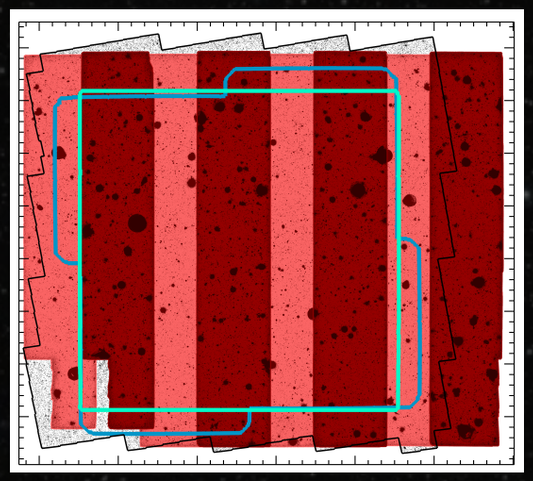
The bright-end of the galaxy luminosity functions at z = (5), 6 & 7

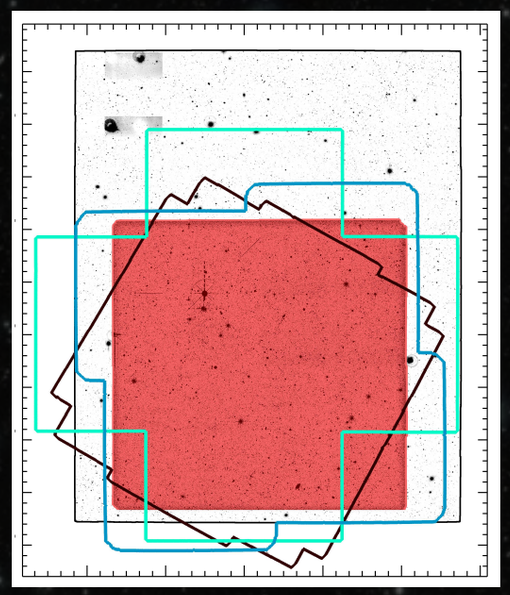
Rebecca Bowler

with Jim Dunlop, Ross McLure + …

High-z LFs from UltraVISTA + UDS



UltraVISTA/COSMOS
+ UDS/SXDS fields
total area = 1.7 deg^2



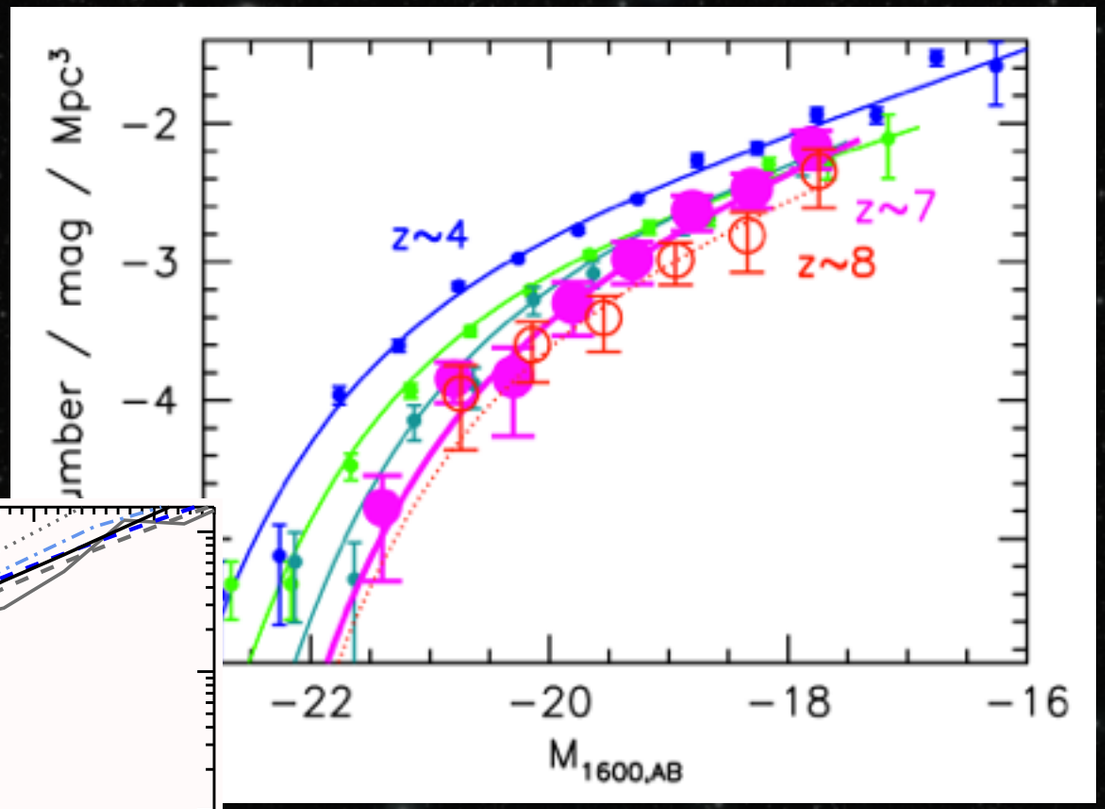
bright-end of the z = 7 LF
(Bowler et al. 2014)

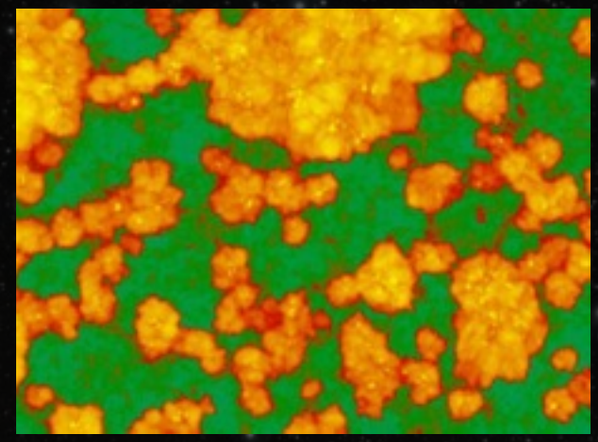
HST/WFC3
follow-up

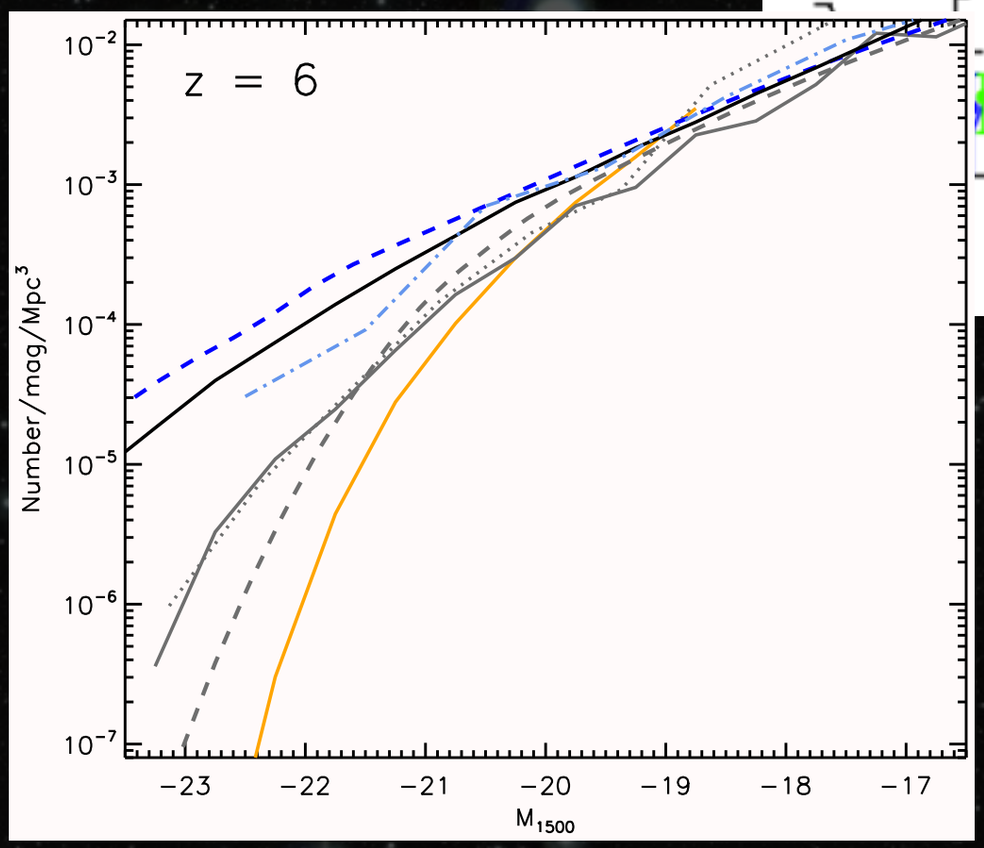
bright-end of the z = 6 LF
(Bowler et al. 2015)

The galaxy luminosity function at high-z

Bouwens et al. 2011





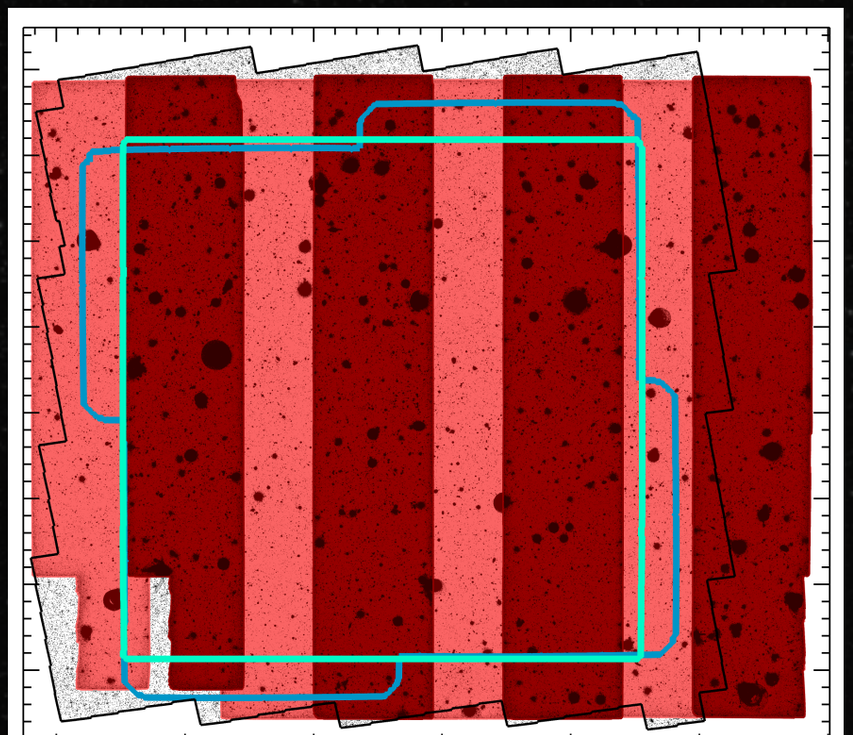


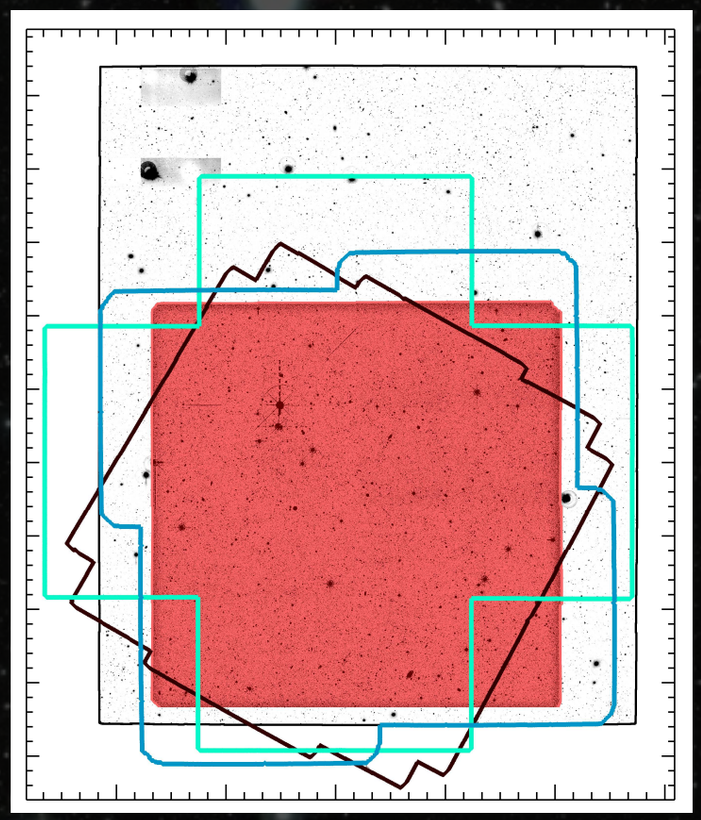
Bright end: constraining dominant astrophysics via comparison with theoretical models

Ground-based optical/near-IR datasets

UltraVISTA/COSMOS

filters	telescope/program	AB 5σ depth
u*, g, r, i, z	CFHTLS	~ 27
i (814)	*HST*/ACS	~ 27
z’	Subaru	~ 26.5
Y, J, H, Ks	Ultra-VISTA DR2	~ 24-25, 25-26
3.6μm, 4.5μm	*Spitzer*/SPLASH	~ 25





UDS/SXDS

filters	telescope/program	AB depth
B, V, R, i	Subaru/SXDS	~ 27
z’	Subaru	~ 26.5
Y	VISTA VIDEO	~ 25
J, H, K	UKIRT/UKIDSS	~ 25-26
3.6μm, 4.5μm	*Spitzer*/SPLASH	~ 25

Ground-based optical/near-IR datasets

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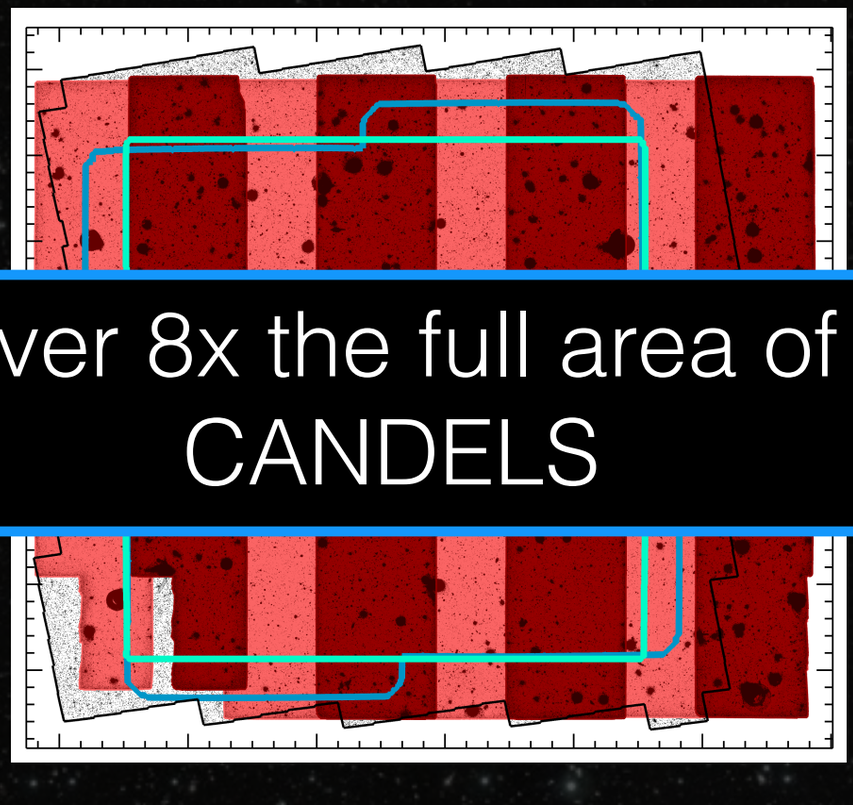
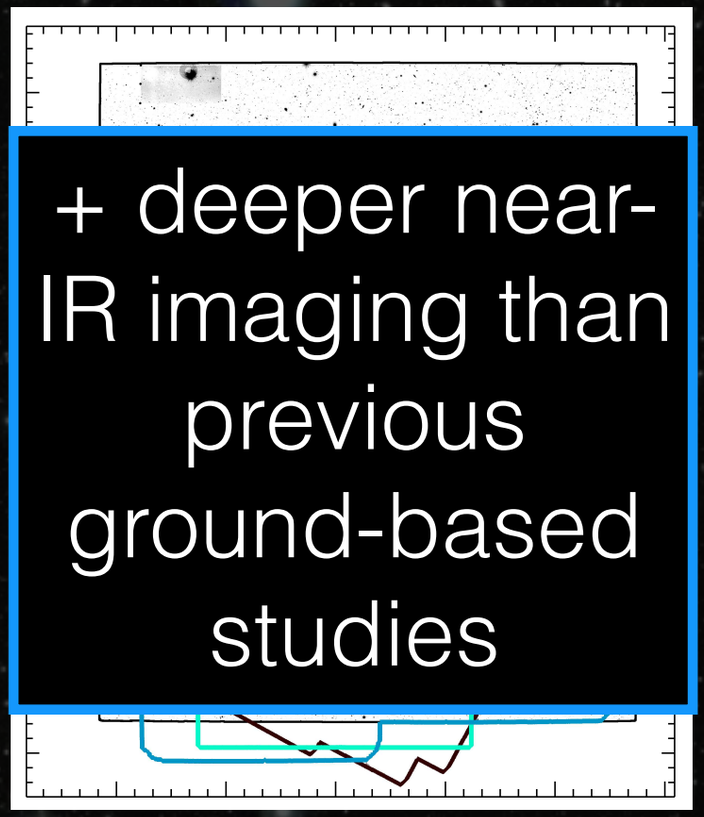


over 8x the full area of CANDELS



+ deeper near-IR imaging than previous ground-based studies

UDS/SXDS

filters	telescope/program	AB depth
B, V, R, i	Subaru/SXDS	~ 27
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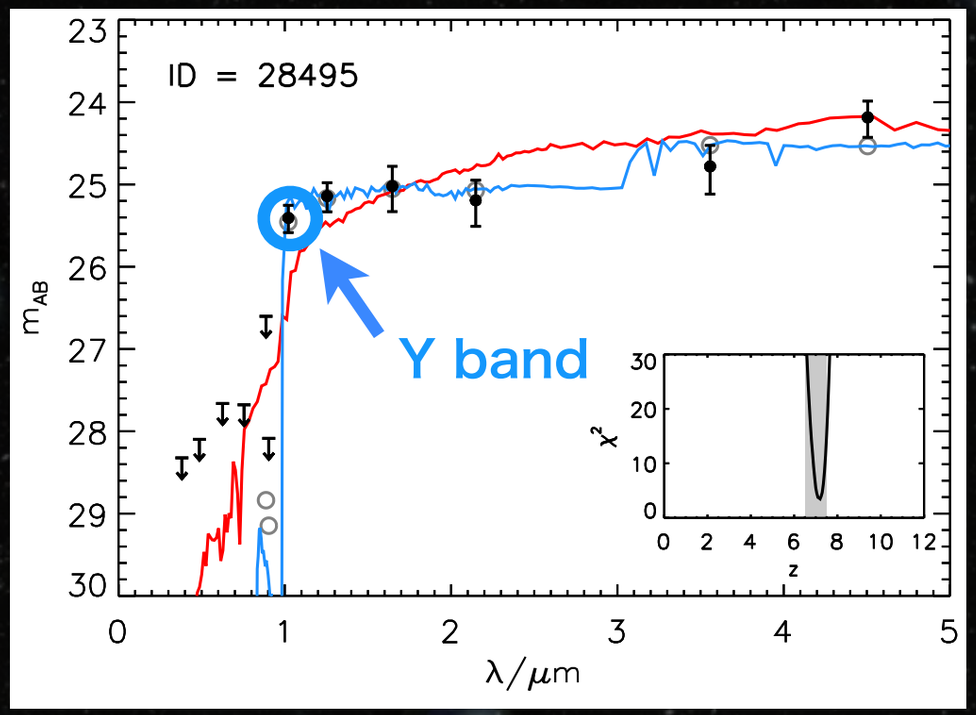
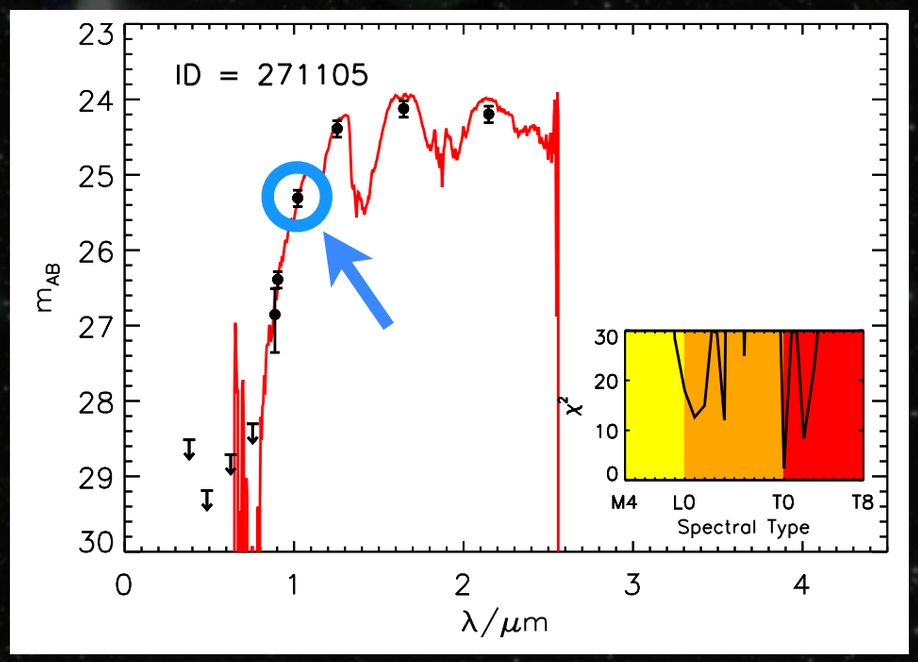
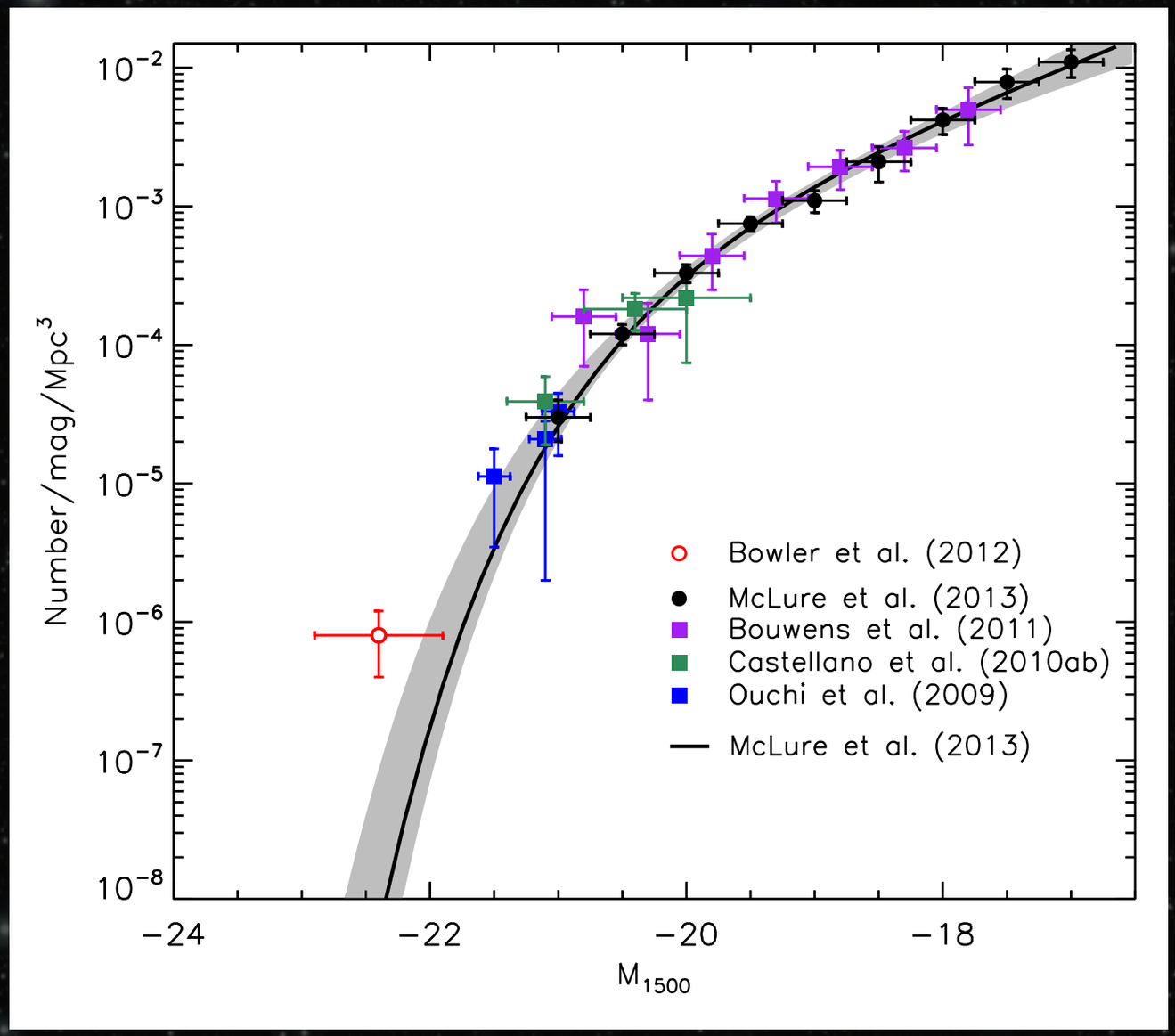
The galaxy luminosity function at z ~ 7

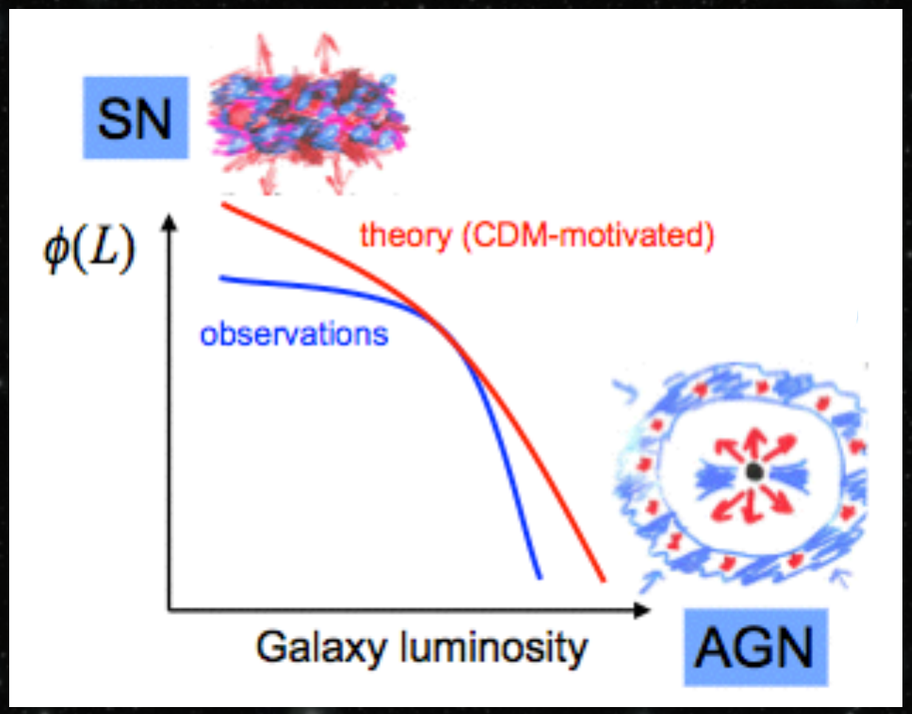




Bowler et al. (2012)

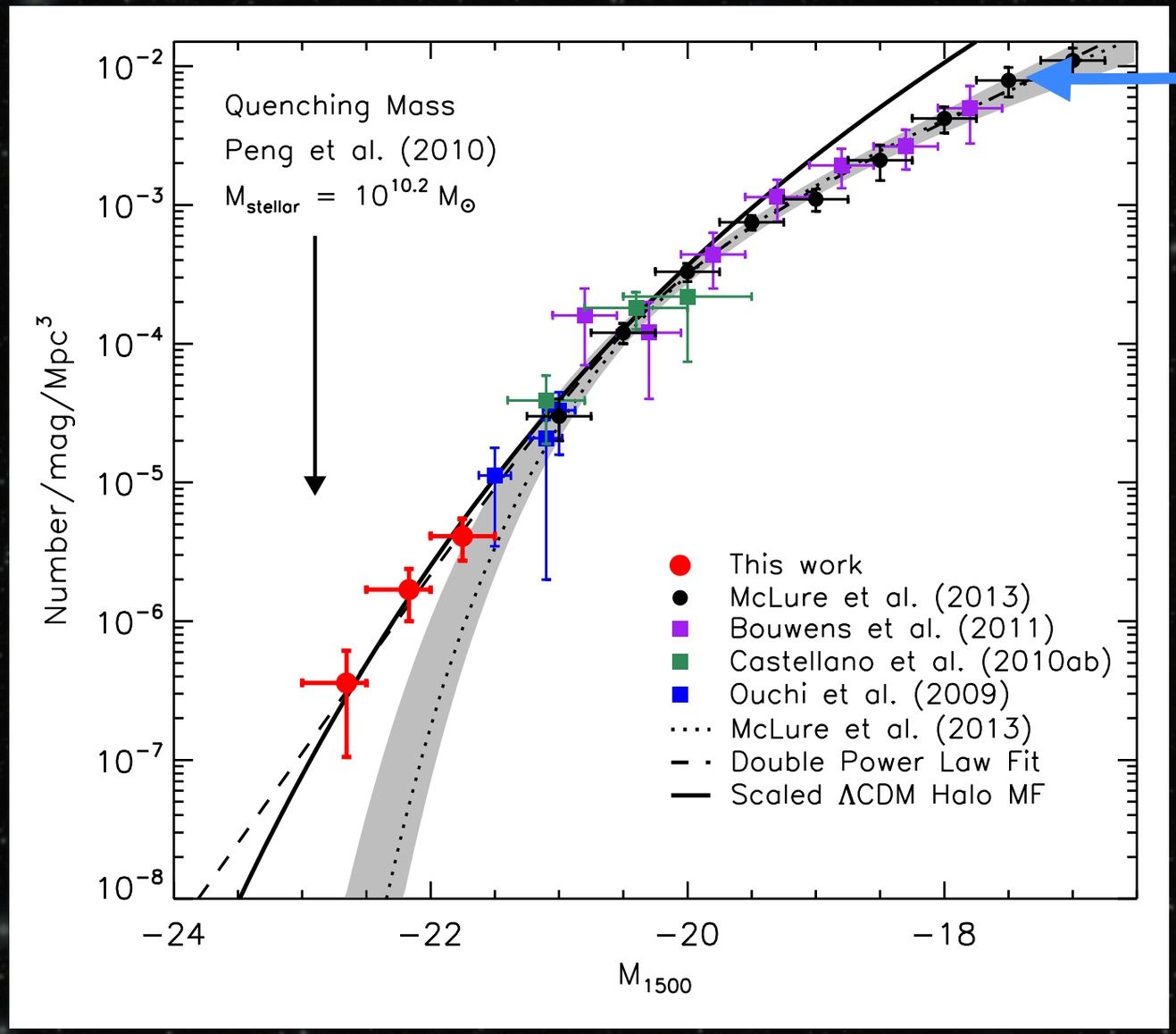


The galaxy luminosity function at z ~ 7



Silk & Mamon (2012)

Bowler et al. (2014)

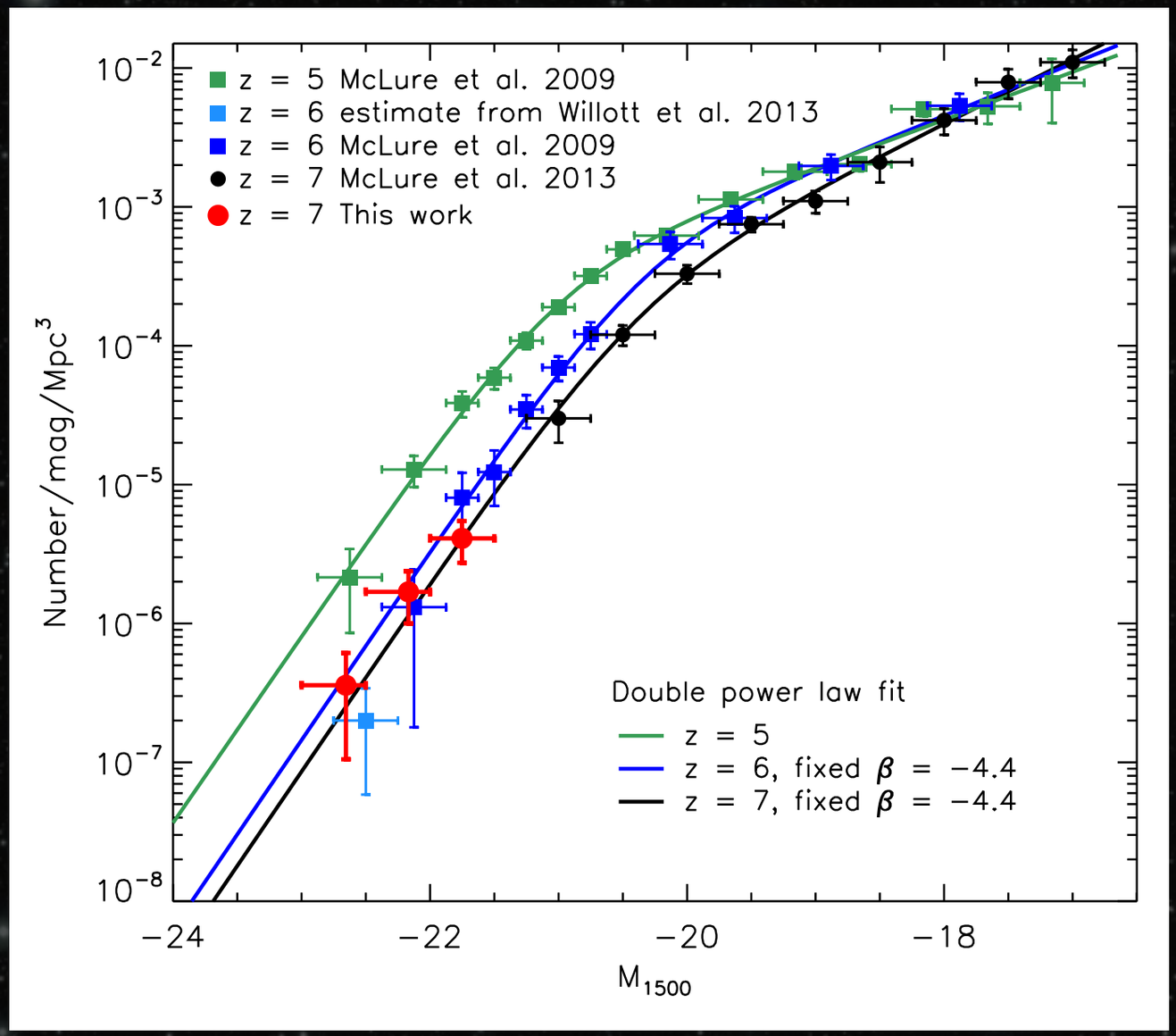


- feedback in faint galaxies already active at z = 7
- but yet to become efficient in bright galaxies?

The galaxy luminosity function at z ~ 6

Q. What is the shape at z ~ 6?
- Schechter function or more power law?

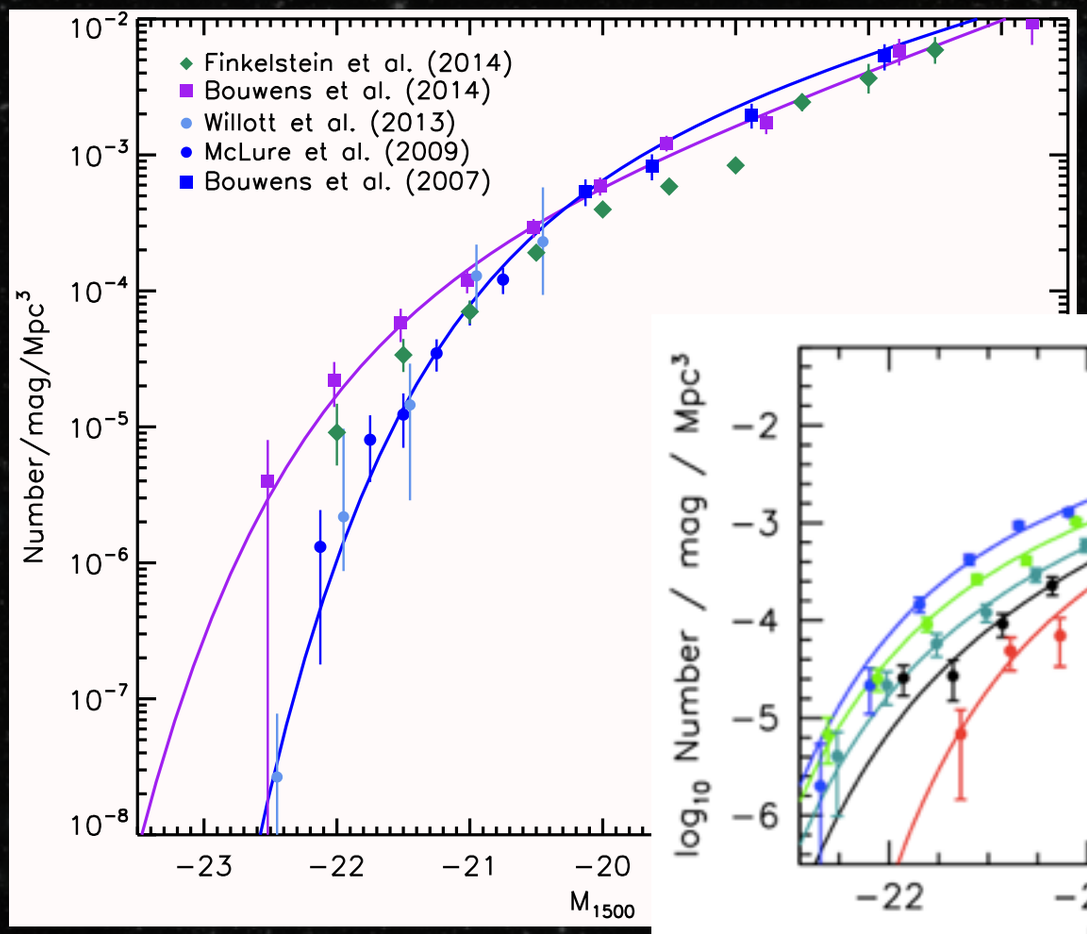
Bowler et al. (2014)

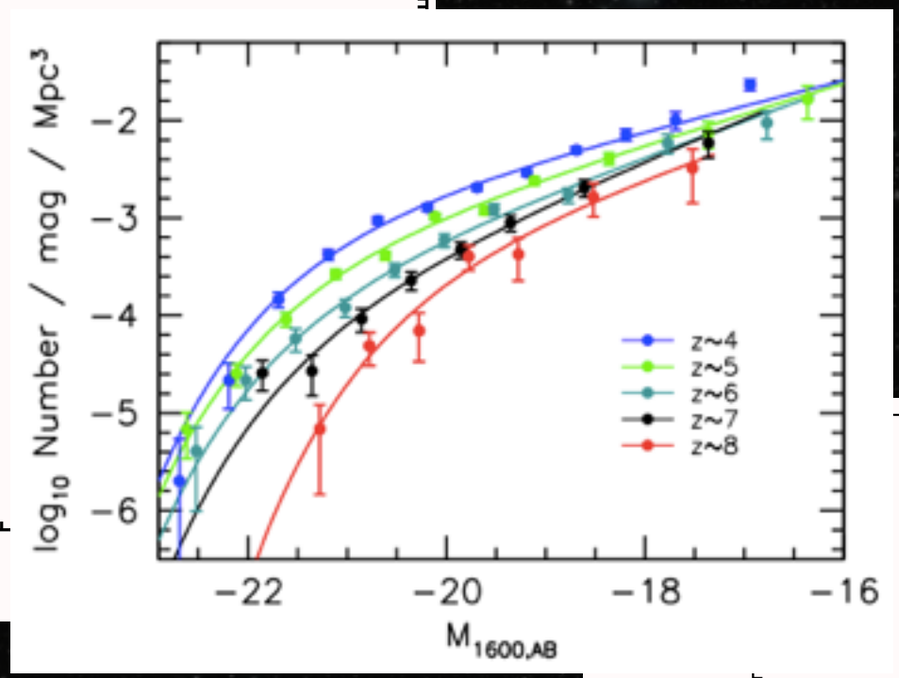


Q. Is there any evolution at the bright-end between z ~ 7 and 6?

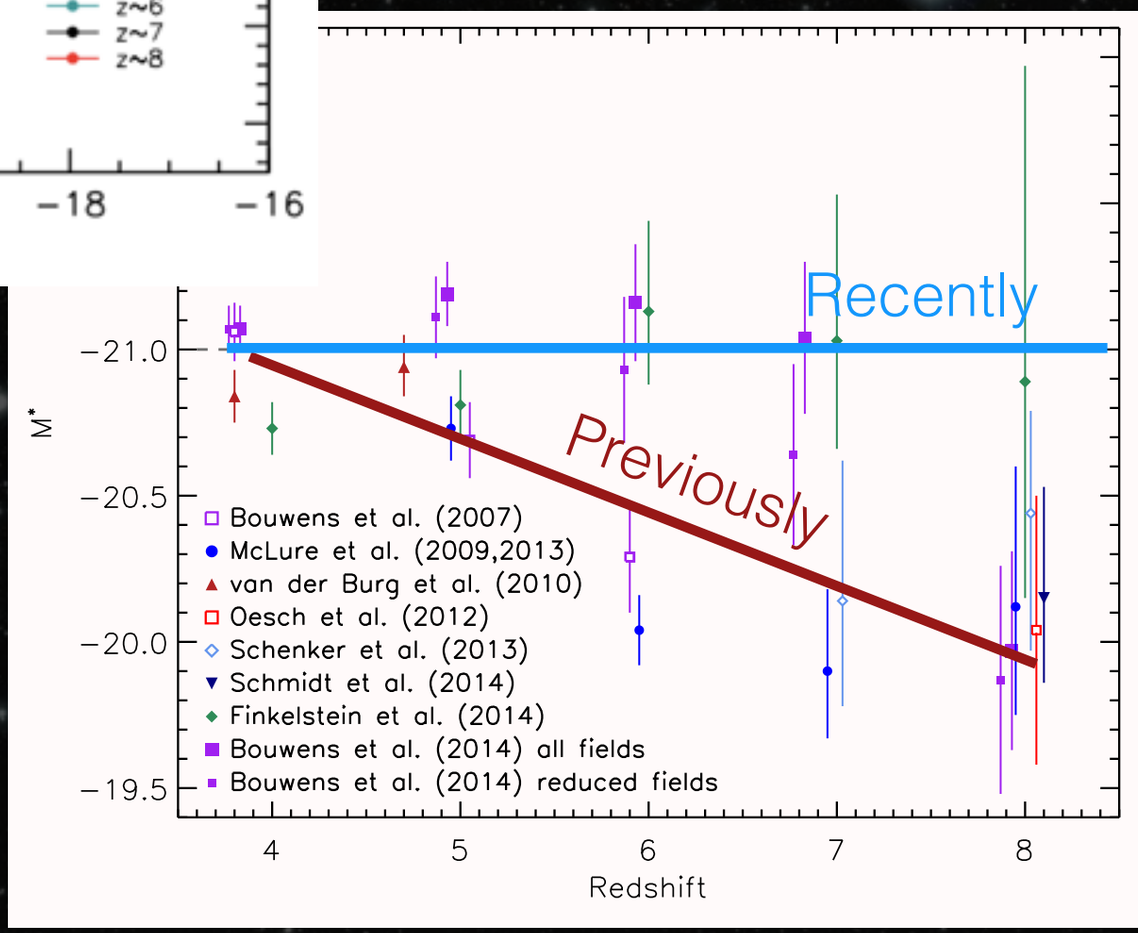
The galaxy luminosity function at z ~ 6

+ recent disagreement
at the bright-end

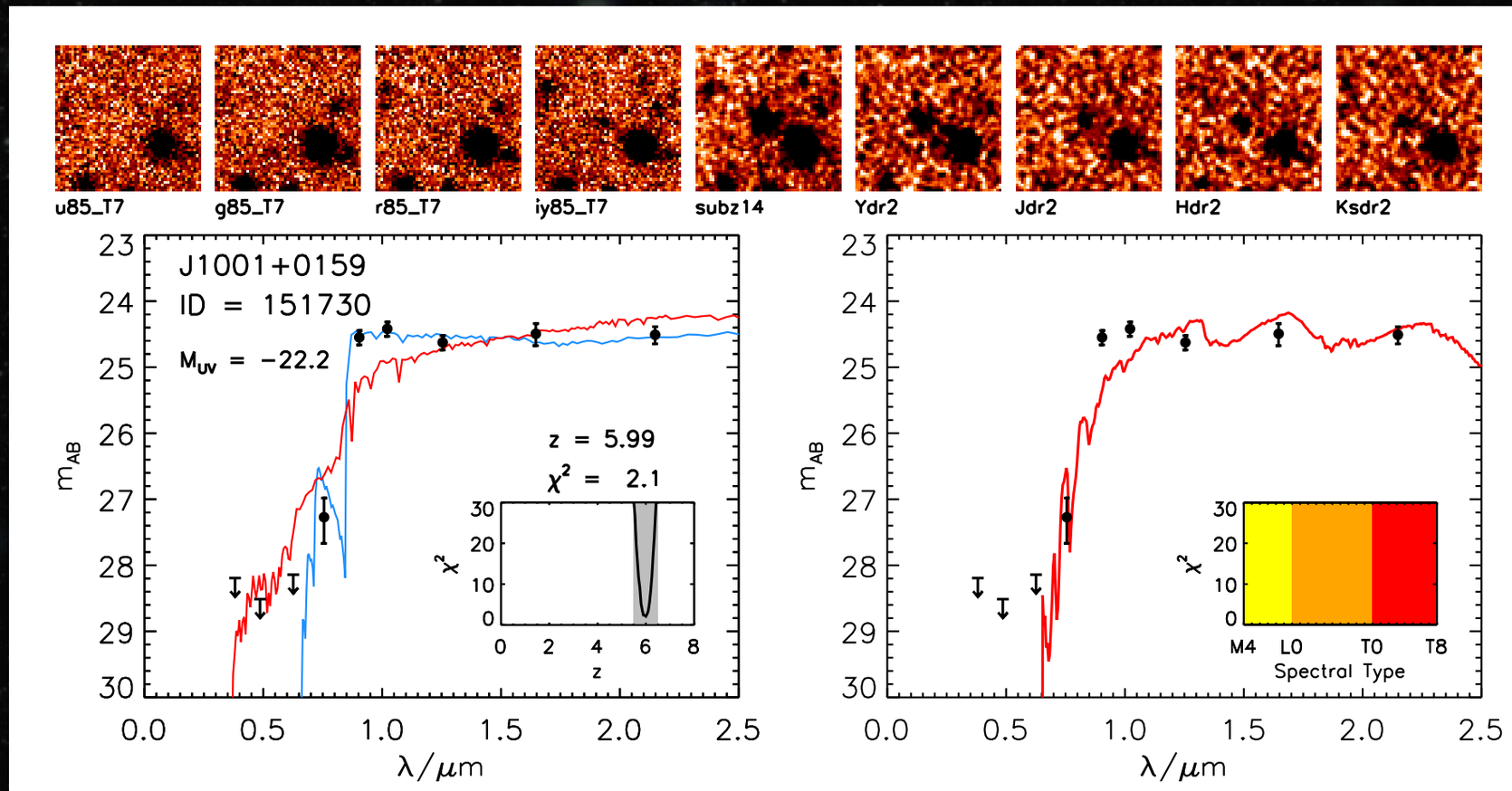




-> disagreement in the
form of the evolution



The sample of z ~ 6 galaxies



266 LBGs with 5.5 < z < 6.5
156 in UltraVISTA/COSMOS
107 in UDS/SXDS

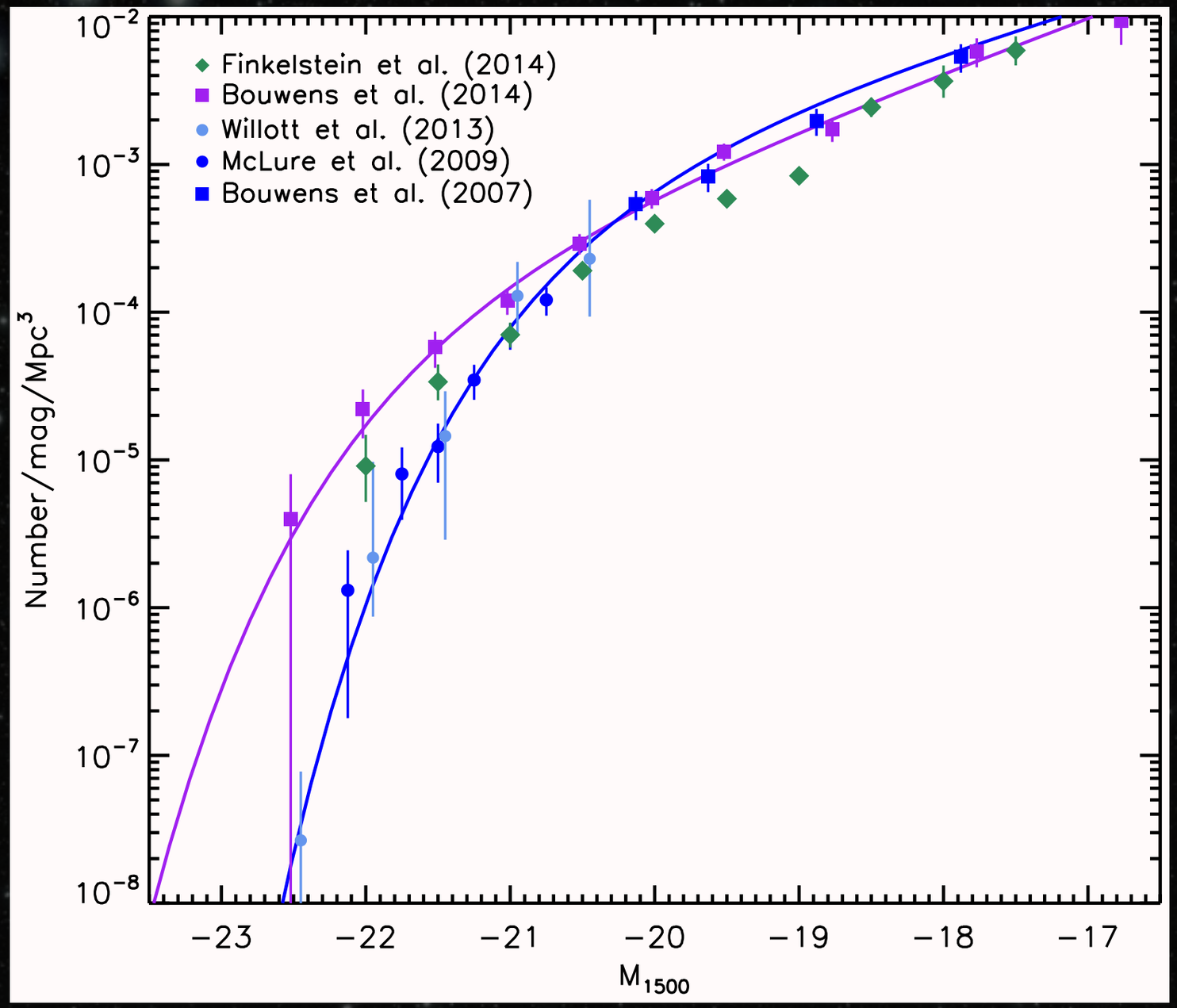
The galaxy luminosity function at z ~ 6

Bouwens et al. 2014
~ 0.2 sq. degree
5 CANDELS fields +

Finkelstein et al. 2014
~ 0.08 sq. degree
2 CANDELS fields +

McLure et al. 2009
~ 0.6 sq. degree
UDS/SXDS field

Willott et al. 2013
~ 4 sq. degree
4 CFHTLS fields



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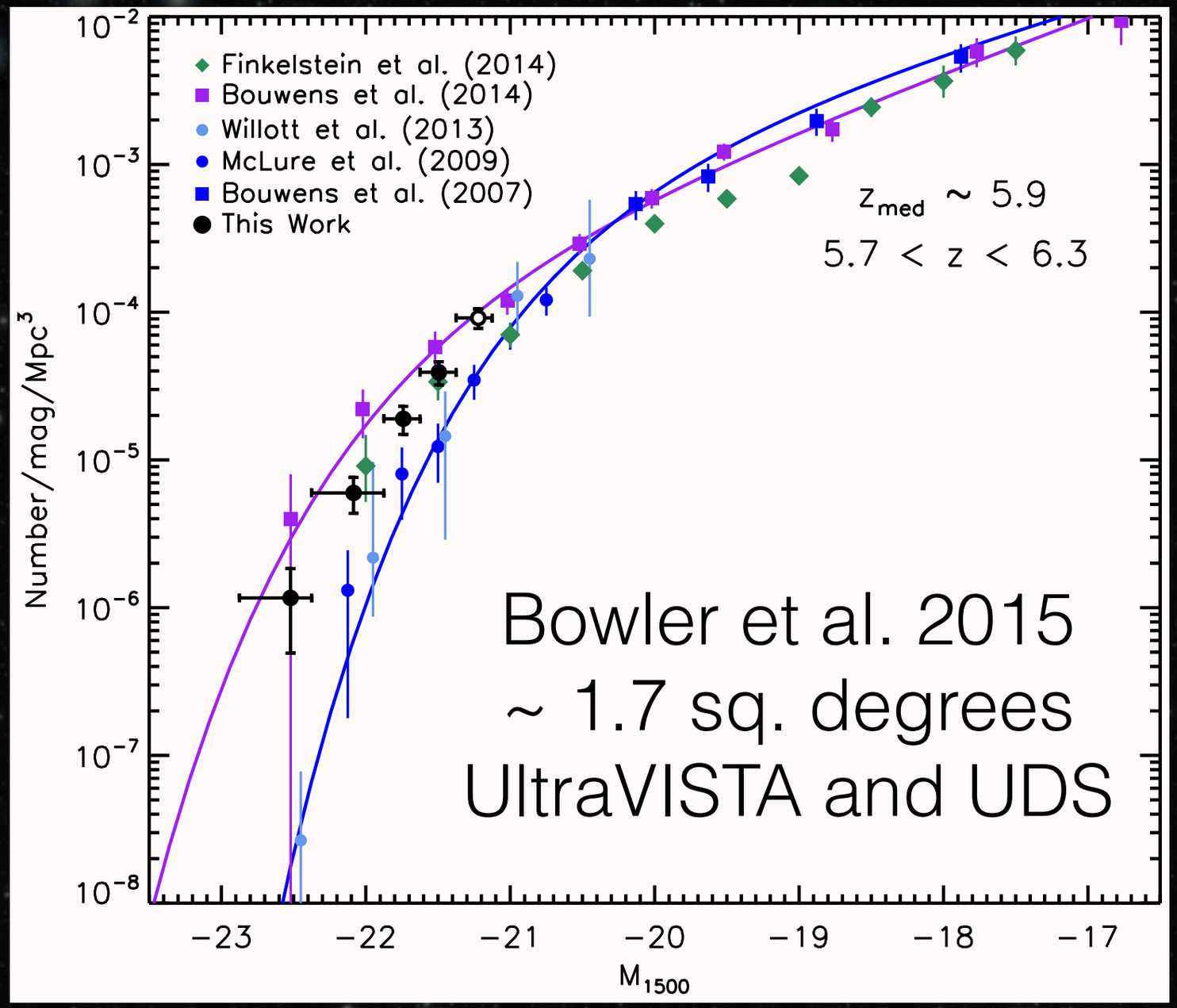
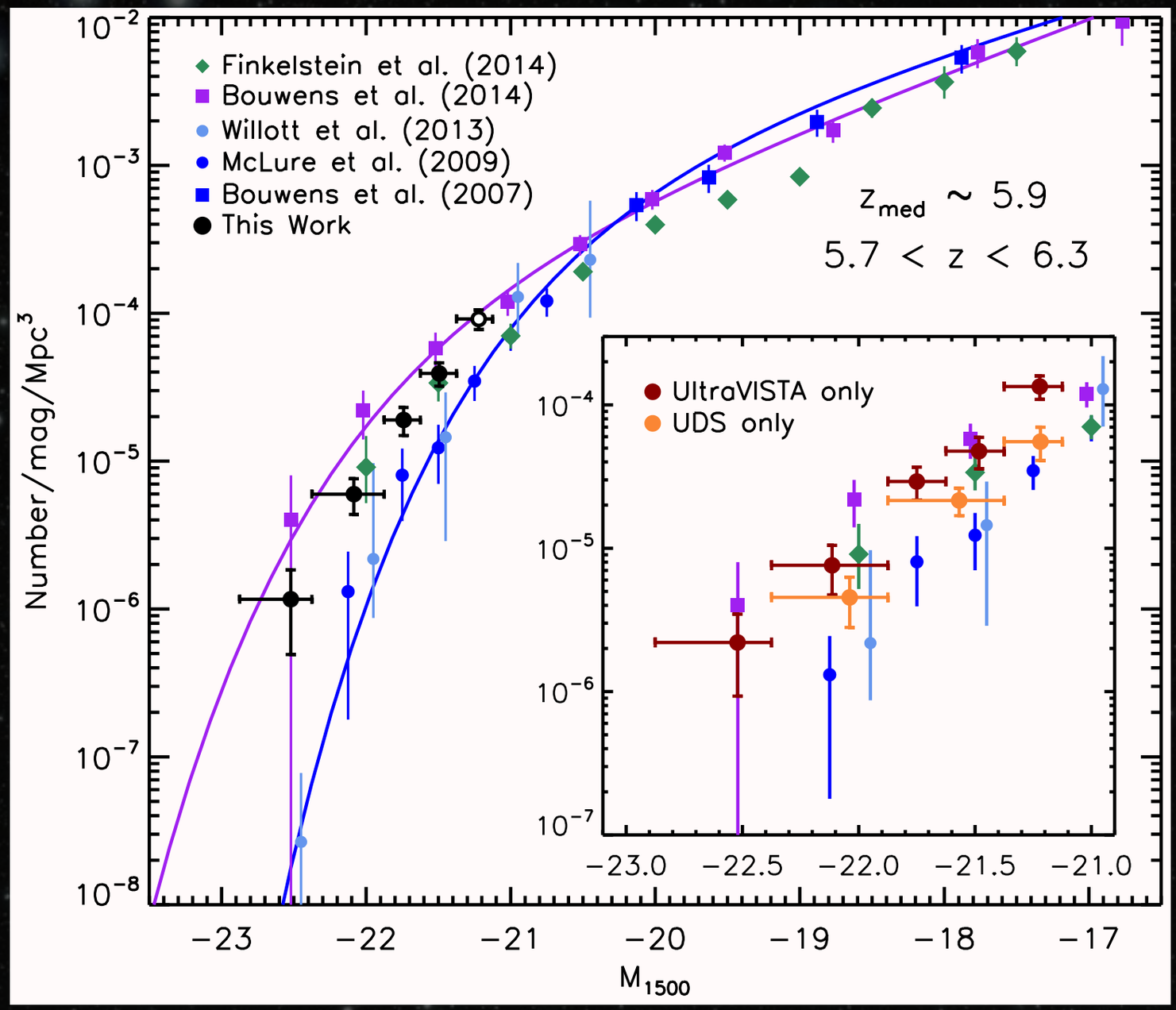


The galaxy luminosity function at z ~ 6

~ 2 x the number density of bright galaxies in UltraVISTA/COSMOS compared to the UDS/SXDS

McLure et al. 2009

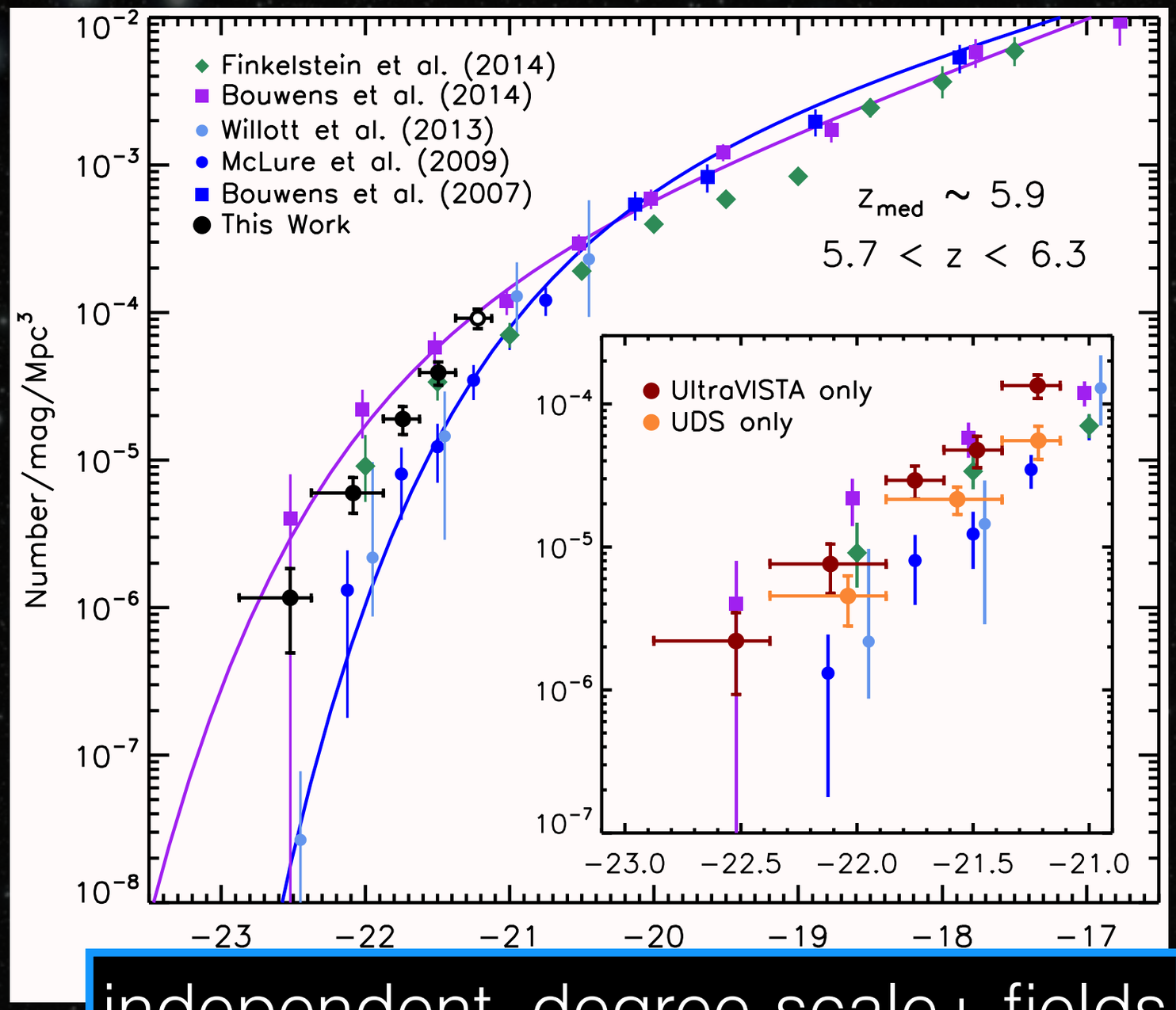
~ 0.6 sq. degree UDS/SXDS field



The galaxy luminosity function at z ~ 6

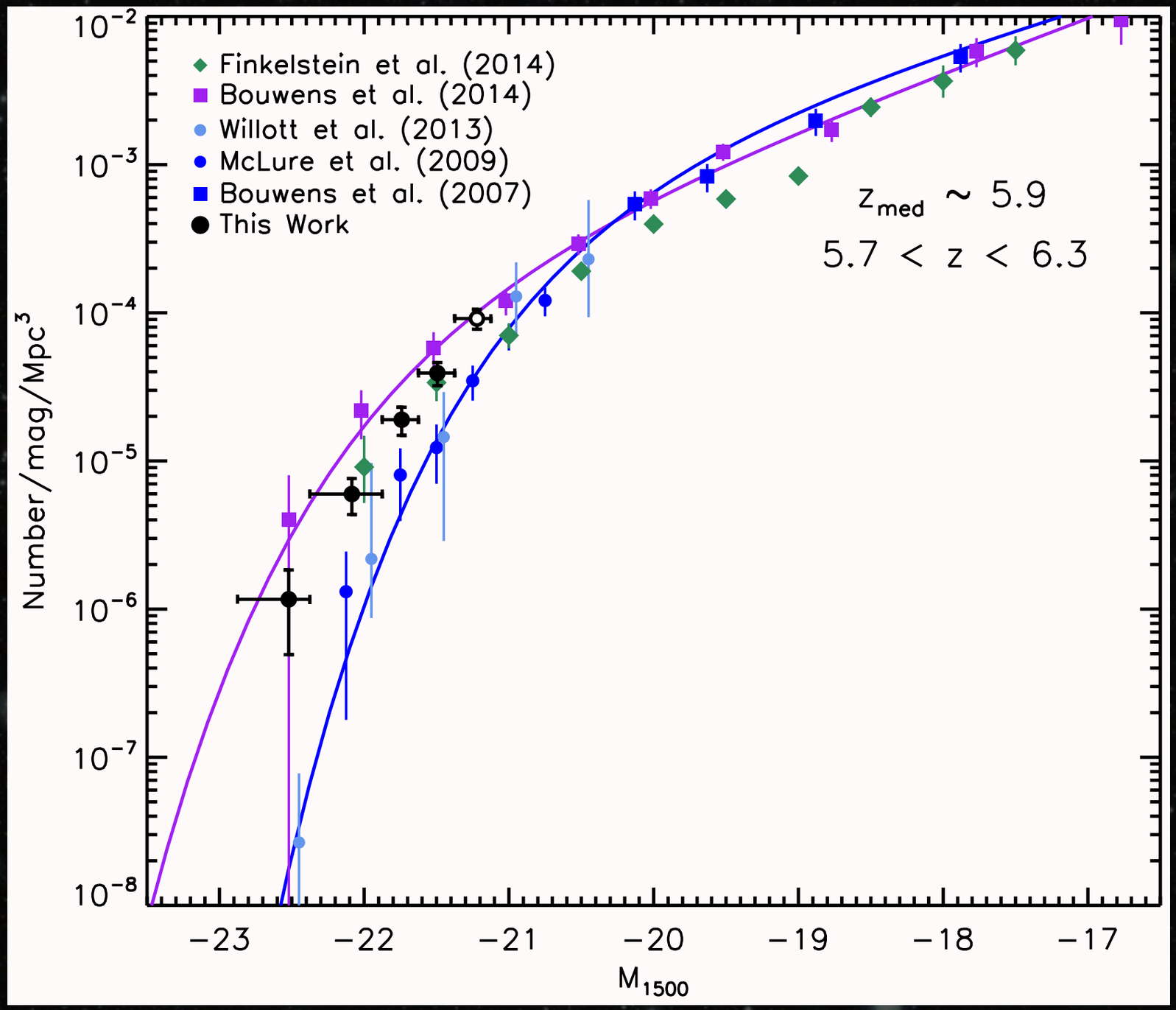
~ 2 x the number density of bright galaxies in UltraVISTA/COSMOS compared to the UDS/SXDS

directly measuring the cosmic variance



independent, degree-scale+ fields are essential to constrain the number density of bright galaxies

The functional form of the LF

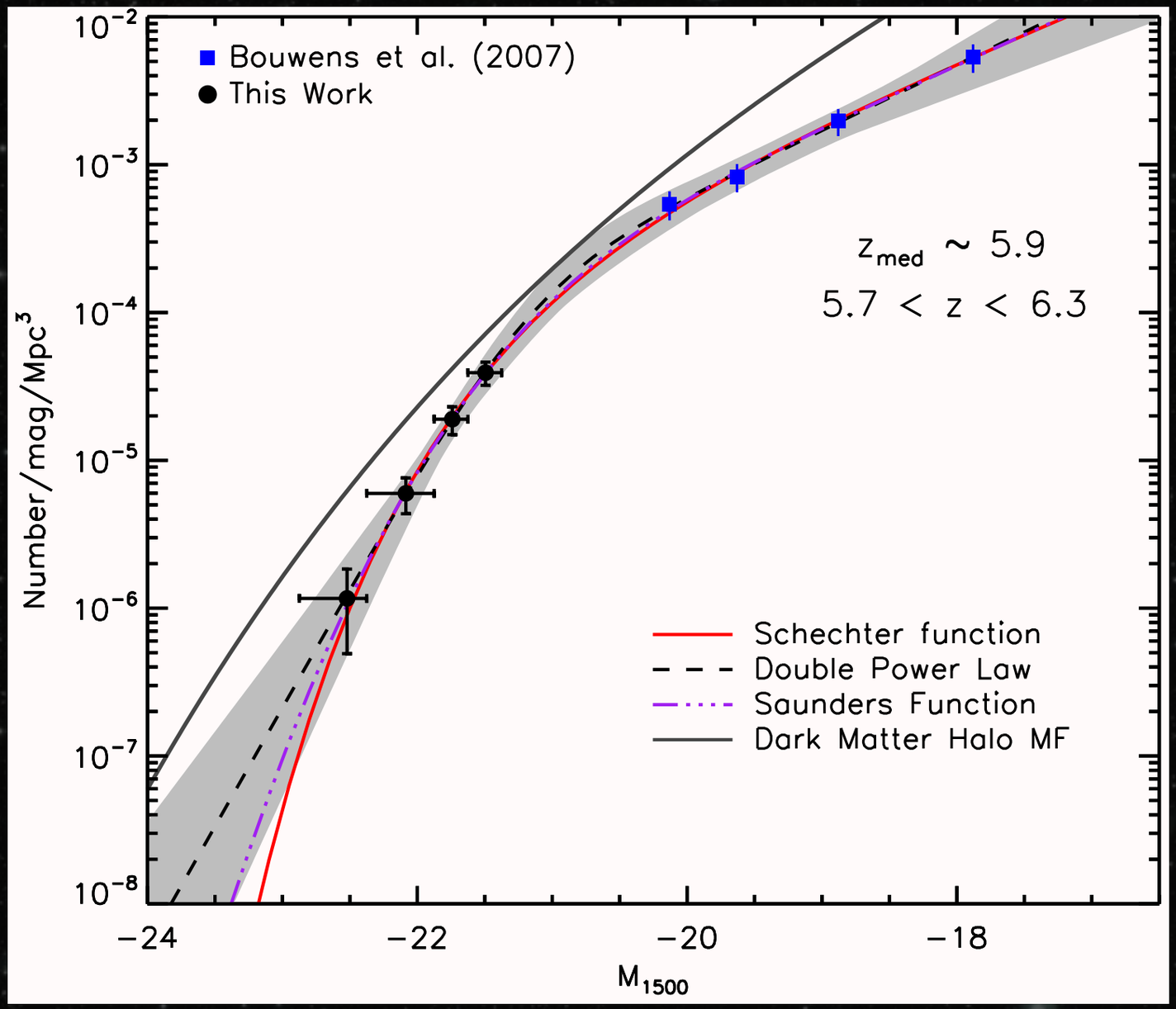


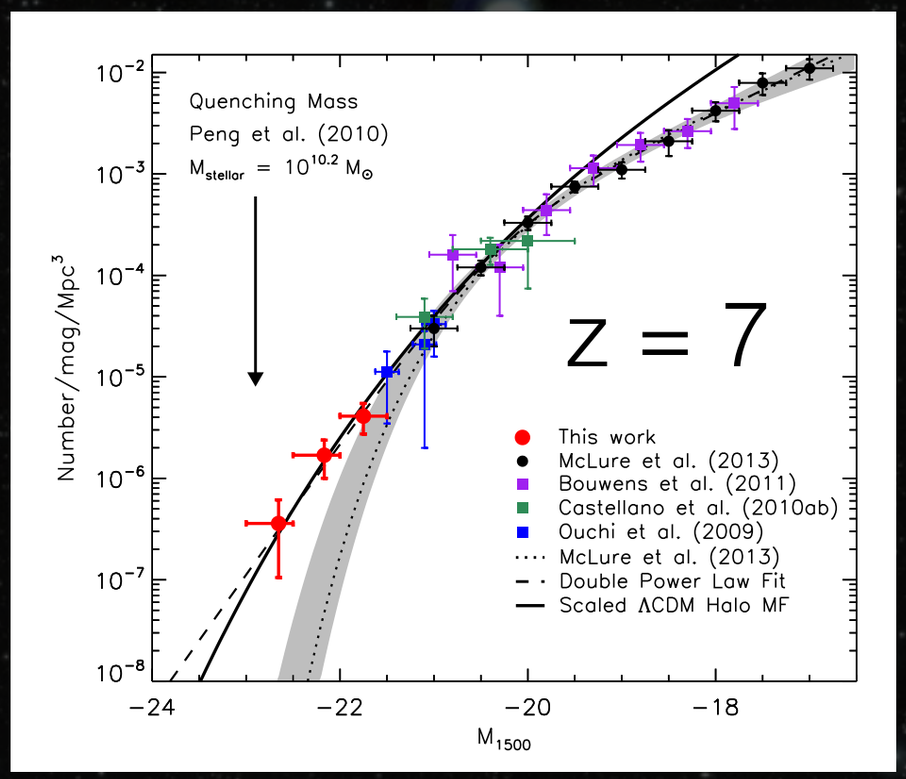
What to fit to given the systematic errors between studies?

The functional form of the LF

DPL or Schechter function equally well describe the LF

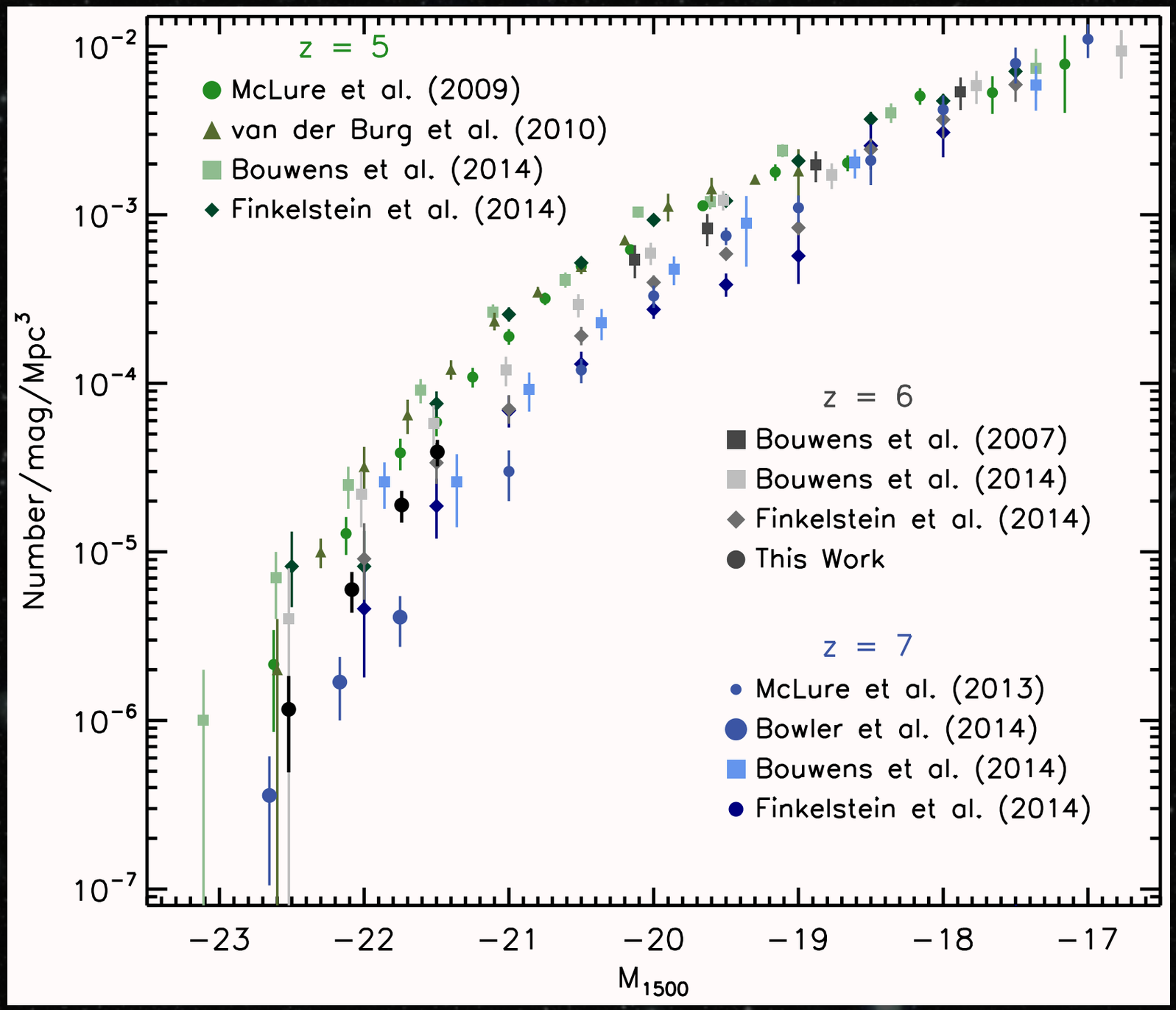
Tentatively steeper bright end slope





Schechter - exponential decline
Double Power Law - power law
Saunders - log normal decline

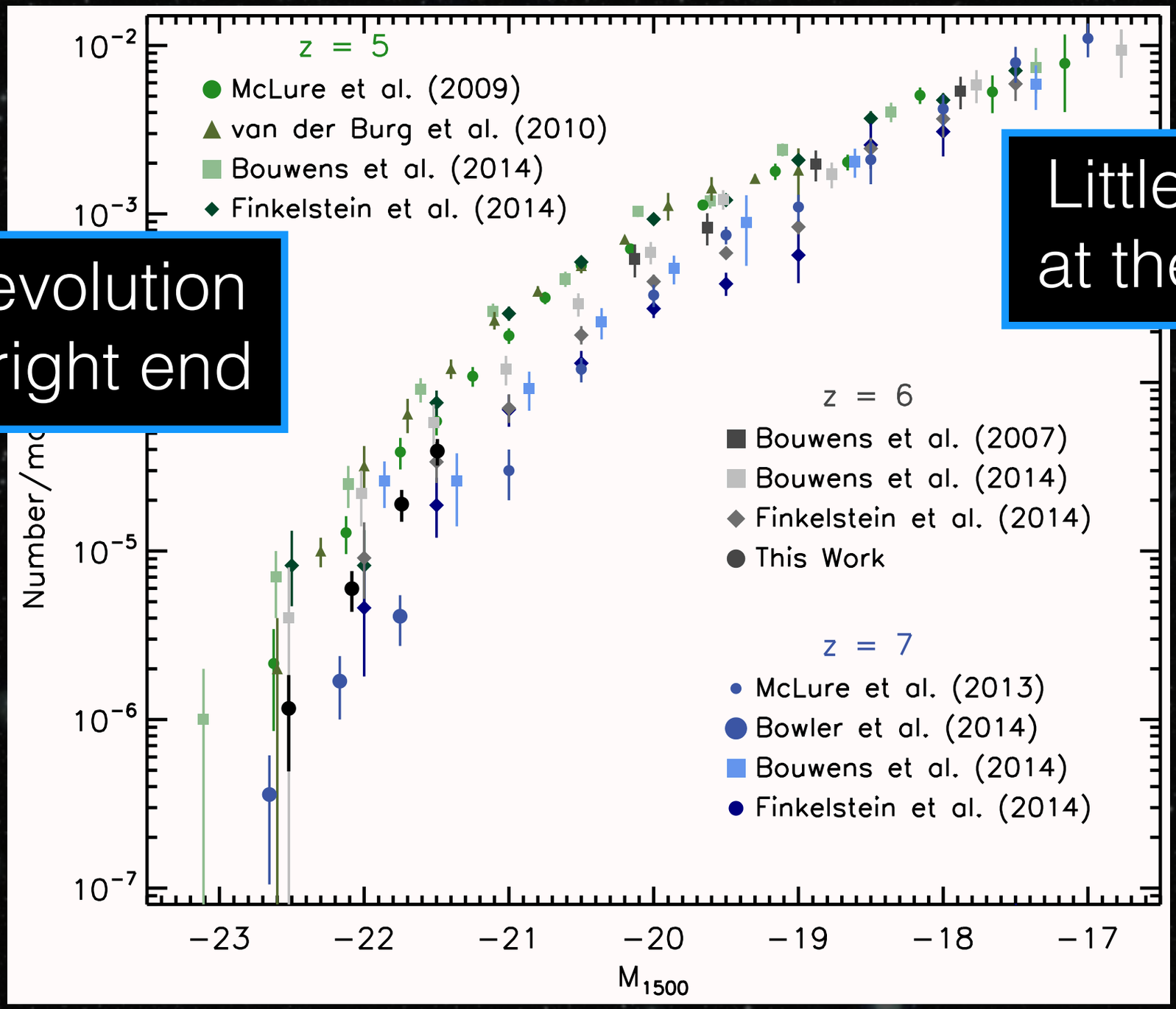
The evolution of the LF from z = 5-7



The evolution of the LF from z = 5-7

Strong evolution at the bright end

Little evolution at the faint end



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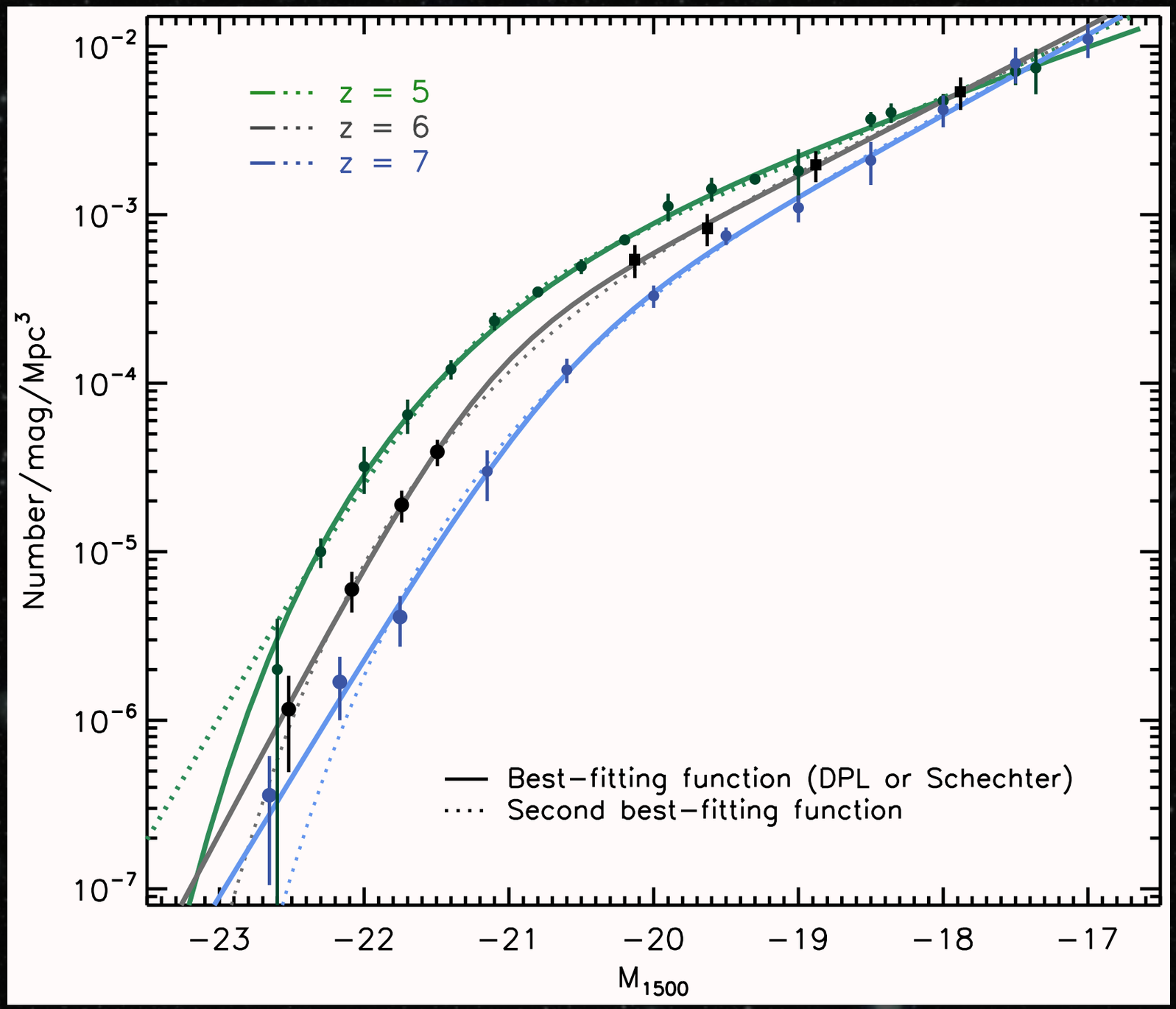

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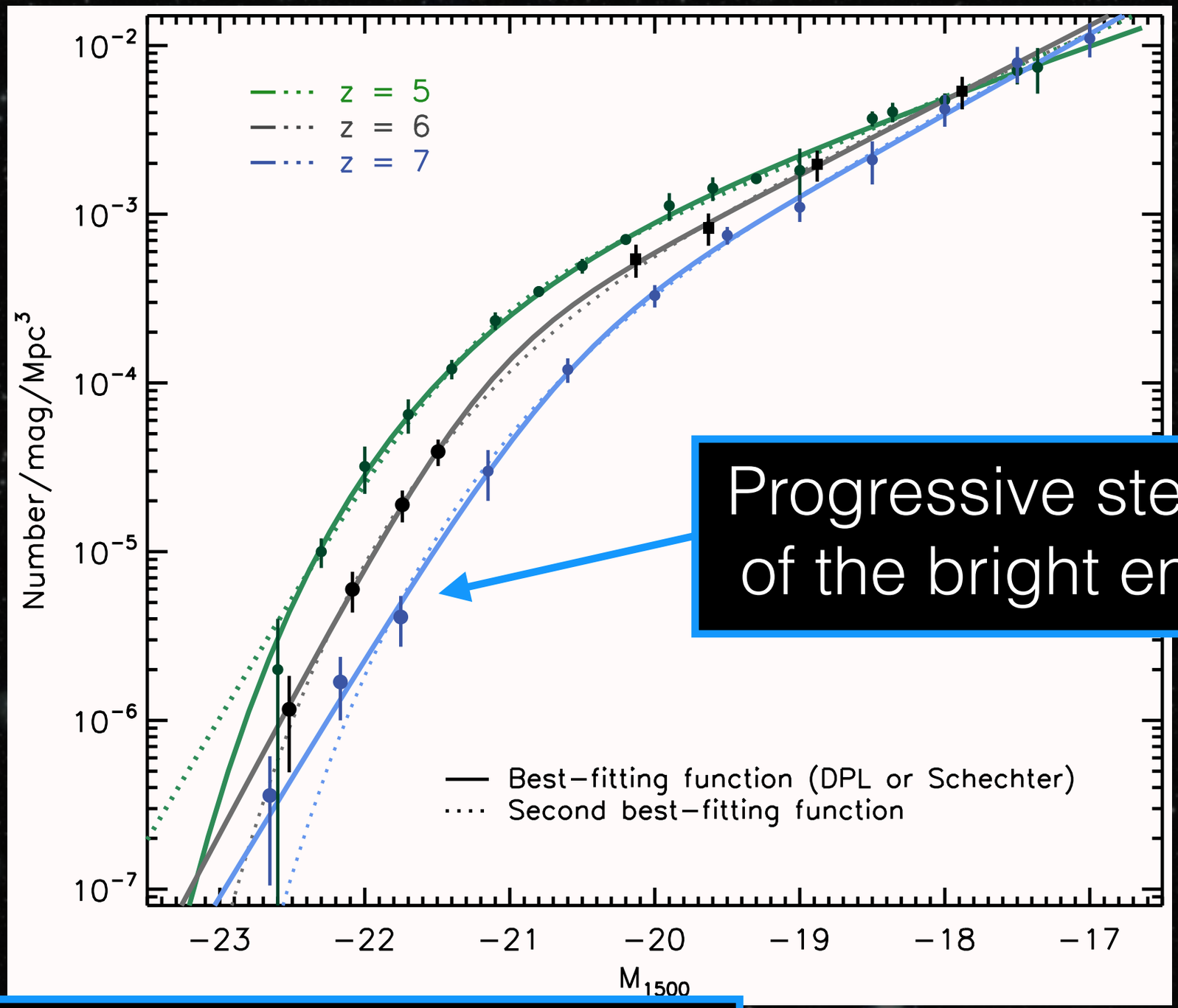
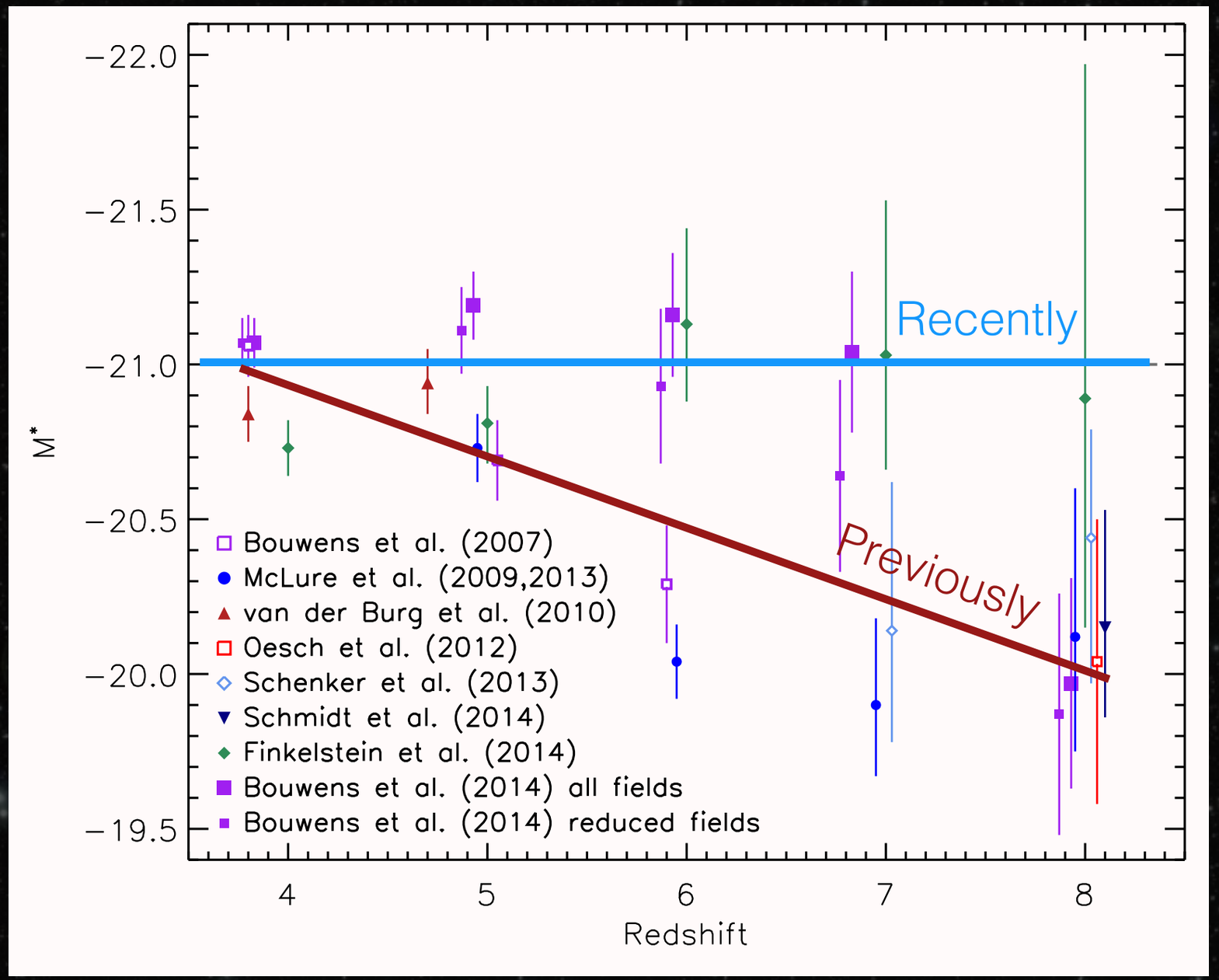


Progressive steepening of the bright end slope

=> onset of feedback, or dust obscuration?

The evolution of M* from z = 5-7



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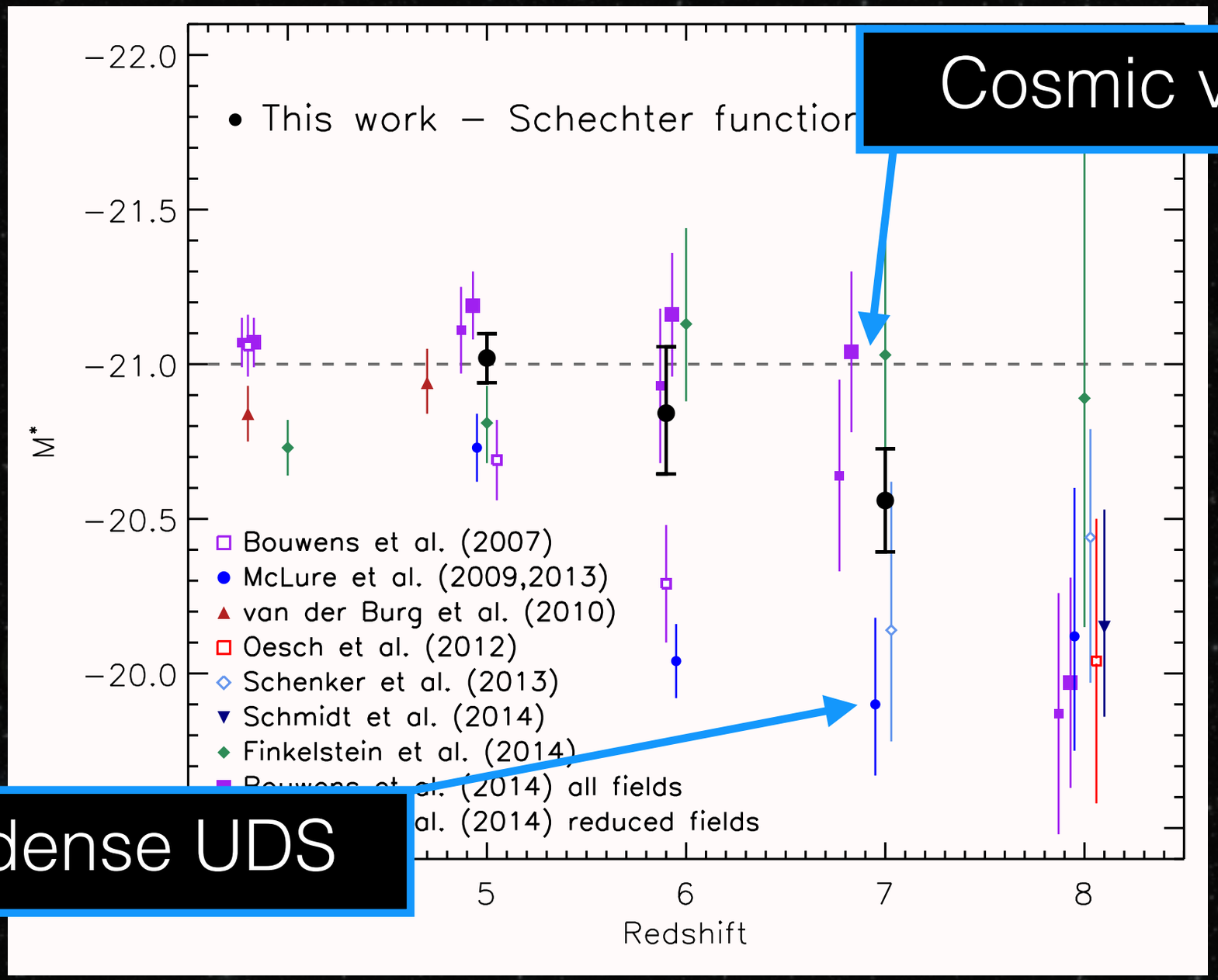
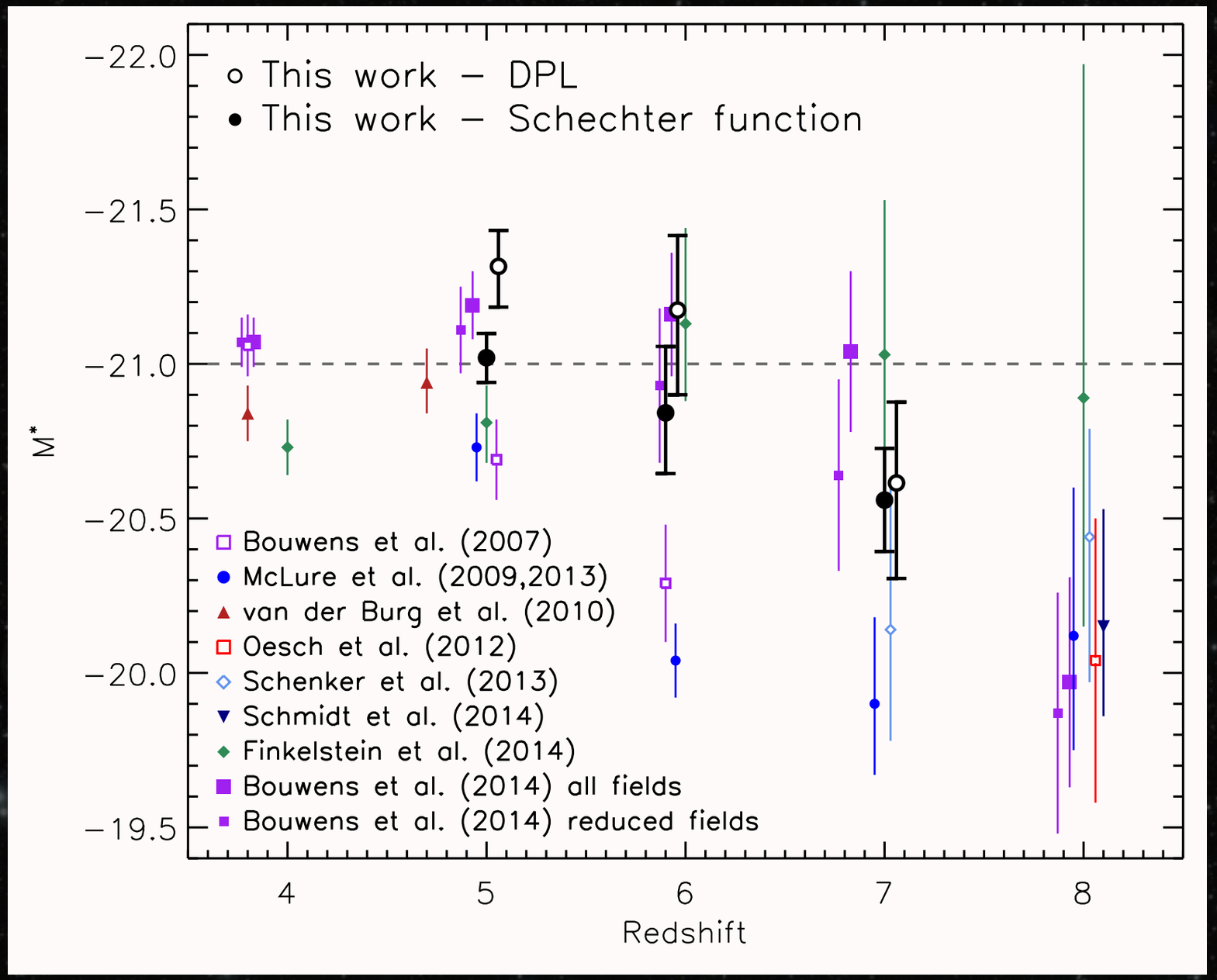


Cosmic variance?

Under-dense UDS

In contrast to recent studies we find an evolution in M* from z = 7 to 5, as expected from the underlying DMHMF

The evolution of M* from z = 5-7



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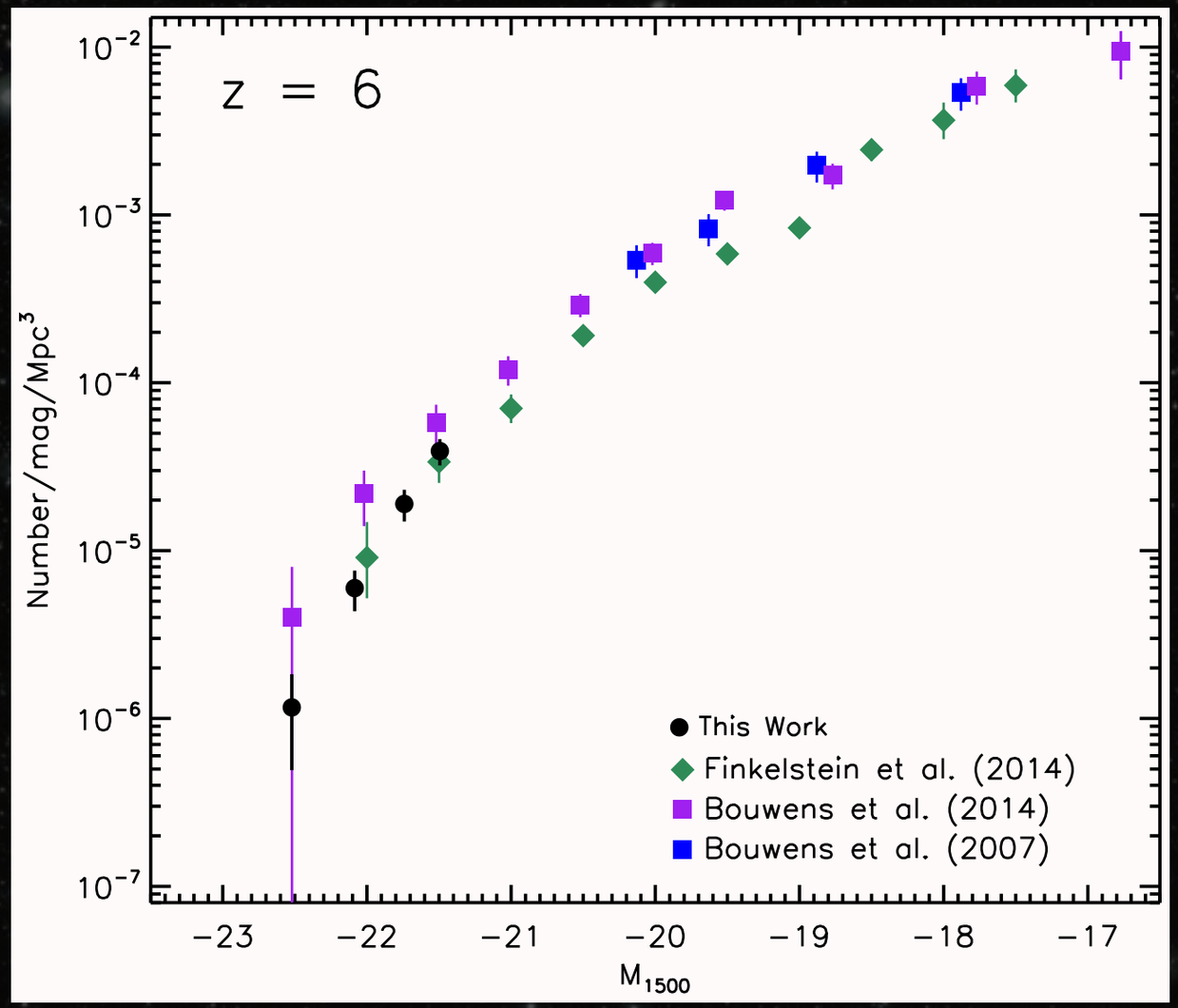
Comparison to theoretical models



Comparison to theoretical models

FiBY simulation
Khochfar et al. (in prep)

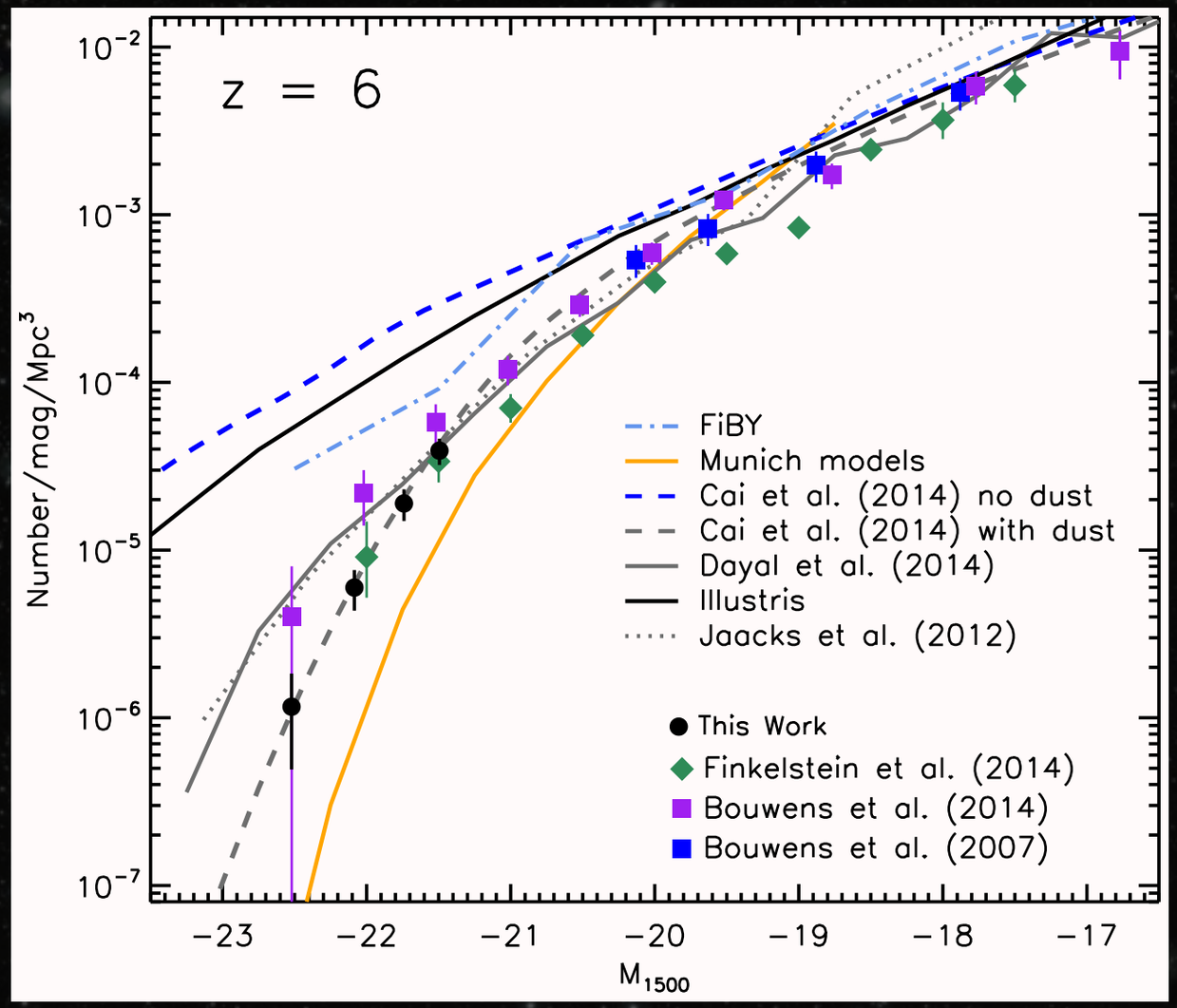
Munich galaxy formation model
Henriques et al. (2014)

Cai analytic model
Cai et al. (2014)

Dayal semi-analytic model
Dayal et al. (2014)

Illustris simulation
Genel et al. (2014)

Jaacks simulation
Jaacks et al. (2012)



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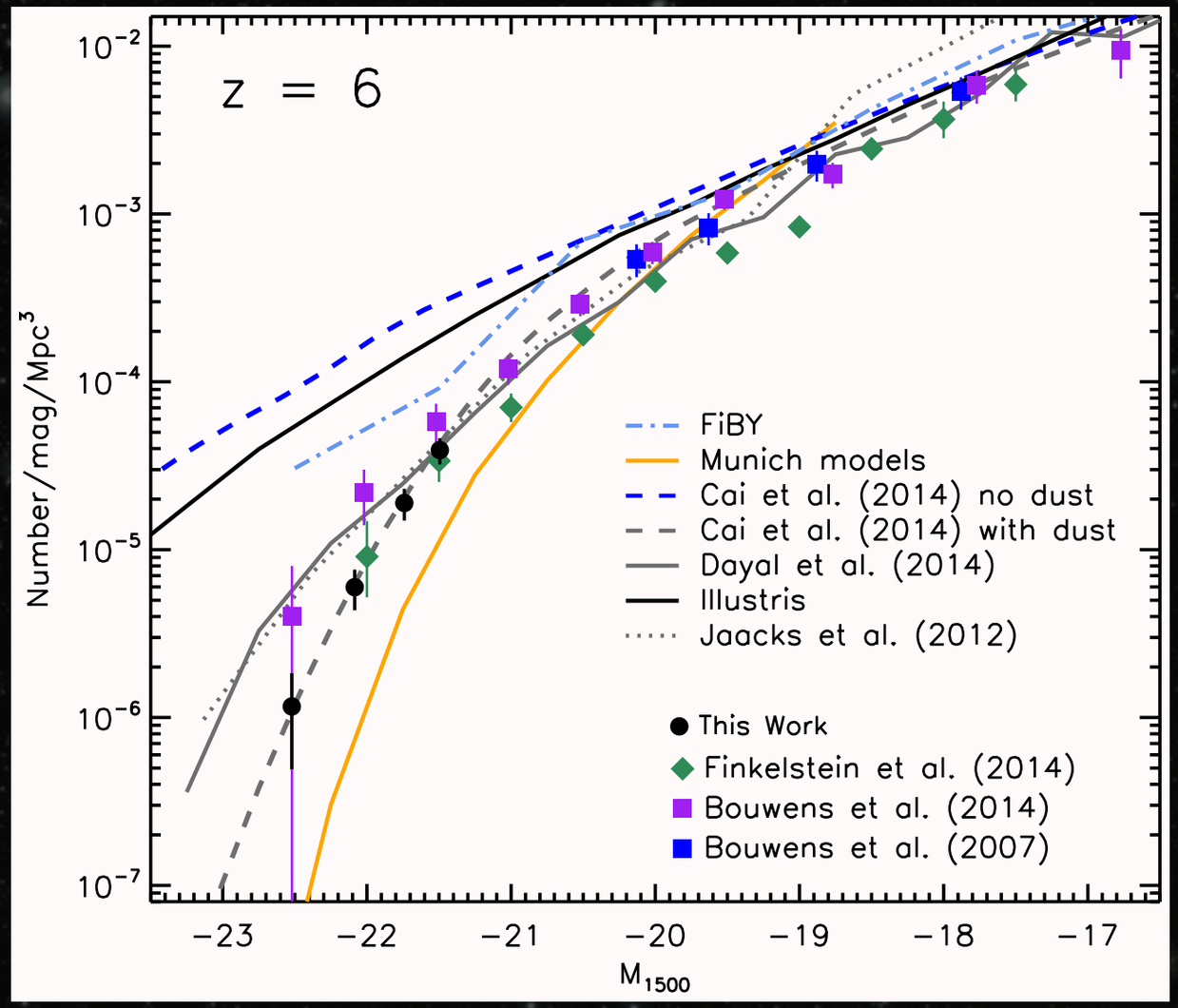
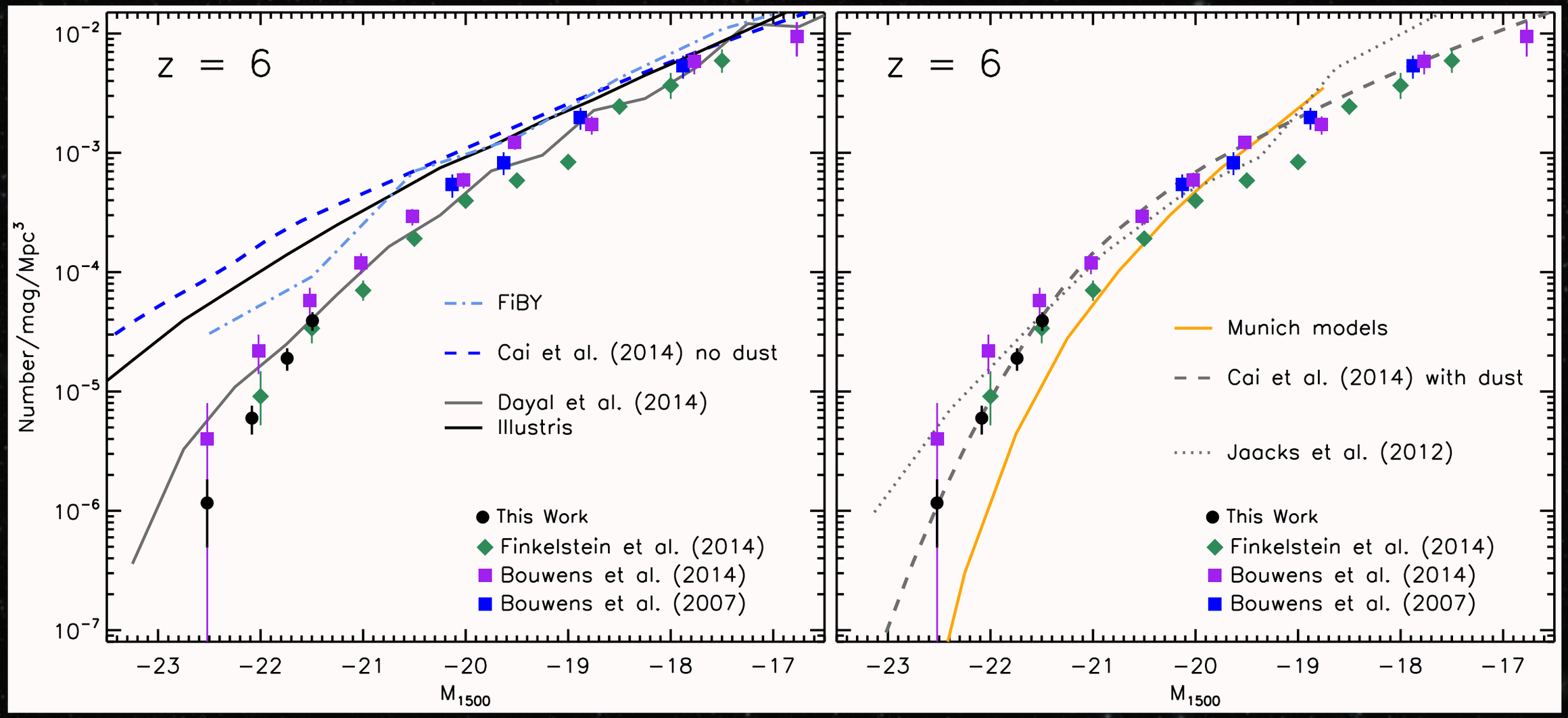


Bright-end of the LF remains a challenge for models

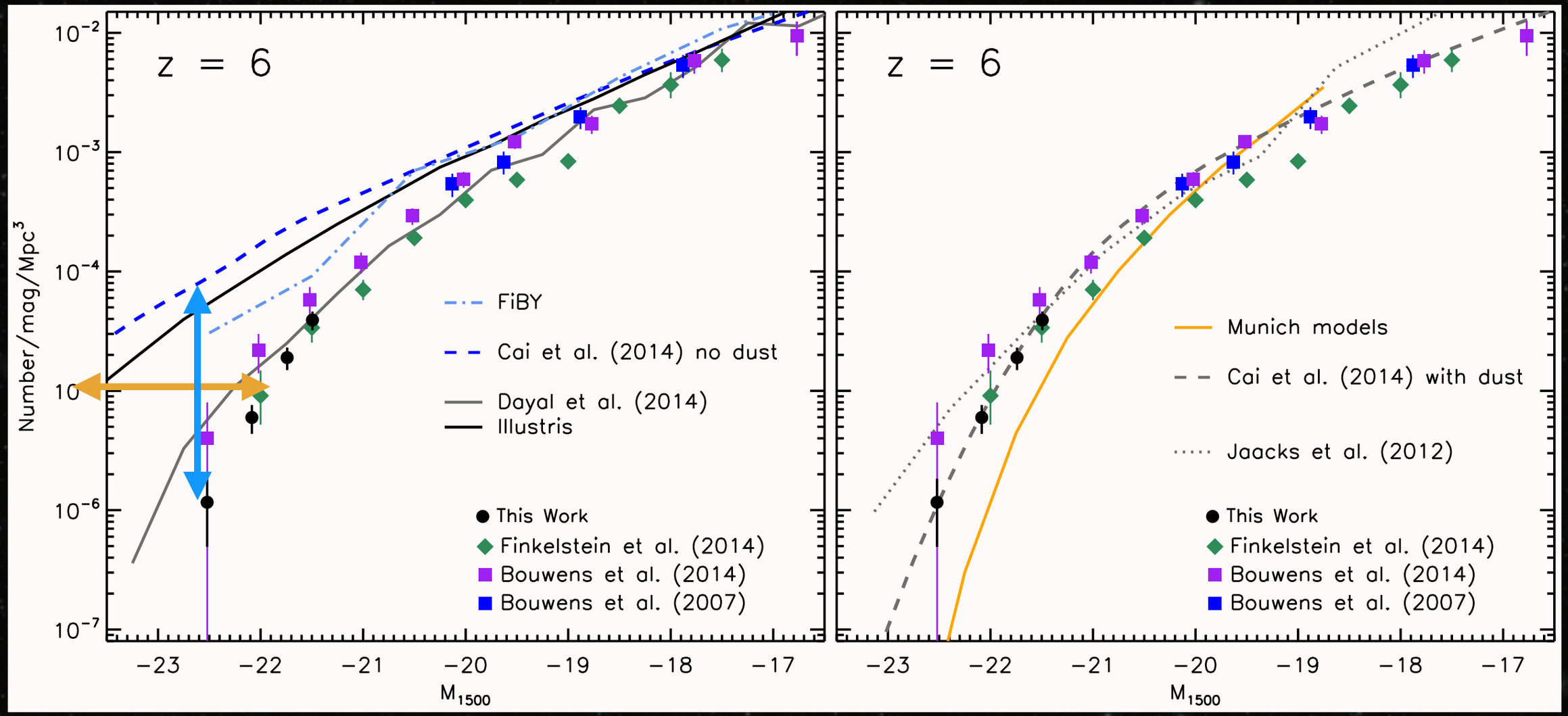
Comparison to theoretical models



No dust

With dust

Comparison to theoretical models



No dust

With dust

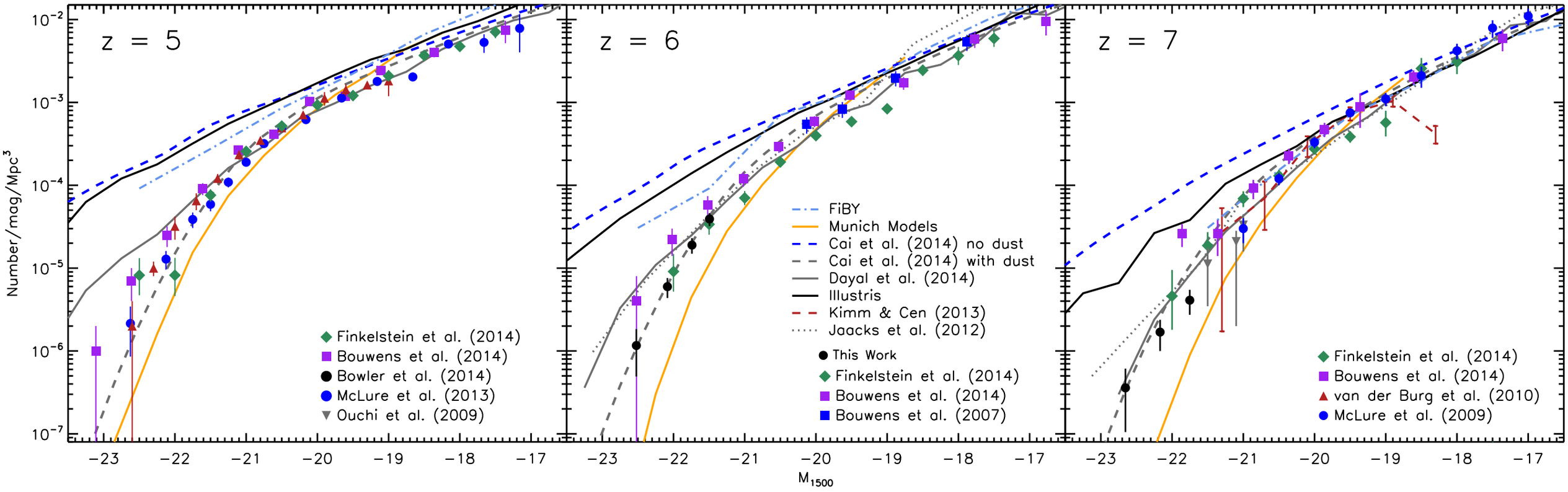
The predicted dust attenuation is large, equivalent to:

A1500 ~ 1.5-2 mag

or a suppression in observed number density of 1/100

Comparison to theoretical models

Future observations by ALMA, VISTA and Euclid will further constrain amount of dust and LF shape
=> strong constraints for models



arXiv: 1411.2976

HST/WFC3 follow-up of bright z ~ 7 LBGs

17 orbits in Cycle 22 (PI Bowler)
"Unveiling the merger fraction, sizes and morphologies of the brightest z ~ 7 galaxies"

wide J140 filter to image 17 bright LBGs

6.5 < z < 7.5, Muv < -21.5
in COSMOS and UDS fields

Summary

: selection of z ~ 6 LBGs in UltraVISTA and UDS fields

: strong cosmic variance even between degree scale fields.

: evidence for rapid evolution at the bright end between z = 5, 6 and 7 with a change in M* ~ 0.5 mag and a steepening in the bright-end slope

: comparison with models indicates strong dust obscuration may be necessary to reproduce the observations

z ~ 6 -> arXiv: 1411.2976

: HST/WFC3 imaging of the brightest z ~ 7 LBGs show multiple components -> future work on Δmag, SB profiles…