Baryonic Tully-Fisher relation at low-mass end

Huijie Hu (胡慧杰) UCAS

Collaborators: Qi Guo, Zheng Zheng, Hang Yang, Chao-Wei Tsai, Hong-Xin Zhang (USTC), Zhi-Yu Zhang (NJU), Yu Rong (USTC), Qing Gu, Shihong Liao (University of Helsinki)

Shanghai 2023/11/2

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Baryon-dynamical relations

Lelli 2022 Nature Astronomy

Baryonic Tully-Fisher relation (BTFR) Central density relation (CDR) Radial acceleration relation (RAR)

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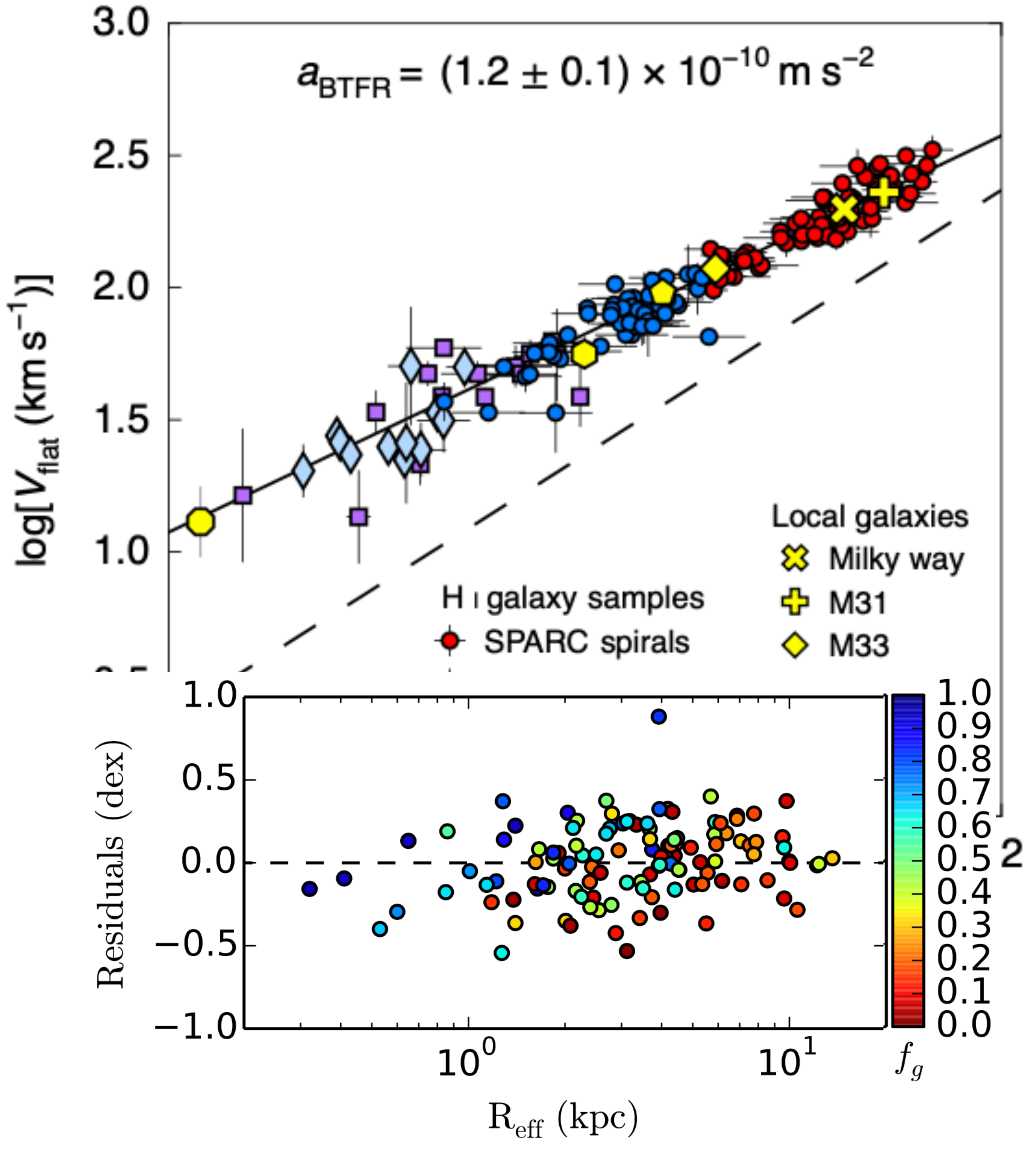
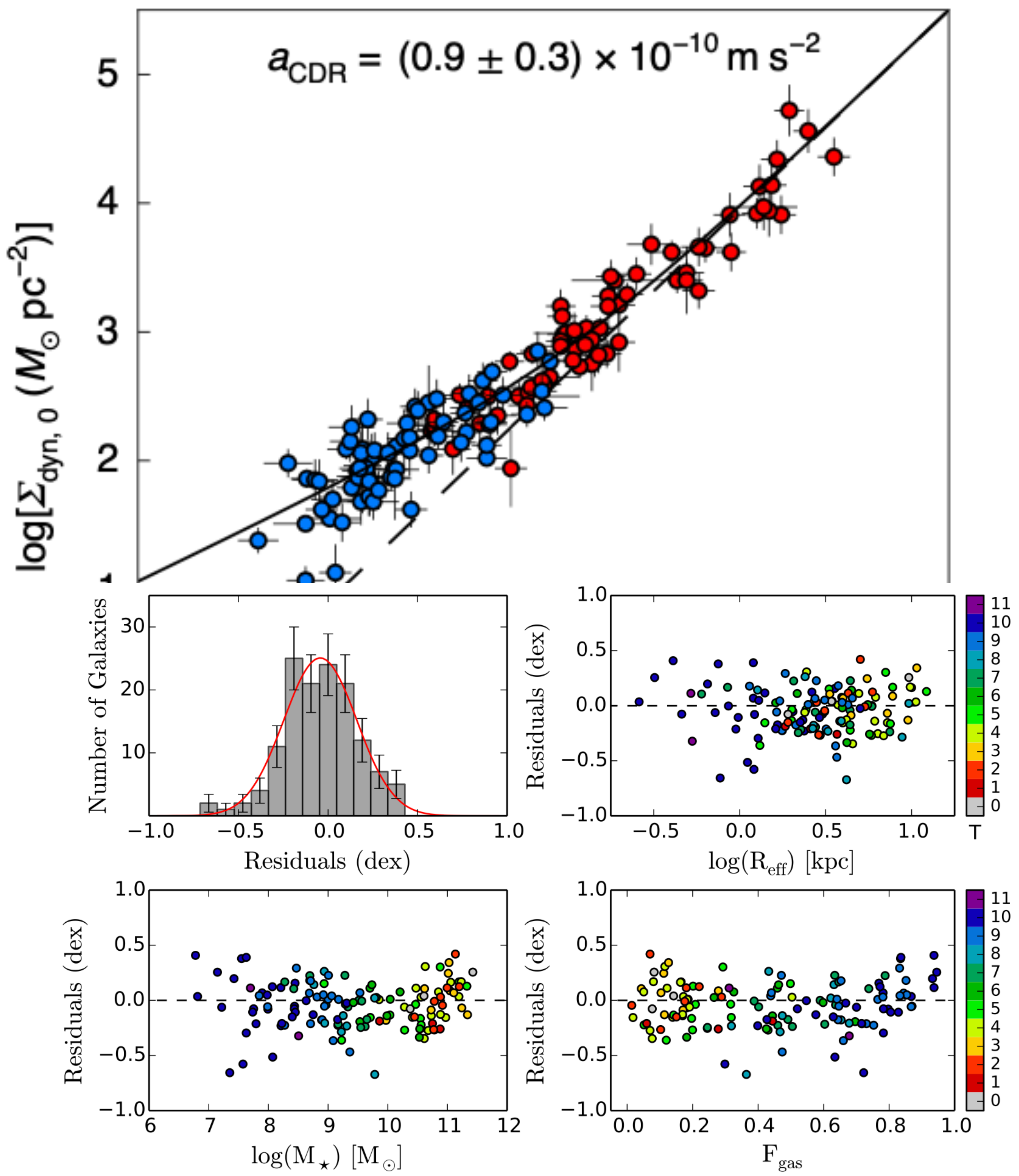
Baryonic Tully-Fisher relation (BTFR)



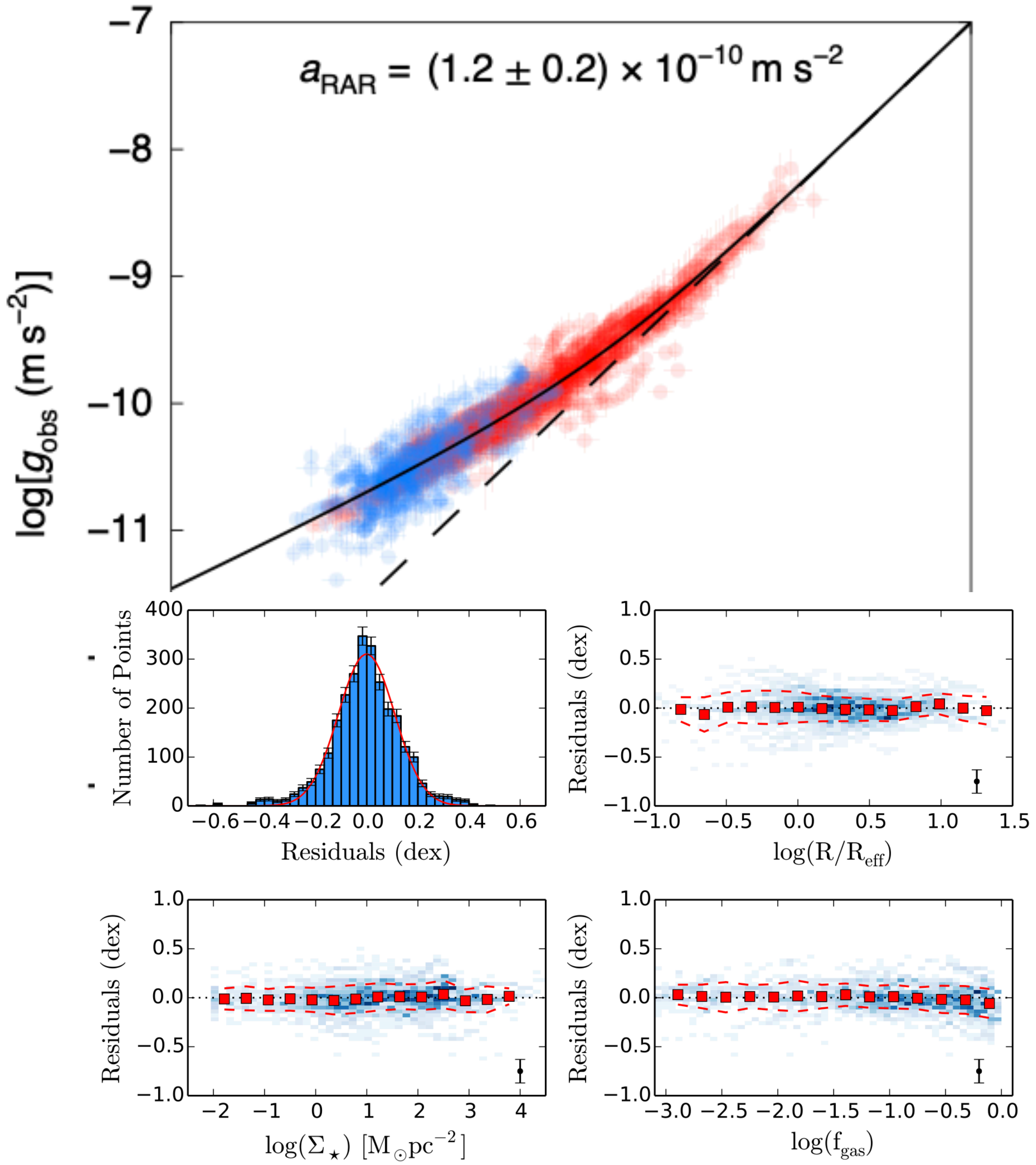
Lelli+2016a ApJL

Central density relation (CDR)



Lelli+2017 ApJ

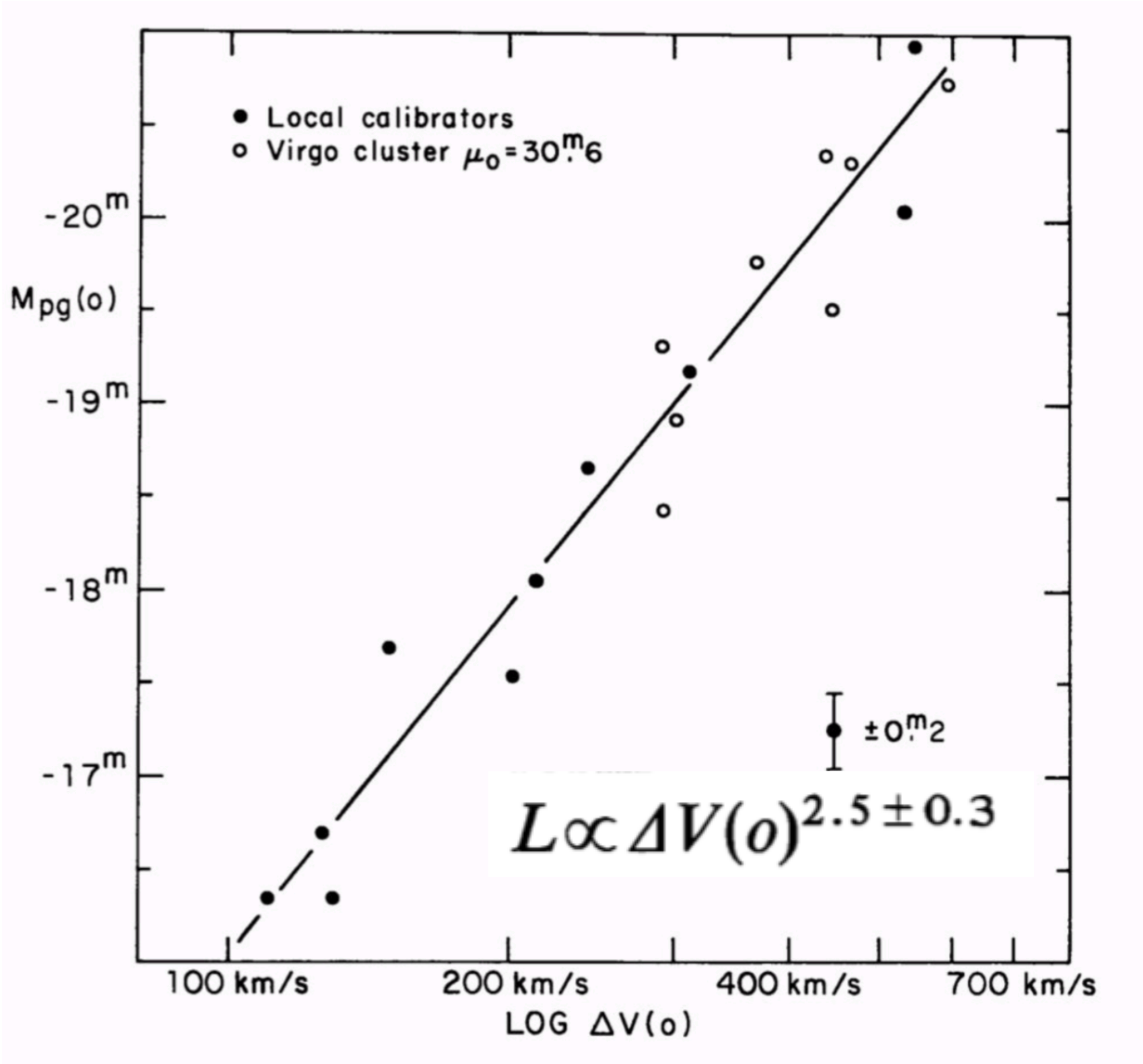
Radial acceleration relation (RAR)



Lelli+2016b ApJL

(Baryonic) Tully-Fisher relation

Sb & Sc with accurate distance   Tully & Fisher 1977 A&A



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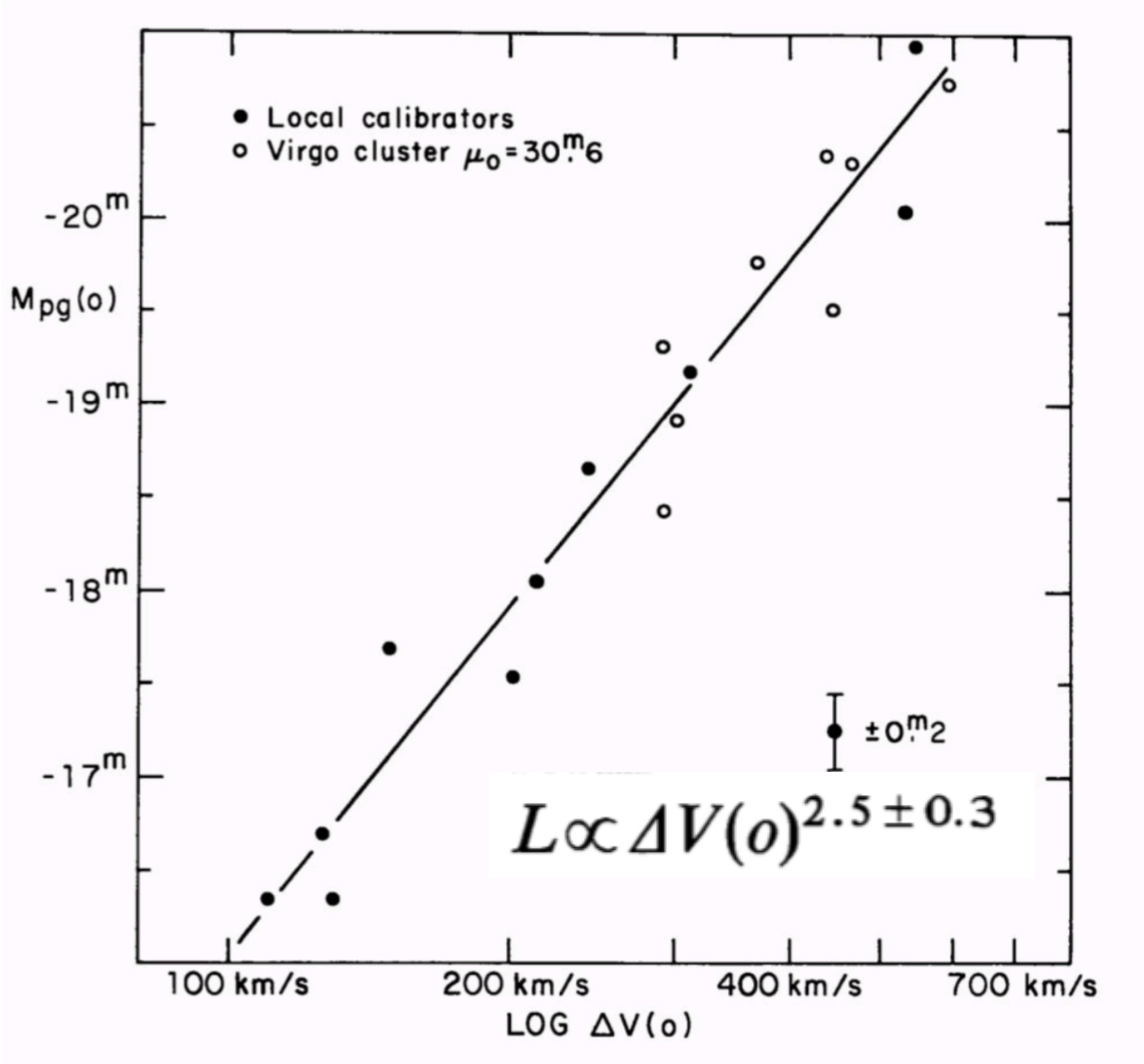

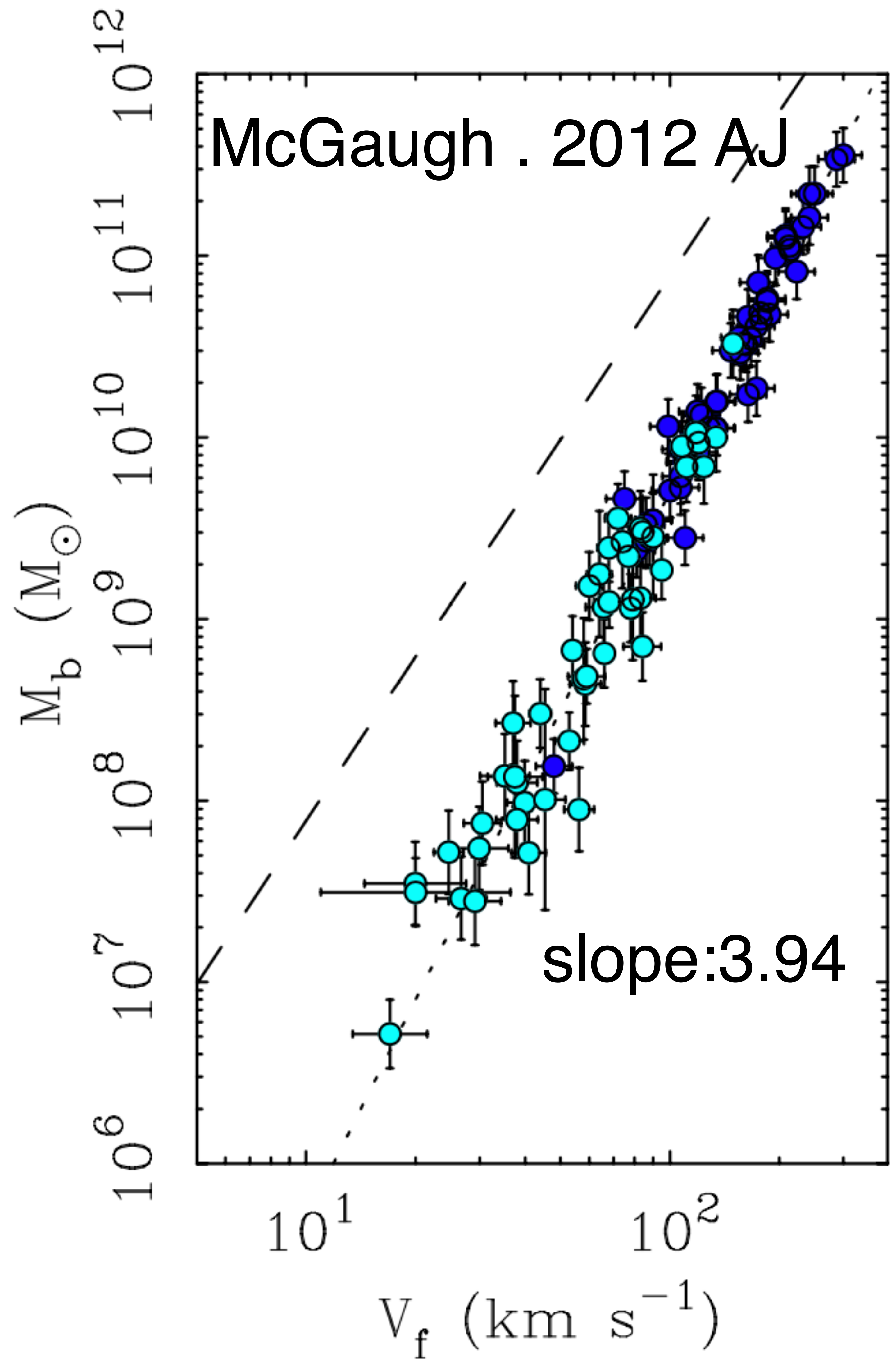

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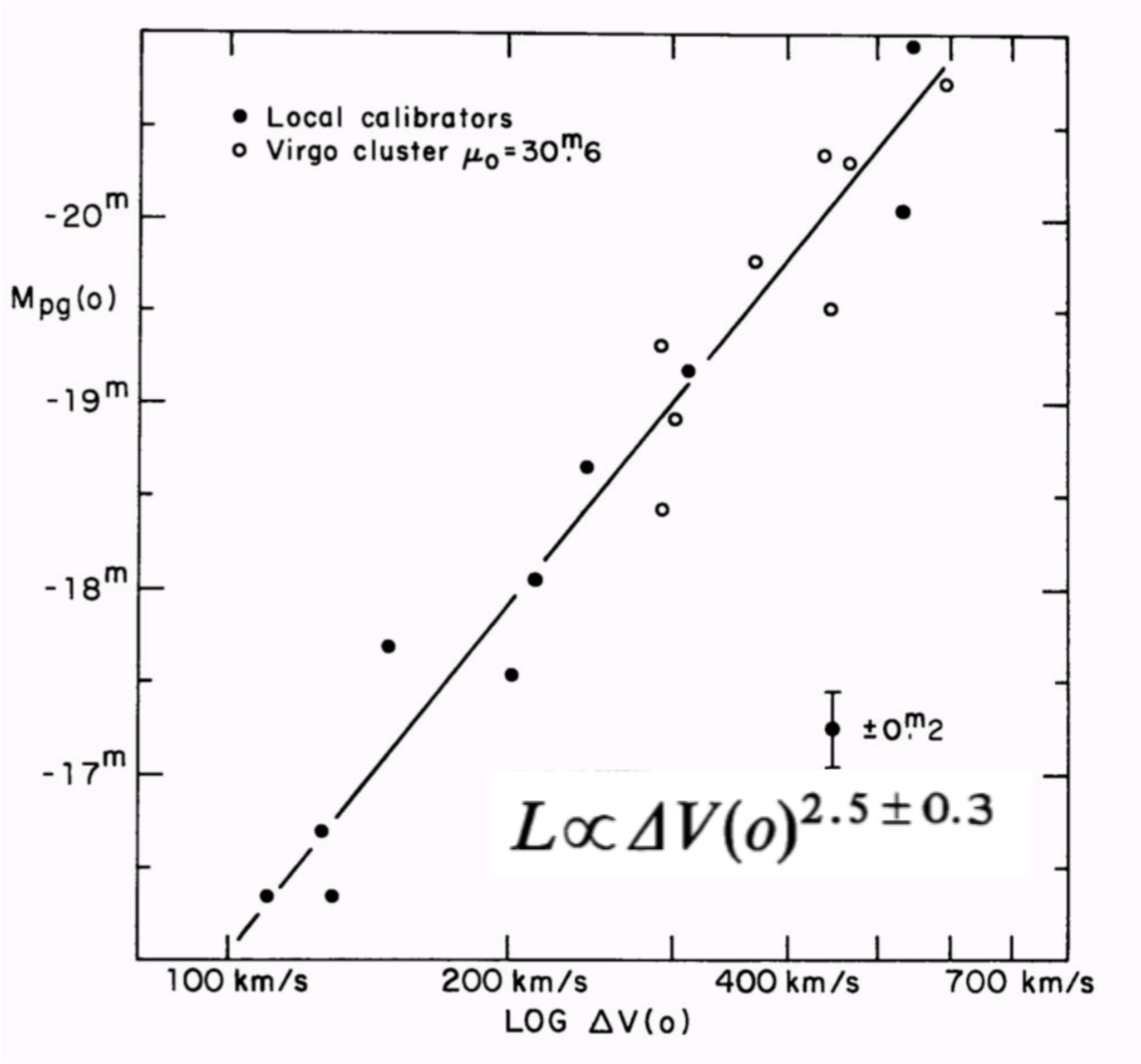
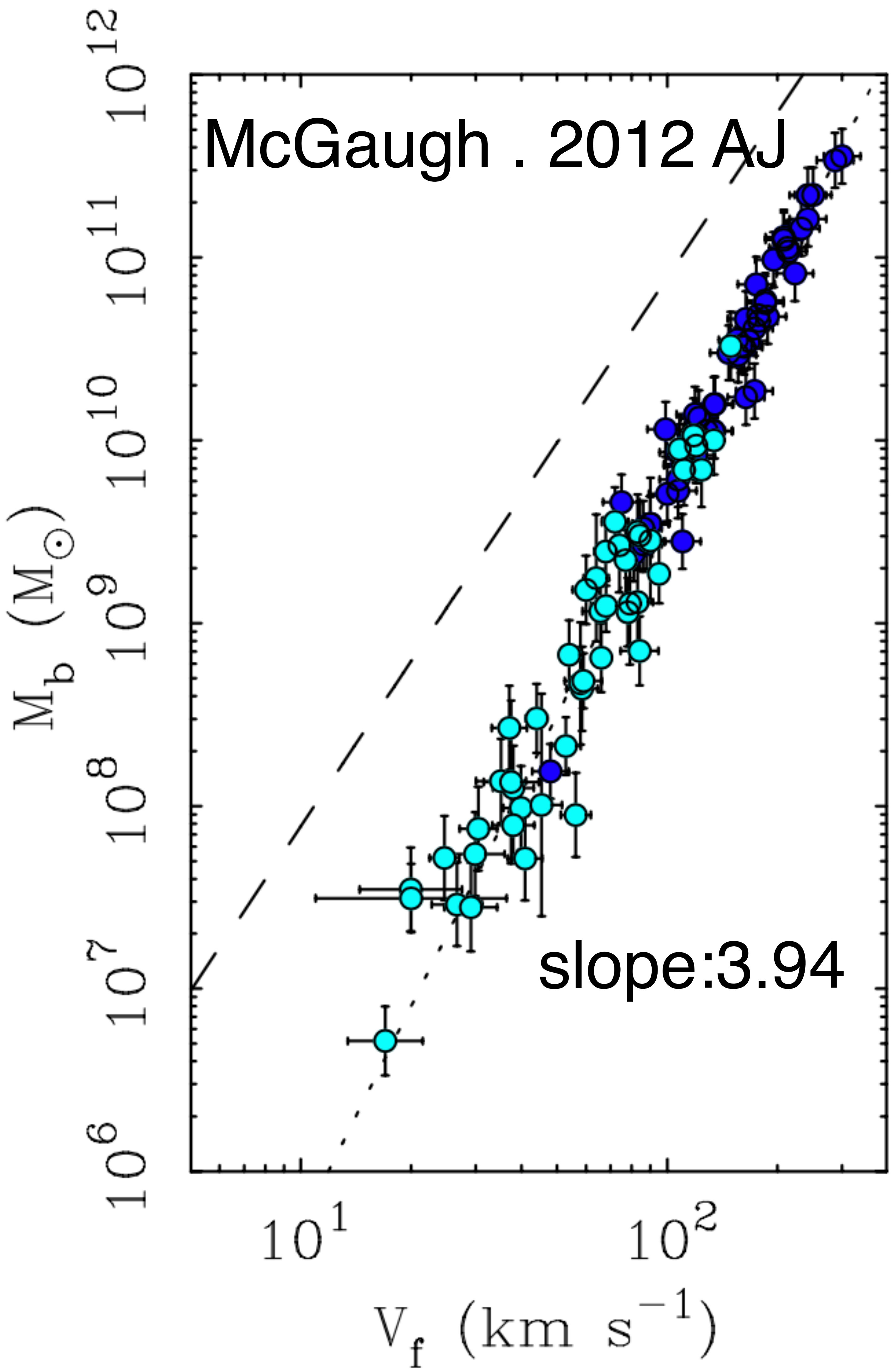


Dark blue gas-poor
Light blue gas-rich
Dash line for slope 3 ΛCDM



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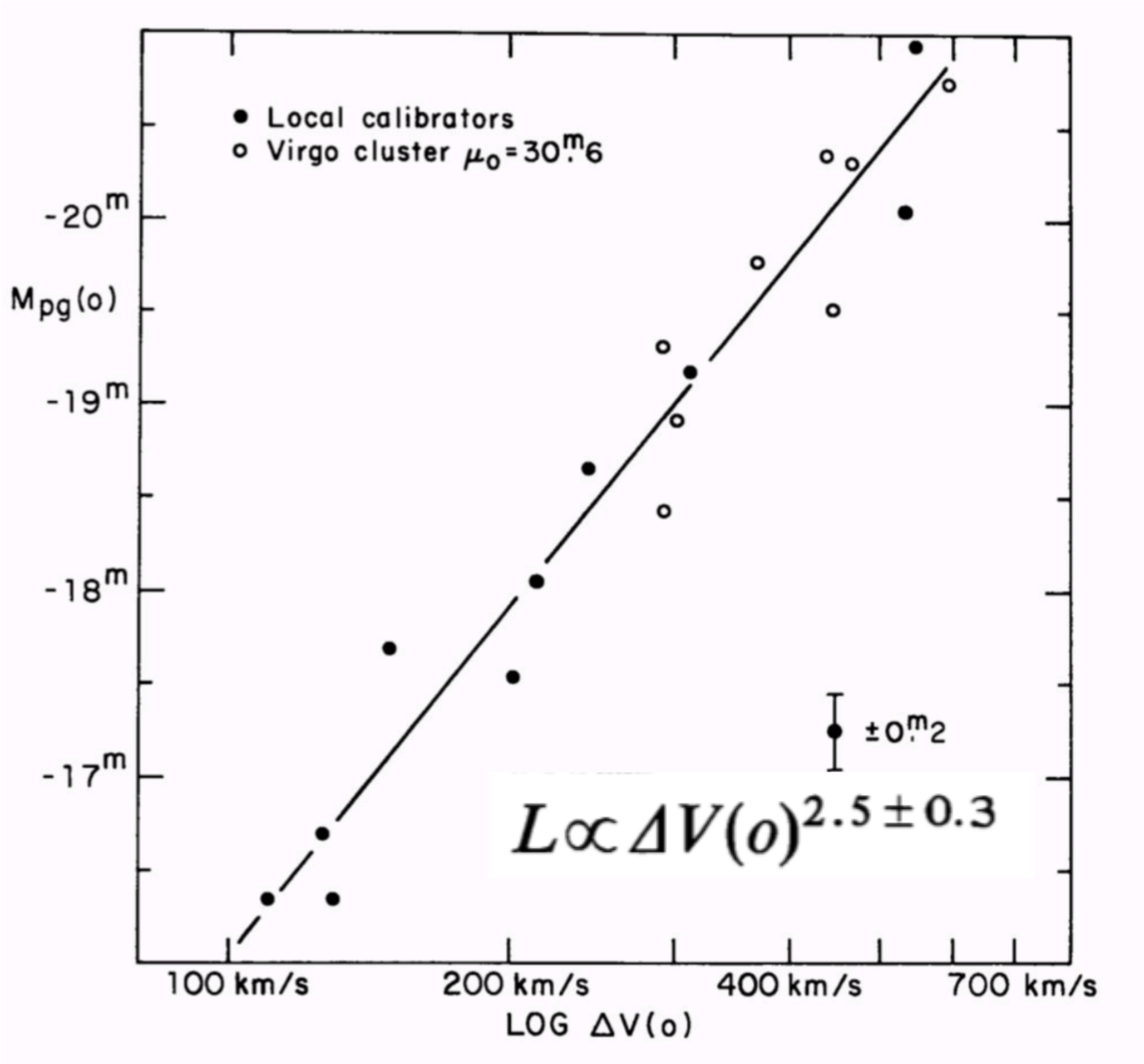

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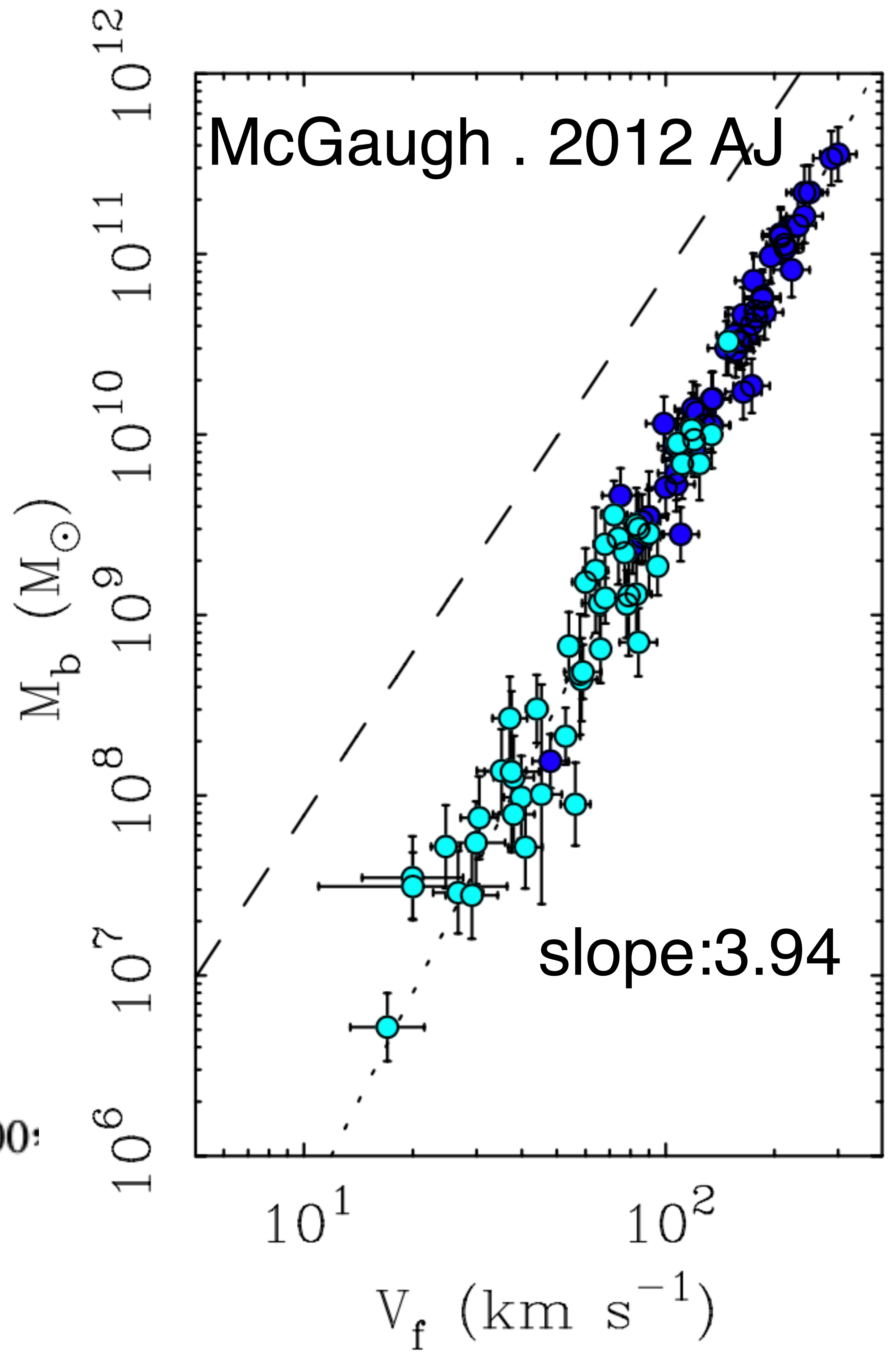
Light blue gas-rich
Dash line for slope
3 ΛCDM

$$M_{200} = (\sqrt{100}\,G\,H_0)^{-1} V_{200}^3$$

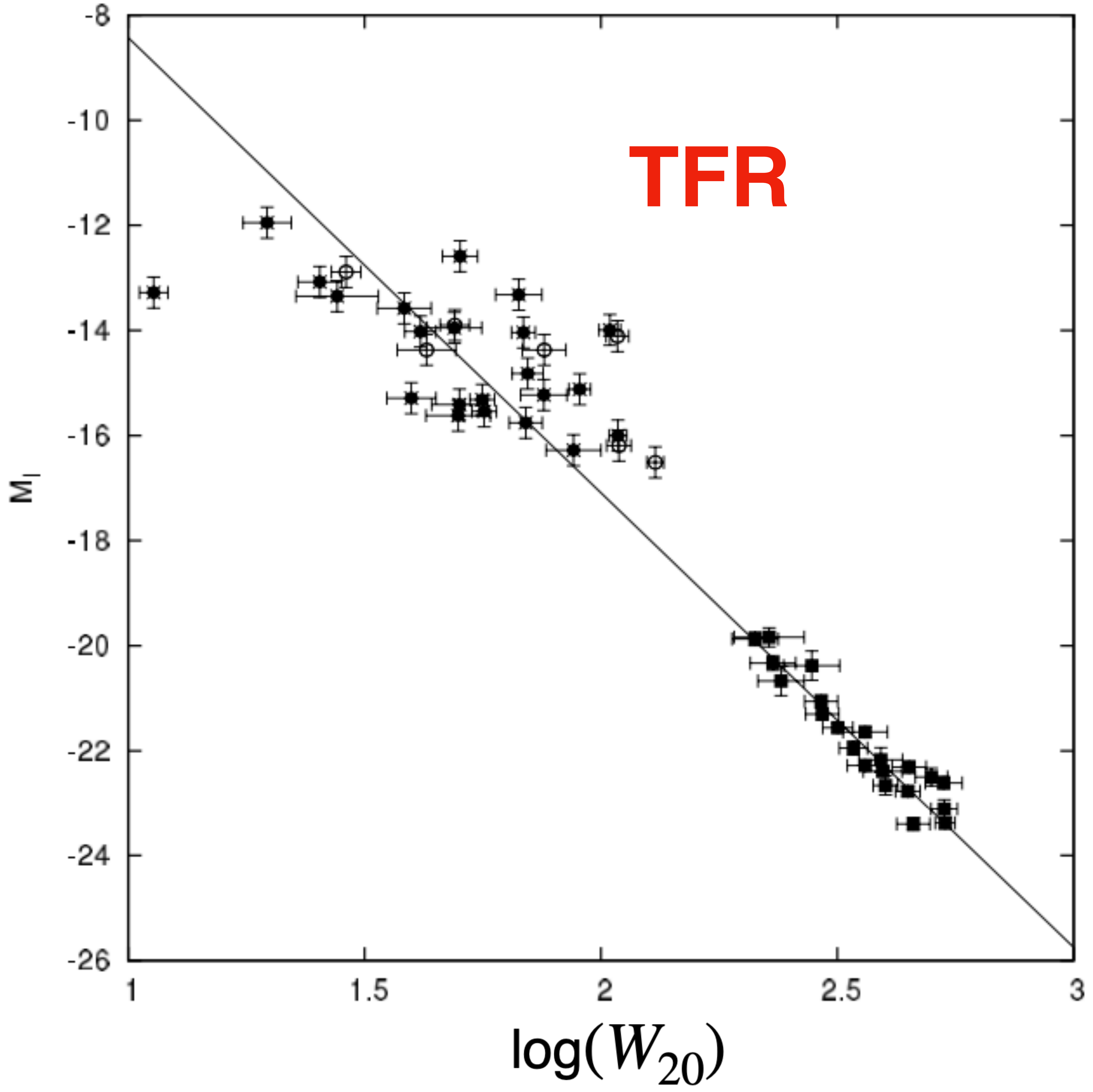
$$M_b \propto f_b f_V^{-3} V_f^3$$

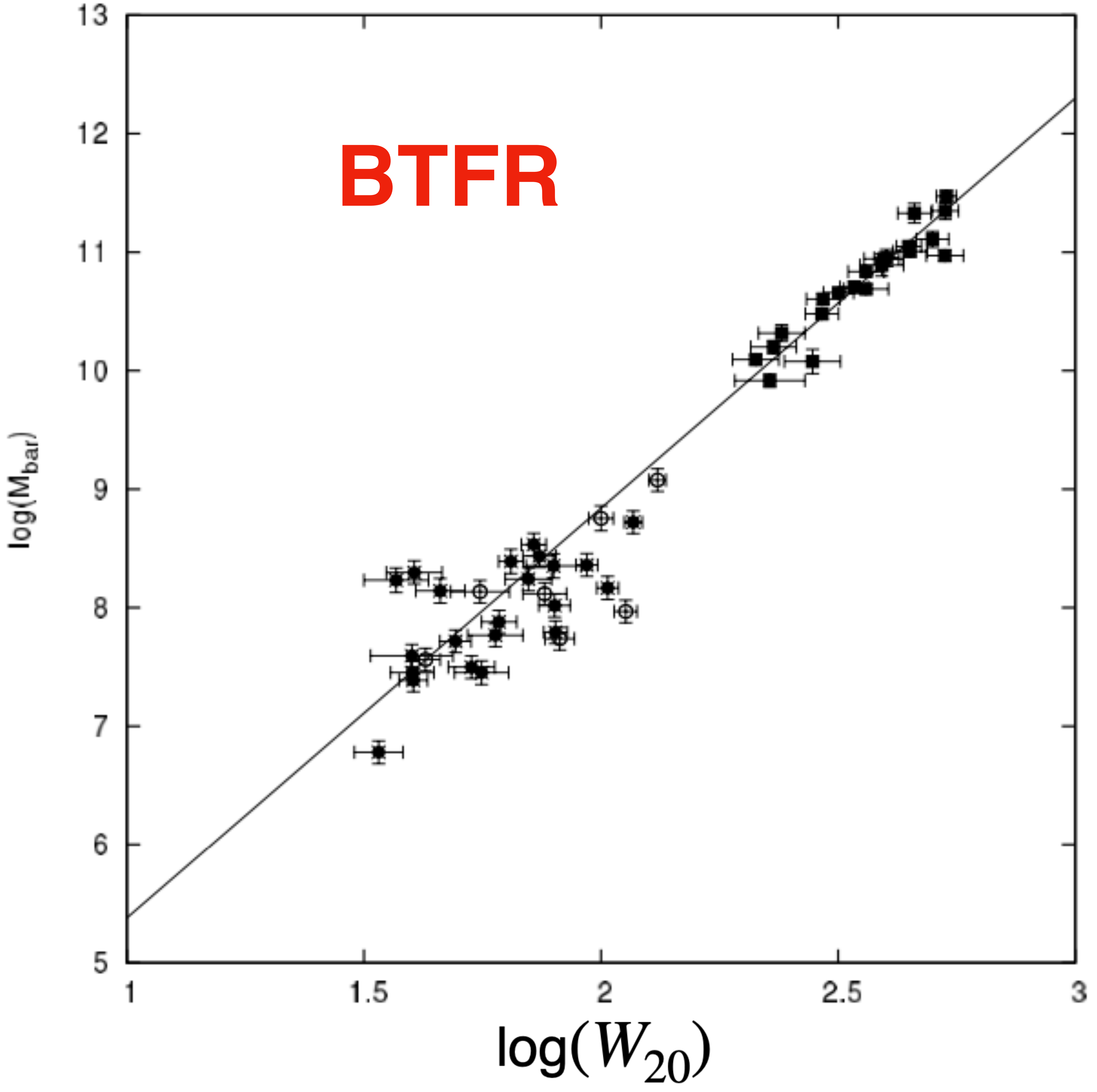


BTFR at low mass

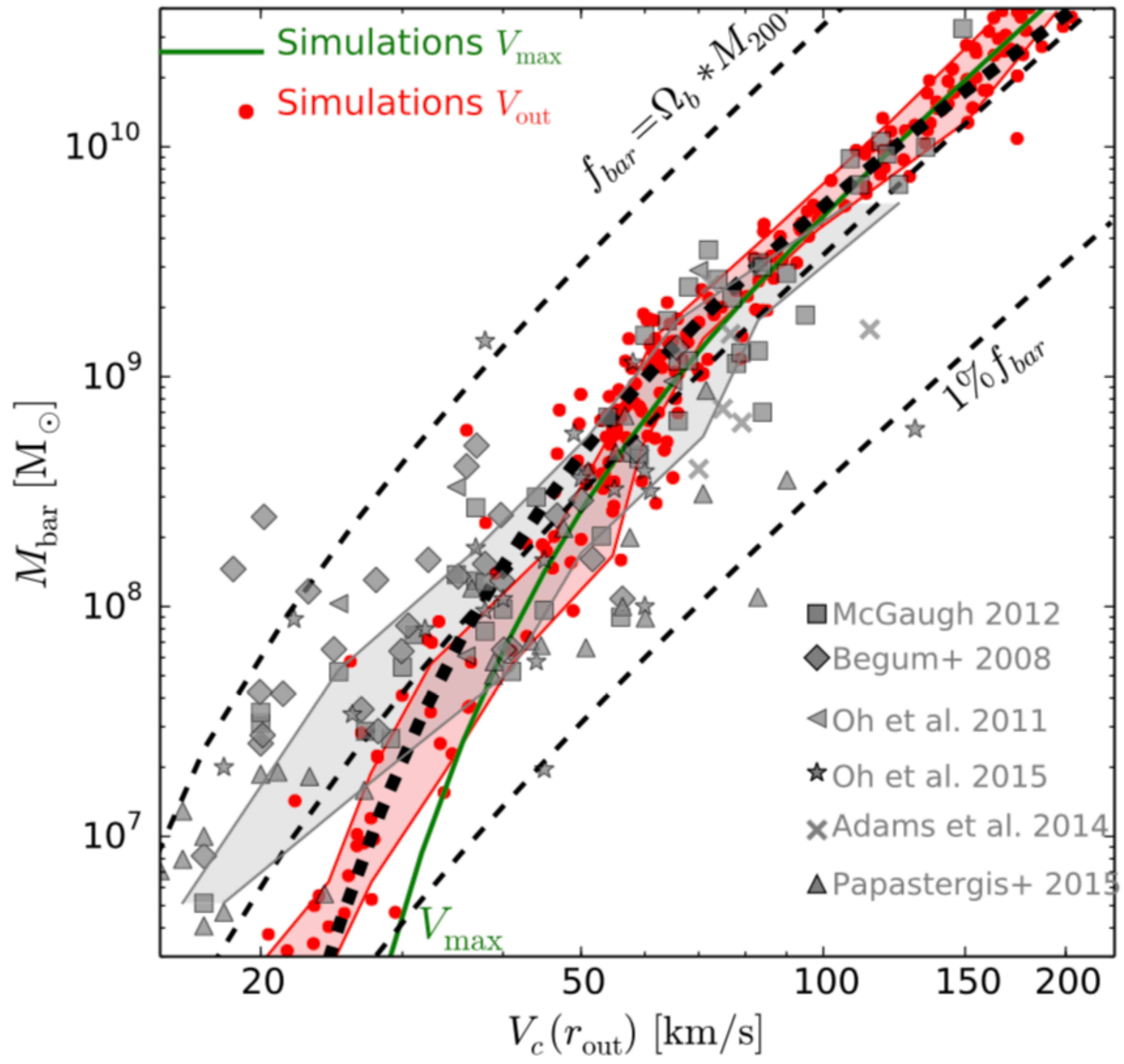
Local Group dwarfs with accurate distances

Begum 2008





BTFR in simulation



APOSTLE
Sales, L. V. et al. 2017 MNRAS

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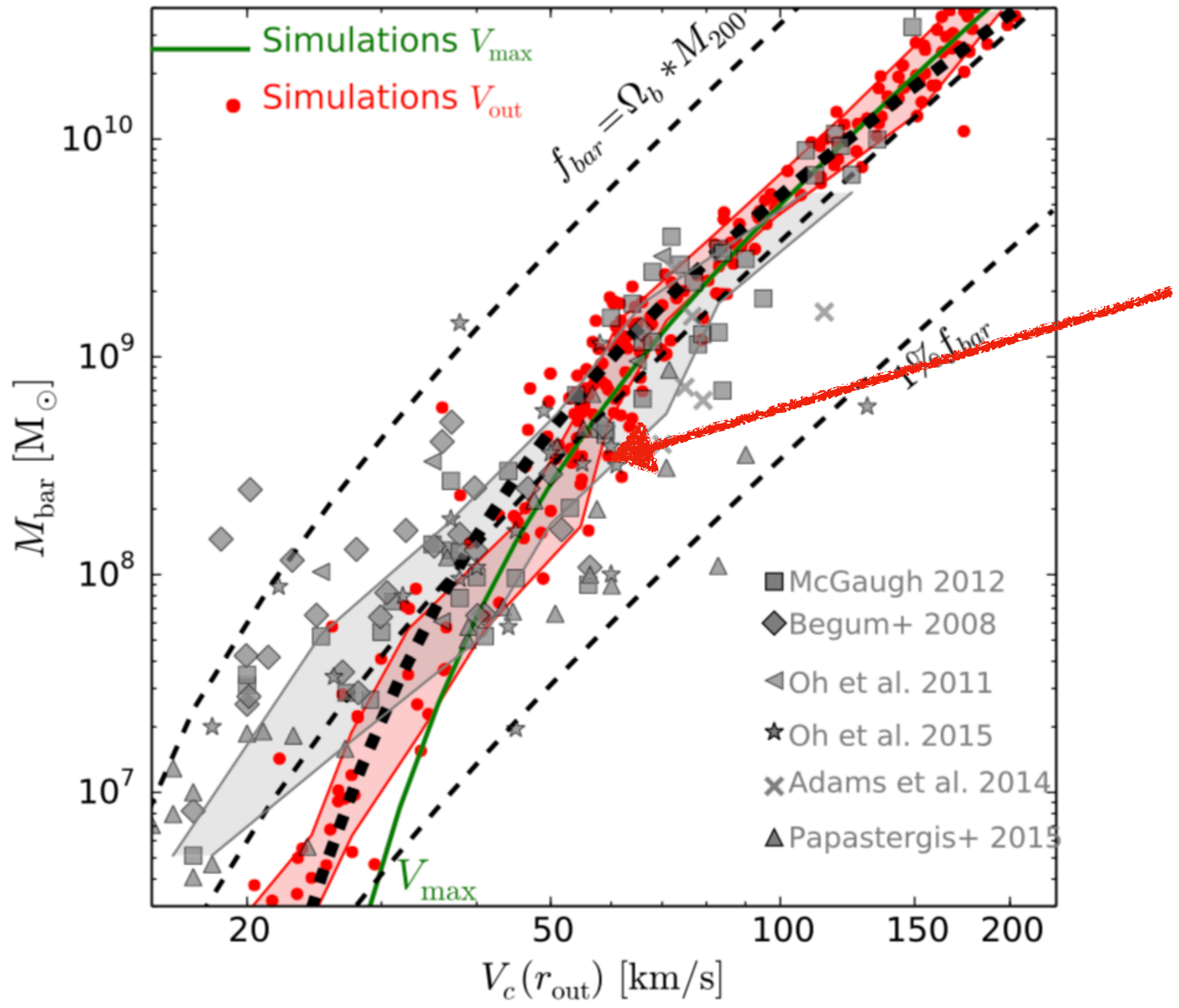
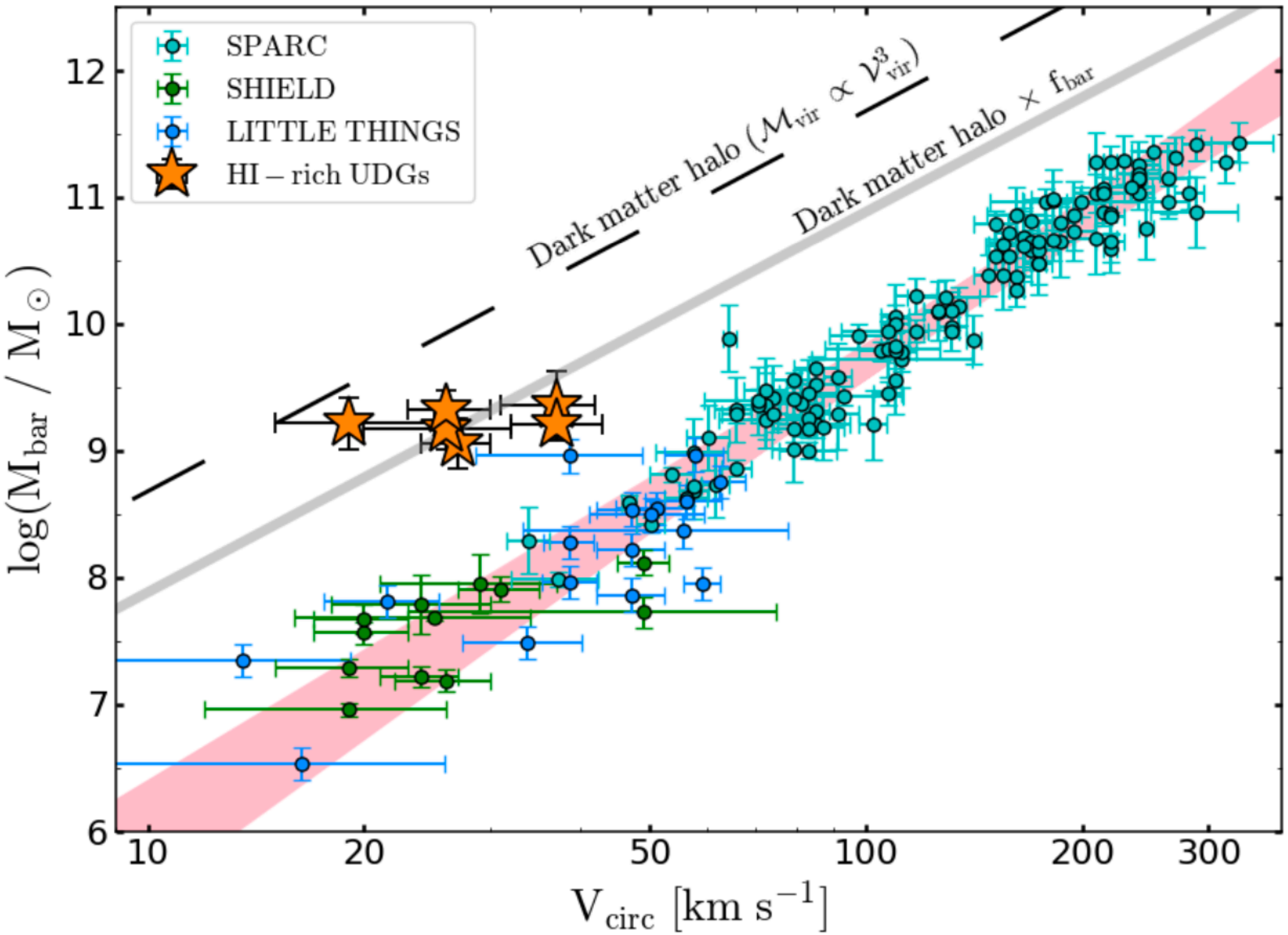


Discrepancy between the observations and simulations **at low mass end**

APOSTLE
Sales, L. V. et al. 2017 MNRAS

UDGs deviate from BTFR



Mancera 2019 ApJL

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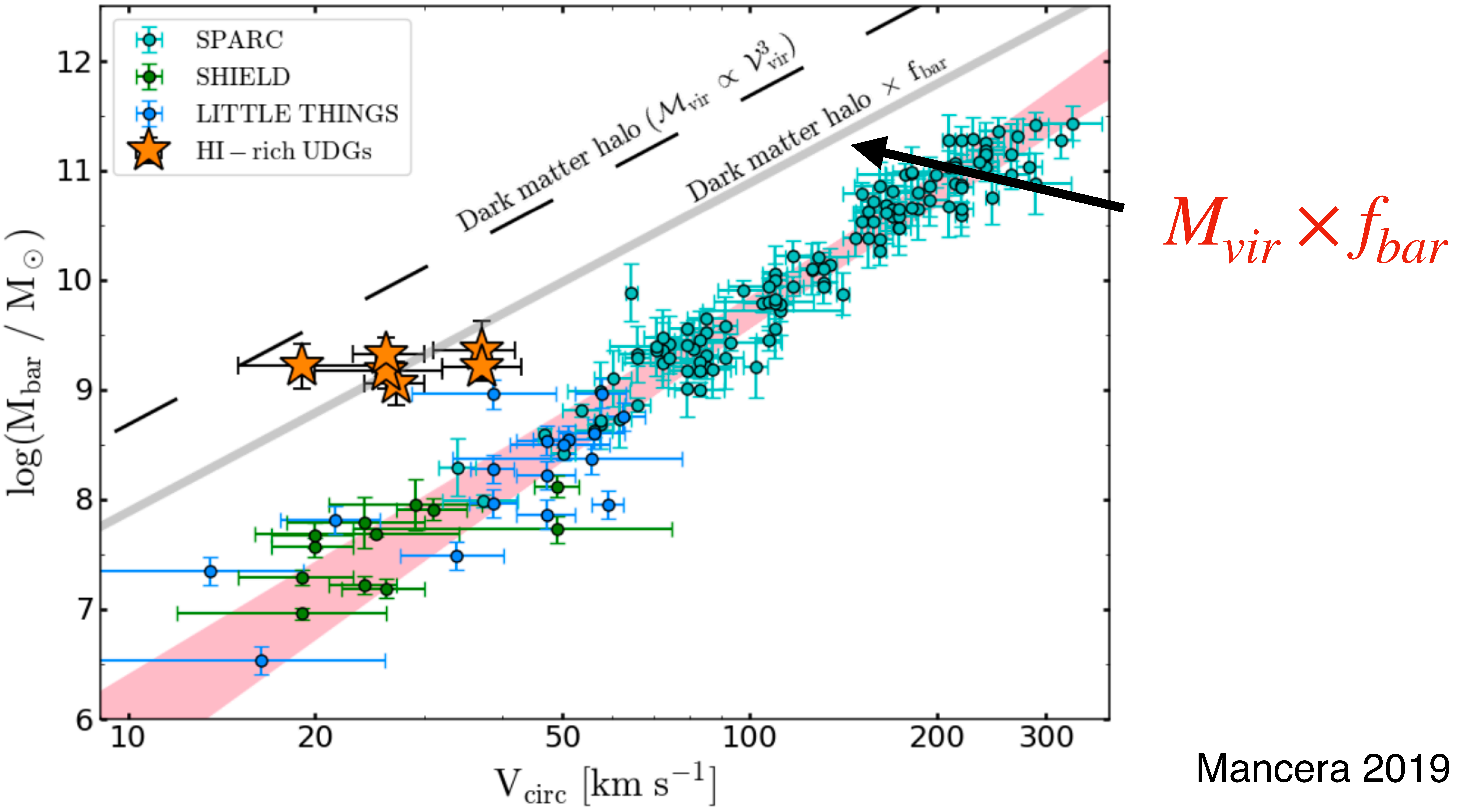
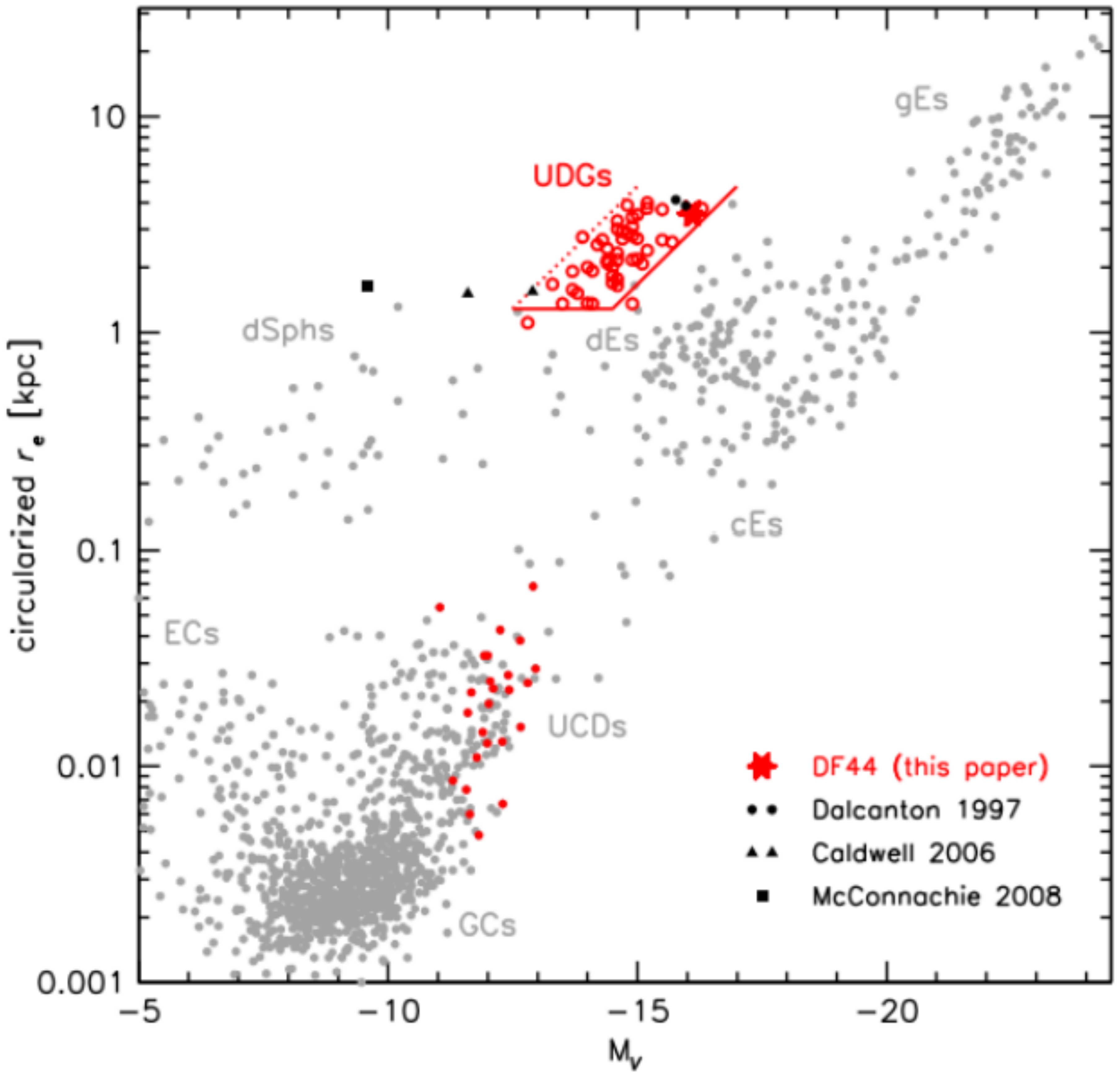


Mancera 2019 ApJL

Ultra-diffuse Galaxy

$\mu_g(0) > 24$ mag arcsec^{-2} and $R_e > 1.5$ kpc



Van Dokkum 2015 ApJL

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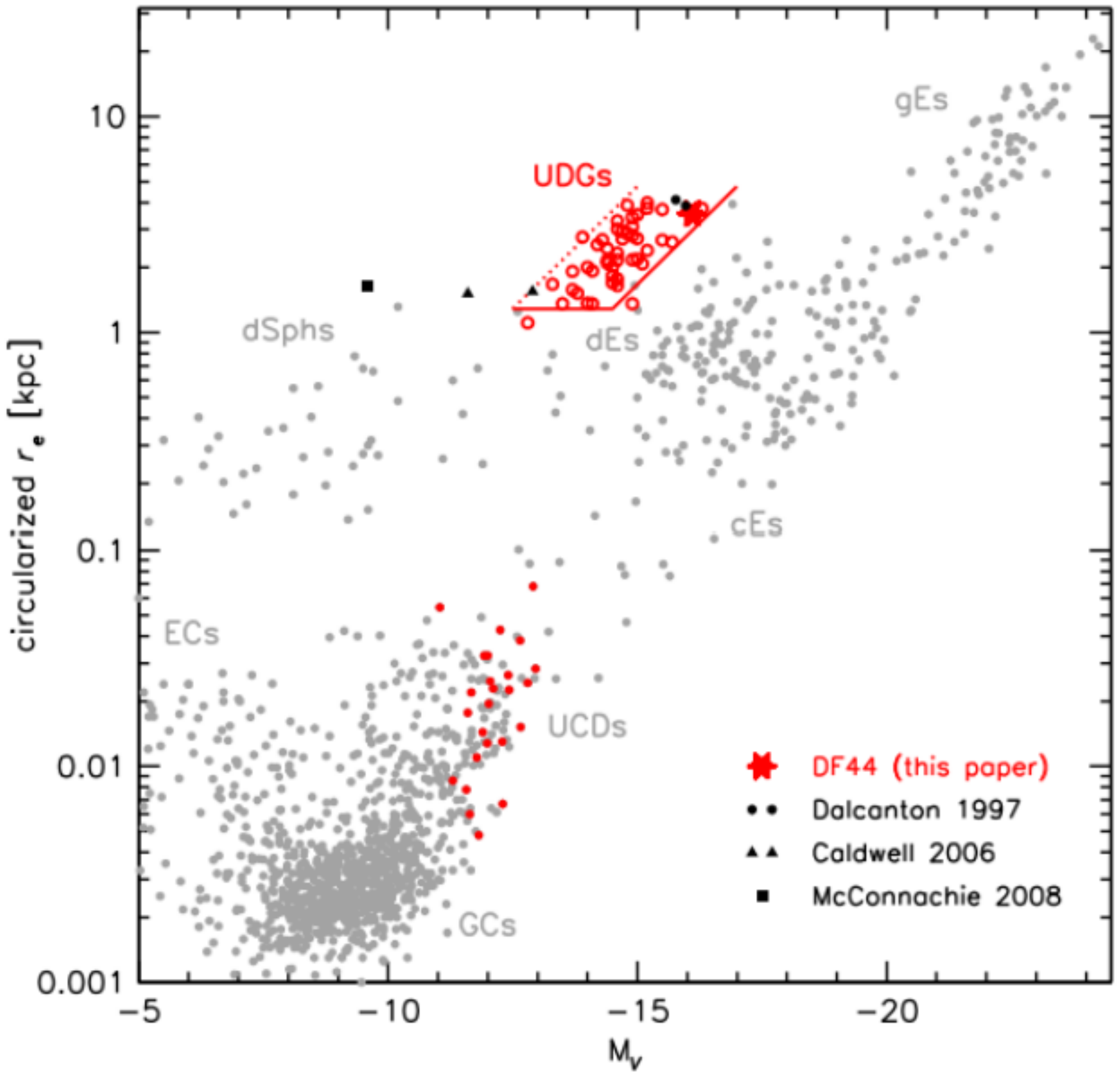

Van Dokkum 2015 ApJL

Field UDGs could stem from 1) stellar feedback, 2) early mergers, and 3) high spins

Satellite UDGs could be the descendants of field UDGs and/or dwarf galaxies reshaped by tidal heating.

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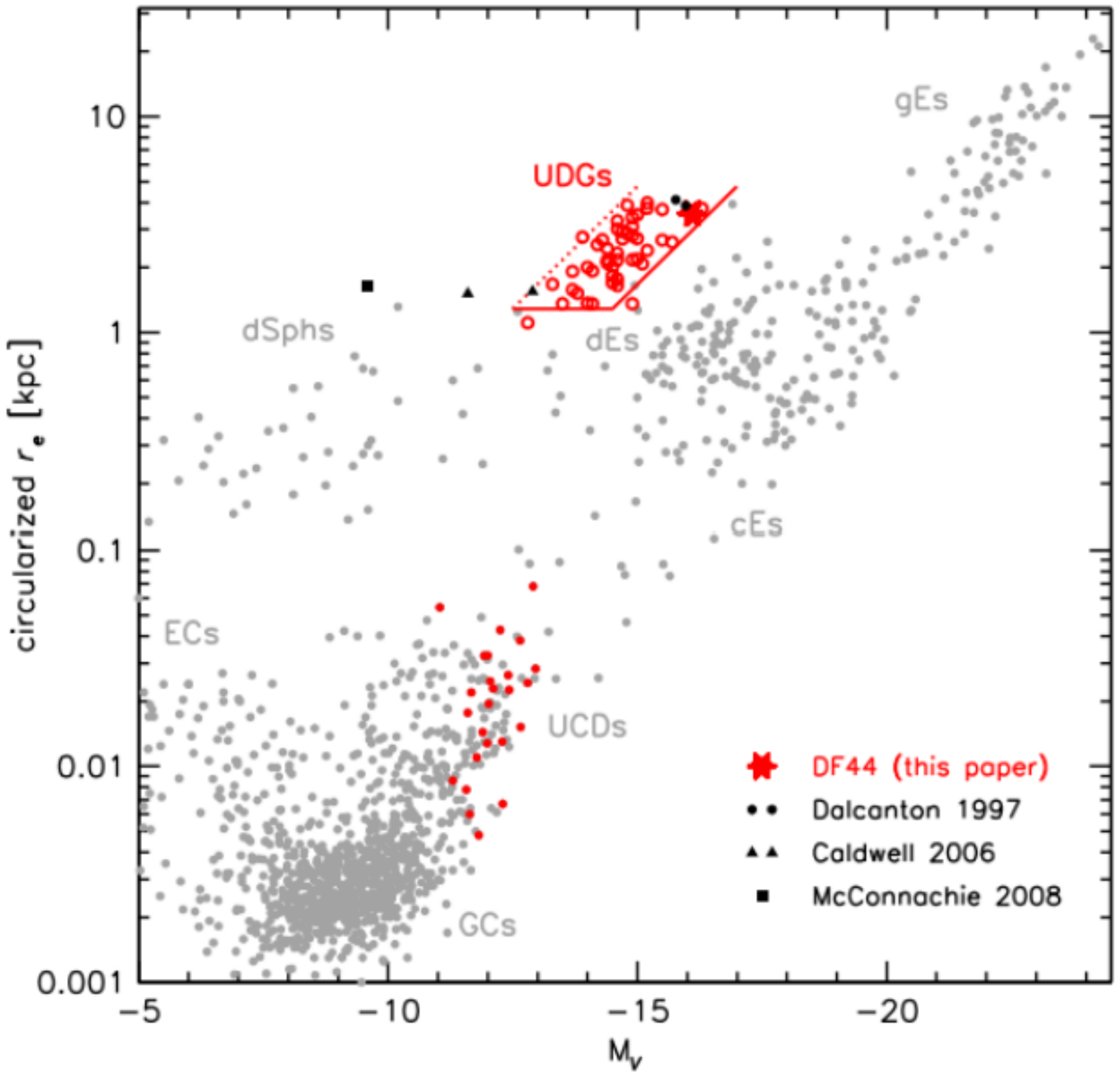

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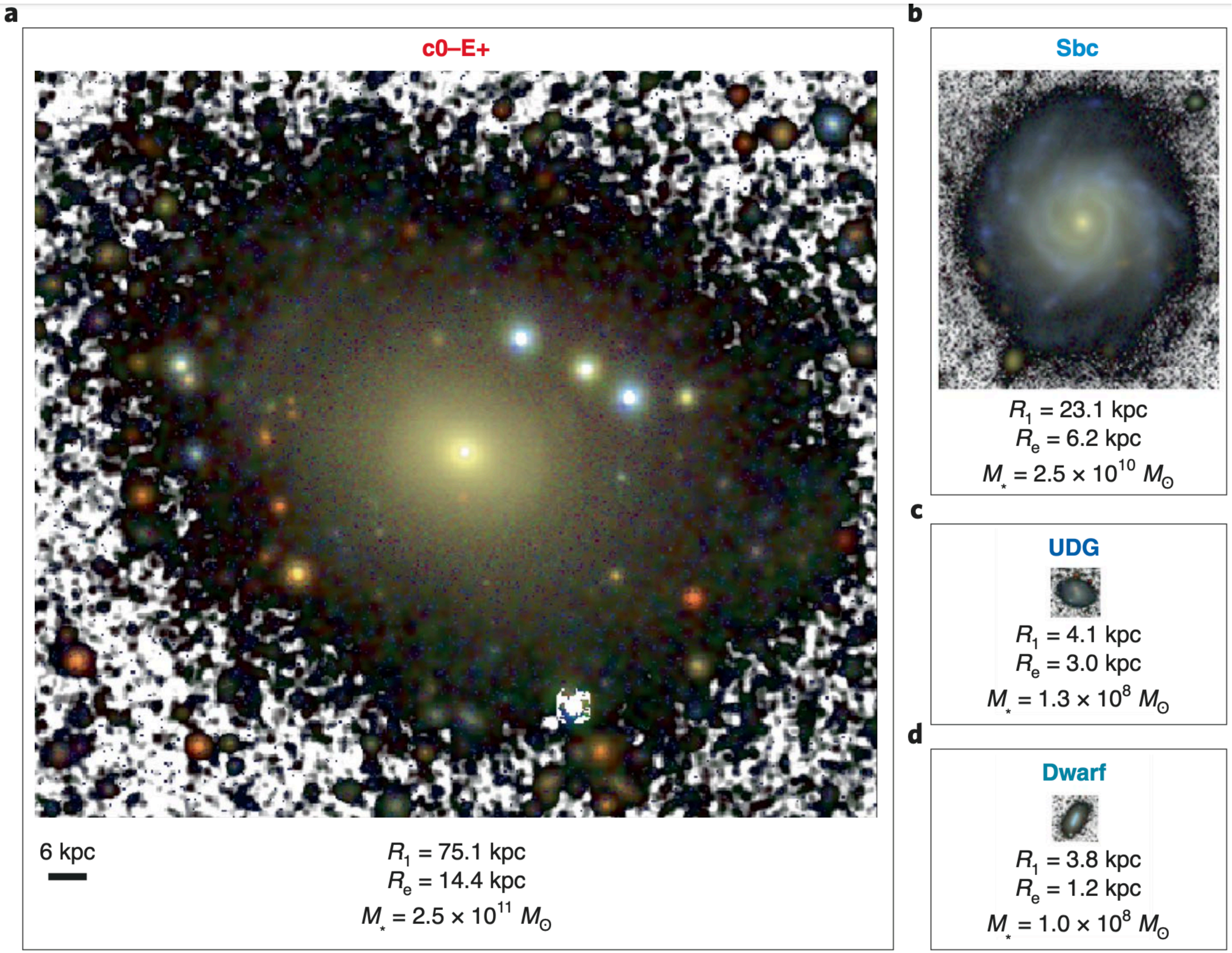
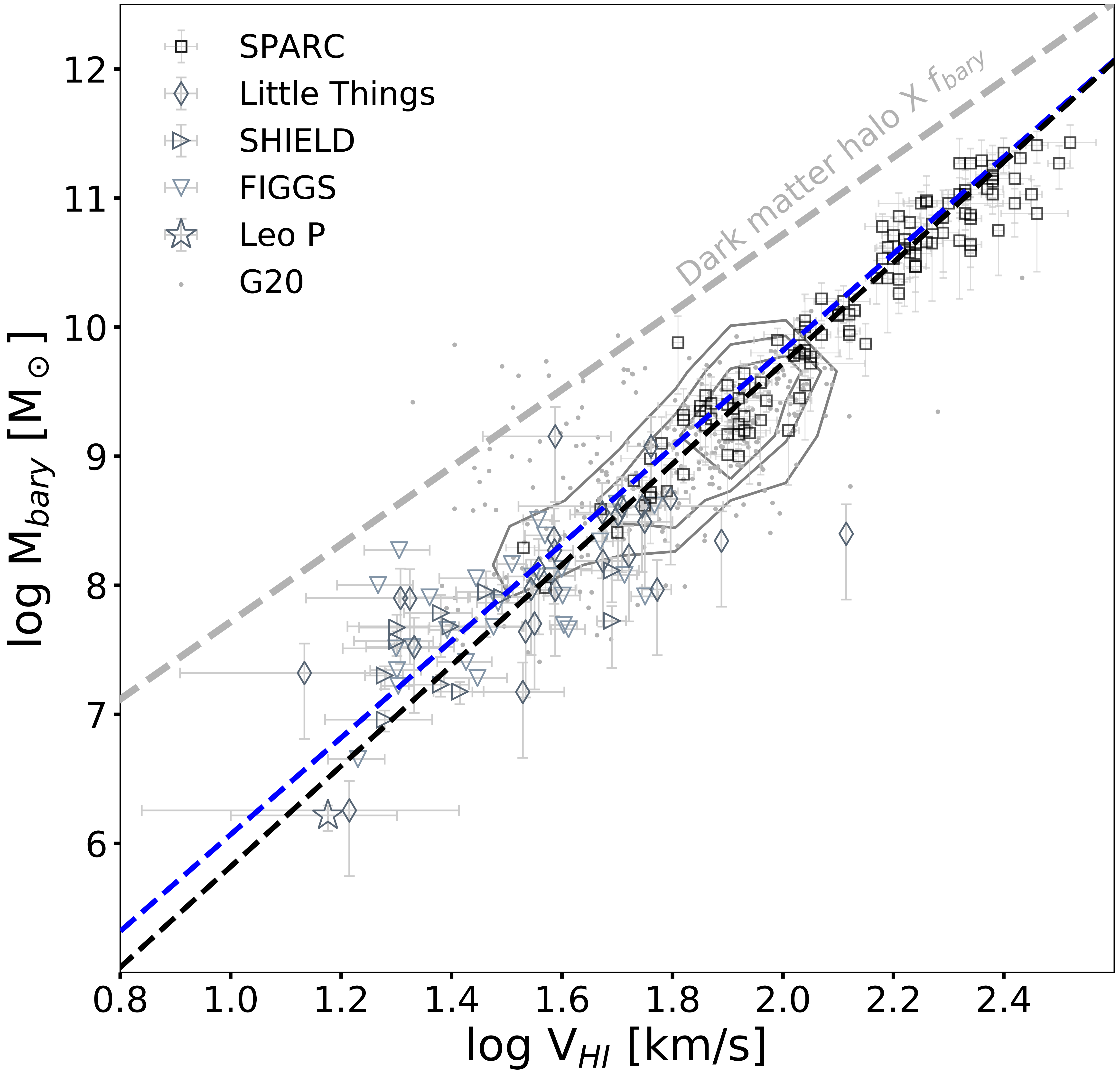


HI-rich UDGs in ALFALFA (a100)



88 HI-rich UDGs (HUDGs)
the largest HUDGs sample with dynamical information

Dwarf galaxies follow the relation from massive spiral galaxies

Hu et al. 2023a

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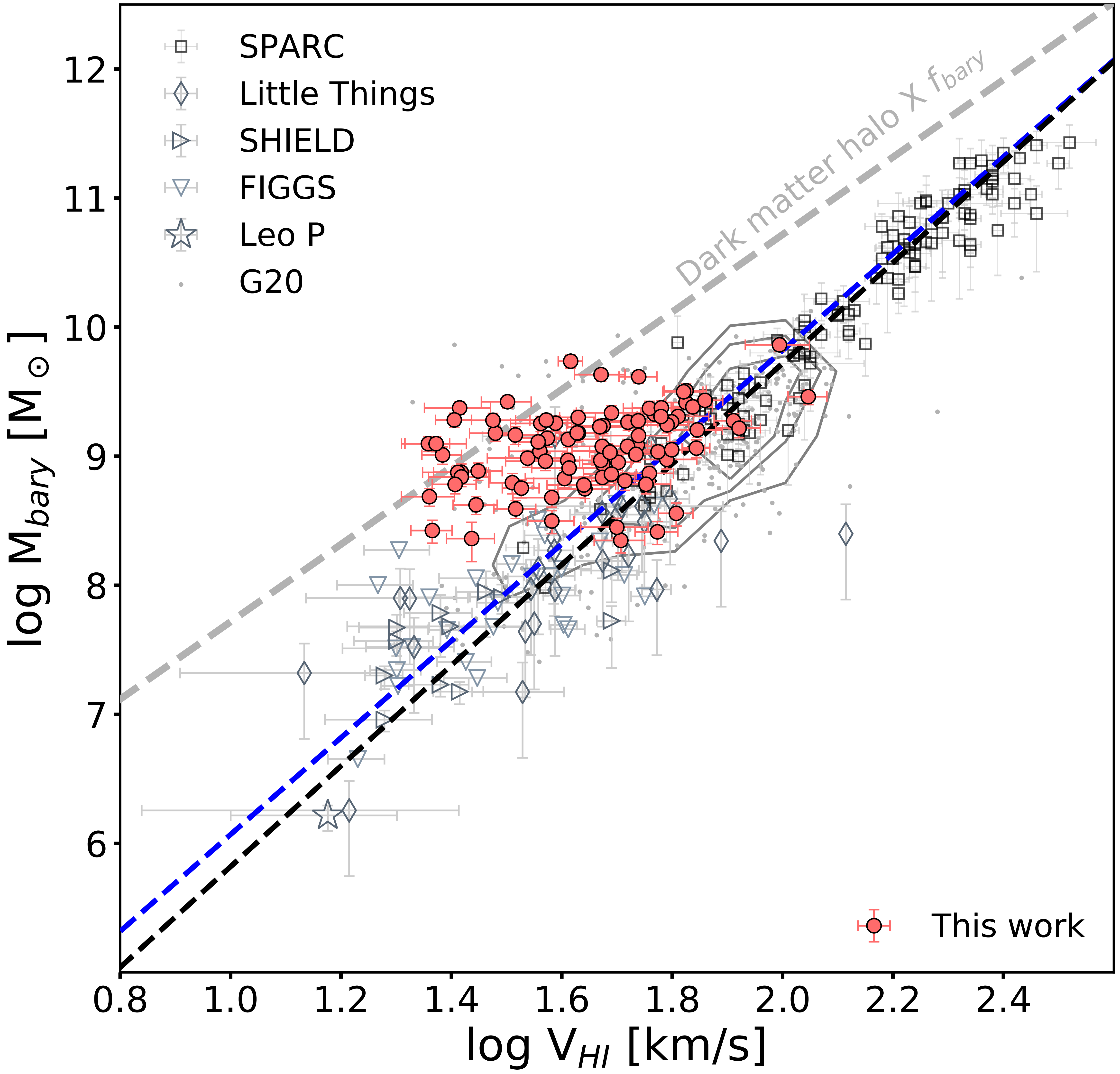

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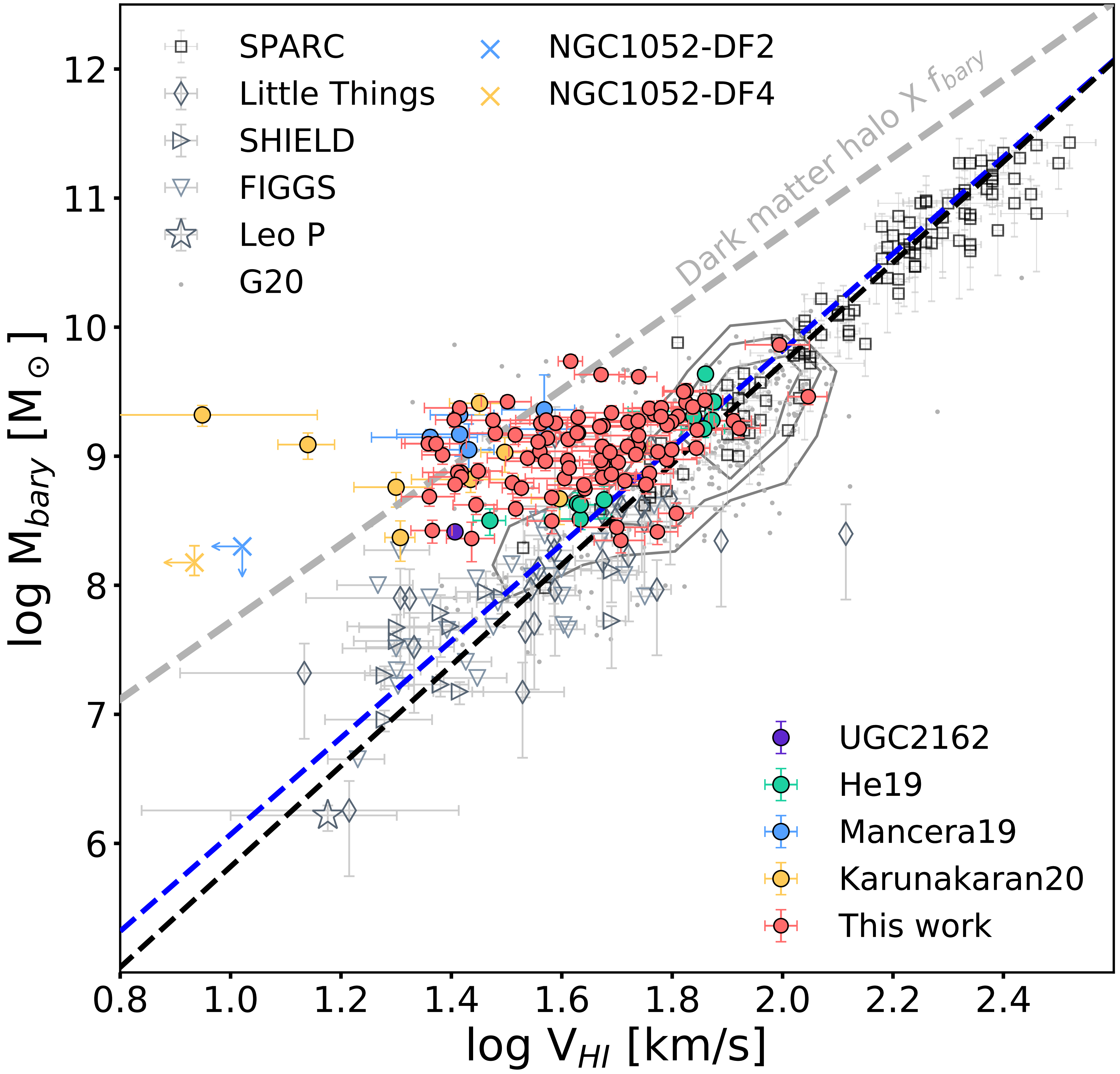

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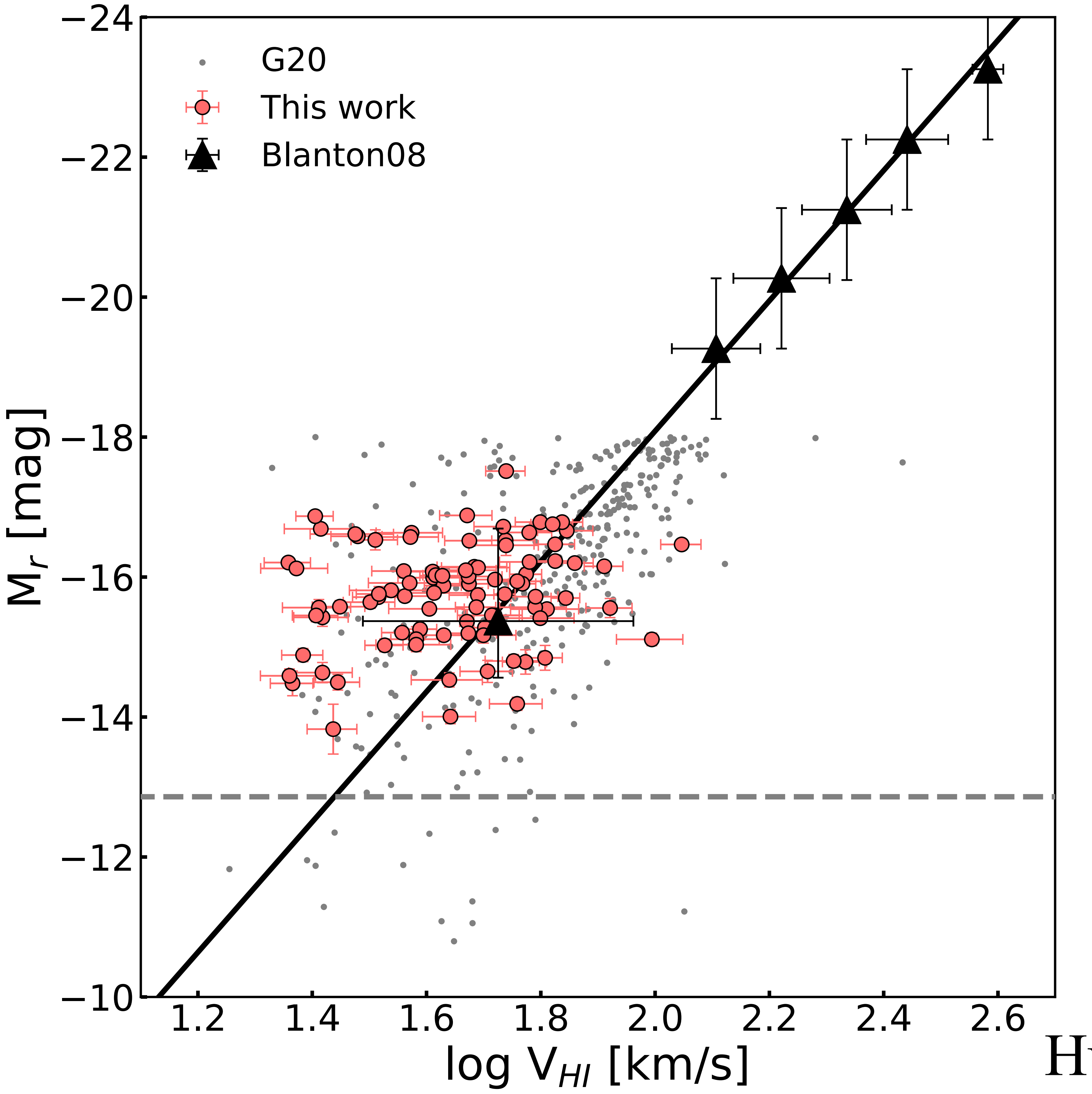
All HUDGs in the literature reside in the region defined by our HUDGs

Hu et al. 2023a

HUDGs deviation



Hu et al. 2023a

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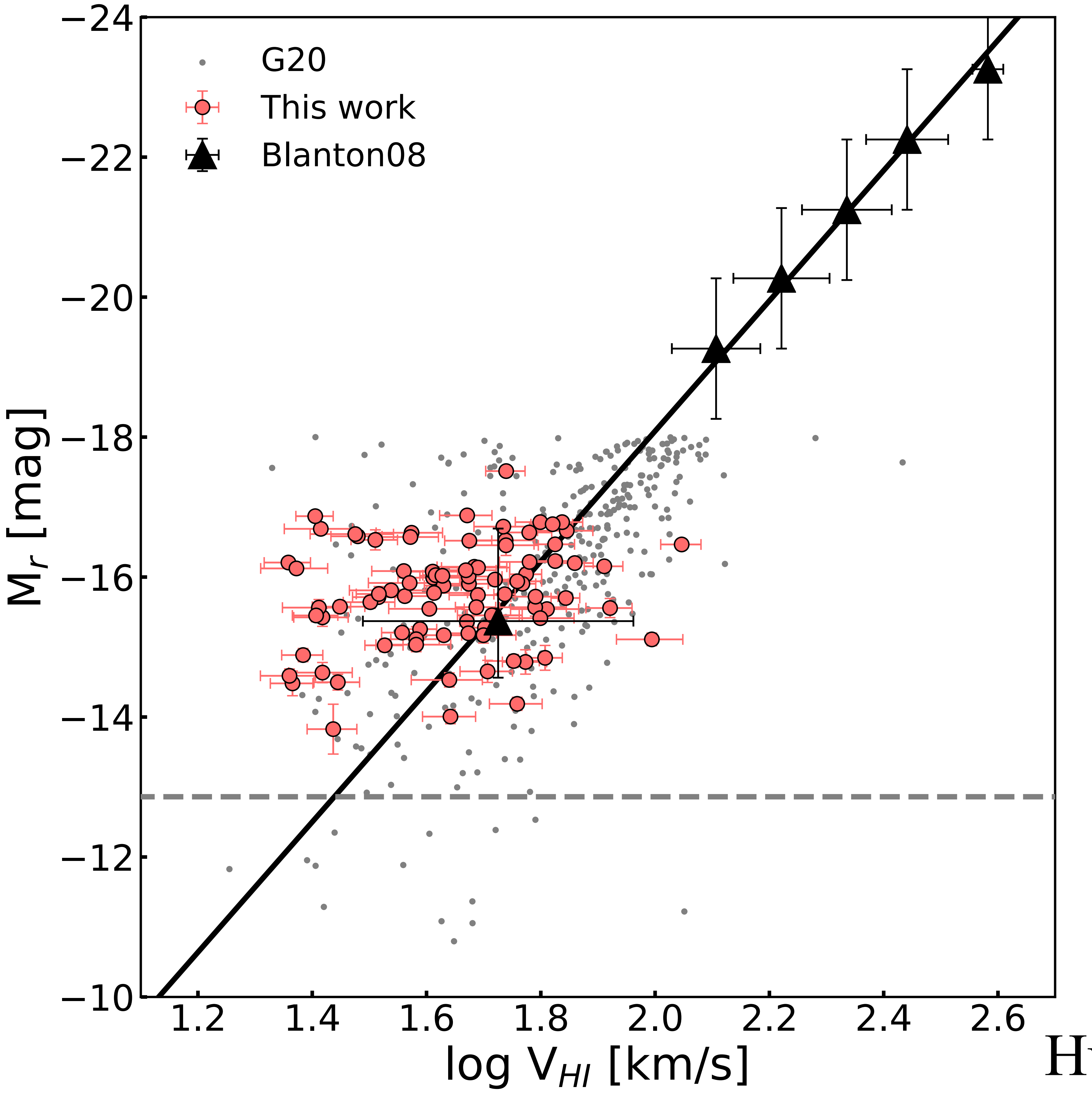
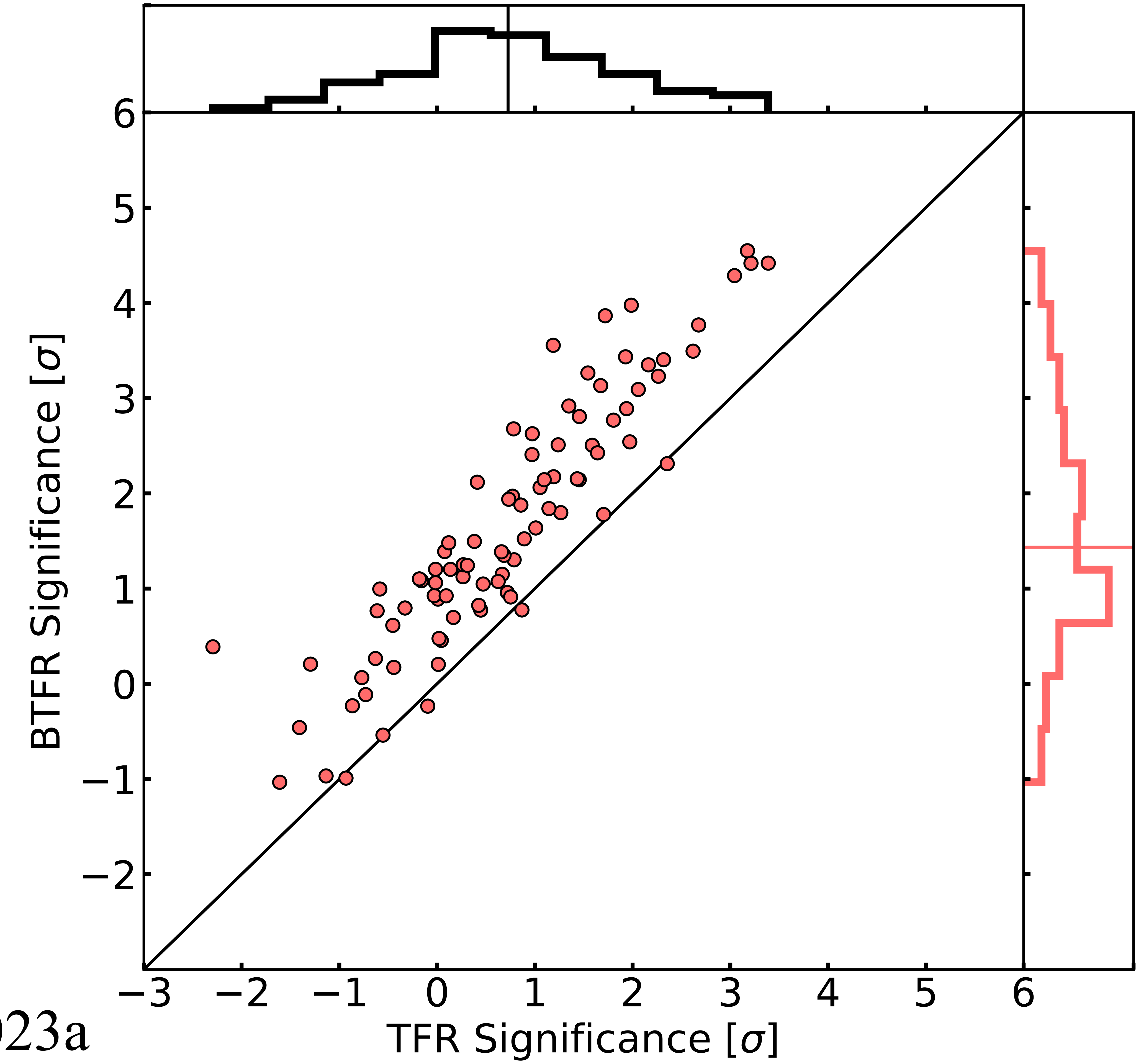


Hu et al. 2023a



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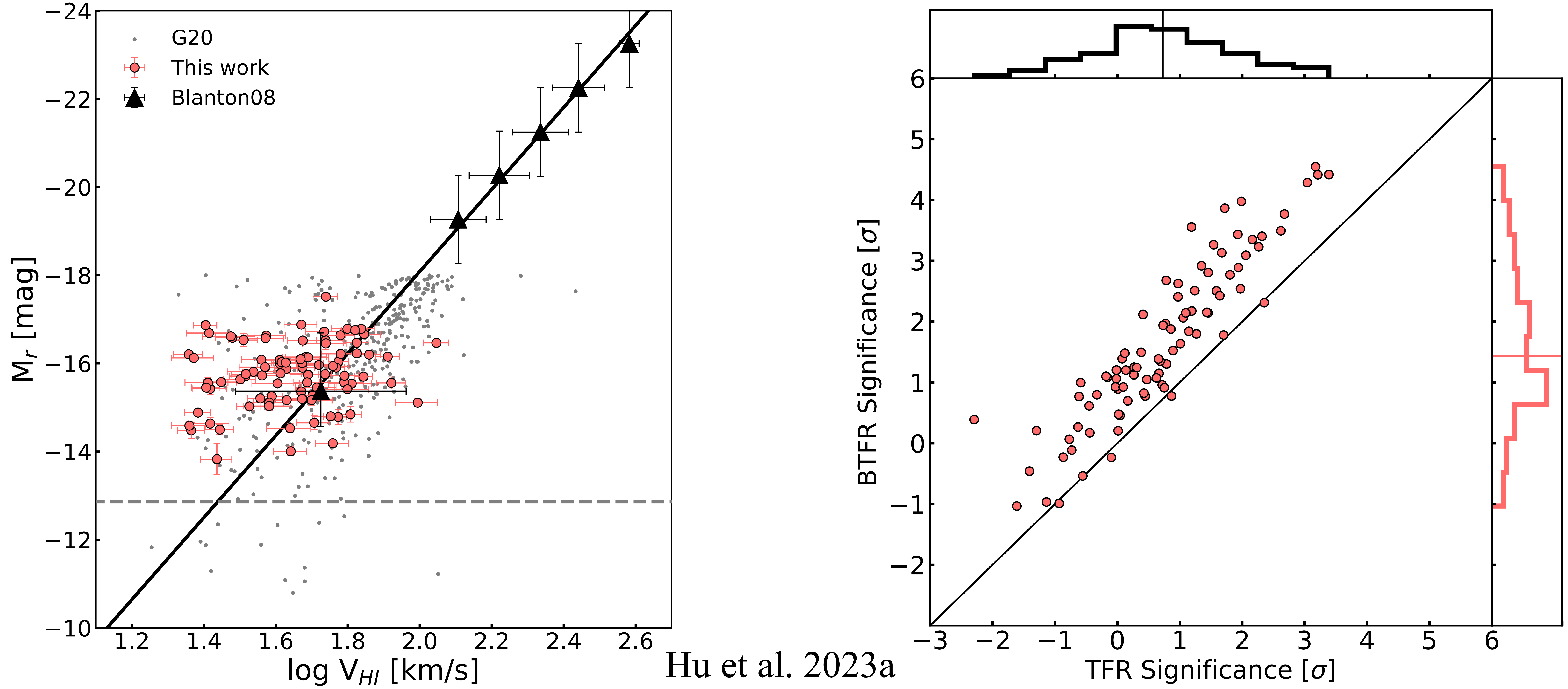
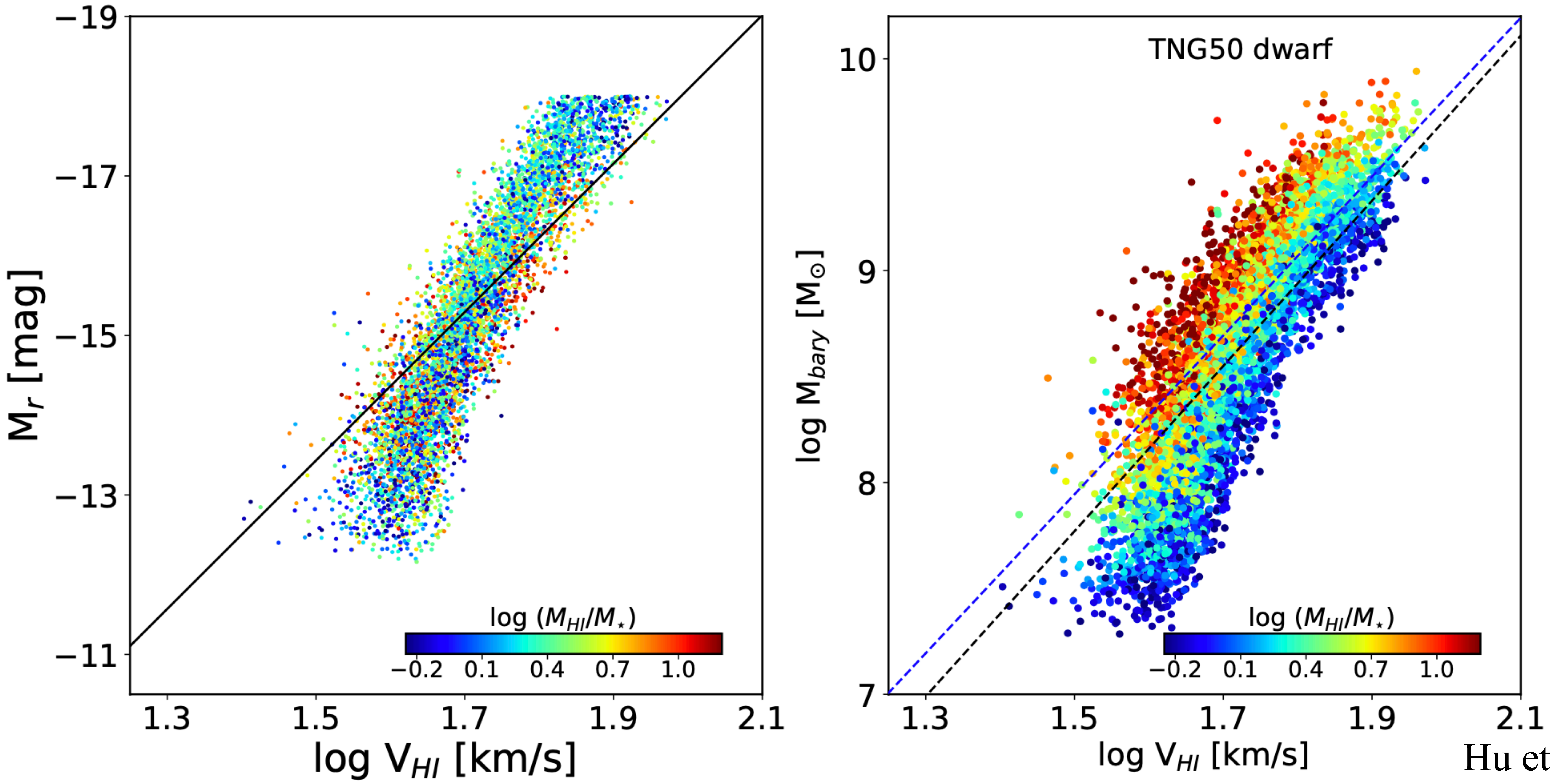


Hu et al. 2023a

HUDGs' deviation from BTFR is more significant than that from TFR.

HUDGs in TNG50



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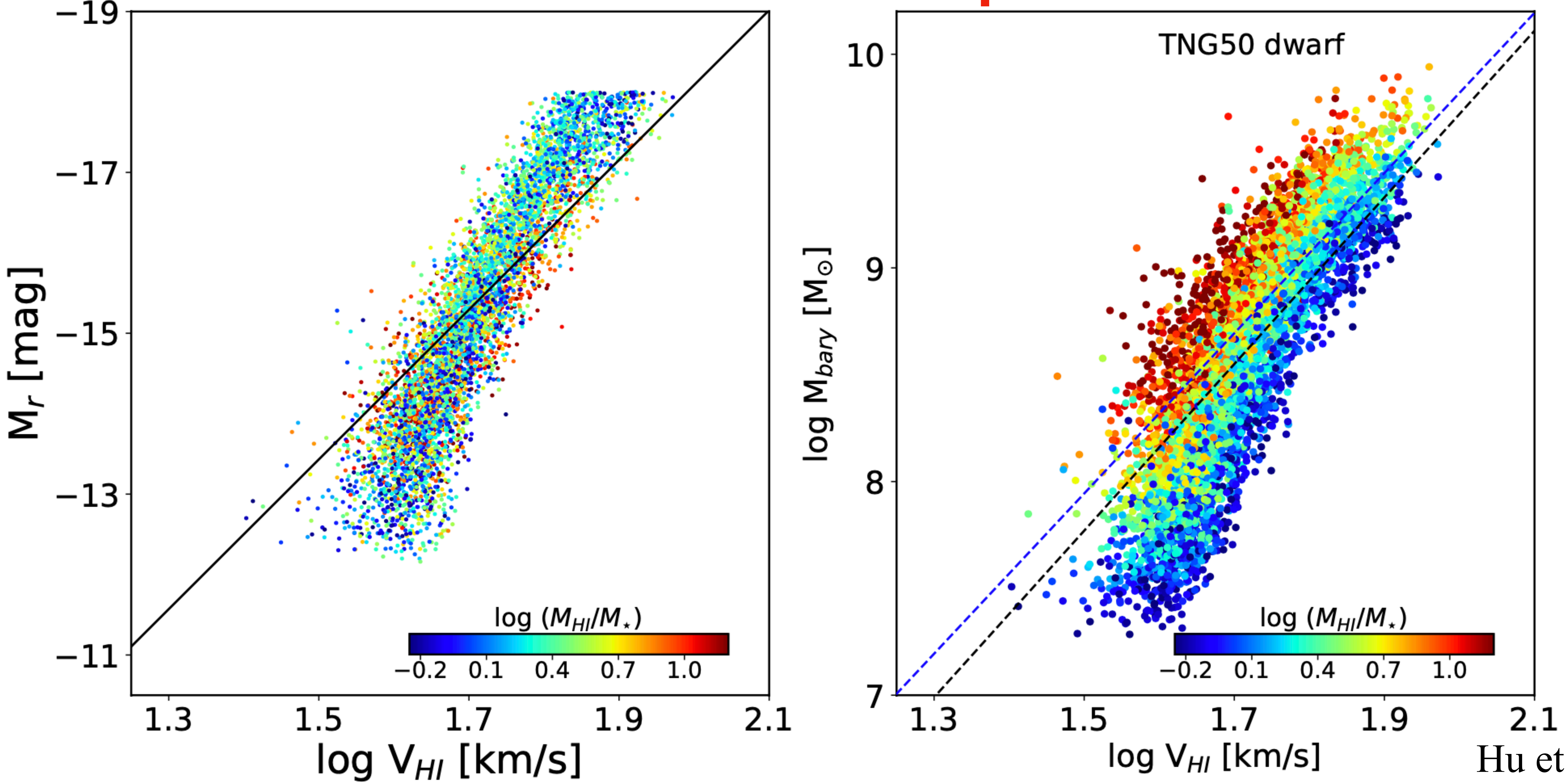
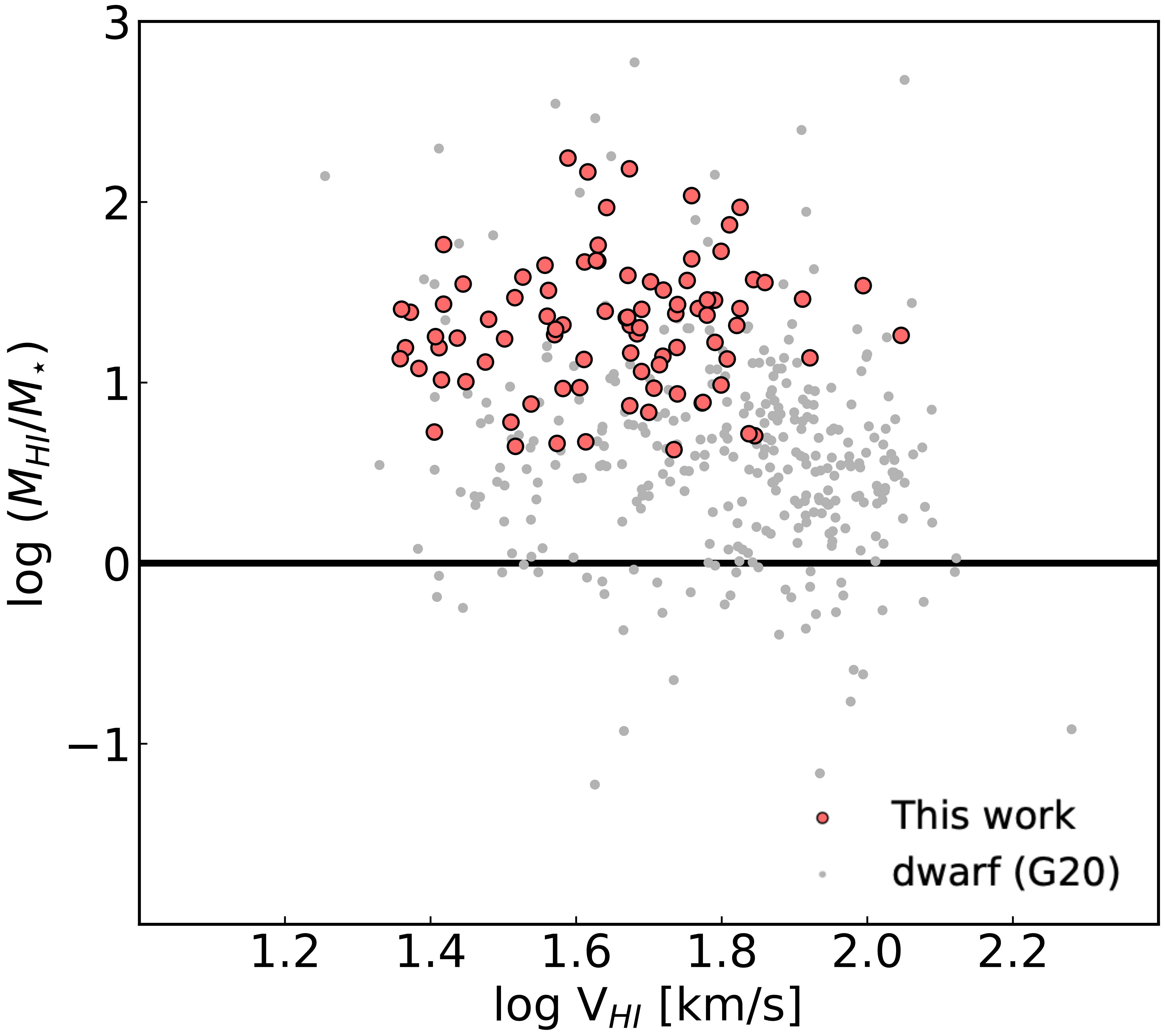
HUDGs in TNG50

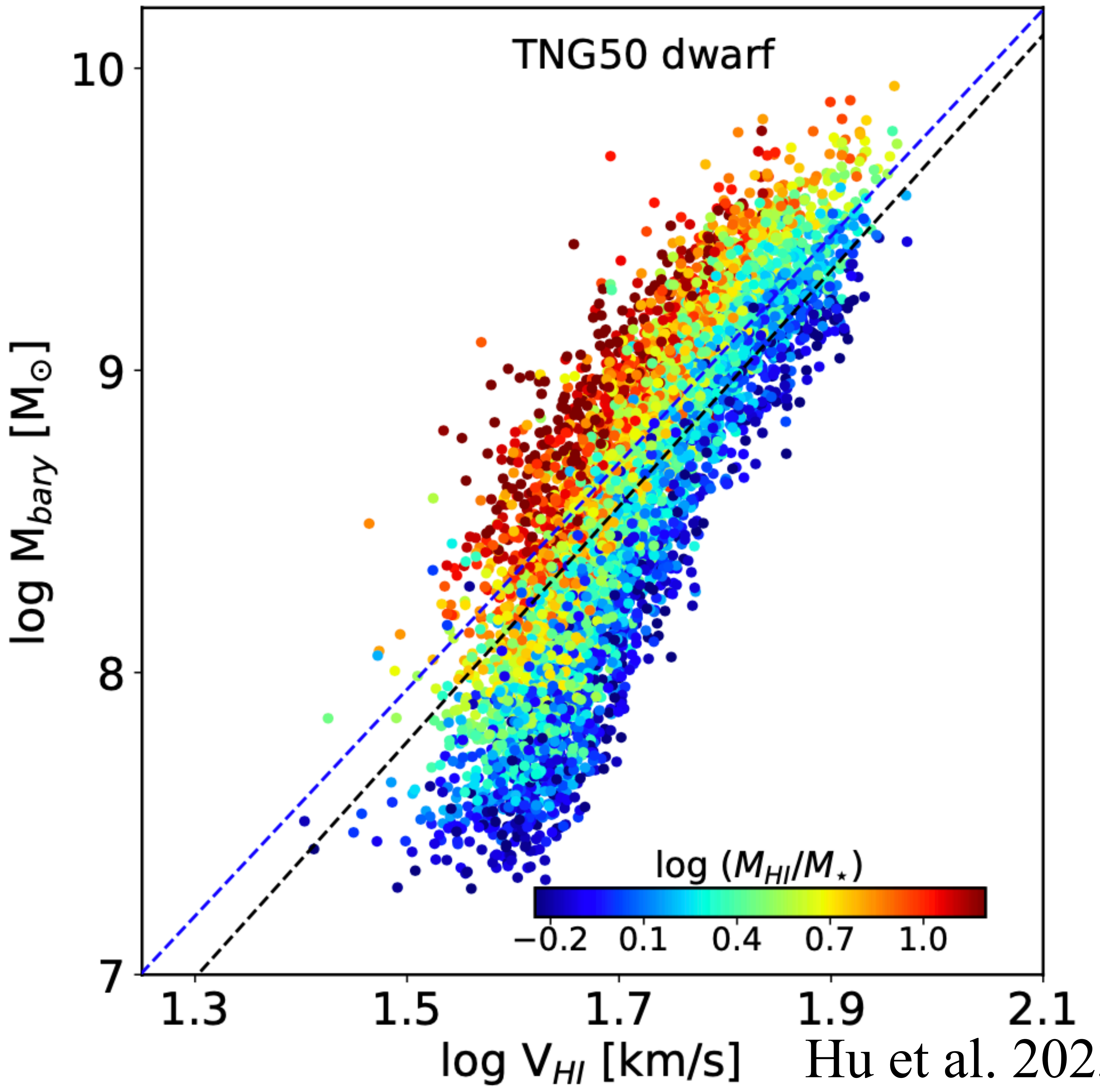
Gas fraction dependence in BTFR but TFR.



Hu et al. 2023a

HUDGs in TNG50





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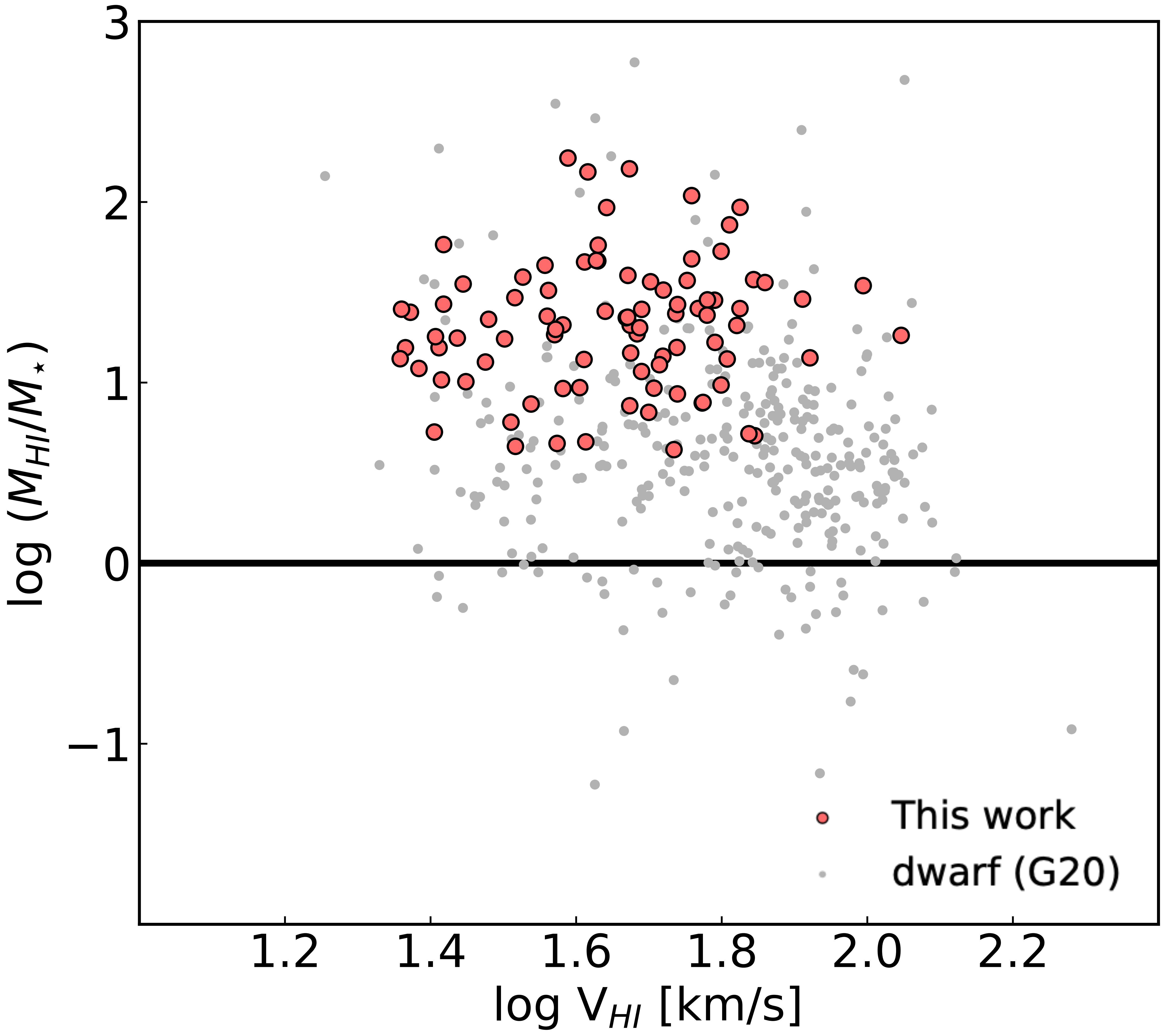
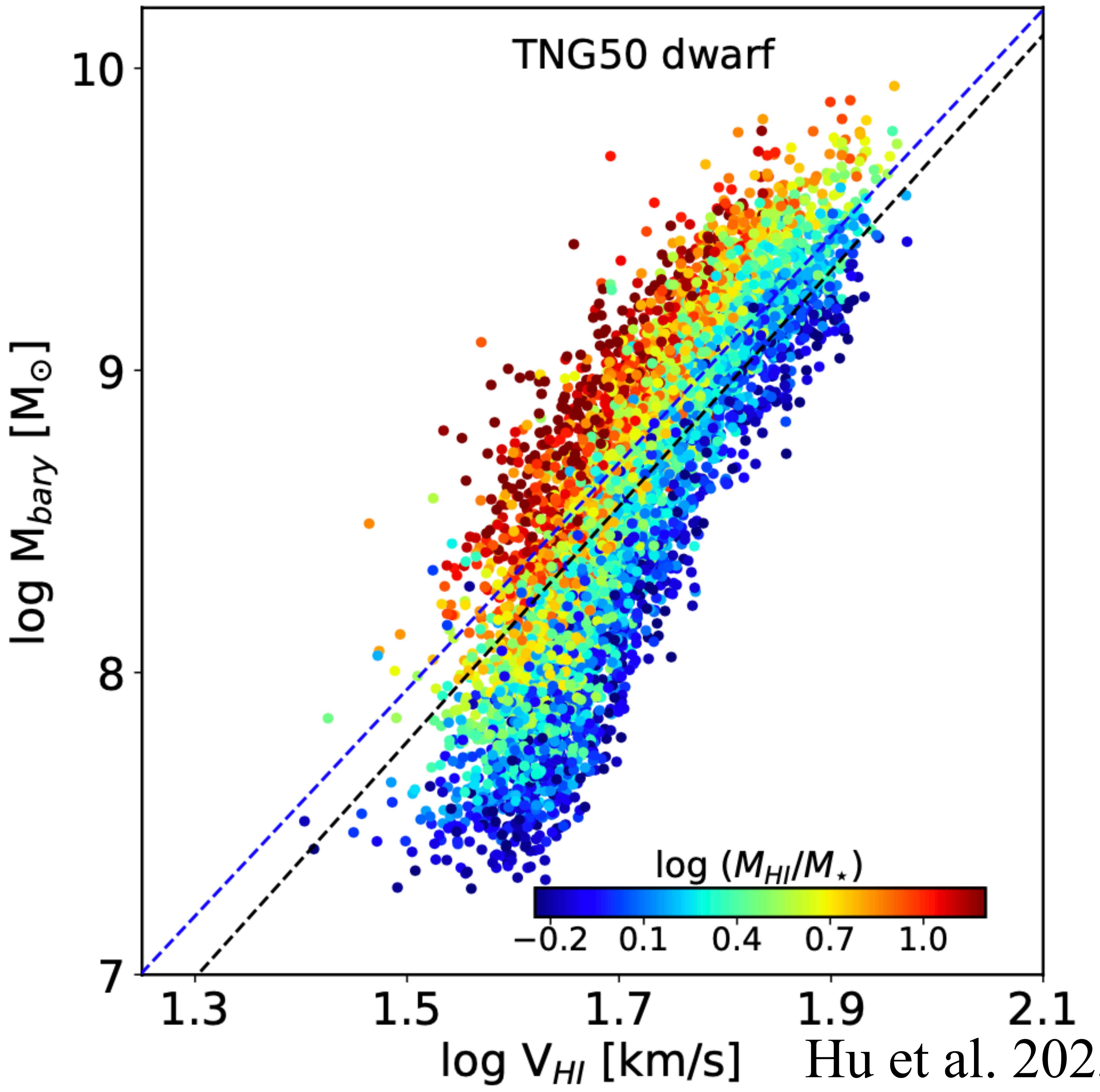
HUDGs in TNG50

High gas fraction may be the reason why HUDGs deviate from BTFR





Hu et al. 2023a

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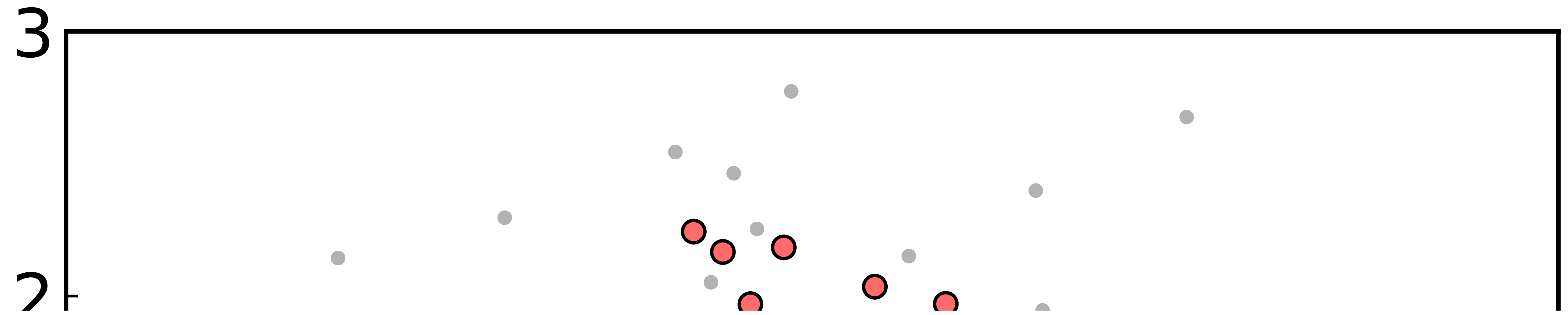
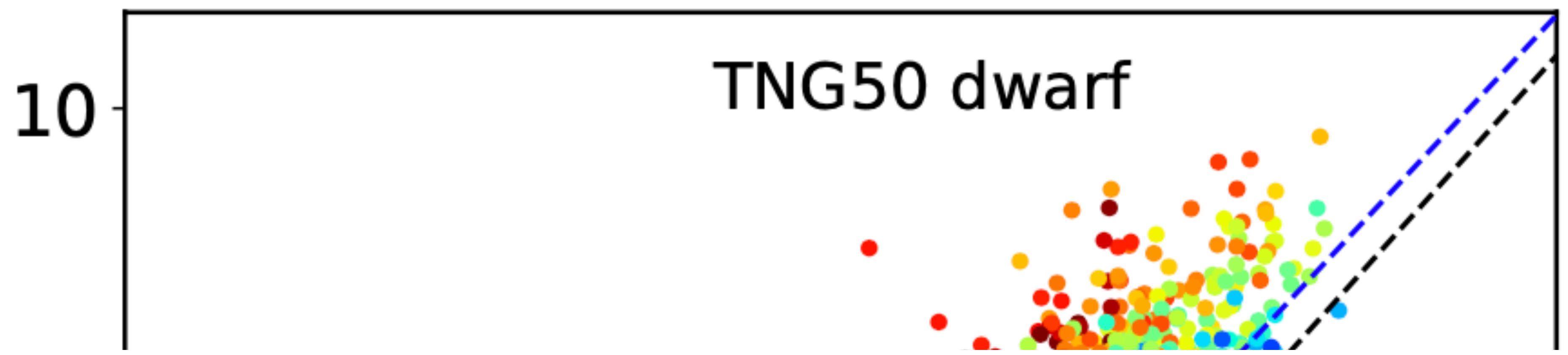
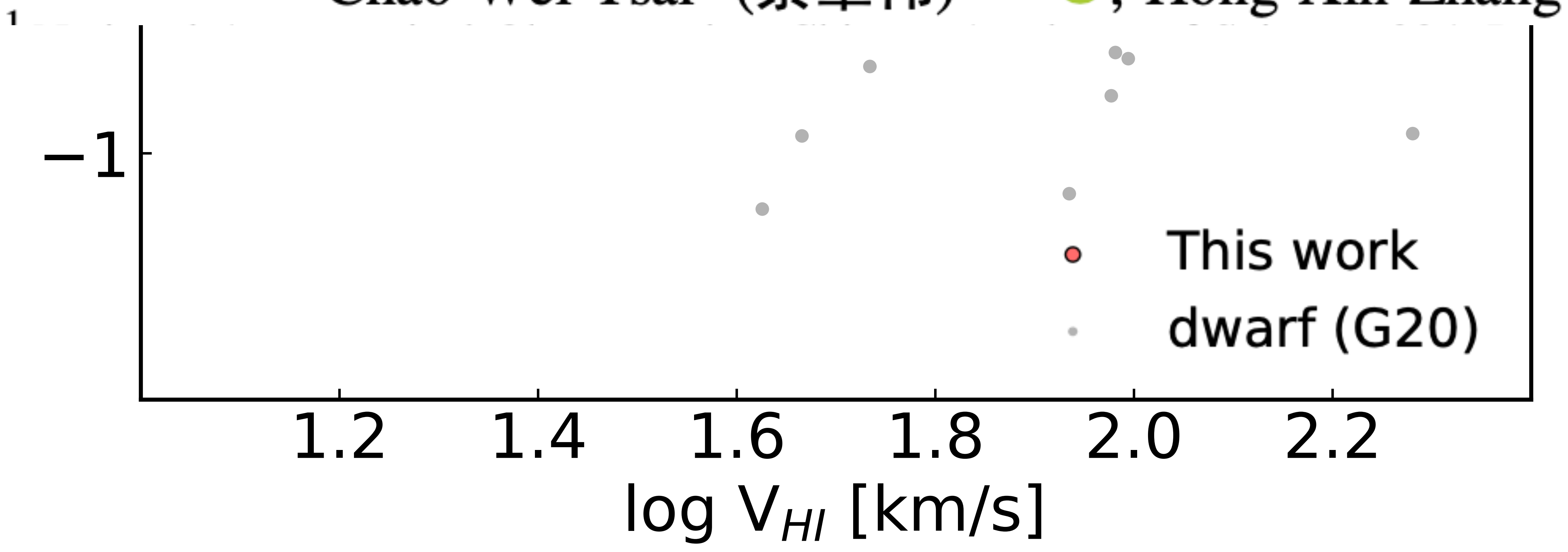


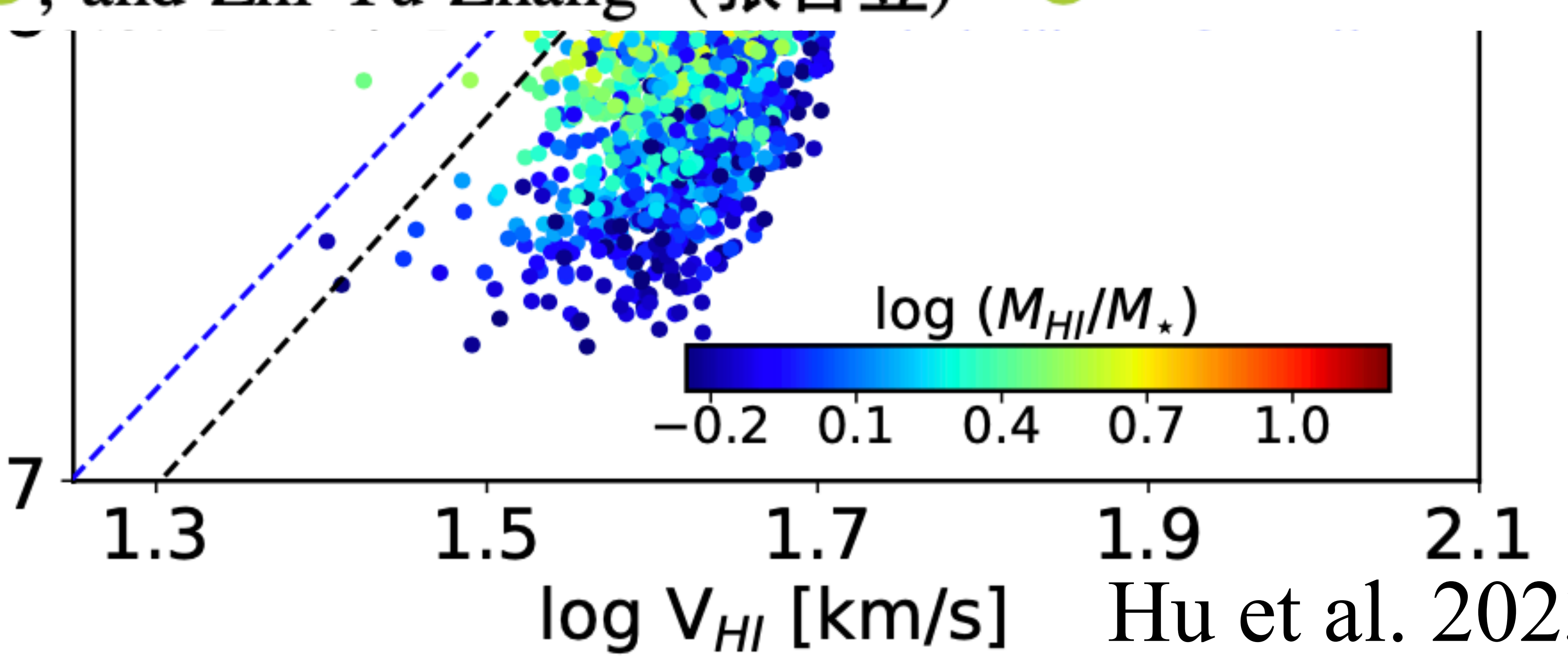


The Astrophysical Journal Letters, 947:L9 (10pp), 2023 April 10
https://doi.org/10.3847/2041-8213/acc7a4

Global Dynamic Scaling Relations of H I-rich Ultra-diffuse Galaxies

Hui-Jie Hu (胡慧杰)[1,2], Qi Guo (郭琦)[1,2,3], Zheng Zheng (郑征)[1,4], Hang Yang (杨航)[1,2], Chao-Wei Tsai (蔡肇伟)[1,2,3], Hong-Xin Zhang (张红欣)[5,6], and Zhi-Yu Zhang (张智昱)[7,8]





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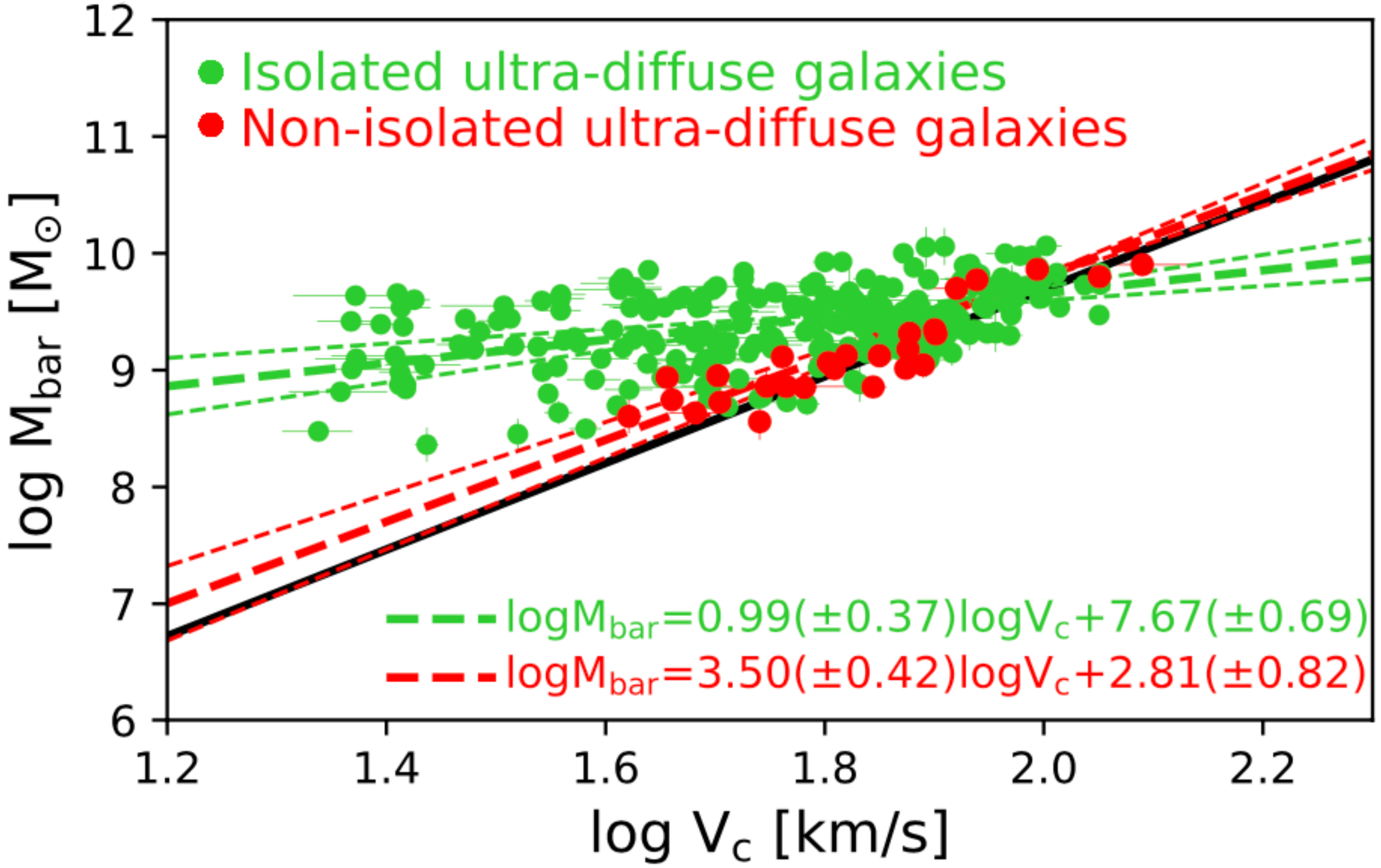
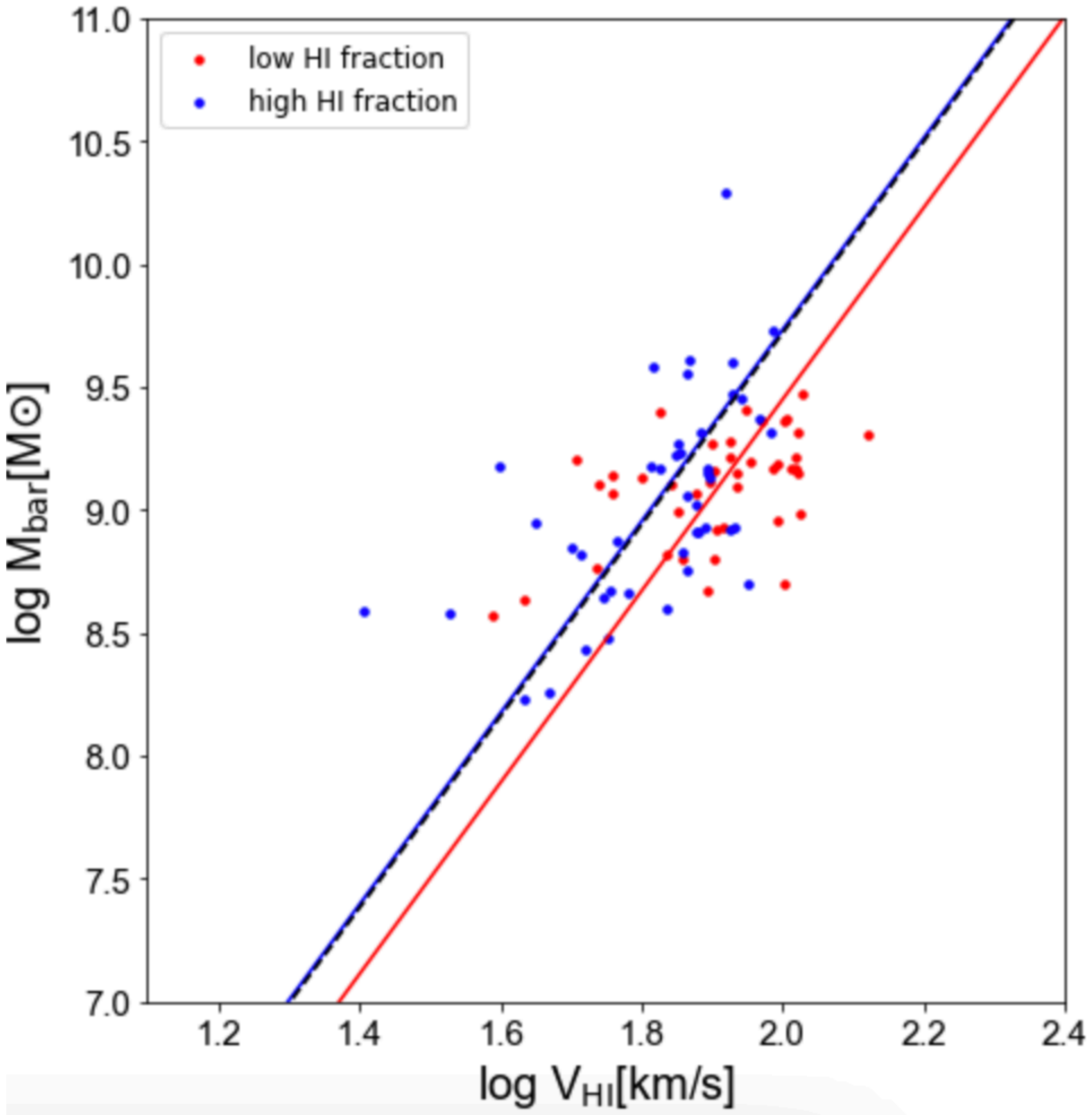
Environmental and gas fraction dependence



Rong, Hu+ submitted



Hu, in prep

Take home massages

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- Dwarf galaxies follow both TFR and BTFR.

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- HUDGs flatten out towards low circular velocities in the BTFR (might come from selection effects), HUDGs in the literature all reside in the region defined by our HUDGs.
- **HUDGs' deviation from BTFR is more significant than that from TFR.**
- High gas fraction plays an important role in explaining the relatively higher baryon fraction in HUDGs.

Thanks for your attention

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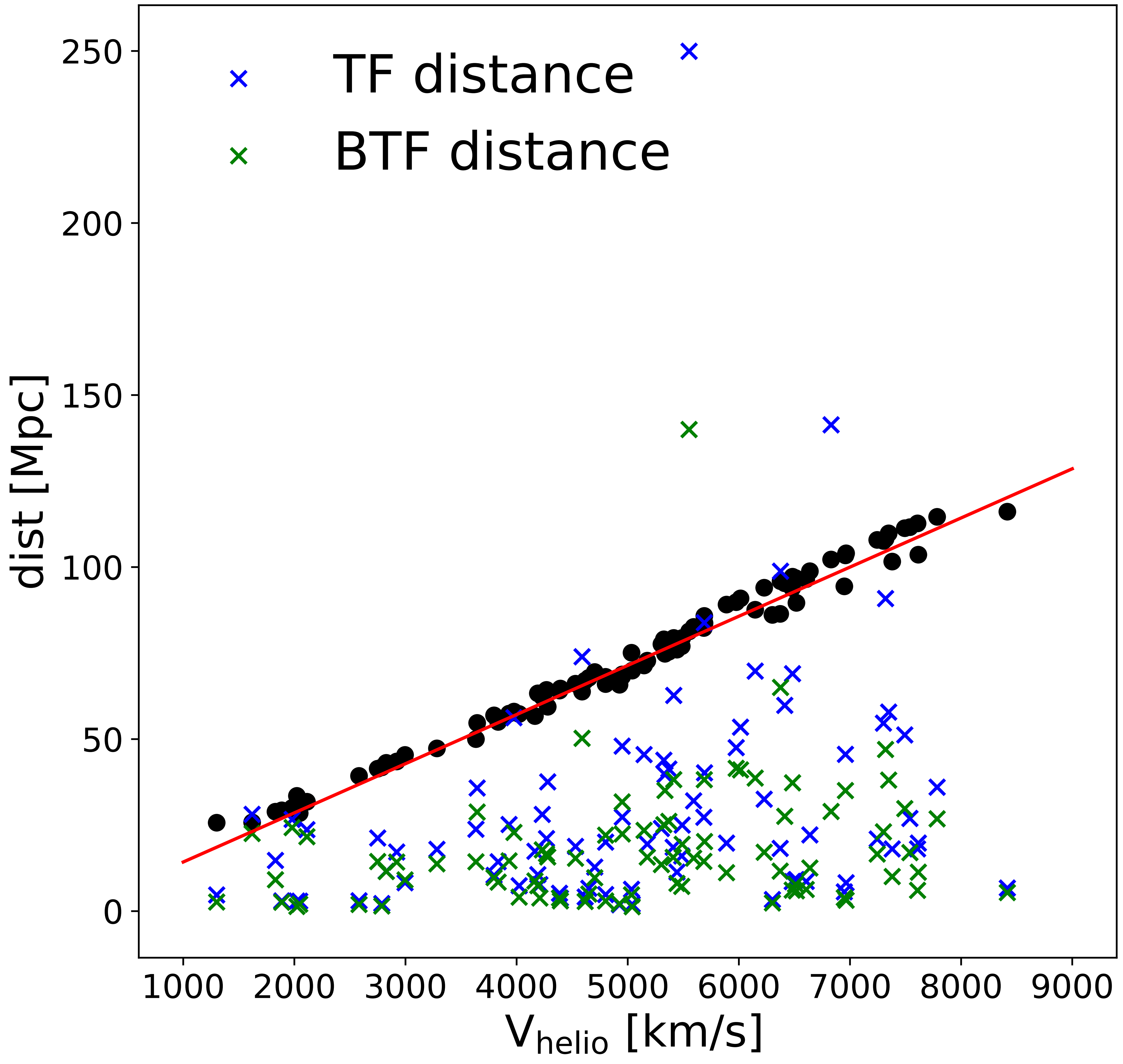
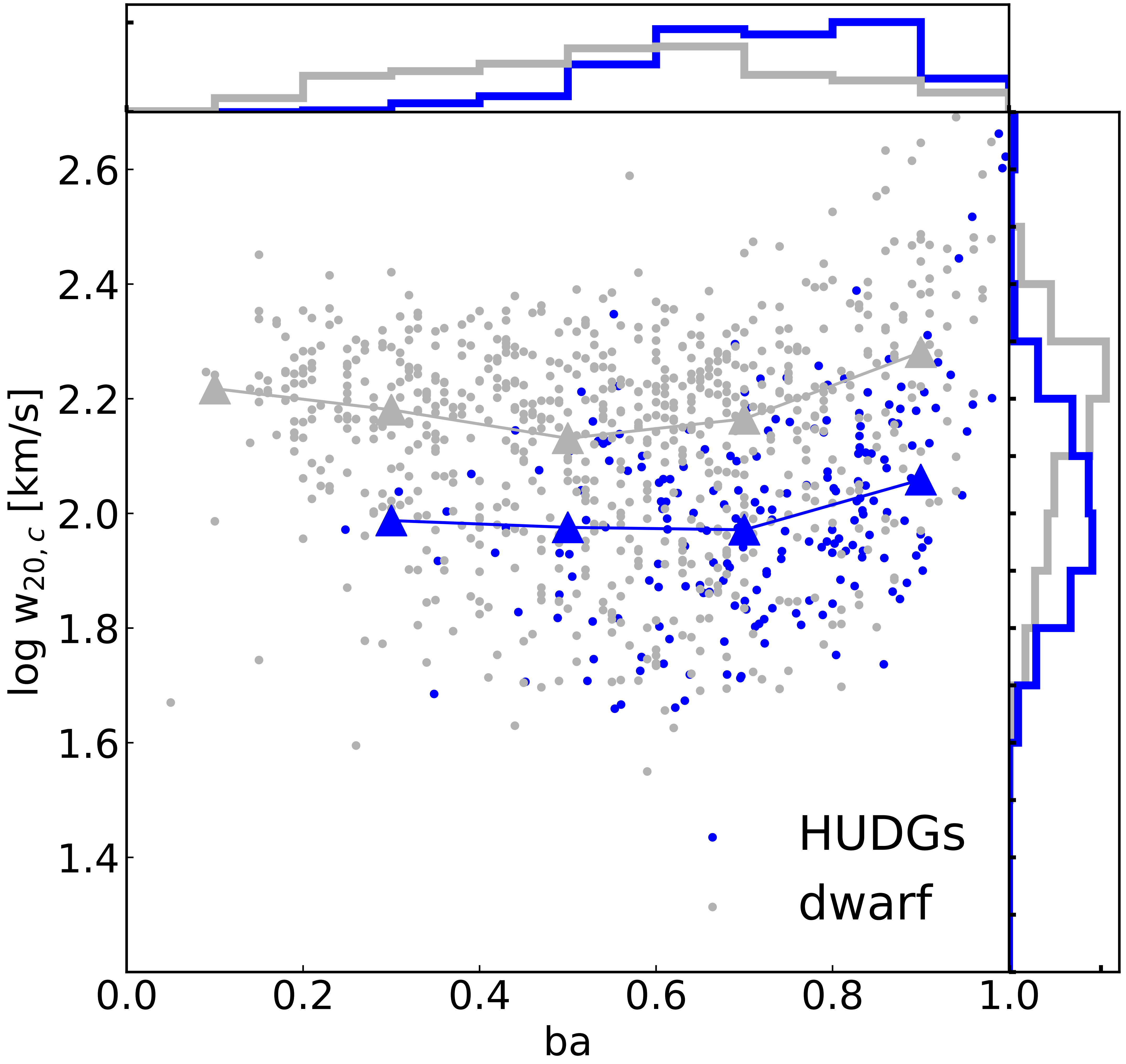
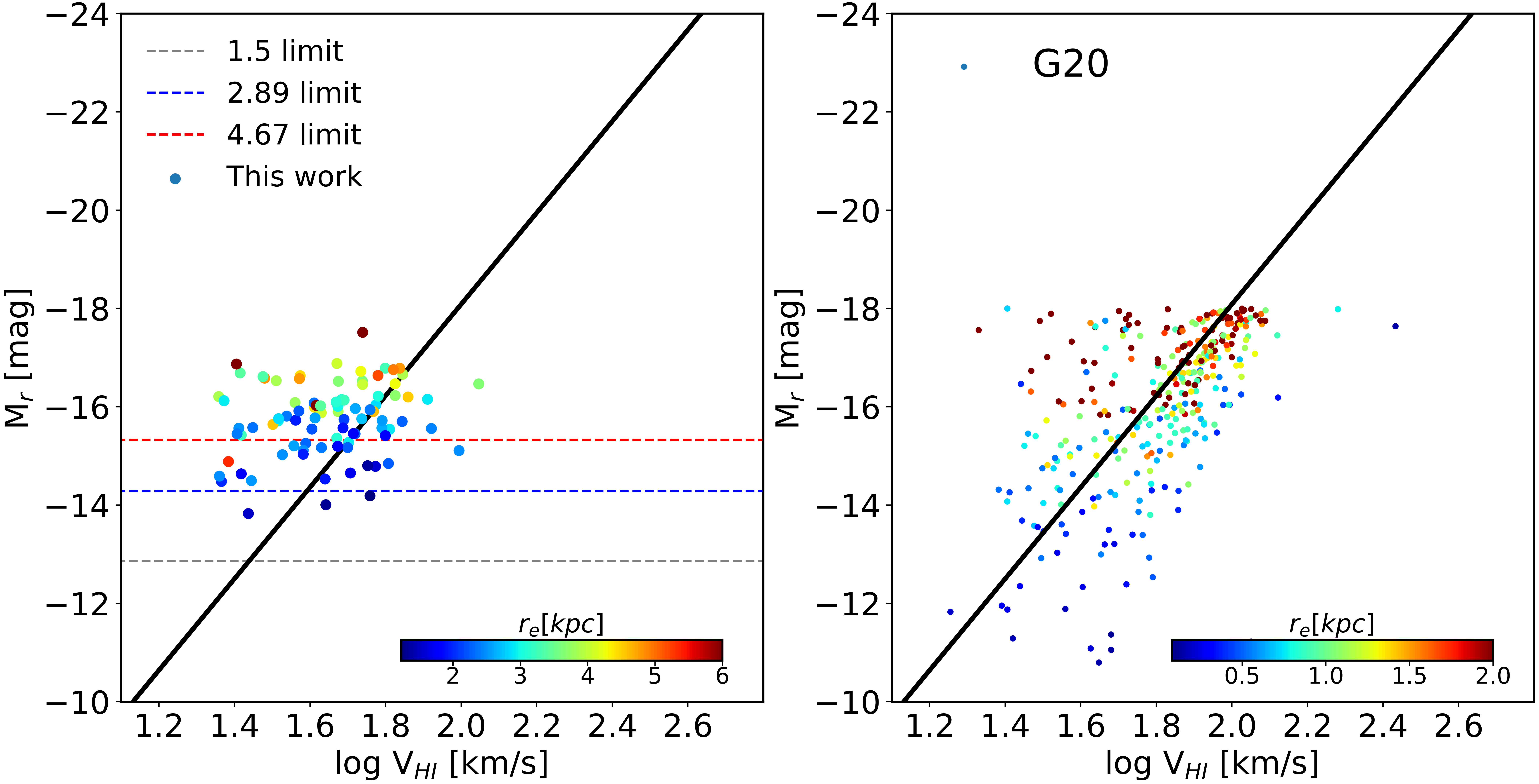
Distance and inclination corrections

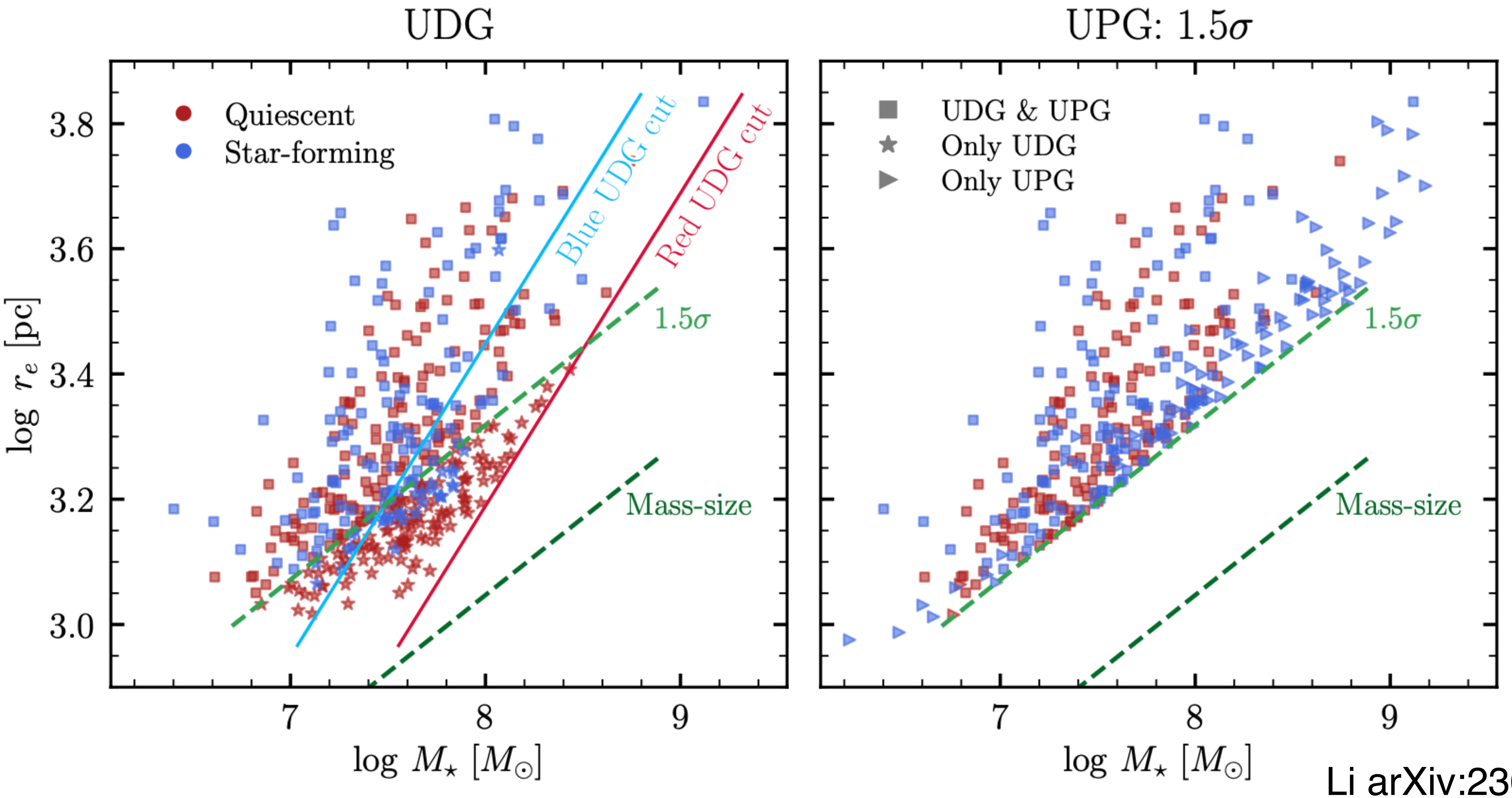




Optical limits



intrinsic scatter



Li arXiv:2302.14108