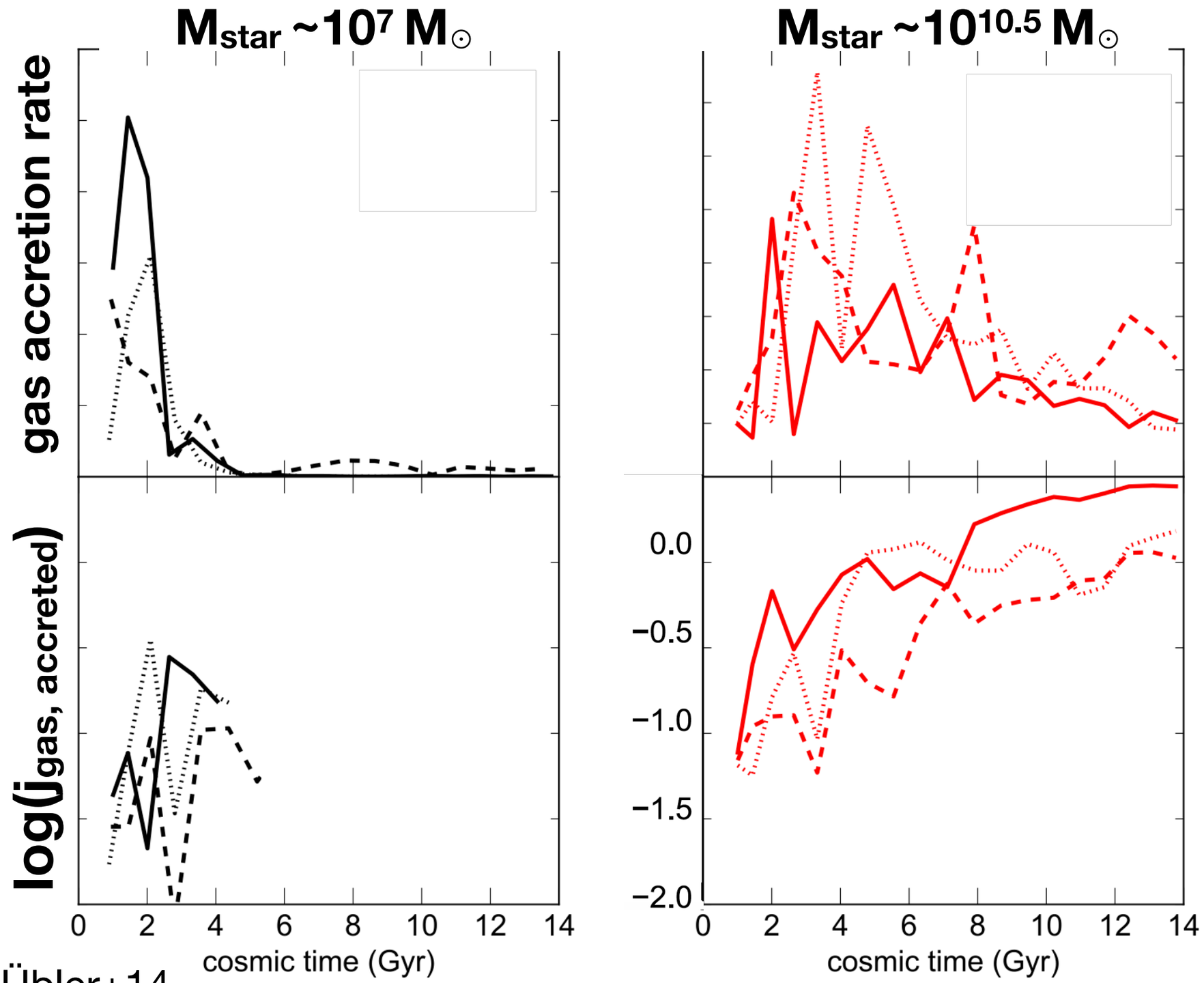
MW-mass galaxies accrete until z=0



Dwarfs accrete mostly at early times



Gas accreted late has higher angular momentum

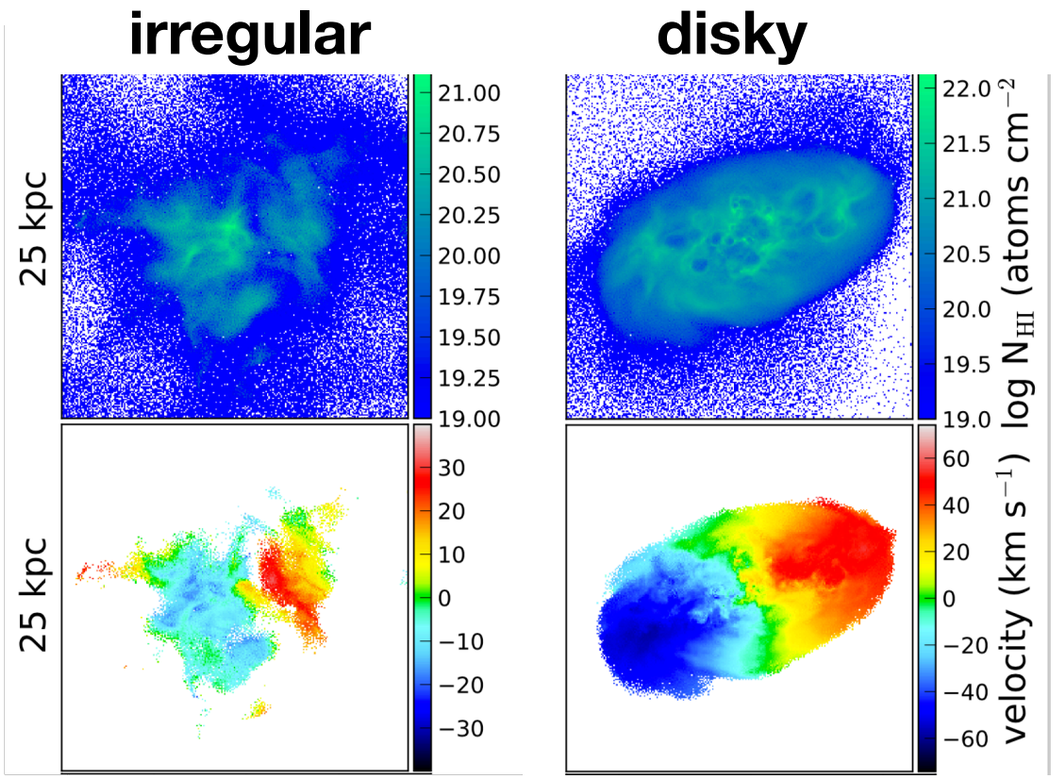


see also Brook+11; Übler+14

Both galaxies have:

$$M_{\rm star} = 10^8 M_\odot$$

$$M_{\rm vir} = 5 \times 10^{10} M_\odot$$



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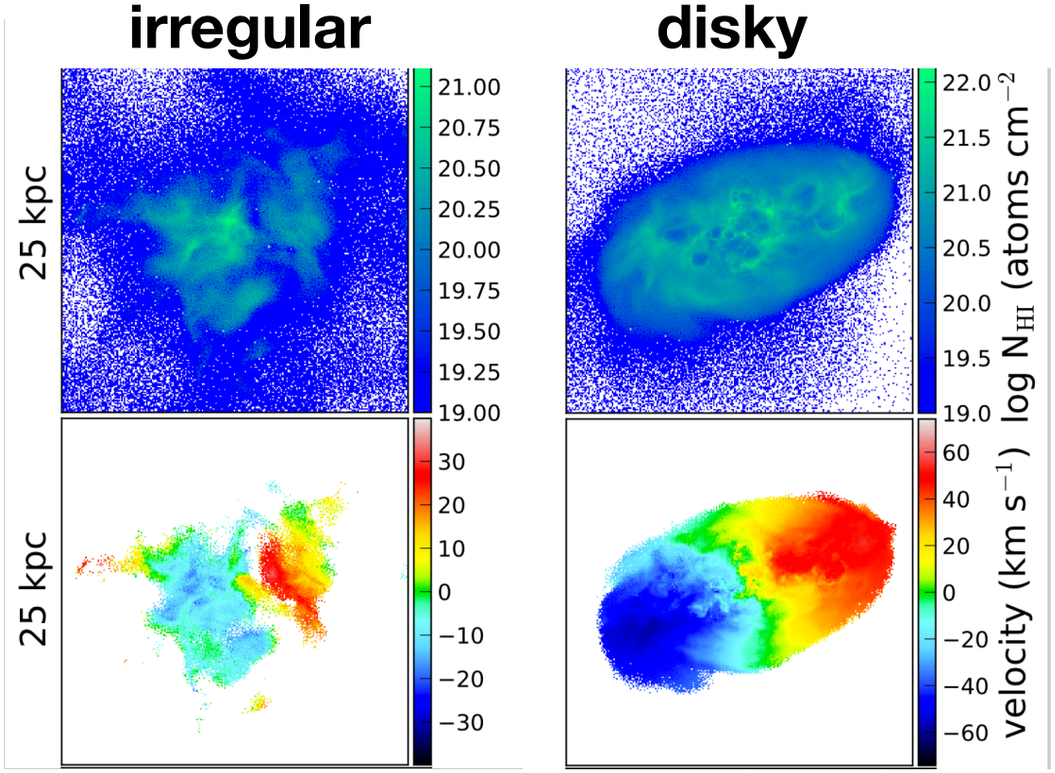

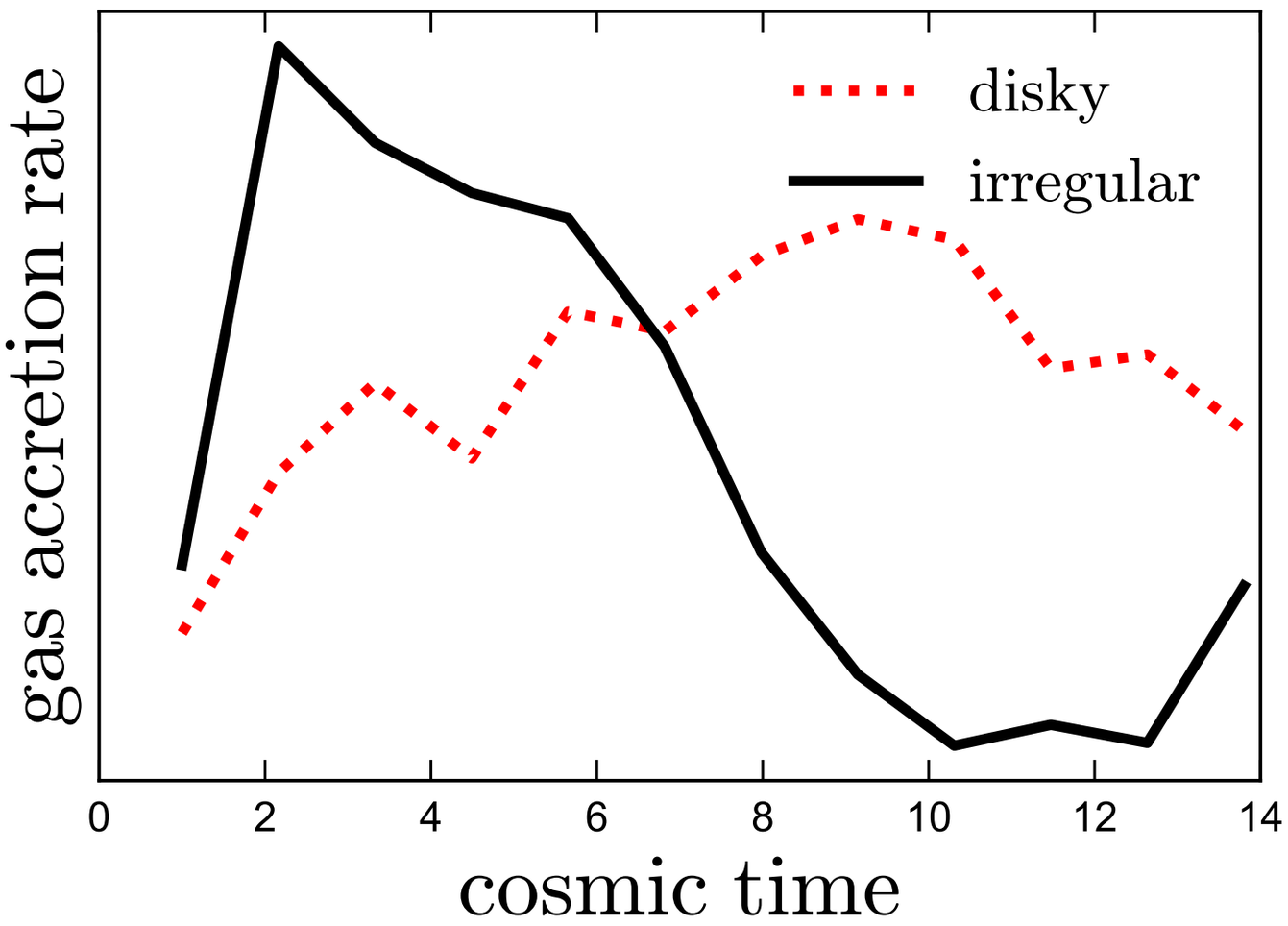

Summary

- FIRE cosmological simulations produce a diversity of dwarf galaxy morphologies and kinematics.

- On average, simulated galaxies are more dispersion supported and less disky than observed.

- Idealized non-cosmological simulations with the same ingredients make diskier dwarfs on average.

- In cosmological simulations, feedback & UV background prevent dwarfs from accreting high-angular momentum gas at late times.

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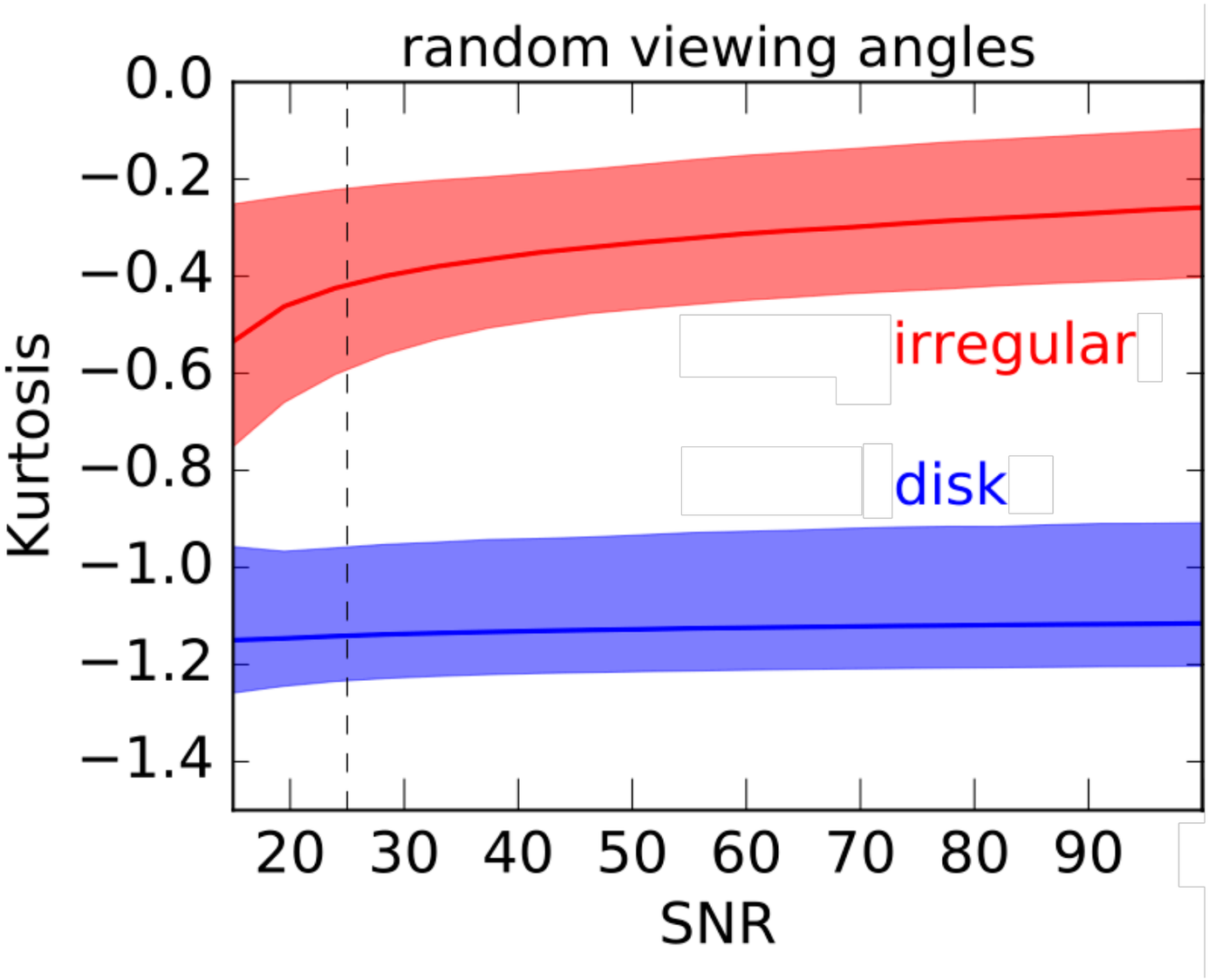
Kurtosis is insensitivity to SNR



KE,
Bradford,
Geha+18

Kareem El-Badry

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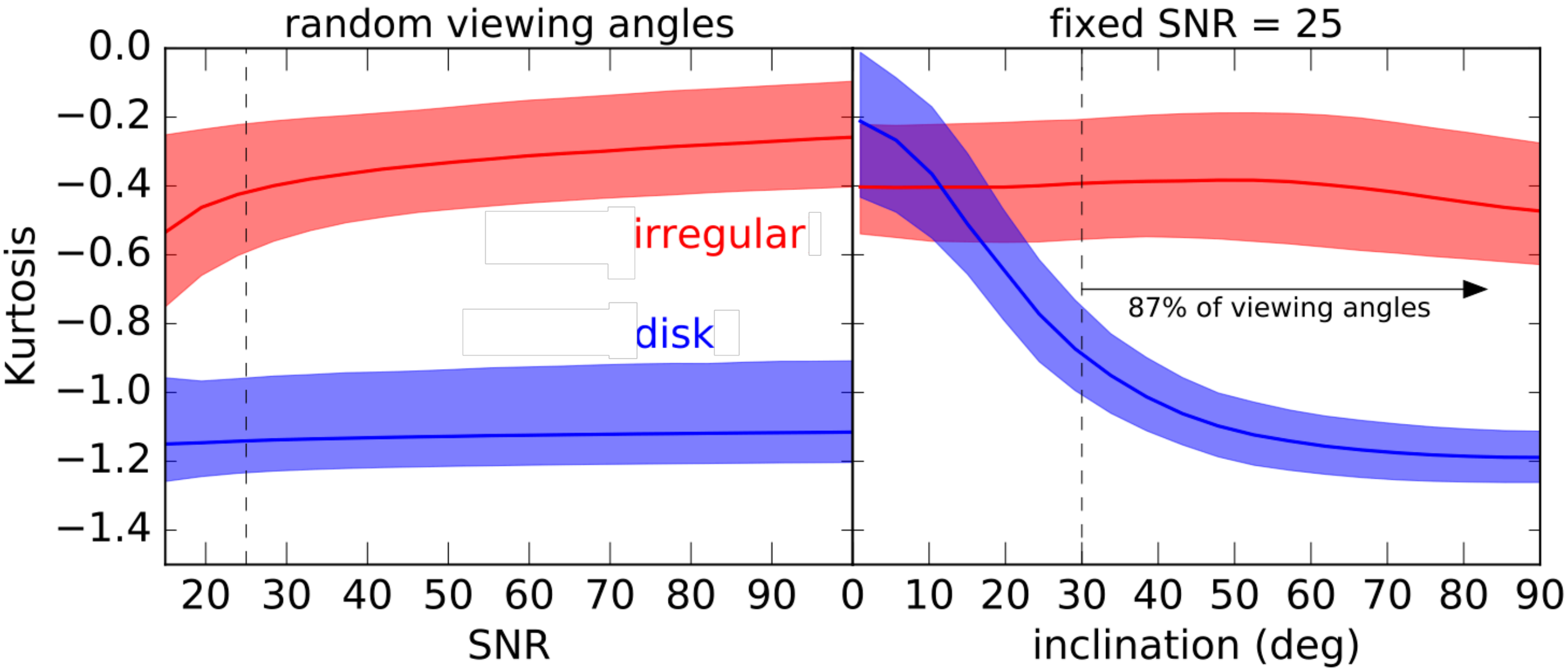

KE, Bradford, Geha+18

…but sensitive to inclination.