

Stellar and dark matter density in the Local Universe

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Diversity of the Local Universe
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Introduction

Global cosmic values

$$\Omega_* \approx 0.27\%$$

(Fukugita&Peebles2004)

$$\Omega_m \approx 0.32$$

(Planck2014)

Local Universe

1. Local Volume
2. Local Supercluster
3. $D < 135$ Mpc

Local Volume, $D < 11$ Mpc

$$V_{LG} < 600 \text{ km s}^{-1}$$

Data from Updated Nearby Galaxy Catalog (UNGC)

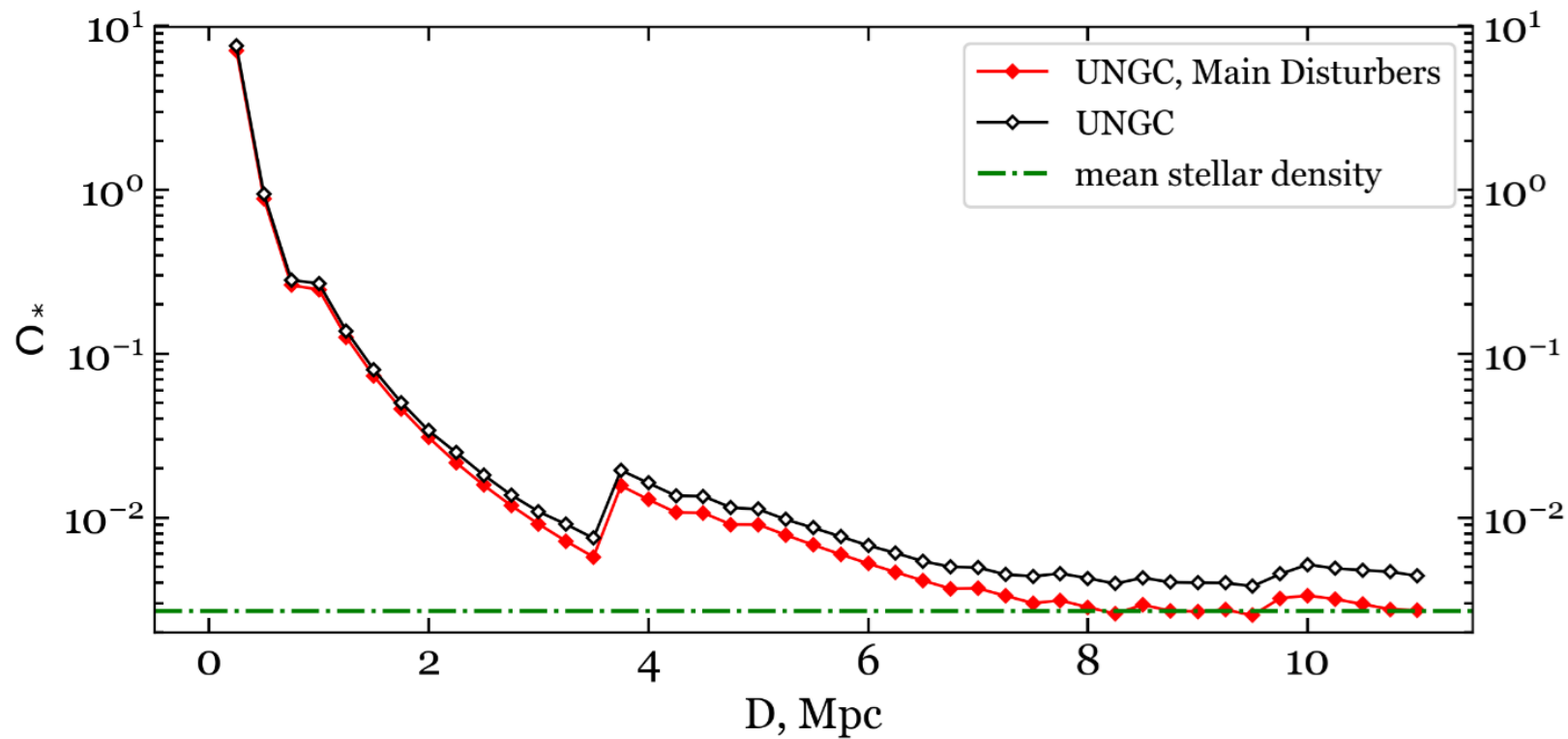
(Karachentsev, Makarov, & Kaisina, 2013)

- Accurately measured galaxy distances
- Kinematics
- K-band magnitudes were measured in 2MASS Redshift Survey *(Jarrett et al., 2000)*

Galaxy	D Mpc	V_{LG} km s ⁻¹	$\log M_*$ M_\odot	$\log M_{tot}$ M_\odot
Milky Way	0.01	-65	10.70	12.07
M31	0.77	-29	10.79	12.23
NGC5128	3.68	310	10.89	12.89
M81	3.70	104	10.95	12.69
NGC253	3.70	276	10.98	12.18
NGC4826	4.41	365	10.49	10.78
NGC4736	4.41	352	10.56	12.43
NGC5236	4.90	307	10.86	12.02
M101	6.95	378	10.79	12.17
NGC4258	7.66	506	10.92	12.50
NGC3627	8.32	579	10.82	12.16
M51	8.40	538	10.97	11.78
NGC2903	8.87	443	10.82	11.68
NGC5055	9.04	562	11.00	12.49
NGC4594	9.55	894	11.30	13.45
NGC6744	9.51	706	10.91	11.72
NGC3115	9.68	439	10.95	12.54
NGC2683	9.82	334	10.81	12.13
NGC891	9.95	736	10.98	11.90
NGC628	10.2	827	10.60	11.66
NGC3379	11.0	774	10.92	13.23

Local Volume, $D < 11$ Mpc

$$M_* = M_{\odot} \frac{L_K}{L_{\odot}}$$



$$\Omega_* = 0.44 \%$$

Local Volume, $D < 11$ Mpc

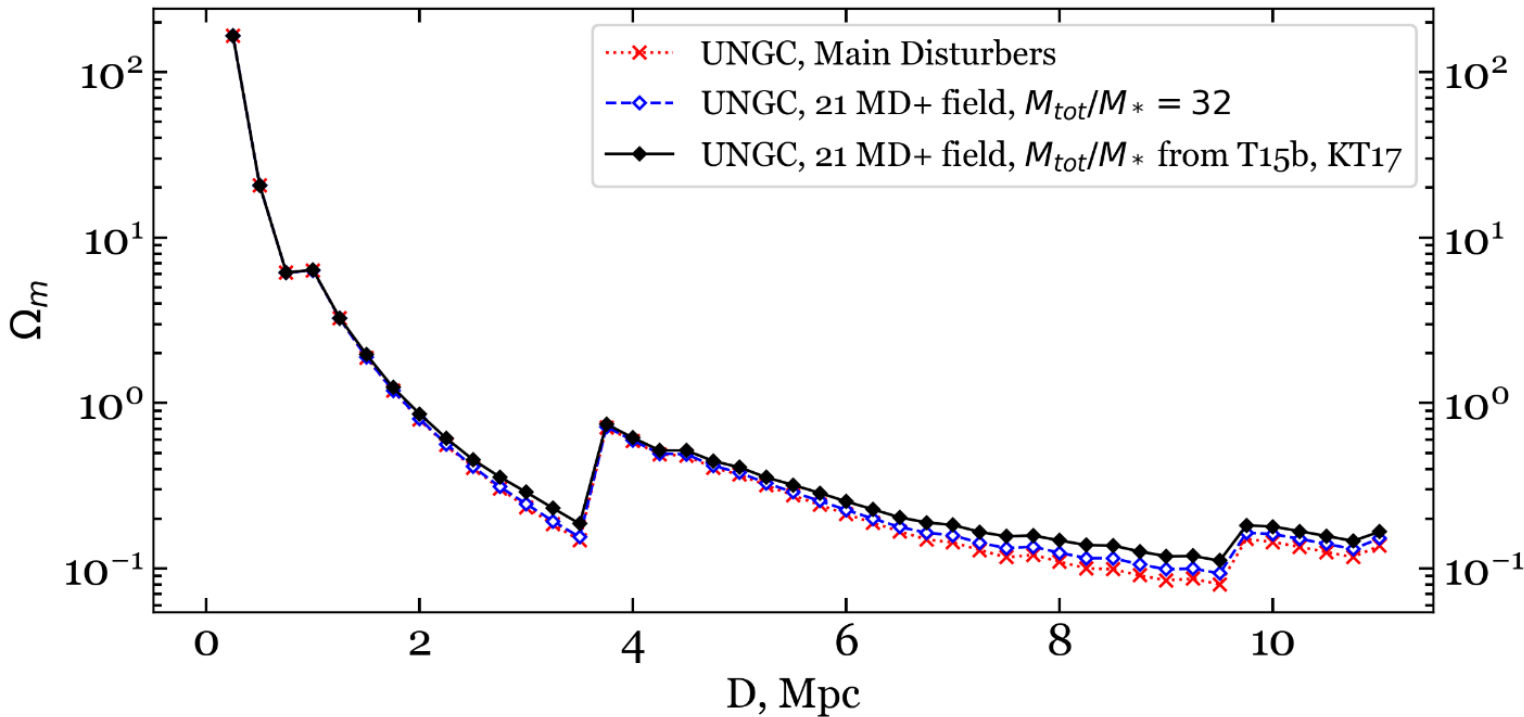
Main Disturbers halo masses

$$M_{tot} = \frac{16}{\pi G} \langle \Delta V^2 R_p \rangle$$

Field galaxies

$$M_{tot} \approx 32 M_*$$

$$\text{vs } \log(M_{tot}/M_*) = \begin{cases} \log(32) - 0.50 \log(M_*/10^{10}), & \text{for } \log M_* < 8.97 \\ \log(32) + 0.15 \log(M_*/10^{10}), & \text{for } \log M_* > 10.65 \end{cases}$$



*Tully (2015),
Kourkchi & Tully (2017)*

$$\Omega_m = 0.17$$

Local Supercluster, $D < 40$ Mpc

$$V_{LG} < 3500 \text{ km s}^{-1}$$

Data from catalog of galaxy groups made by Kourkchi & Tully (2017) (KT17)

Total mass of the group

Dynamical mass

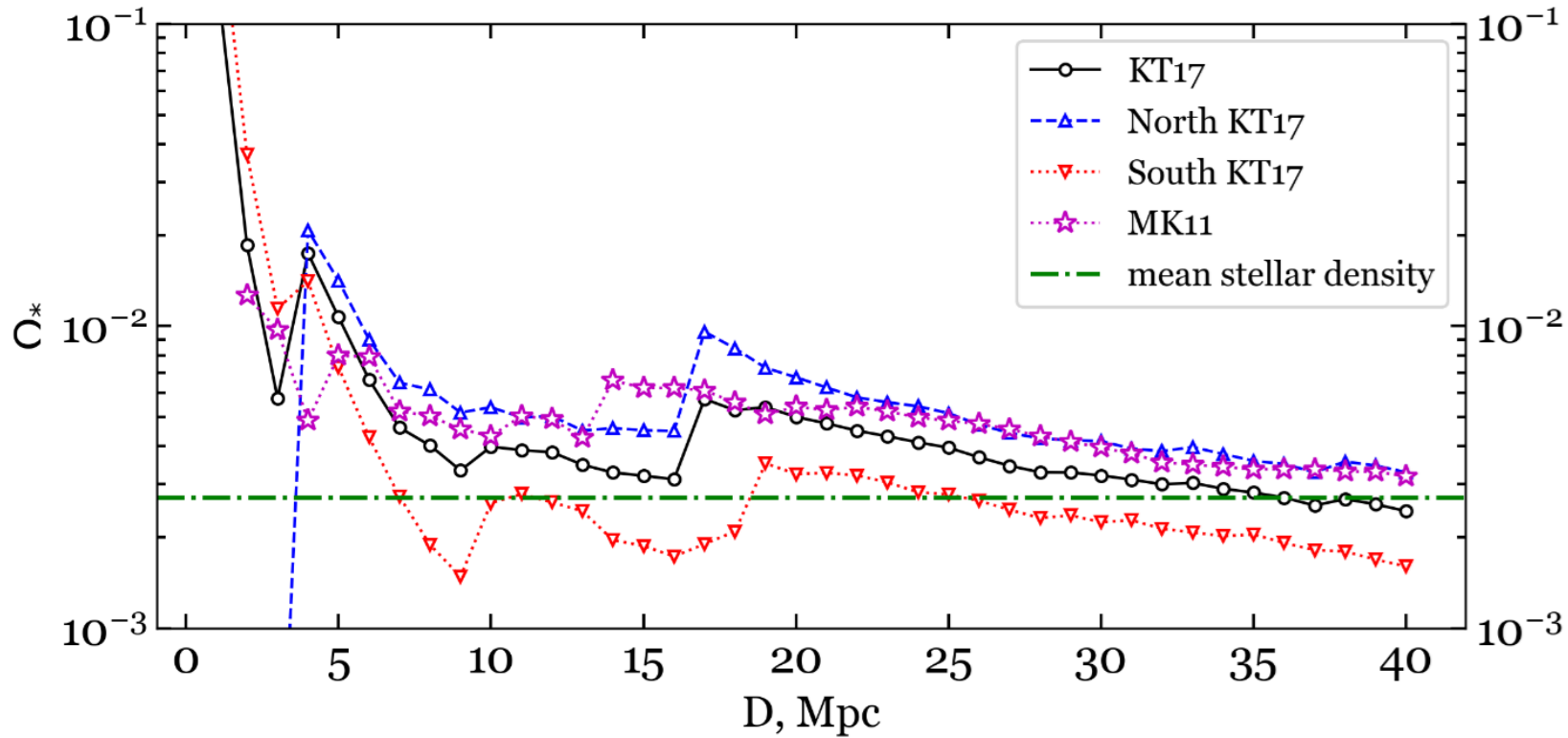
Inferred from K-band luminosity

$$M_{tot} = \frac{\alpha \pi}{2 G} \sigma_p^2 R_h$$

Harmonic radius

Radial velocity dispersion

Local Supercluster, $D < 40$ Mpc



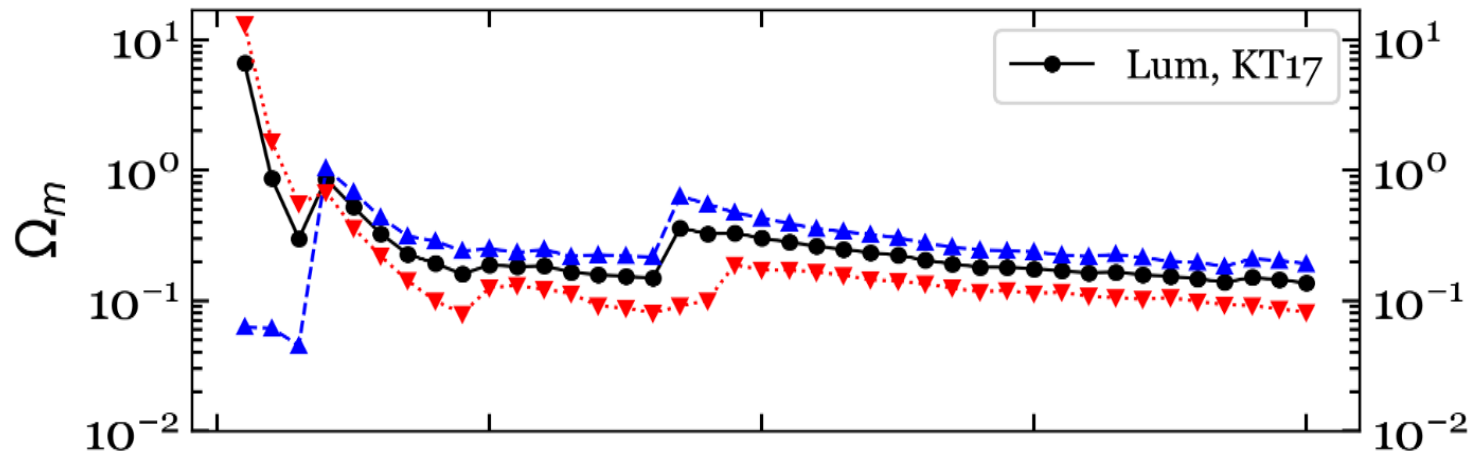
$$\Omega_* = 0.24 - 0.32\%$$

Global value

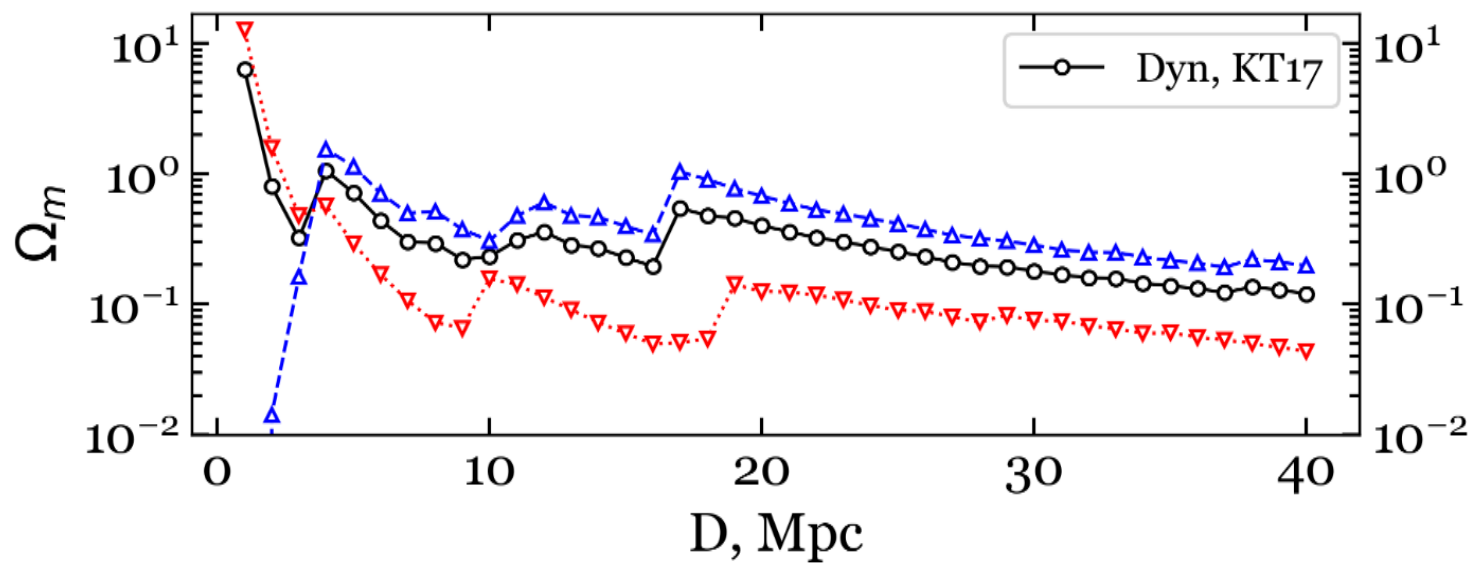
$$\Omega_* \approx 0.27\%$$

(Fukugita&Peebles2004)

Local Supercluster, $D < 40$ Mpc



$$\Omega_m = 0.12 - 0.14$$



$D < 135 \text{ Mpc}$

$V_{LG} < 10000 \text{ km s}^{-1}$

Data from catalog of galaxy groups made by Tully (2015b) (hereafter T15b)

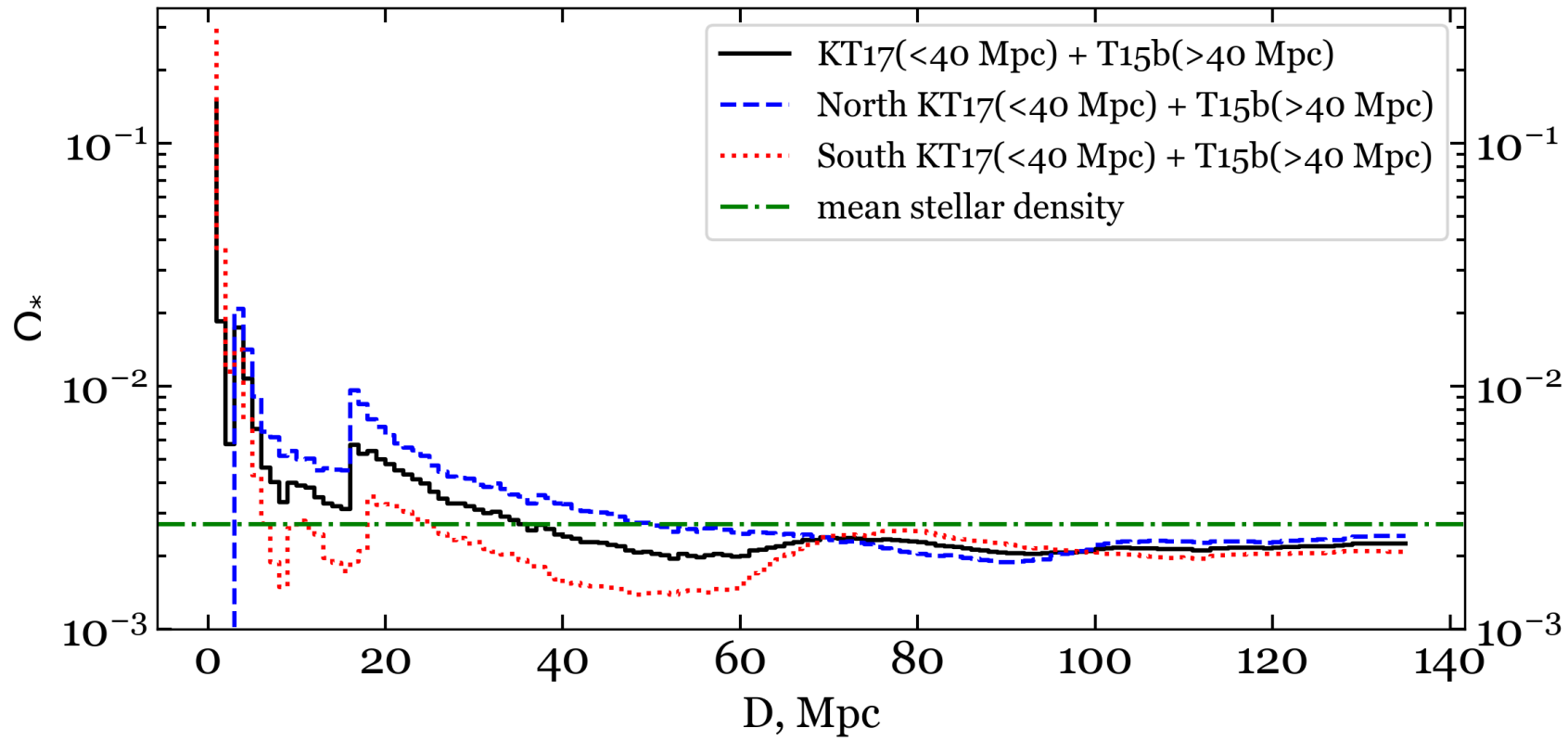
- 2MASS Redshift Survey observational limit 11.75^m



Correction factor for total luminosity of the group

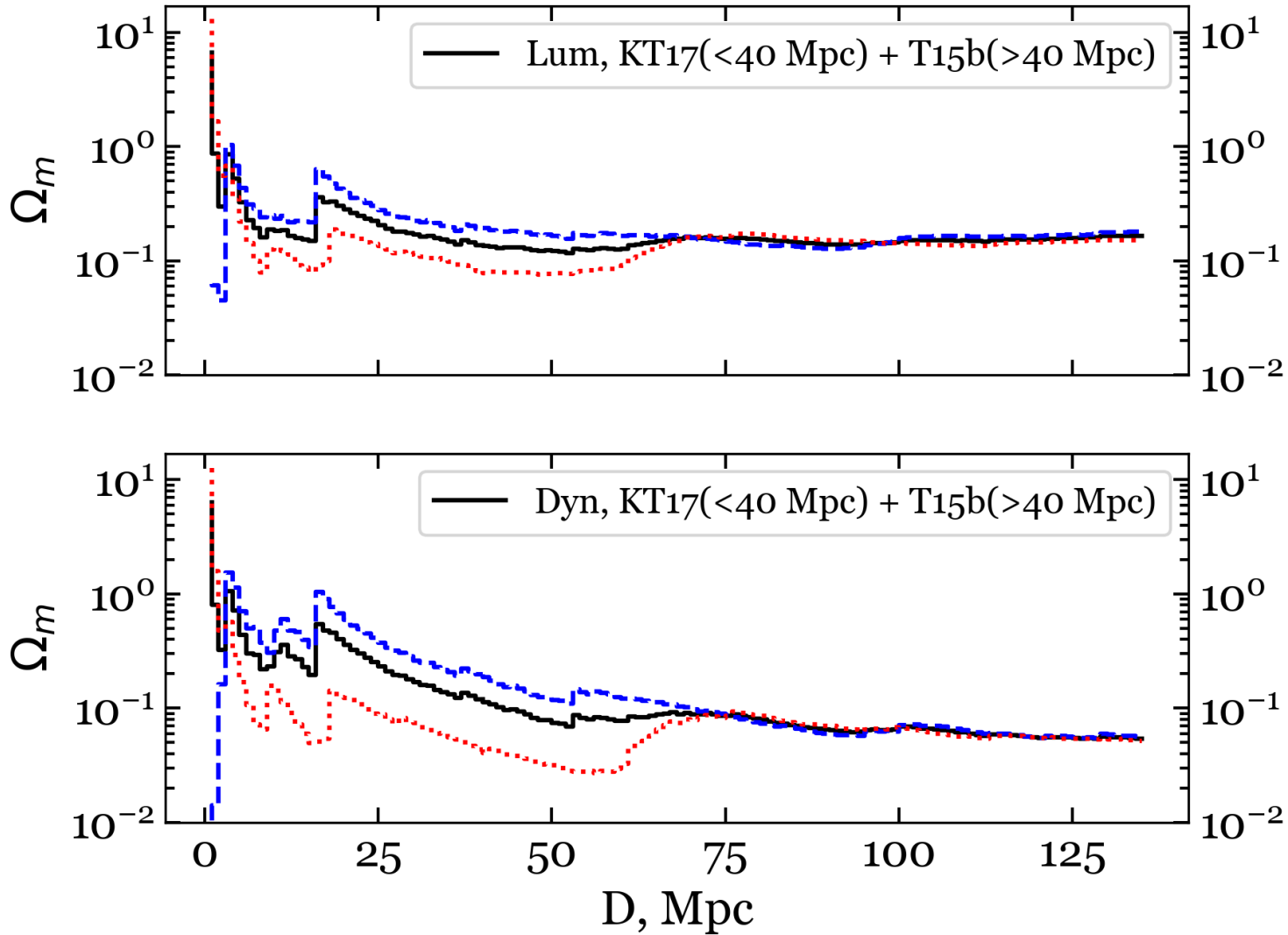
- Dynamical total mass and total mass inferred from mass-to-light ratio

$D < 135 \text{ Mpc}$



$$\Omega_* = 0.20 - 0.24\%$$

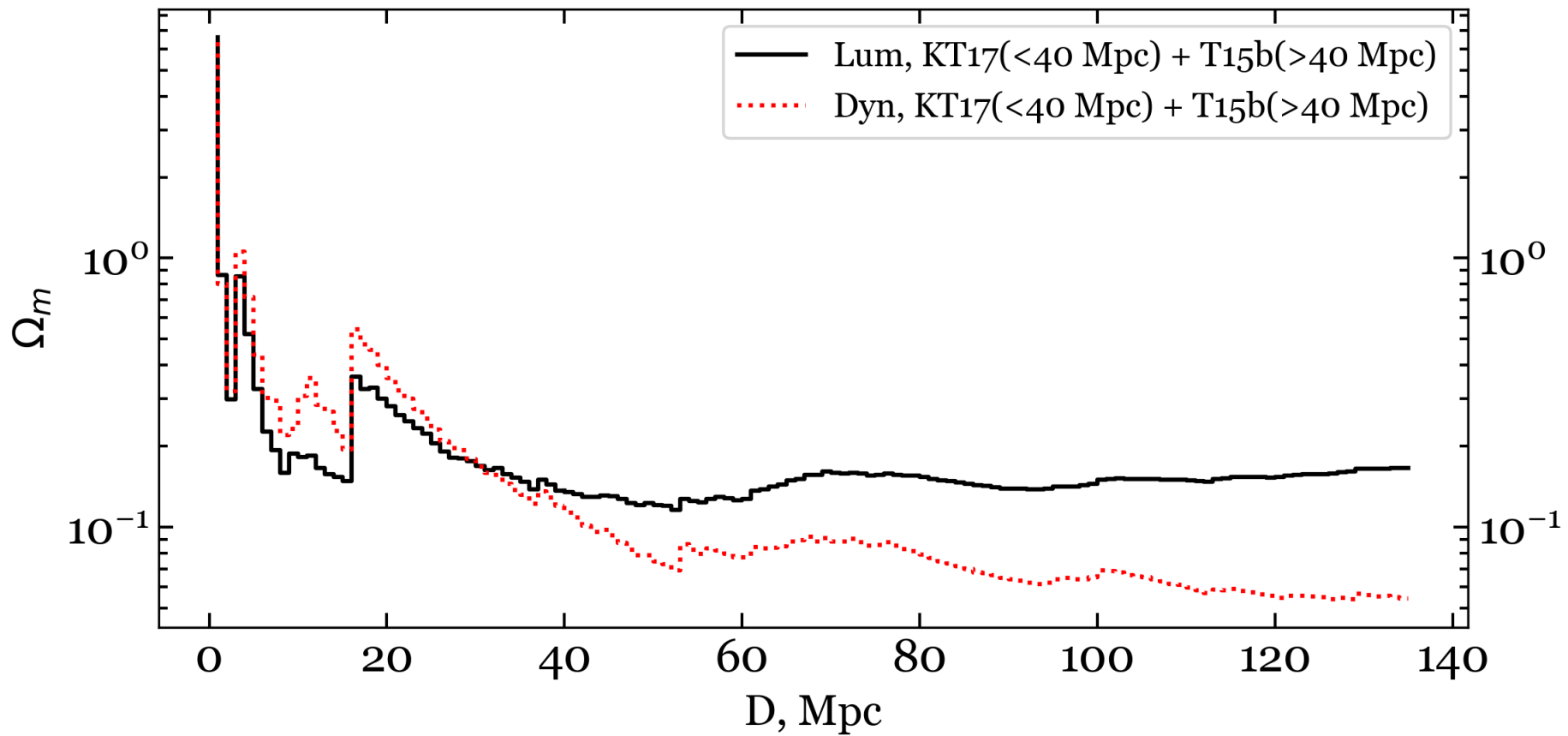
D < 135 Mpc



$$\Omega_m = 0.05 - 0.16$$

- Difference between Ω_m for Northern and Southern Galactic hemispheres decreases with increasing D and at $D > 70$ Mpc it becomes within (10 – 15)% of the mean value.

$D < 135$ Mpc



Summary

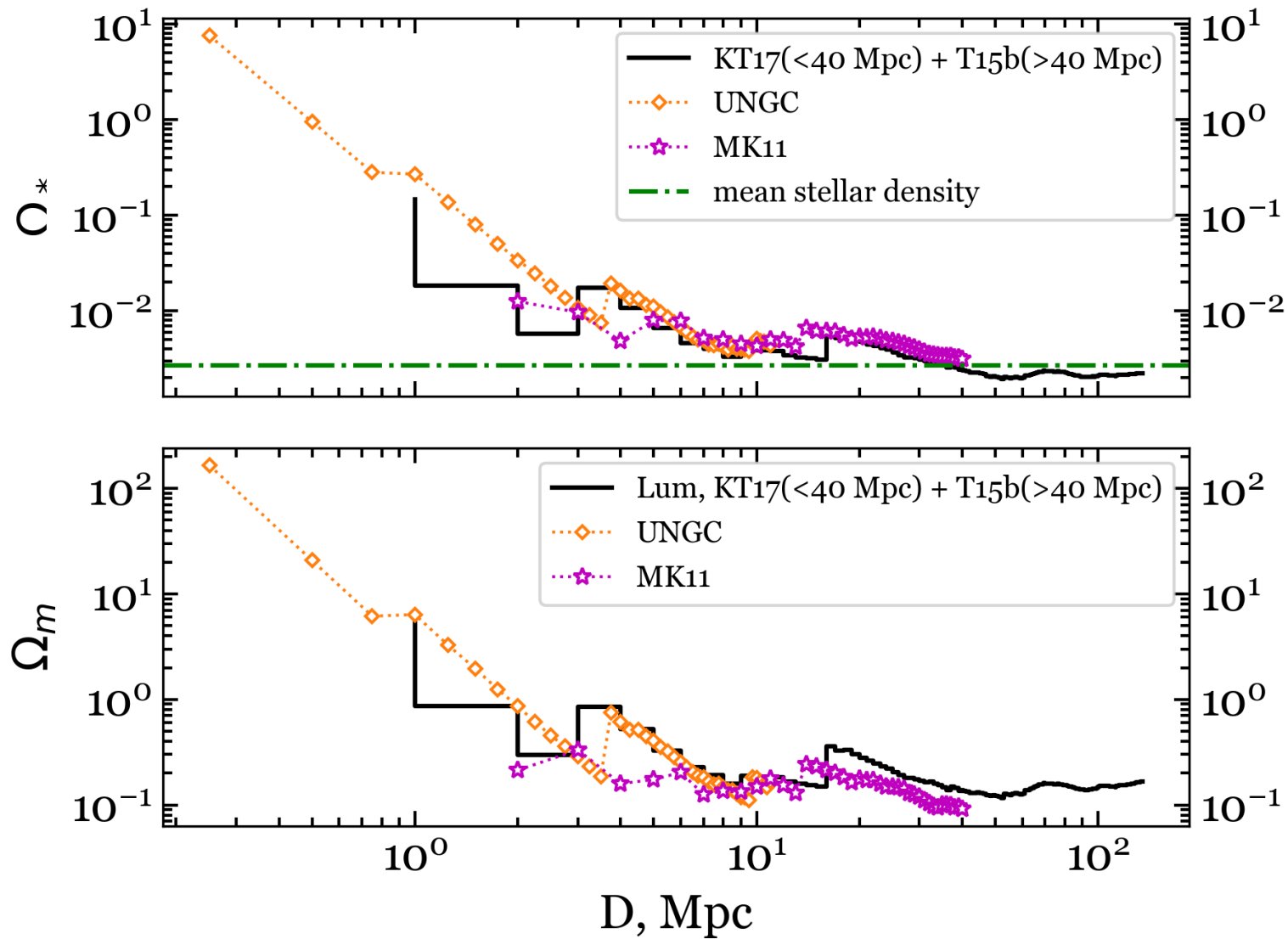
- In the Local Volume stellar density is $\Omega_* = 0.44\%$ and total density is $\Omega_m = 0.17$
- Within the sphere with radius of 40 Mpc stellar density is similar to its global value $\Omega_* = 0.24 - 0.32\%$, while total density is $\Omega_m = 0.12 - 0.14$, which more than 2 times less than that of the global value
- Within the sphere with radius of 135 Mpc because of the observational complications estimations of Ω_* and Ω_m have significant systematic uncertainties and drop to the values $\Omega_* = 0.20 - 0.24\%$, $\Omega_m = 0.05 - 0.16$
- Major part of the cosmic dark matter locates outside the virial and collapsing zones of groups and clusters

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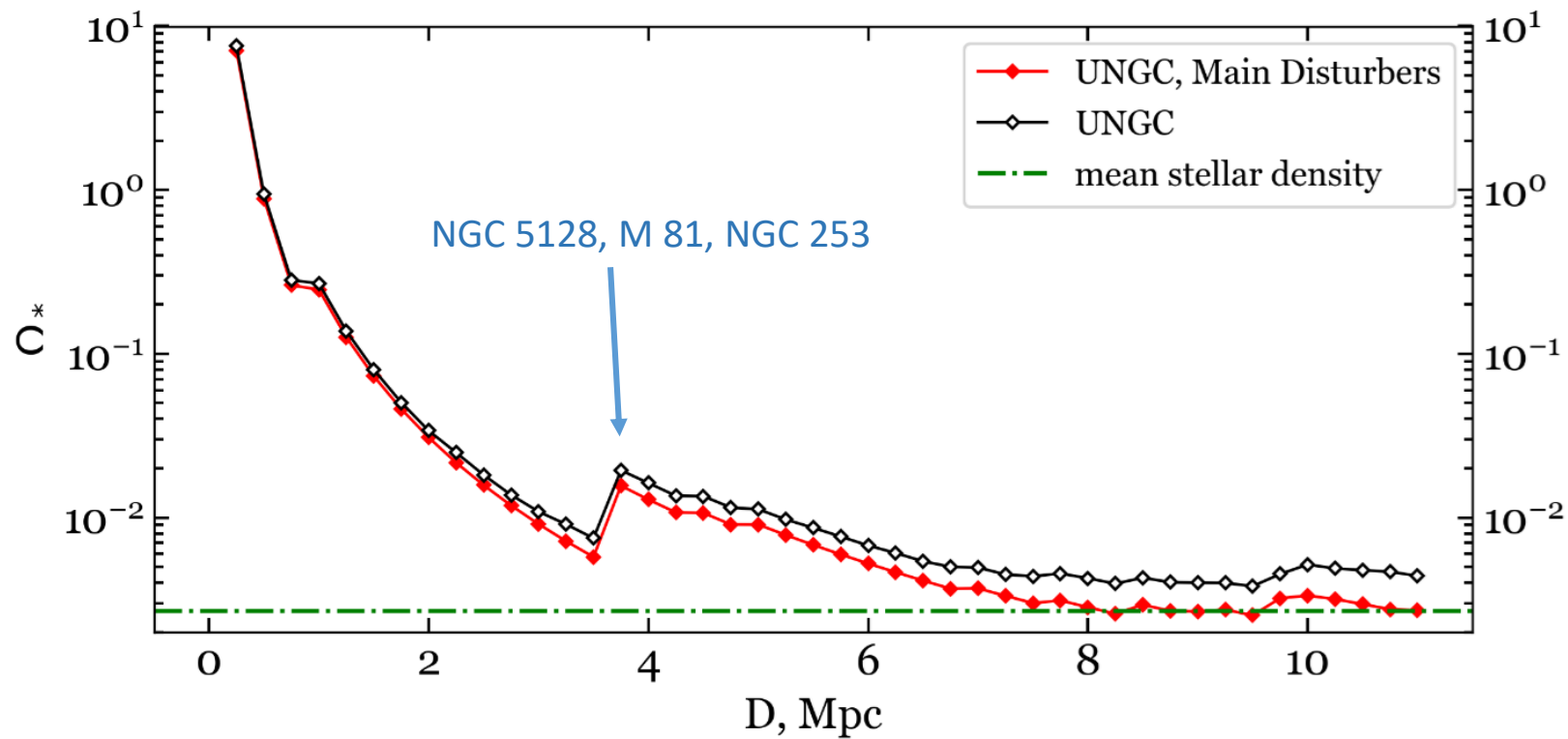
Thank you!

Densities in log-log scale



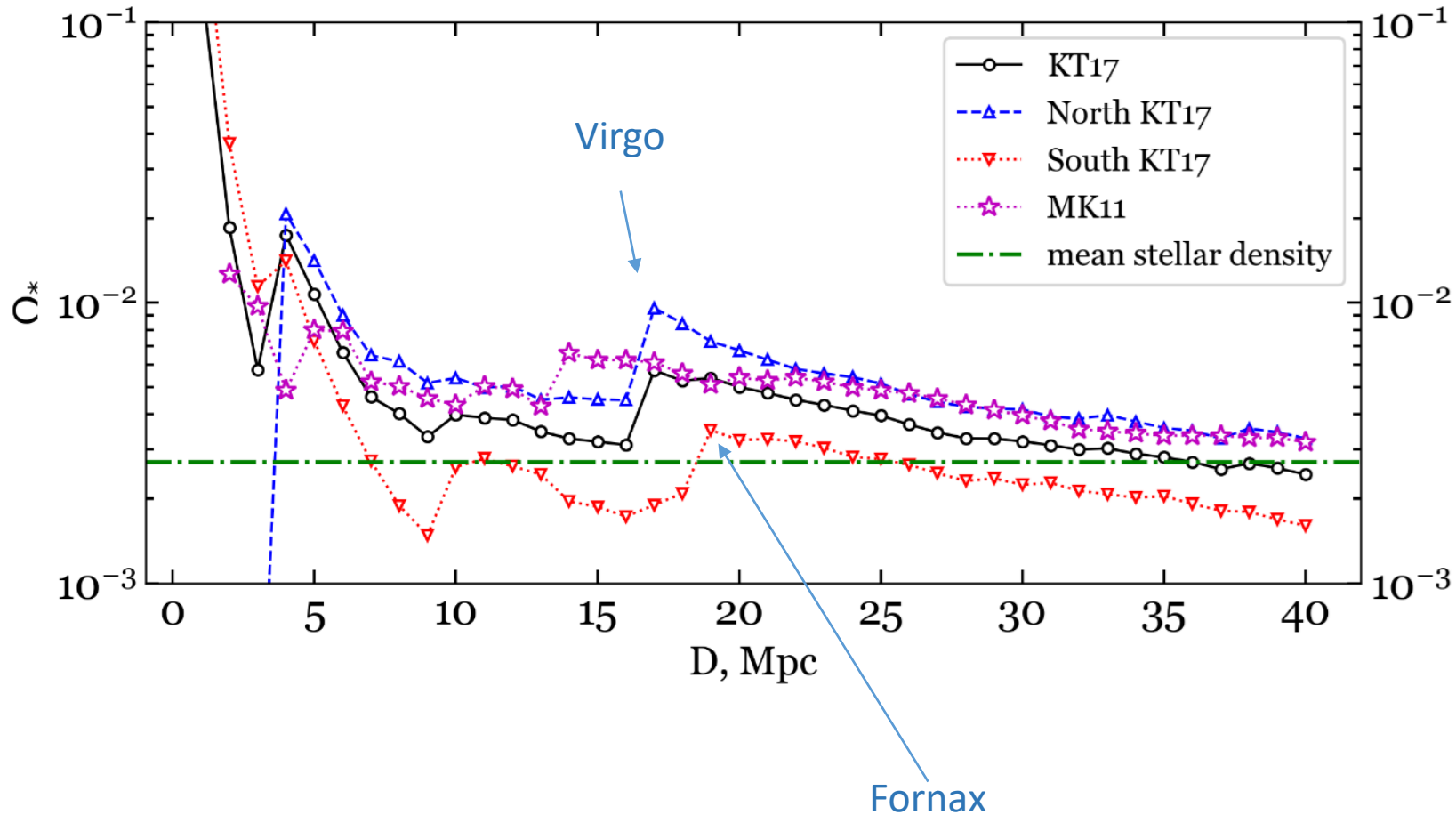
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Global value

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