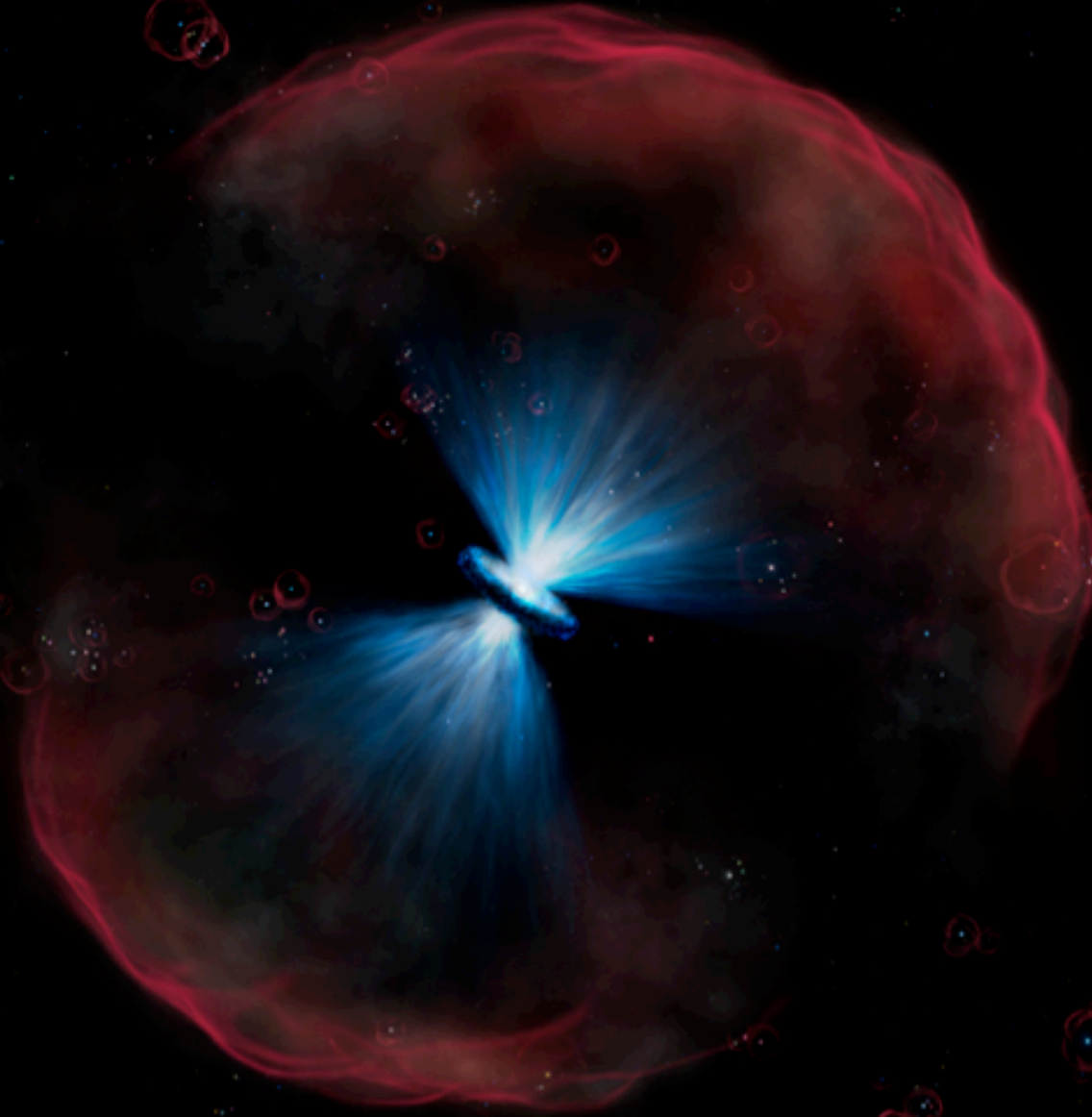
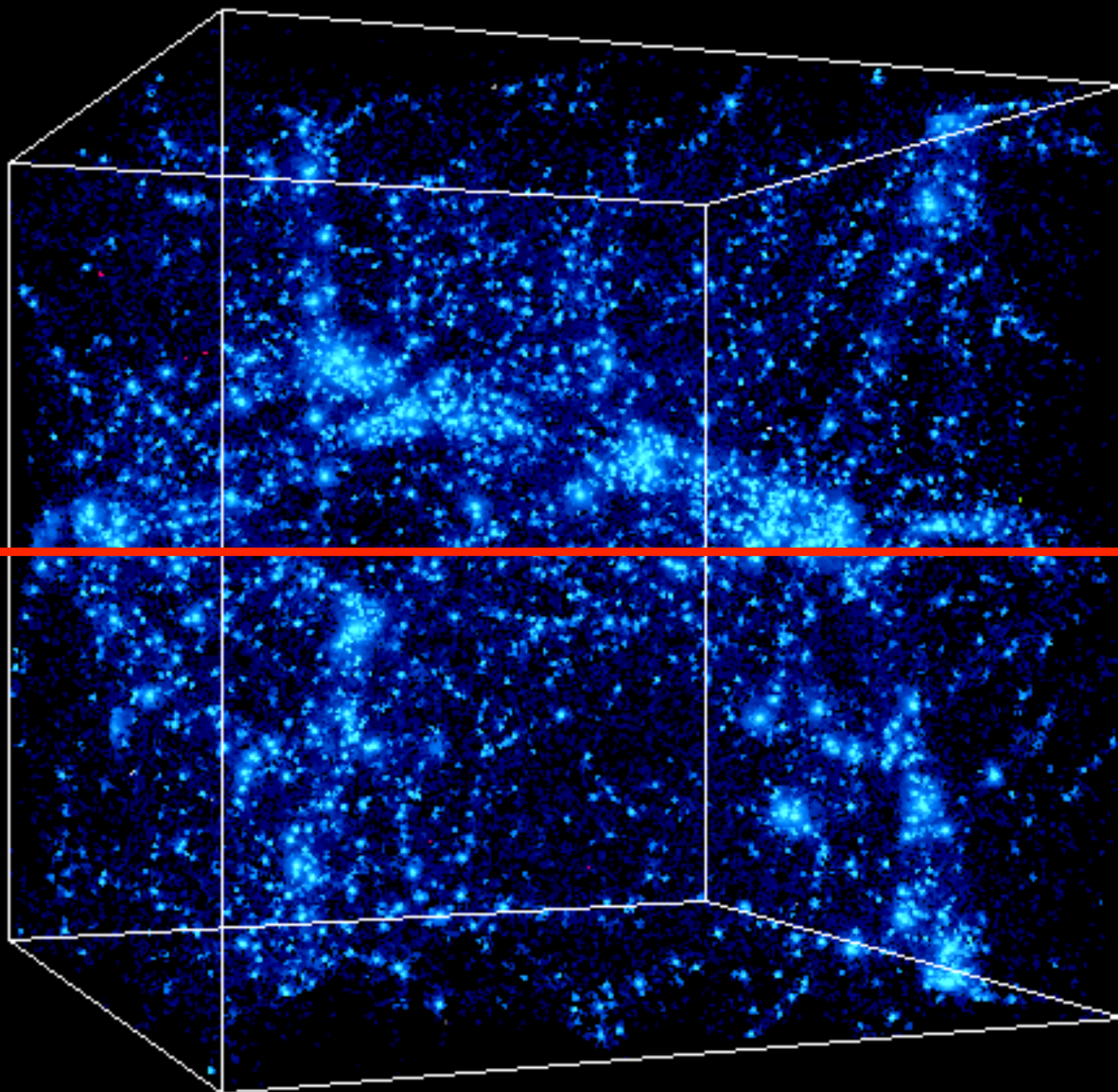


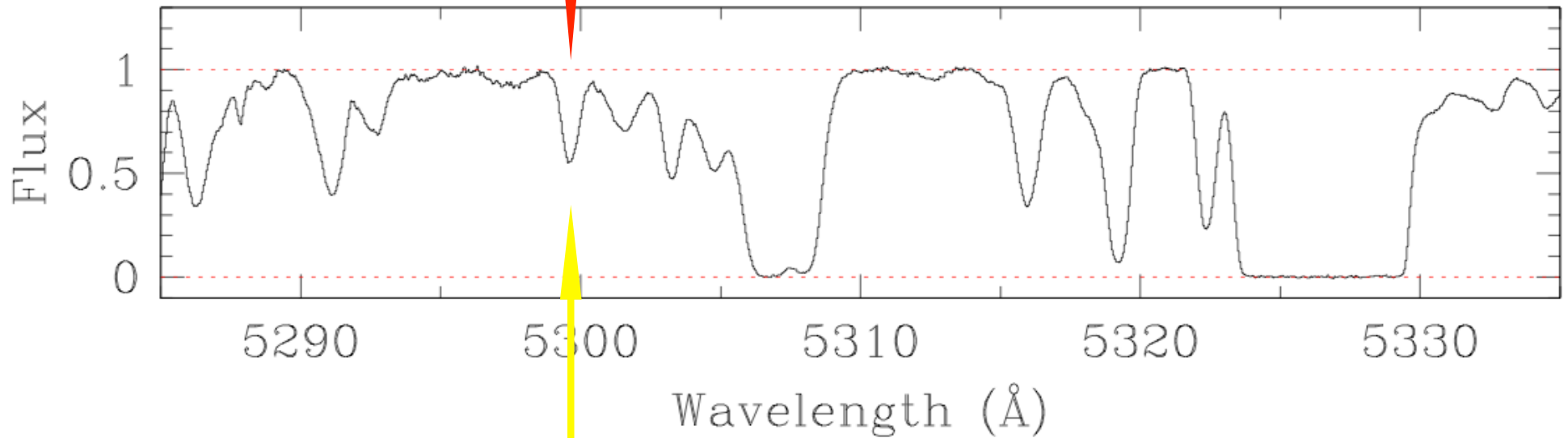
Introduction to Cosmology



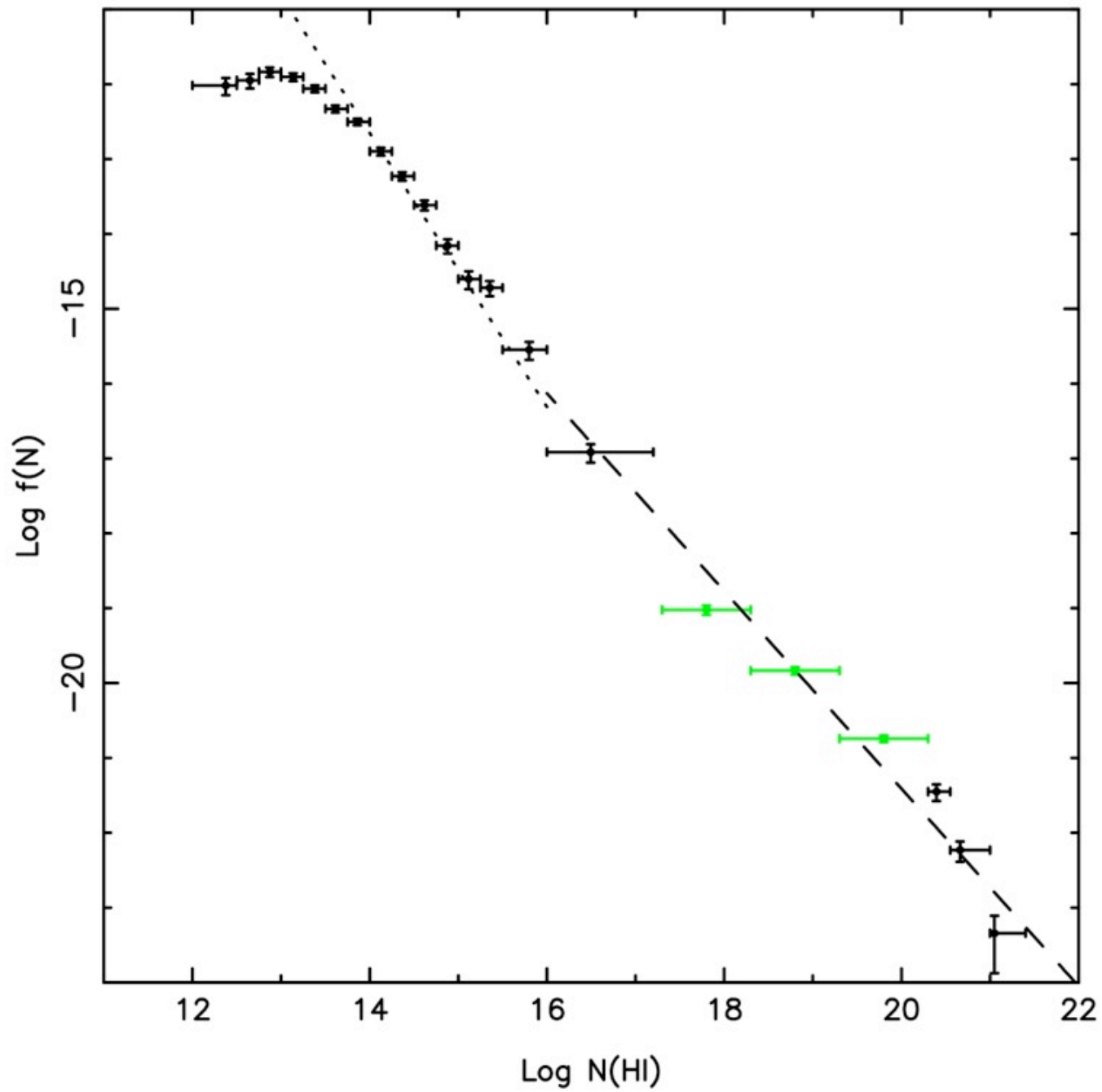
Lecture 13



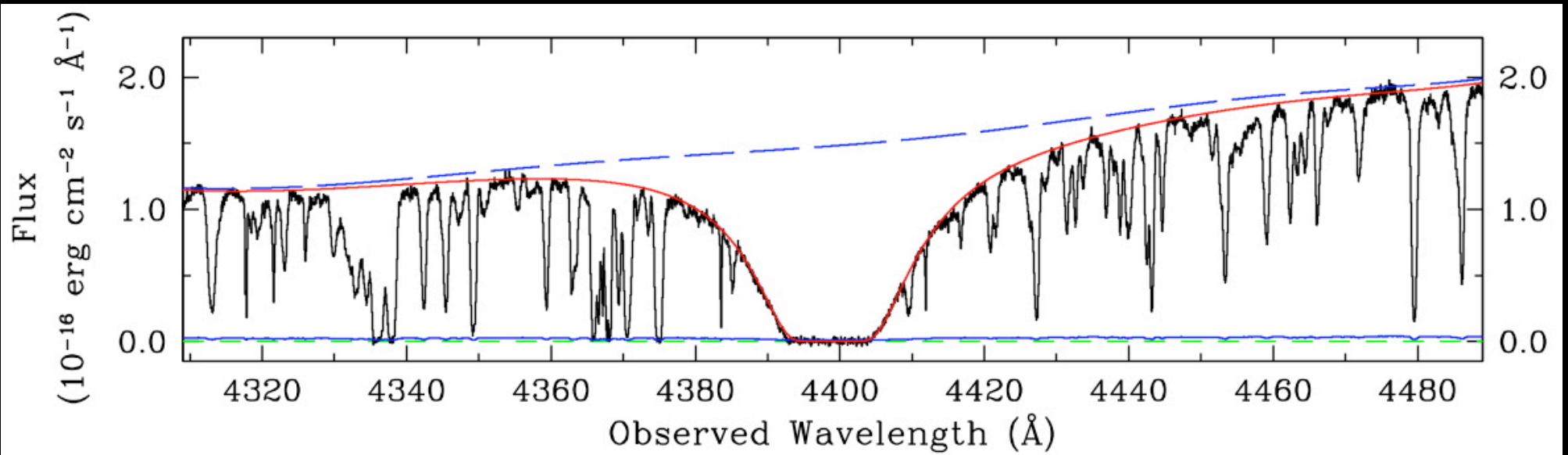
$$W_\lambda = 0.327 \text{ \AA} / (1 + z) = \frac{1}{\lambda_{\text{obs}}/\lambda_0} \rightarrow W_0 = 0.075 \text{ \AA}$$



$$N(\text{HI}) = 1.4 \times 10^{13} \text{ cm}^{-2}$$



$$N(\text{H I}) = 2.2 \times 10^{20} \text{ cm}^{-2}$$



Cooke+ 2014





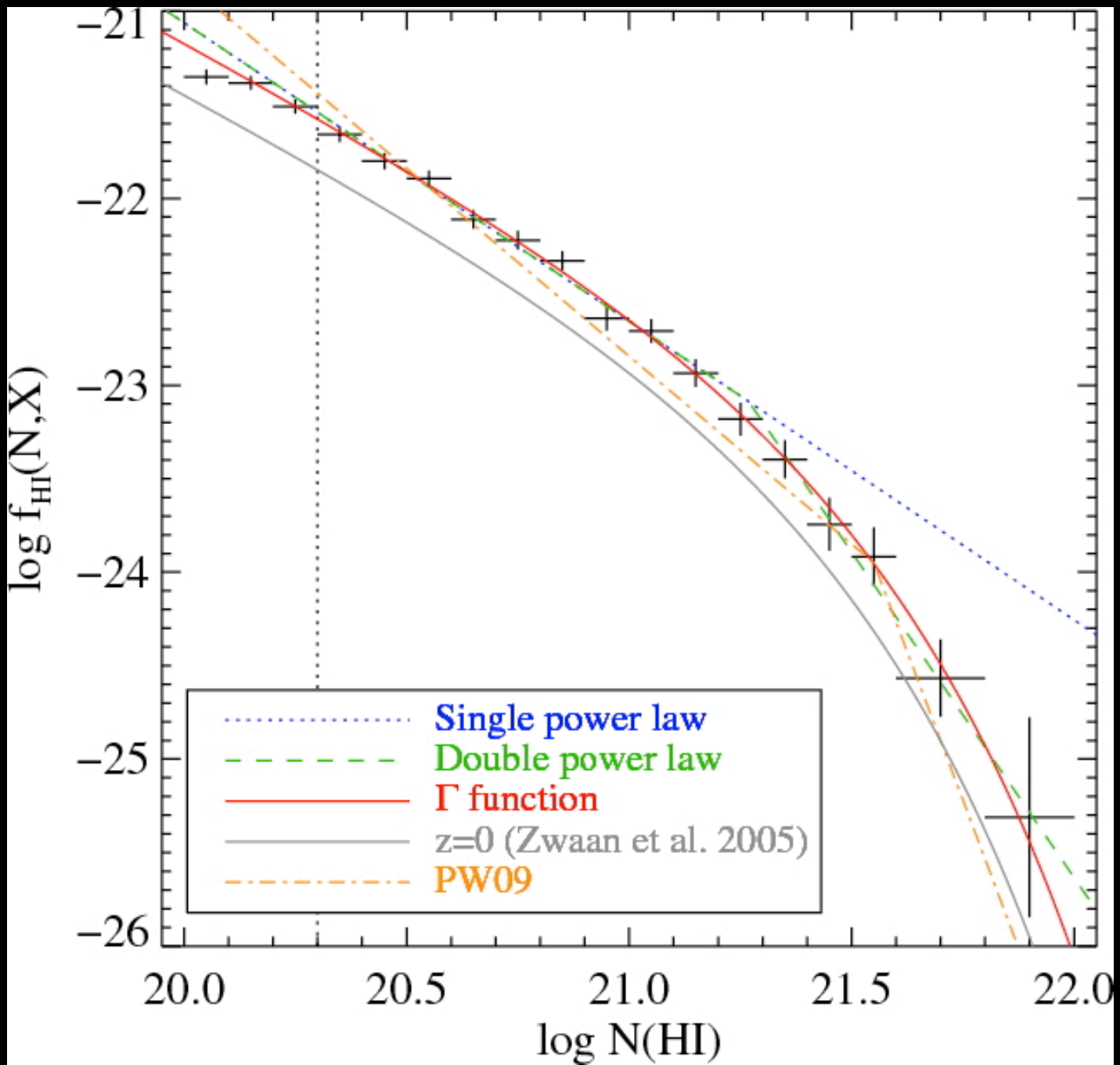
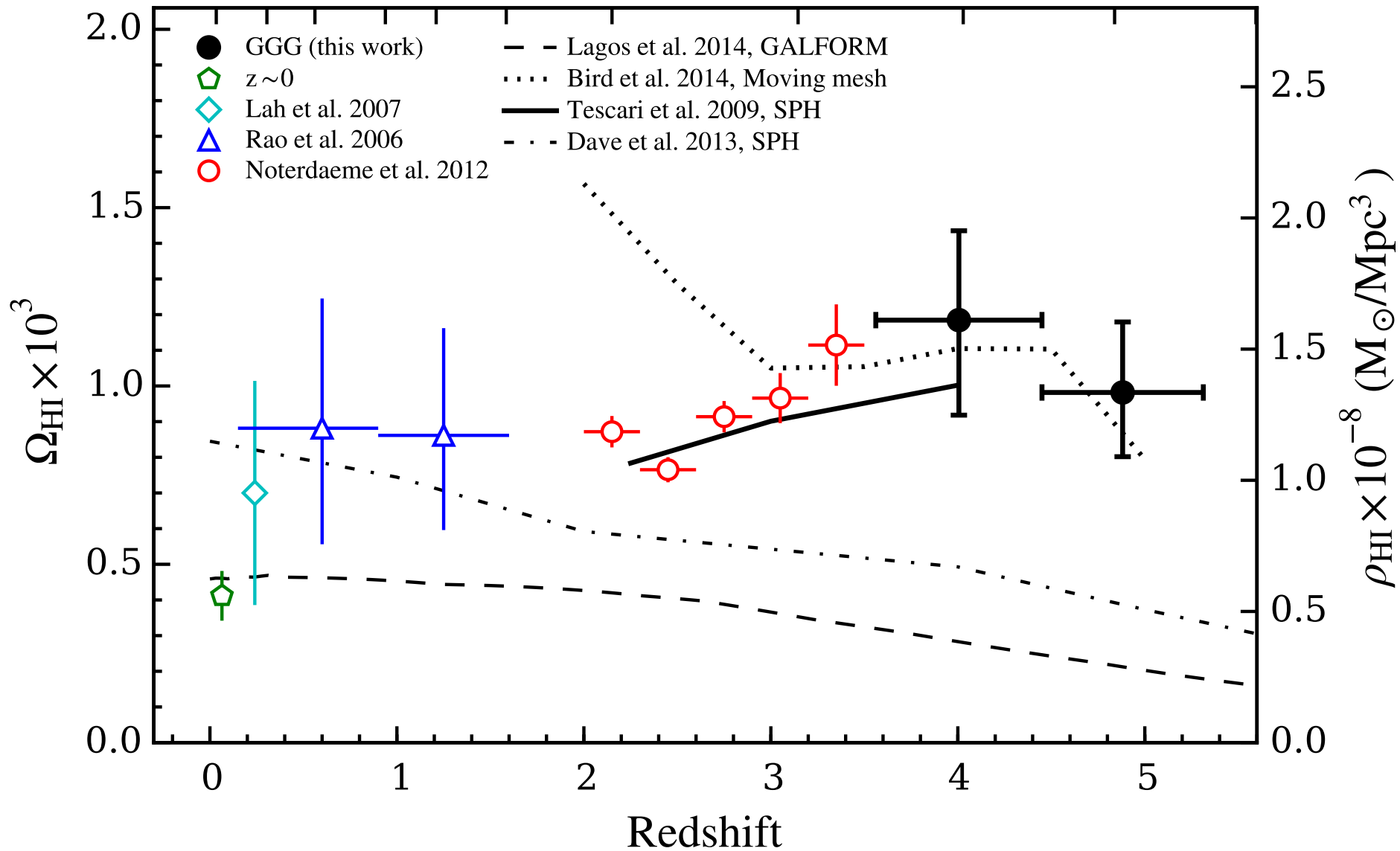


Table 1.1: COSMIC INVENTORY

Component	Ω (ρ/ρ_c)
Dark Energy	0.691 ± 0.006
Matter (baryonic and non-baryonic)	0.312 ± 0.009
Baryons (Total)	0.0488 ± 0.0004
Baryons in stars and stellar remnants	~ 0.003
Neutrinos	~ 0.001
Photons (CMB)	5×10^{-5}

Time since Big Bang (Gyr)

13 10 8 6 5 4 3 2 1.5 1.2 1



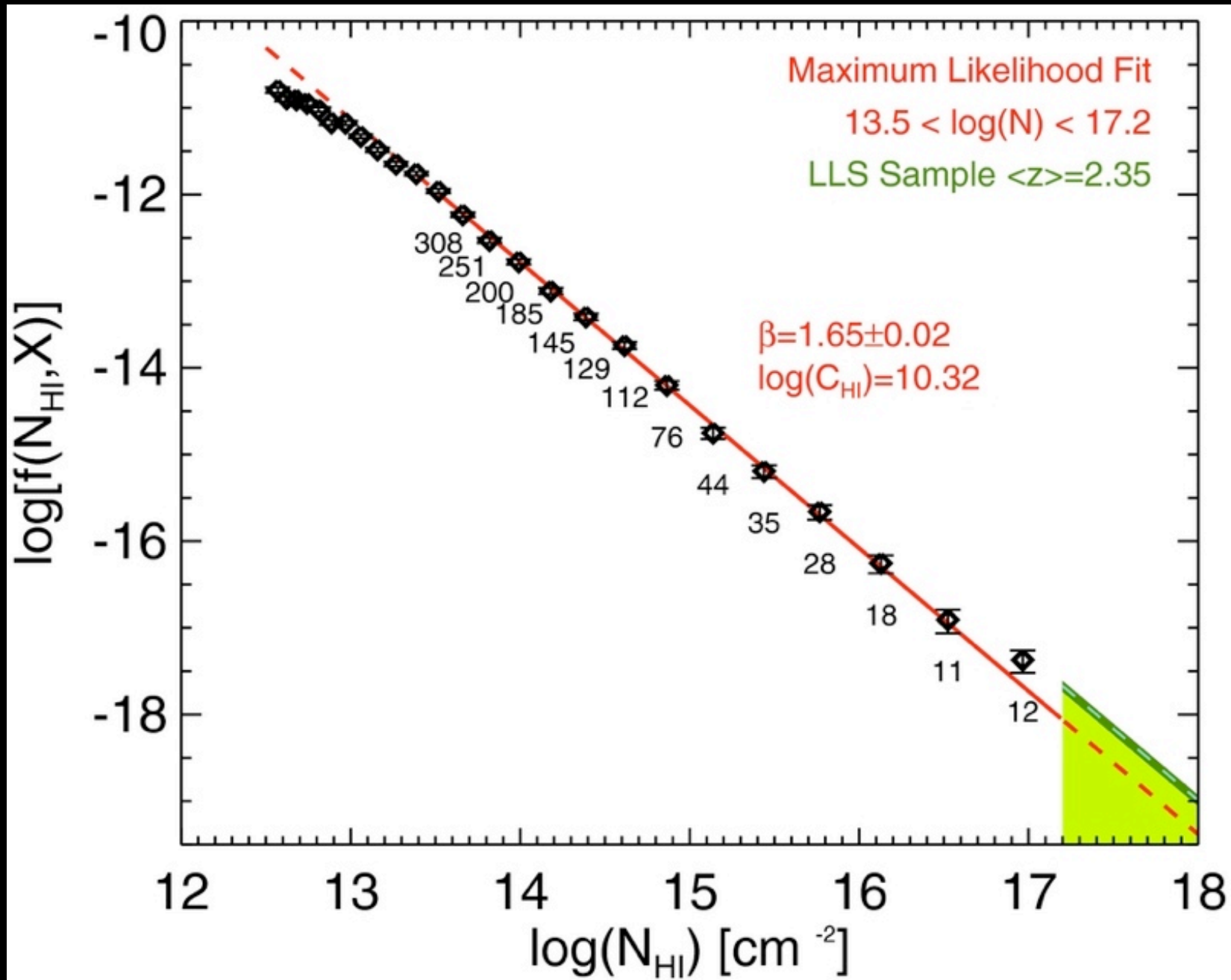
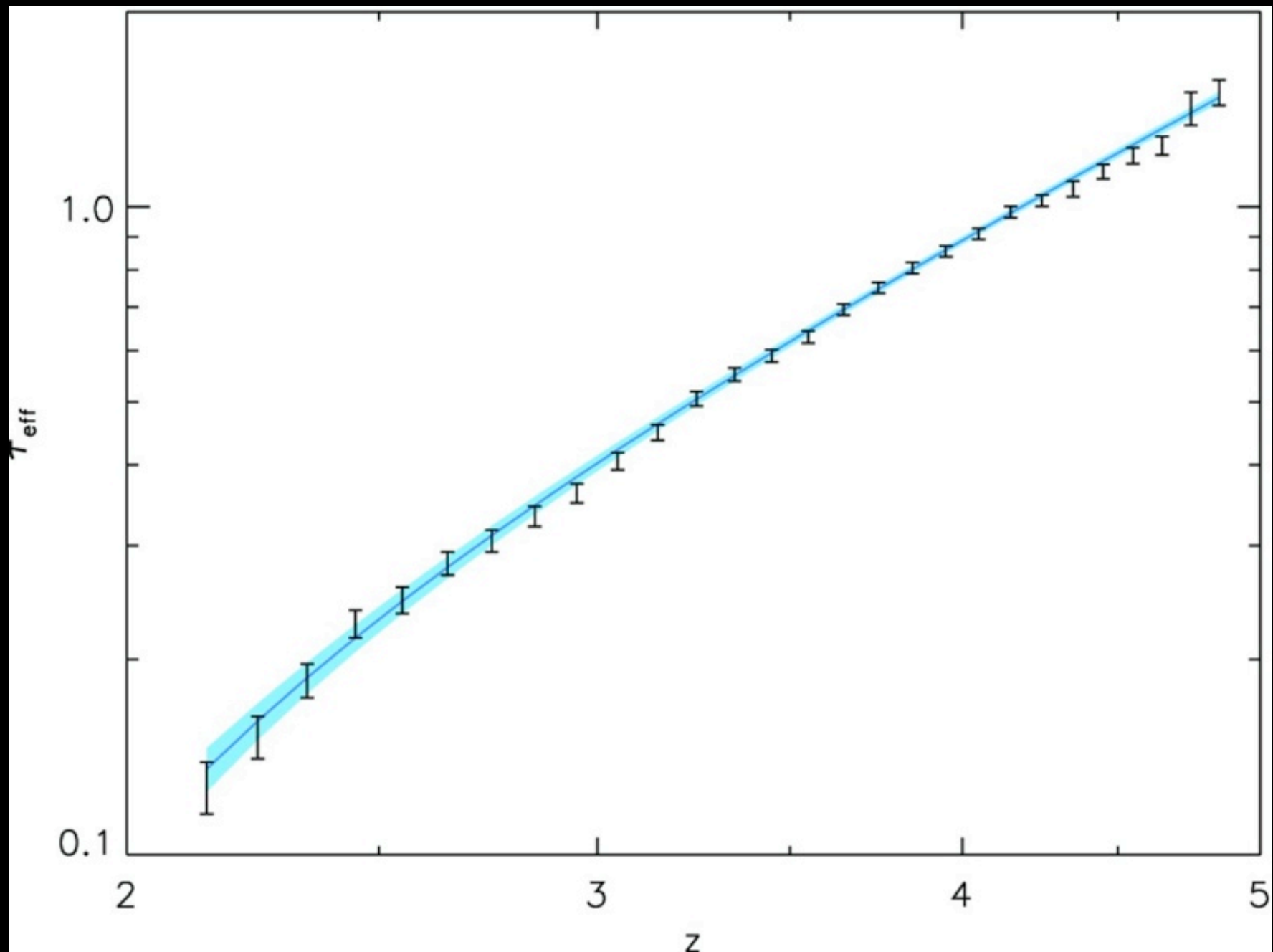




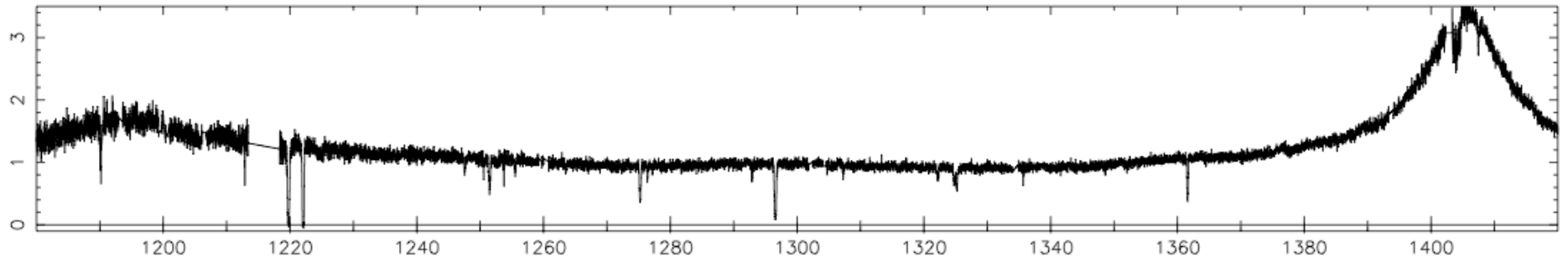
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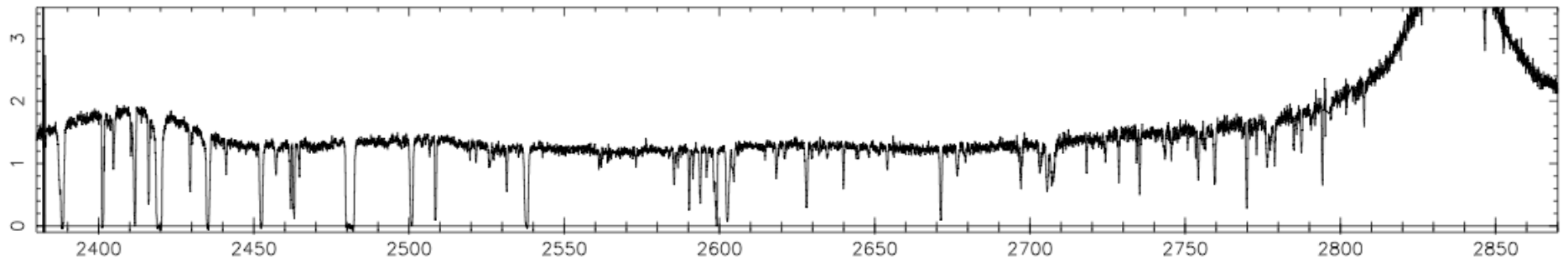


Becker 2013

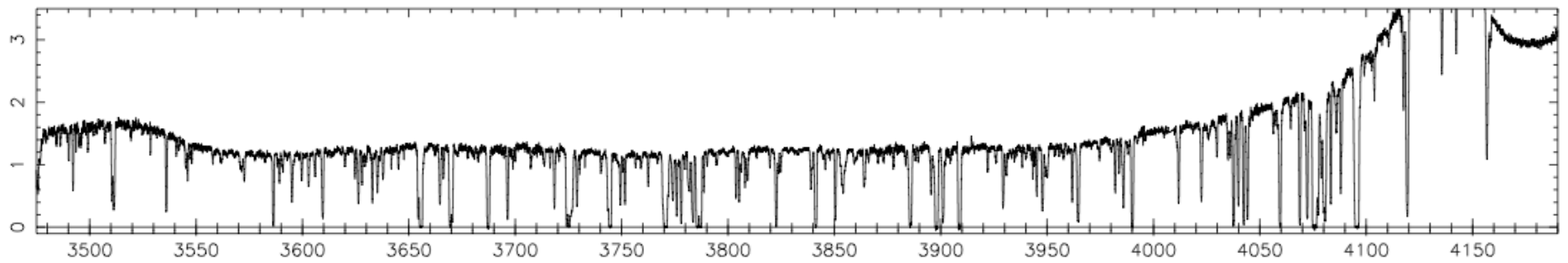
3C273 $z=0.158$



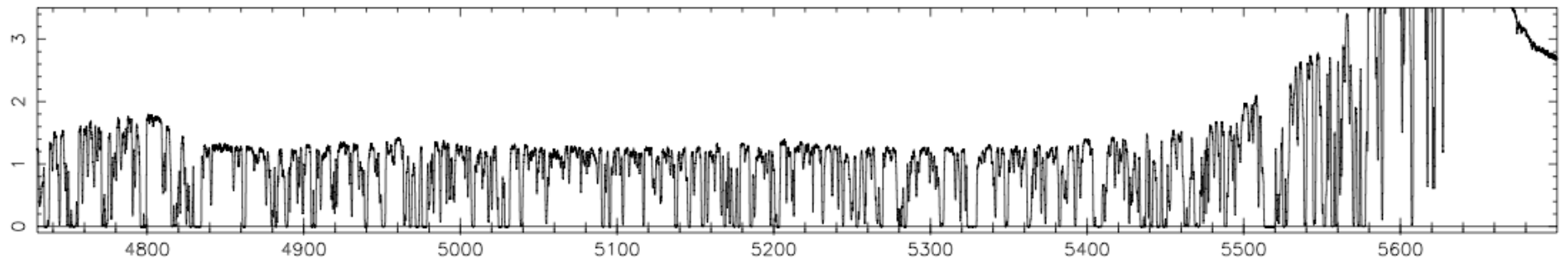
PG1634+706 $z=1.337$



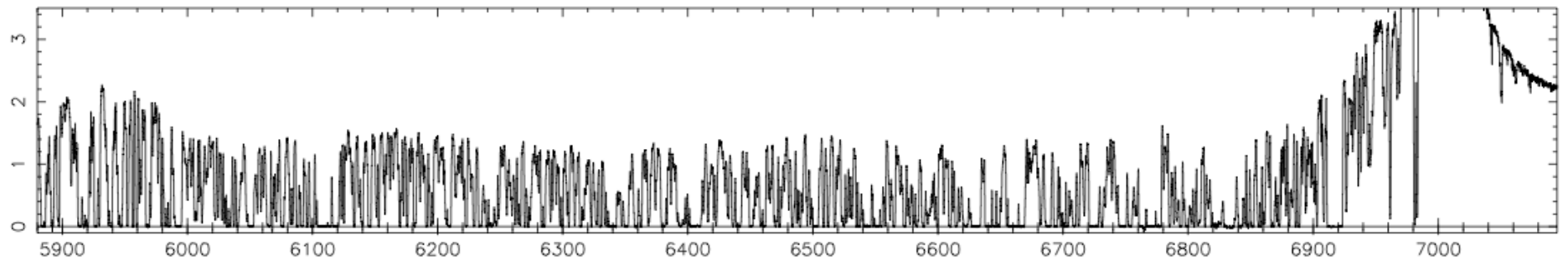
HE1122-1648 $z=2.405$



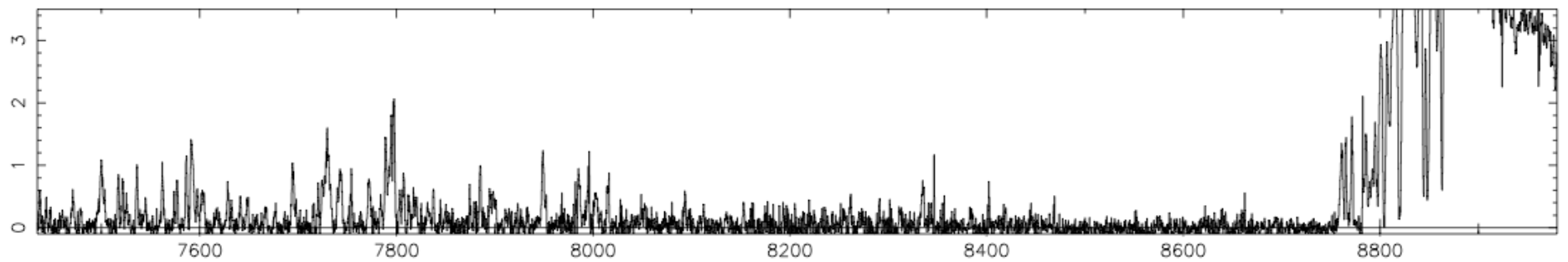
1422+231 $z=3.635$



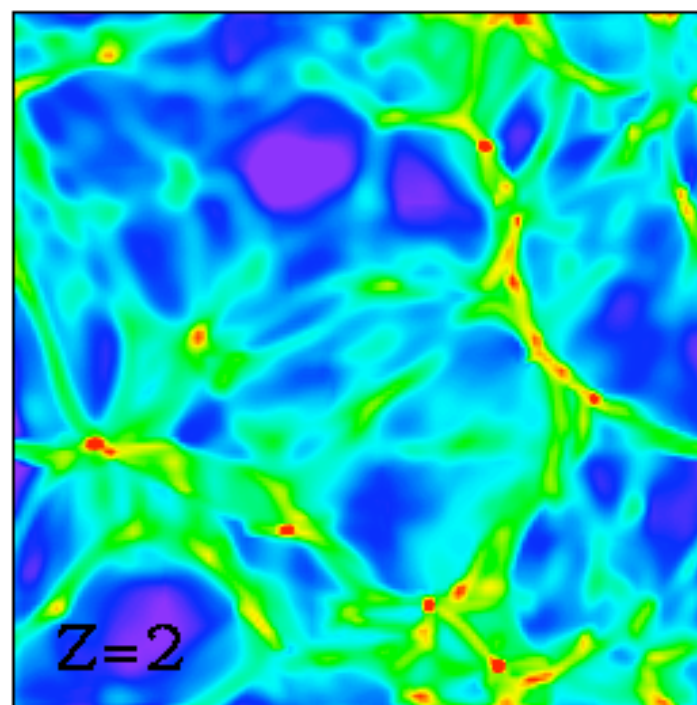
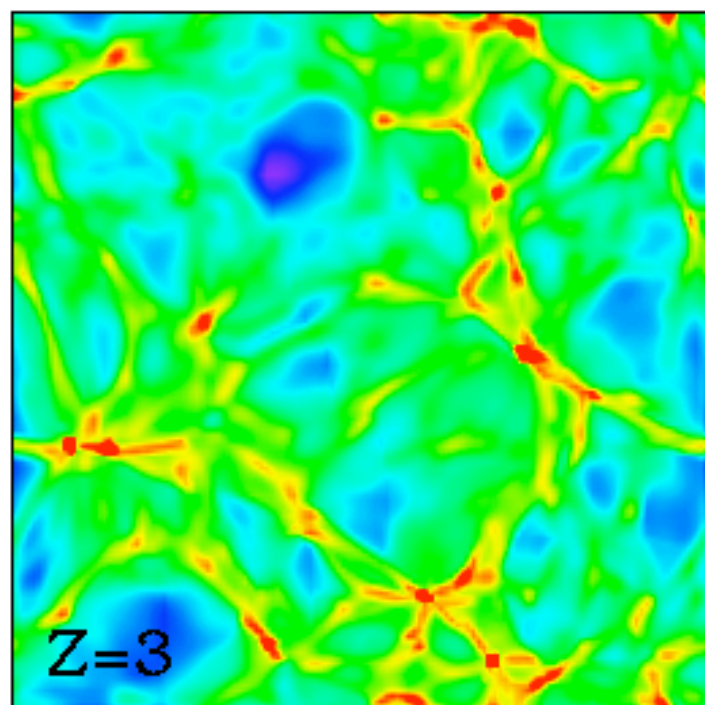
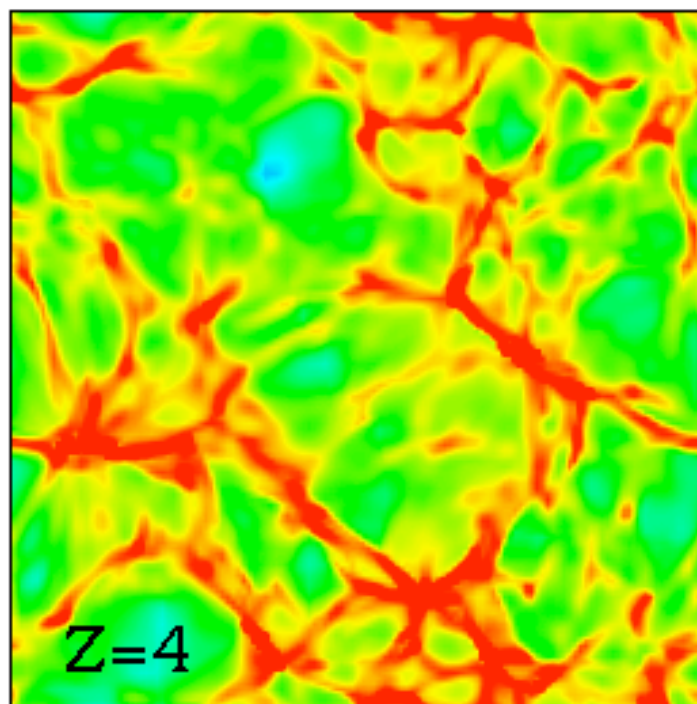
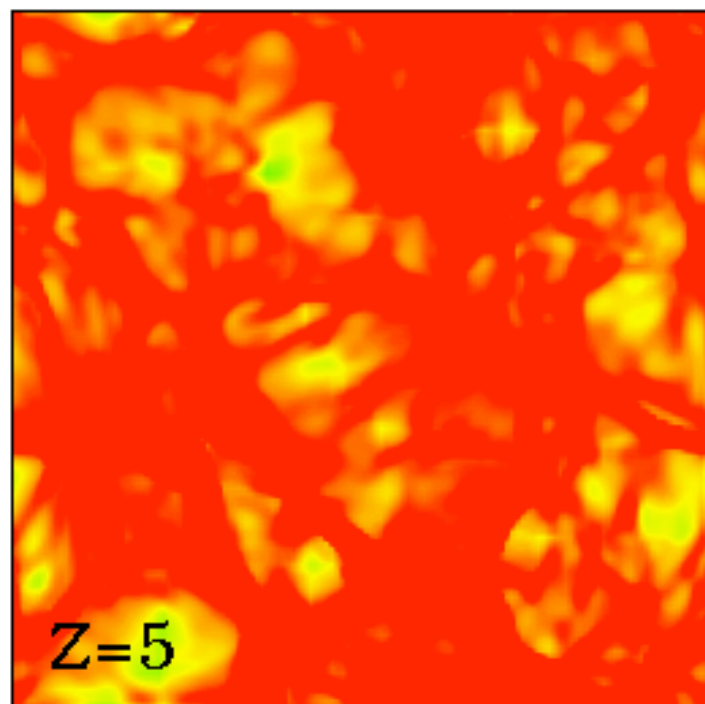
Q1451-15 $z=4.762$



1030+0524 $z=6.290$



wavelength (A)

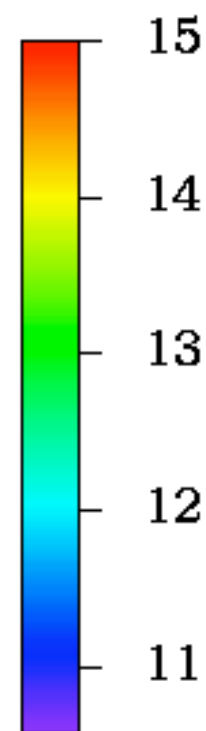


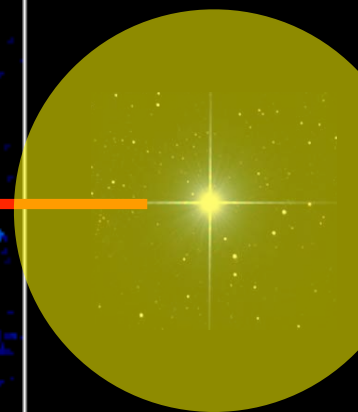
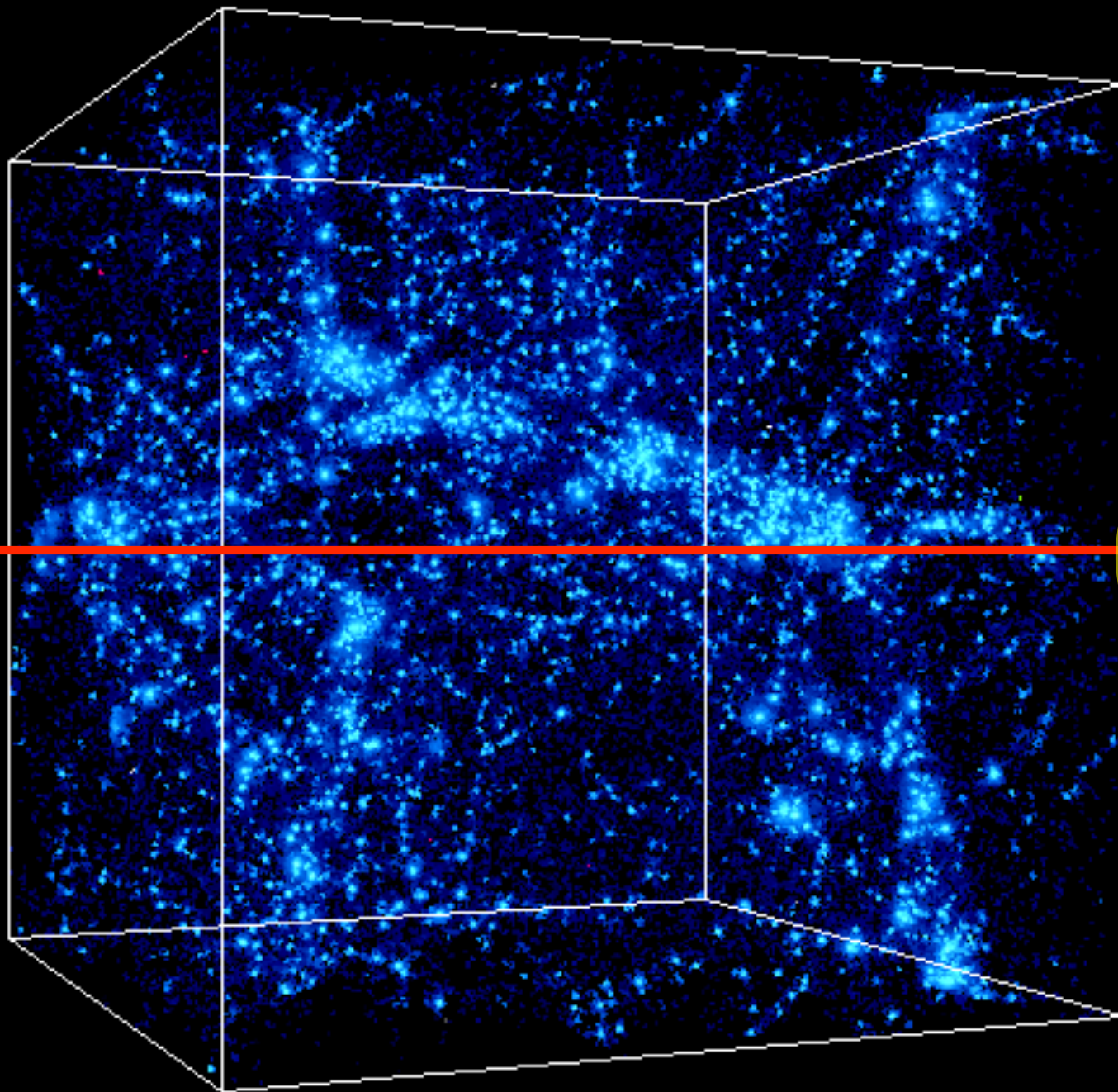
N_{HI} Evolution

SCDM+HM

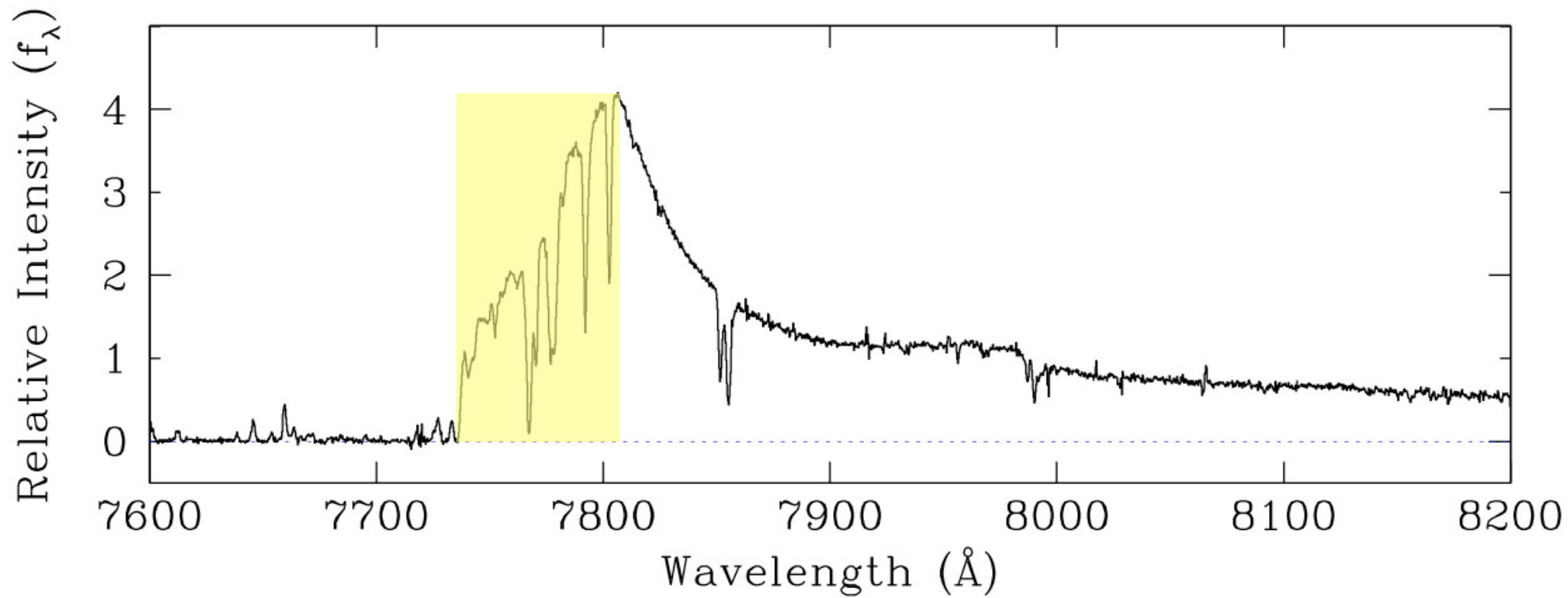
$L_{\text{box}}=9.6\text{Mpc}$

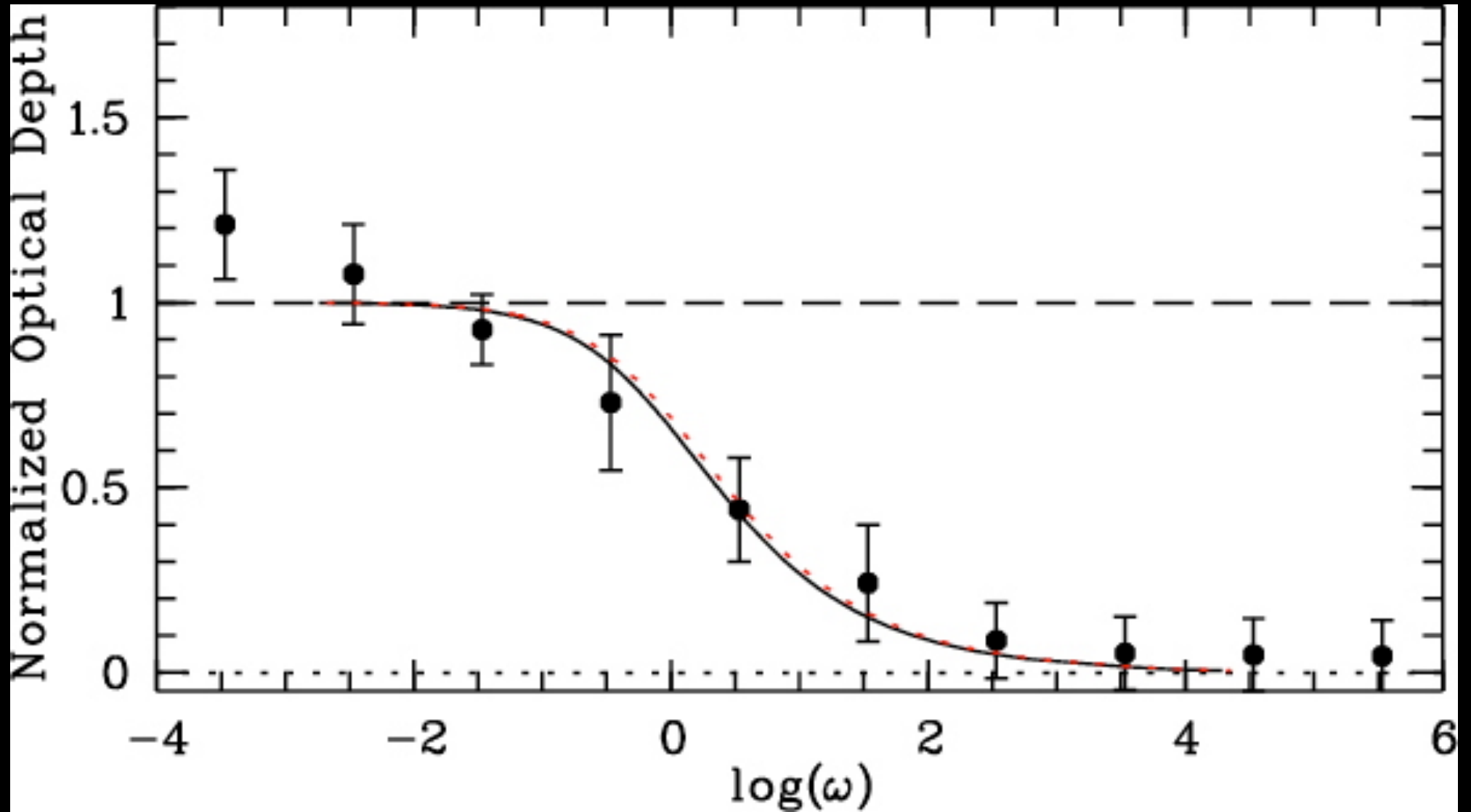
$\log(N_{HI})$



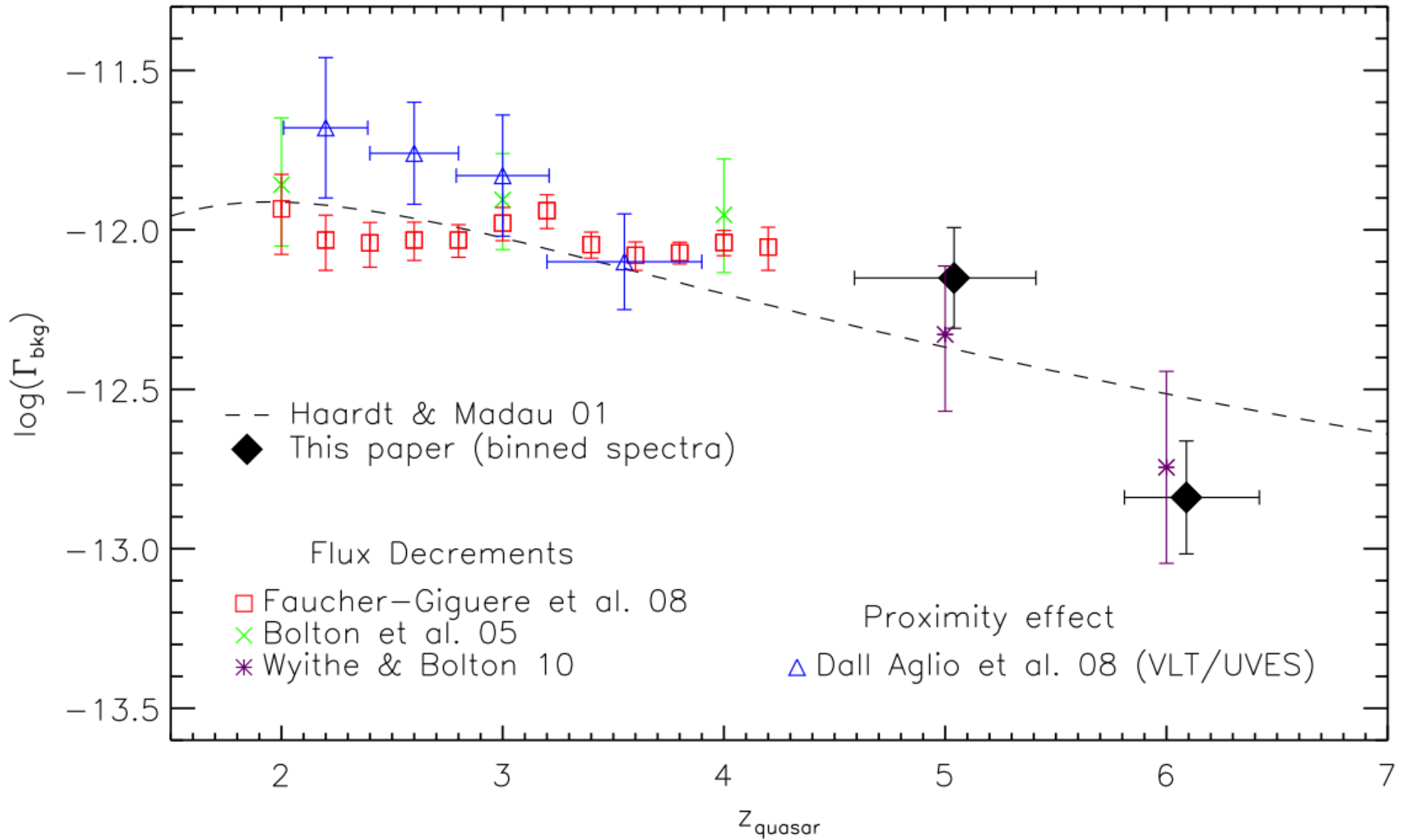


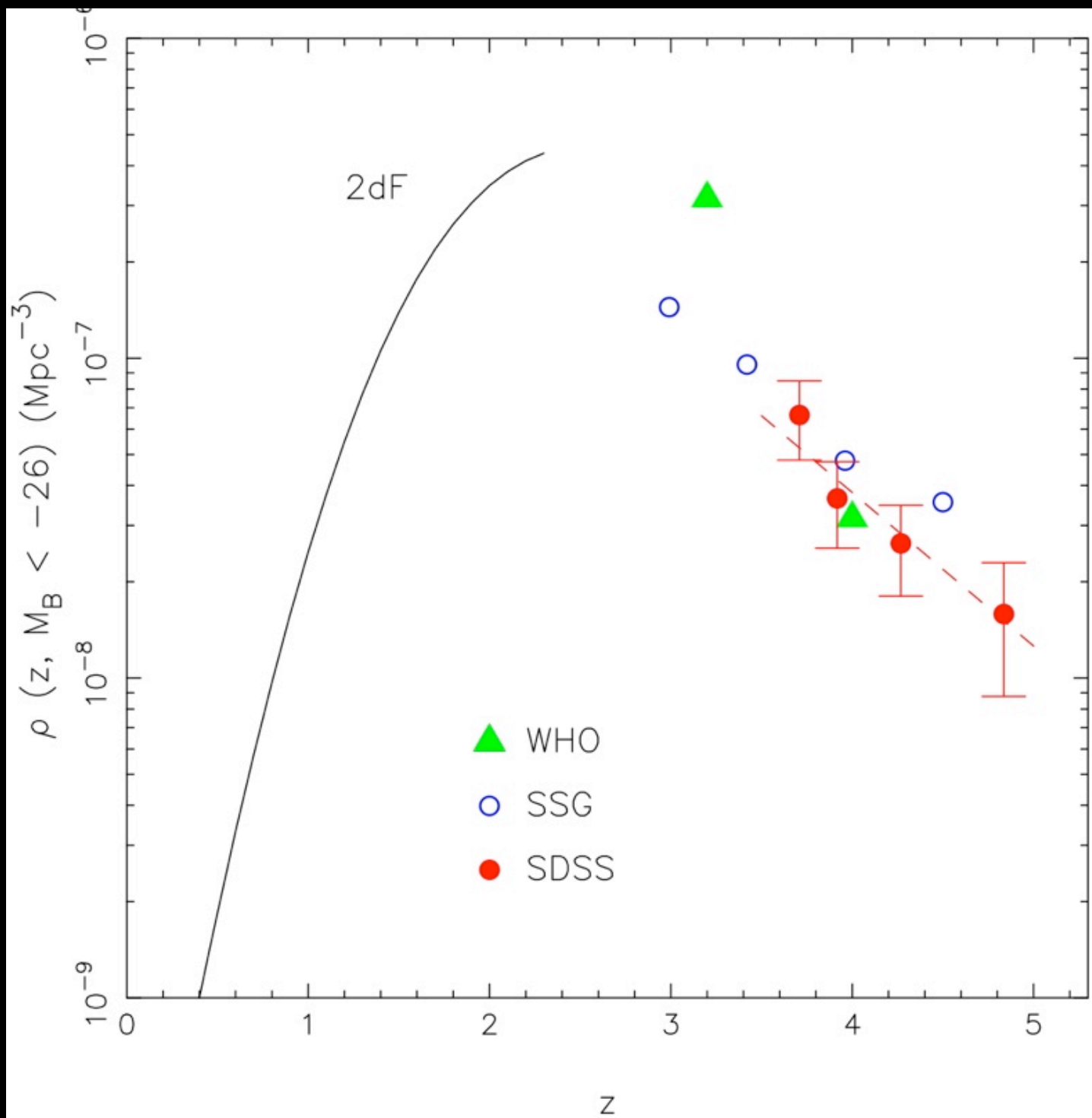
SDSS 0231-0728 $z_{em} = 5.421$



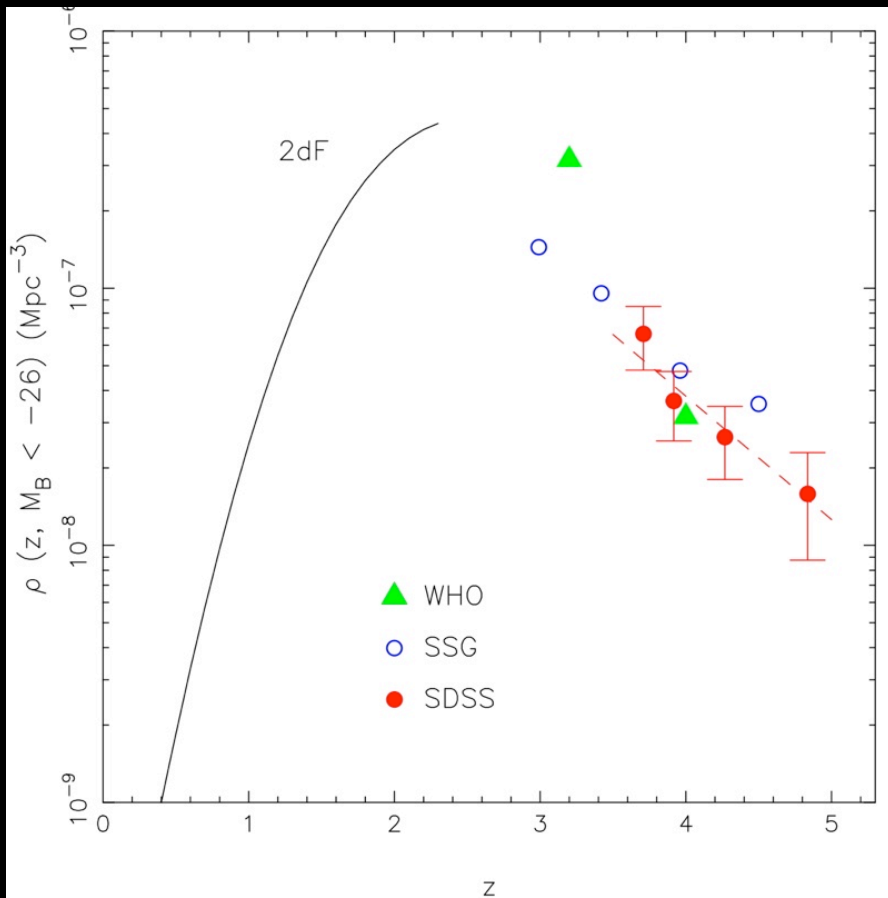


Dall'Aglio+ 2008



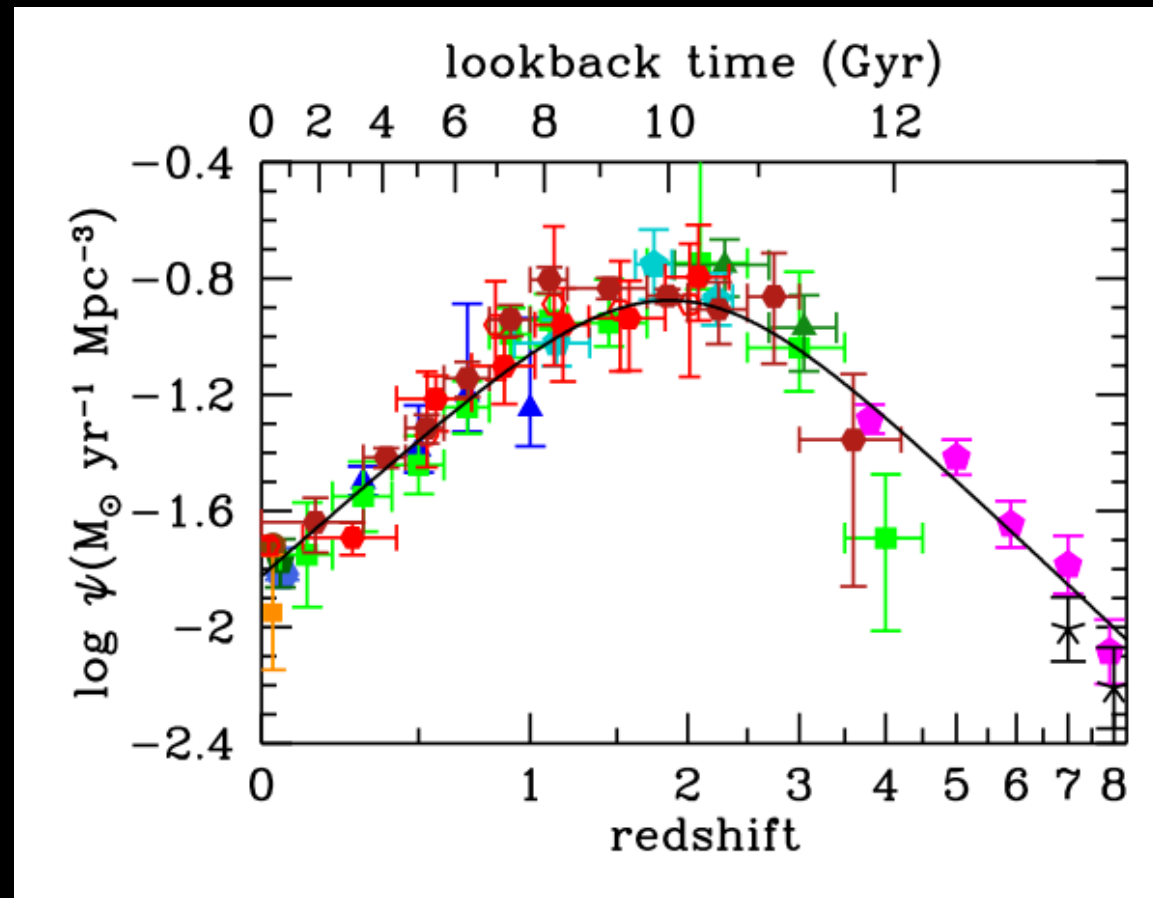


QUASARS



Fan+ 2001

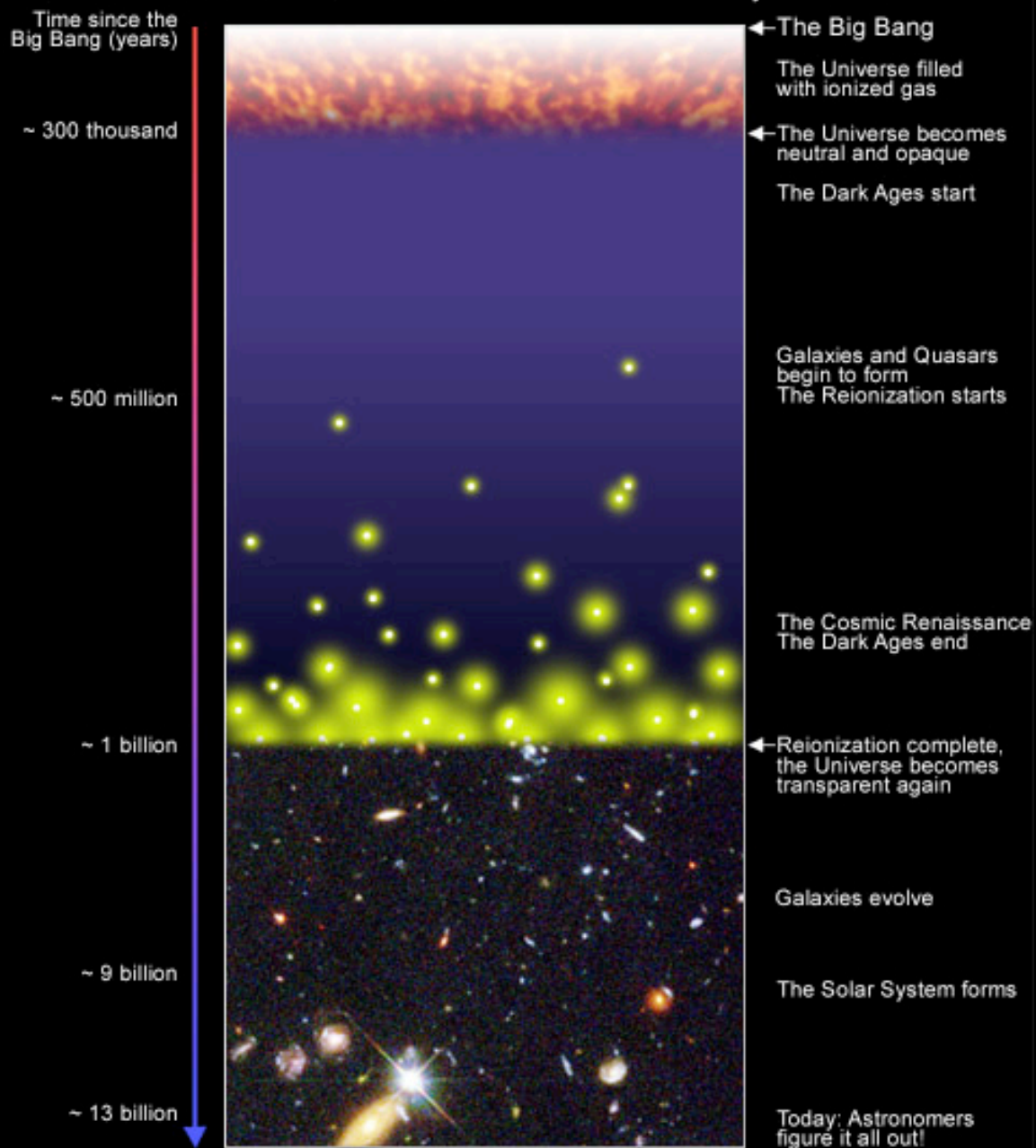
STARS



Madau & Dickinson 2014

What is the Reionization Era?

A Schematic Outline of the Cosmic History



S.G. Djorgovski et al. & Digital Media Center, Caltech

