

Constraining the nature of DM with Lyman alpha forest

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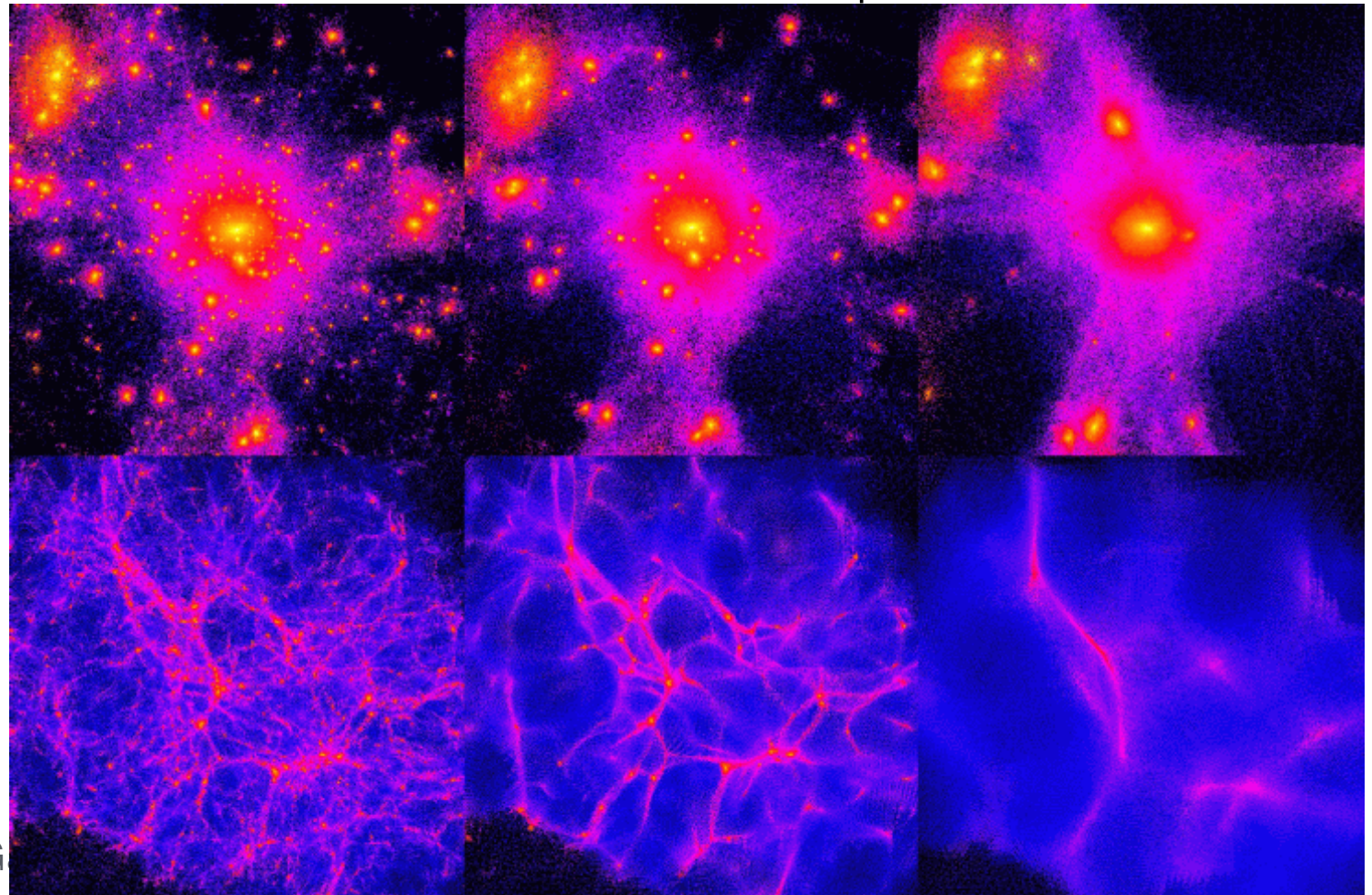
[arXiv:1510.07006](https://arxiv.org/abs/1510.07006)

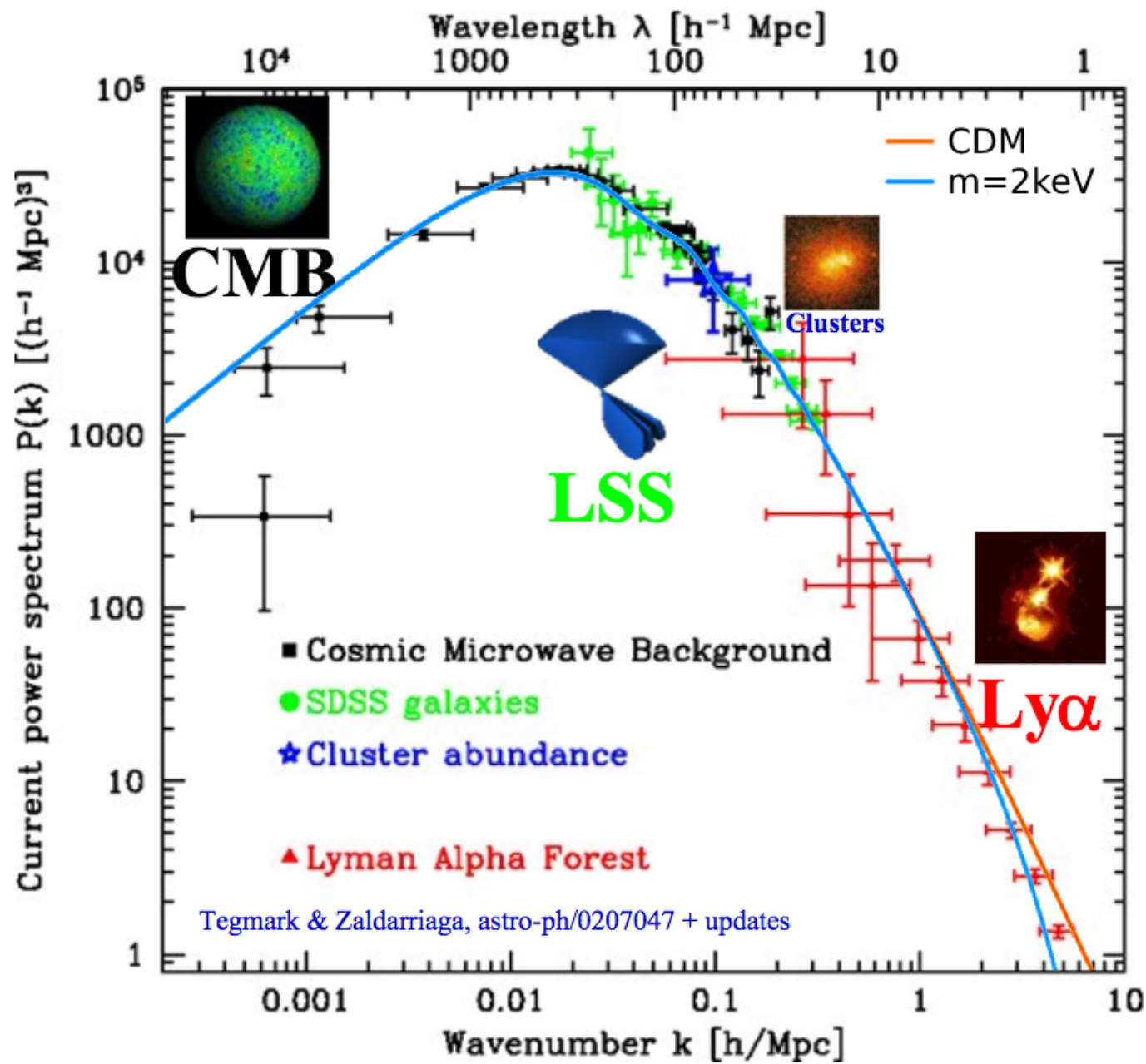
[arXiv:1809.06585](https://arxiv.org/abs/1809.06585)

COLD DARK MATTER: the particles were created/decoupled non-relativistic

WARM DARK MATTER: particles were created/decoupled relativistic, but became non-relativistic in the radiation-dominated epoch

HOT DARK MATTER: particles were created relativistic, became non-relativistic around the matter-dominated epoch





(Tegmark & Zaldarriaga 2002)

THE BIG BANG

INFLATION

GALAXY EVOLUTION

CONTINUES...

DARK ENERGY?

FIRST STARS
400,000,000 YEARS
AFTER BIG BANG

THE DARK AGES

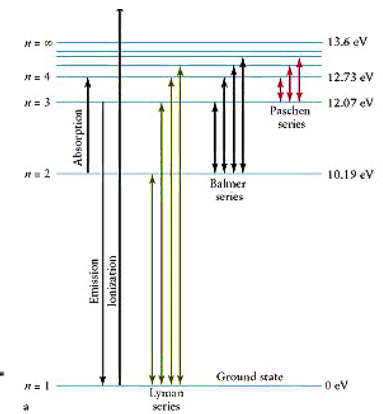
COSMIC MICROWAVE
BACKGROUND
400,000 YEARS AFTER
BIG BANG

FIRST GALAXIES
1,000,000,000 YEARS
AFTER BIG BANG

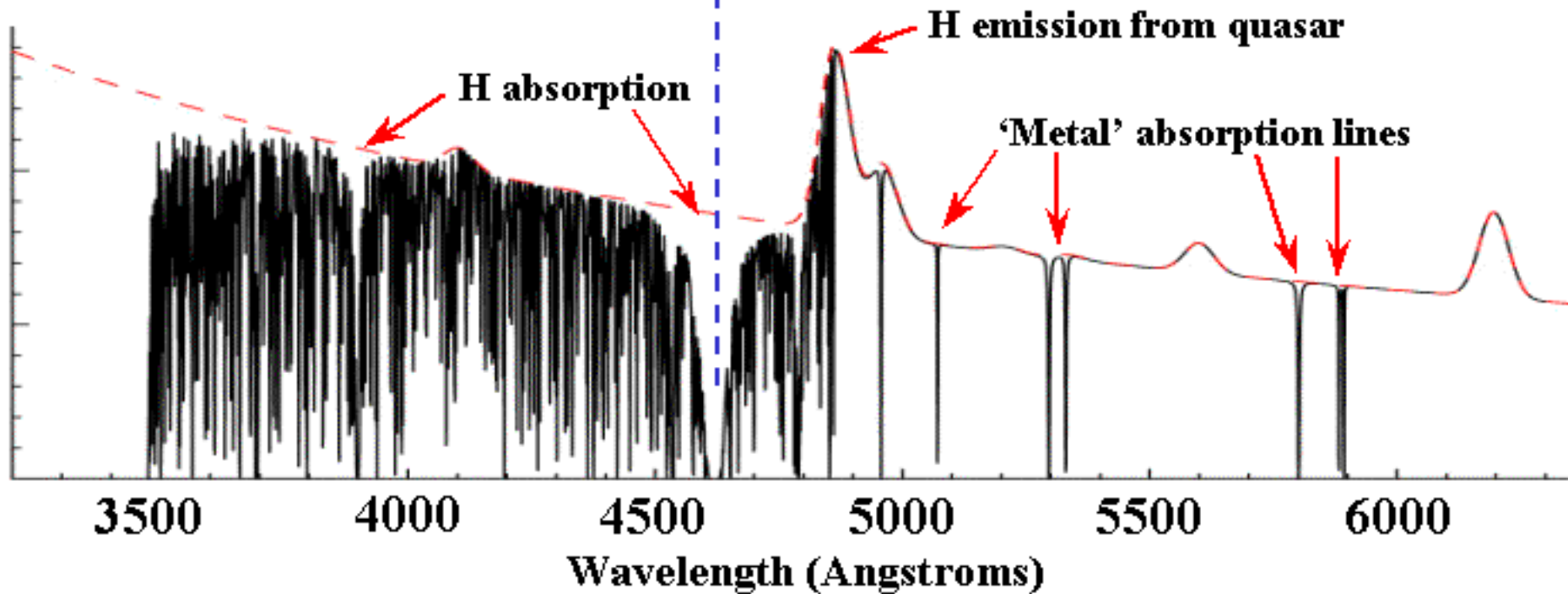
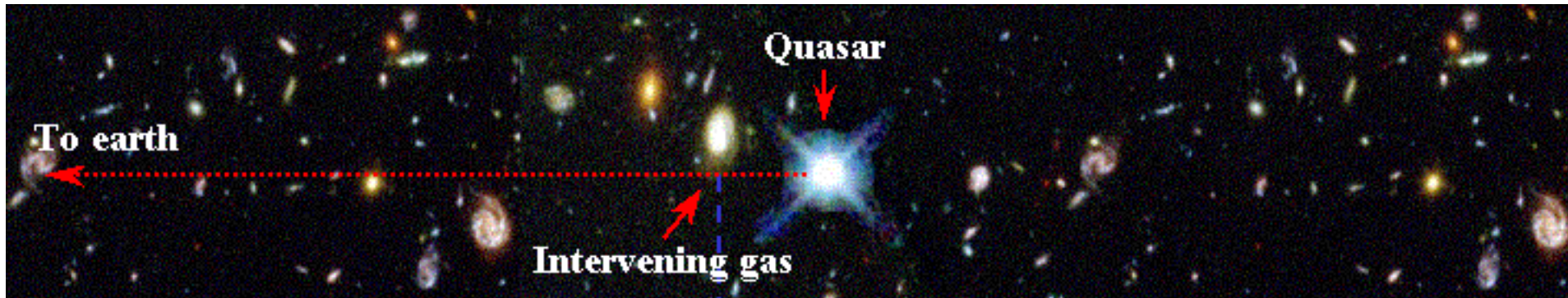
Now
13,700,000,000 YEARS
AFTER BIG BANG

FORMATION OF
THE SOLAR SYSTEM
8,700,000,000 YEARS
AFTER BIG BANG

Lyman- α forest

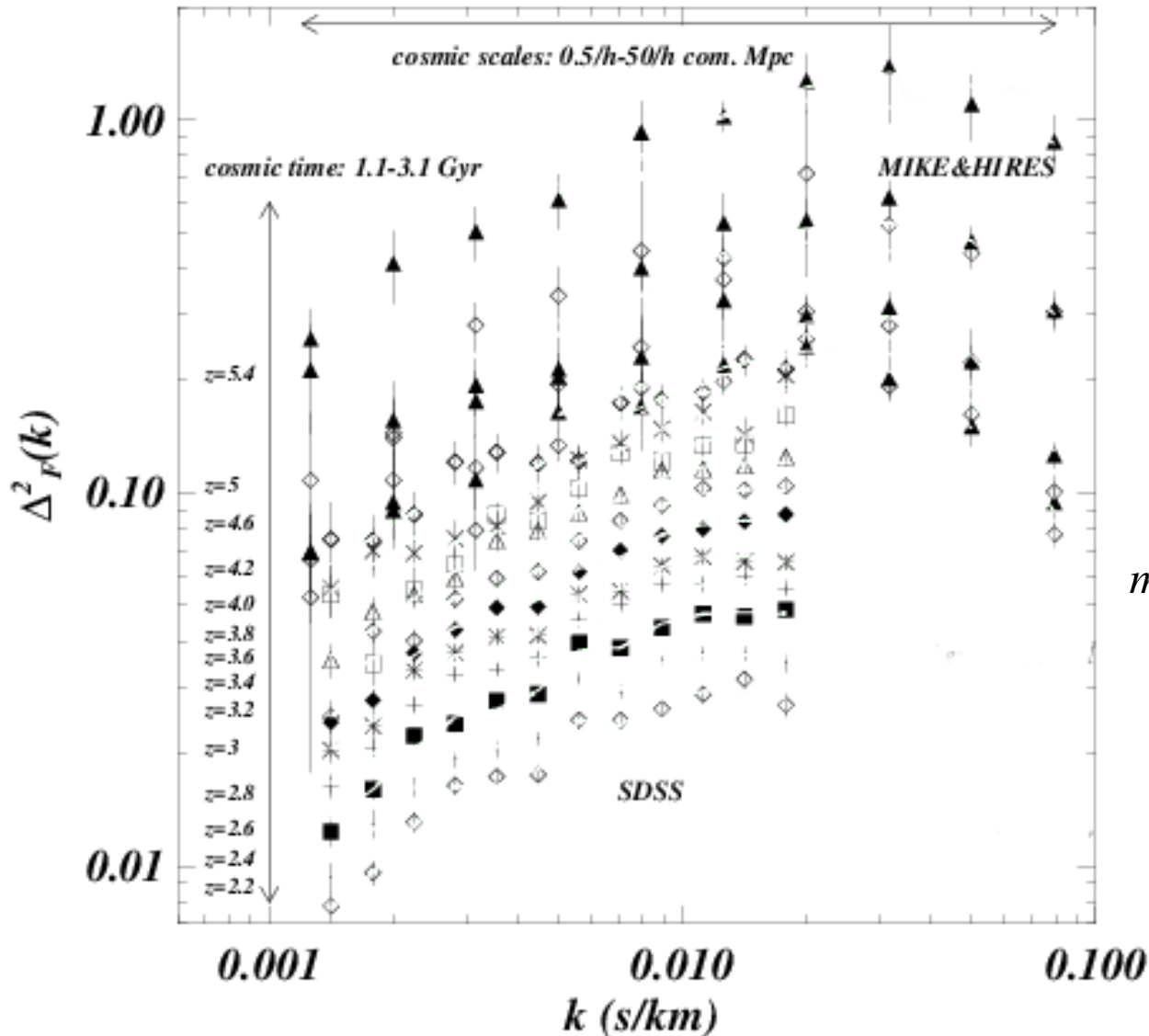


$$\lambda_{\alpha} = 1216\text{\AA}$$



DATA for constraining on WDM from the Lyman- α forest

(Viel et al, 2013)

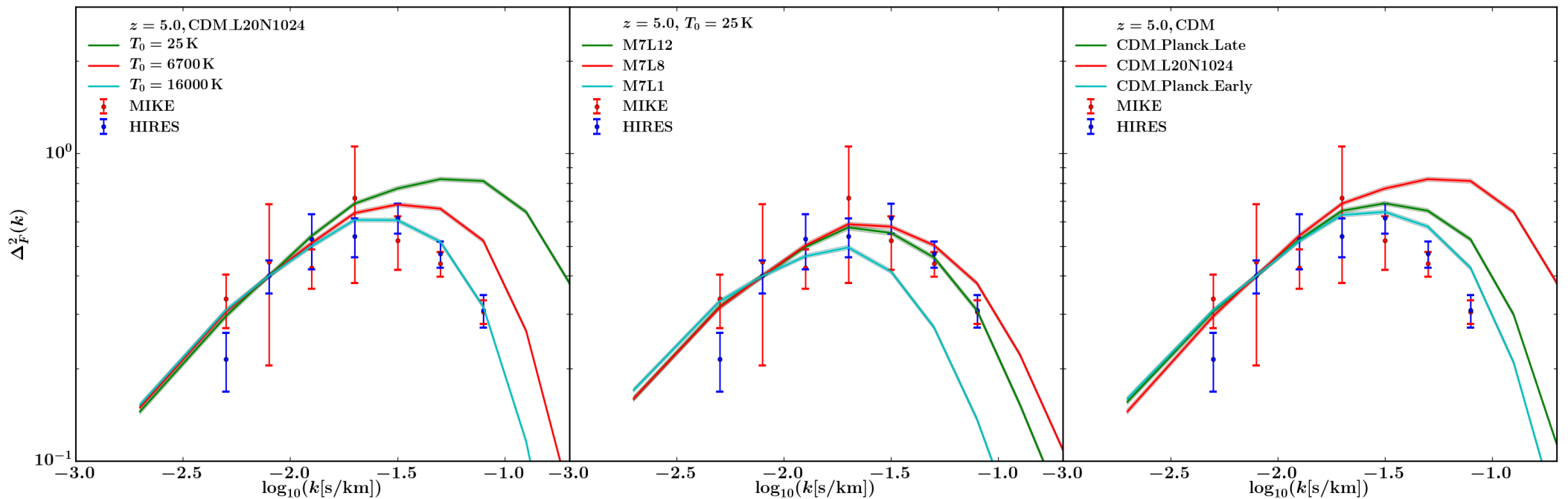


(Seljak et al, 2006)

SDSS

$m_{\text{WDM}} > 2 \text{ keV}$ at $2 - \sigma$ level

WDM or IGM temperature?



The flux power spectrum at small scales is affected by:

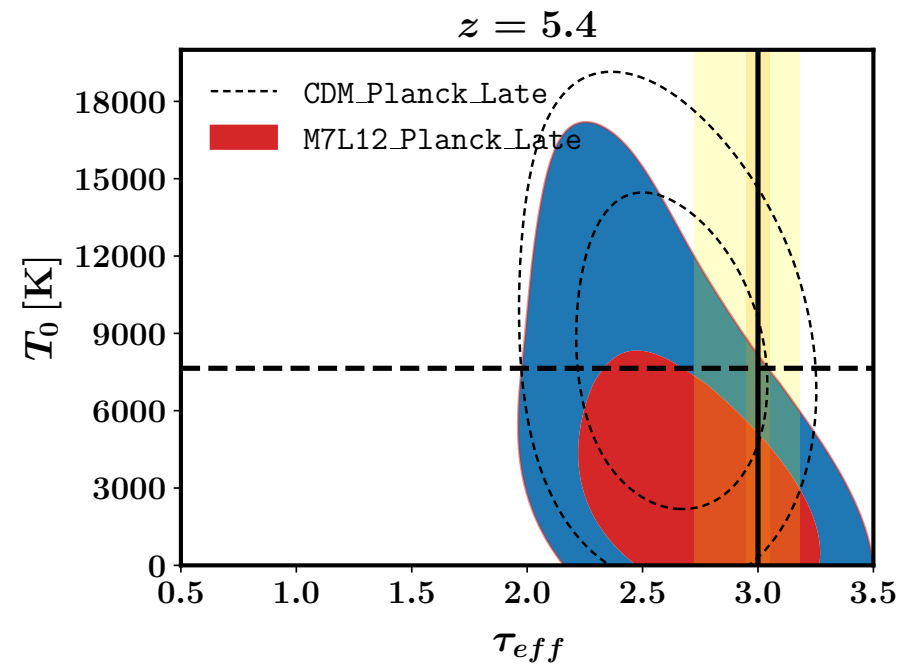
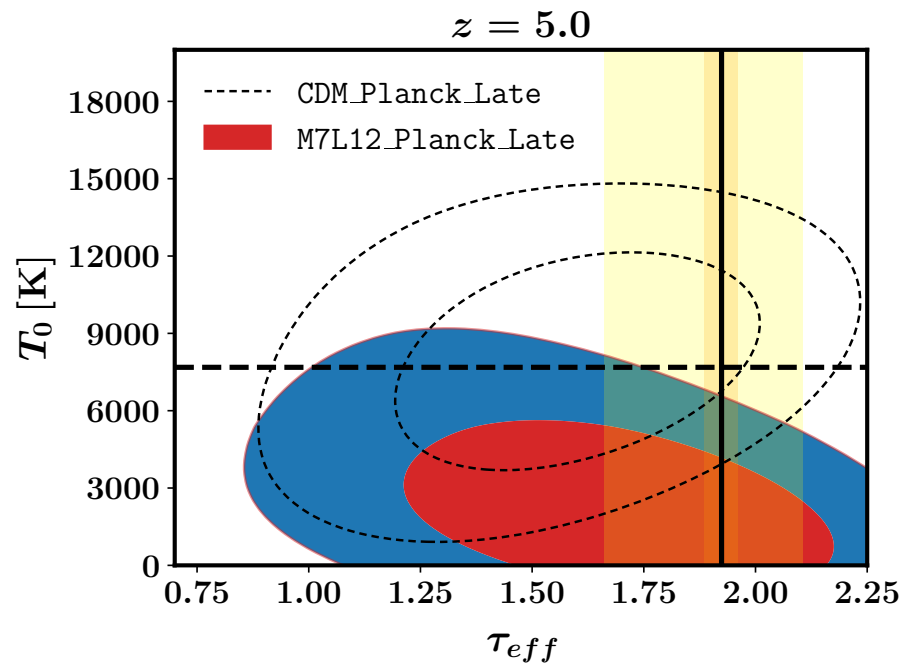
- temperature of the IGM (1D effect)
- pressure (3D)

(Gnedin & Hui 1998)

(Theuns, Schaye & Haehnelt 2000)

(Onorbe et al 2017)

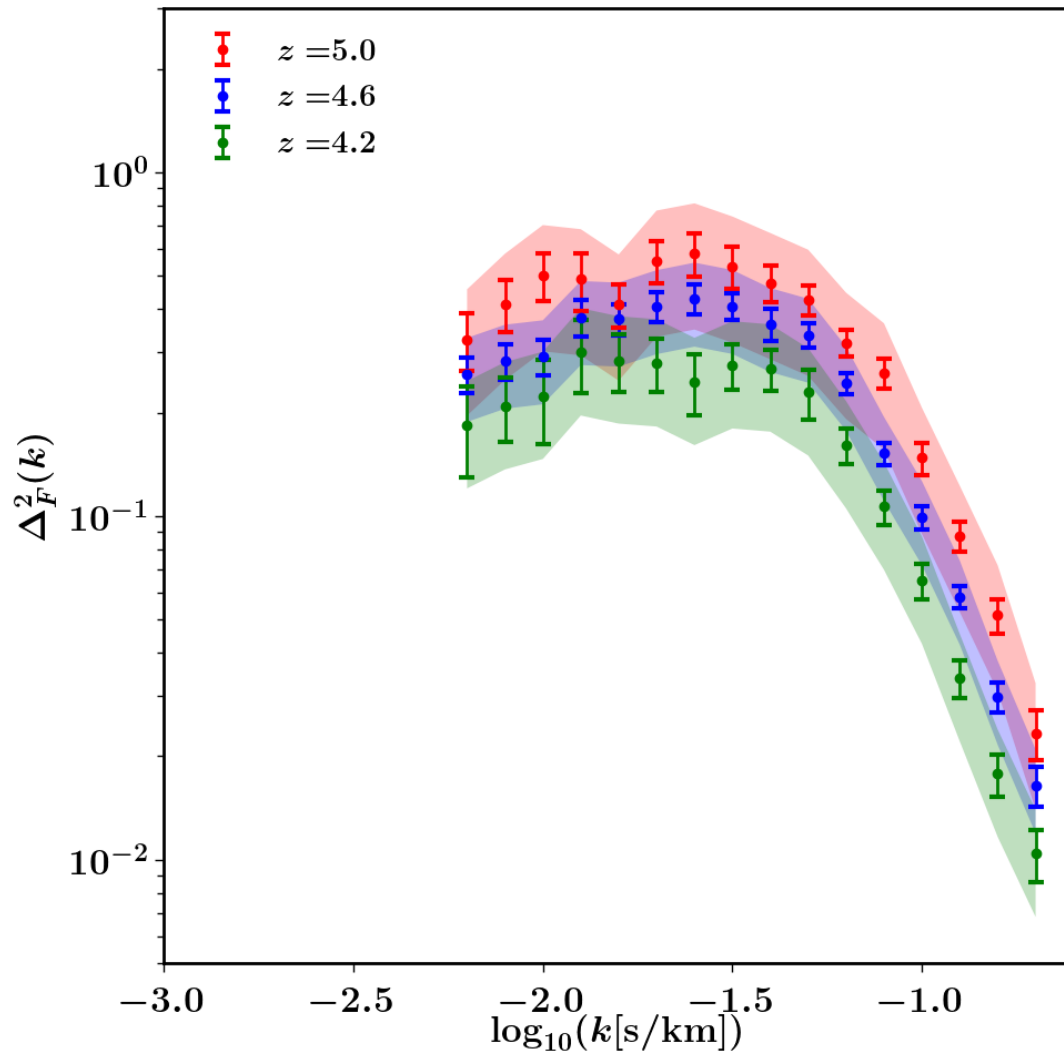
temperature of M7L12 compatible with data HIRES



Garzilli et al. MNRAS (2019) [1809.06585]

we have considered uncertainties from the small data sample

new HIRES data-set



$m_{\text{WDM}} > 1.9 \text{ keV}$ at $2 - \sigma$ level

Garzilli et al to appear soon

Summary

- We have re-analyzed previously available HIRES data, taking into account sample variance and varying thermal history of the IGM -> we conclude that previous constraints do not hold
- We have shown that Sterile neutrinos dark matter with mass $\sim 7\text{keV}$ is allowed by large scale structures data
- We have analyzed the most recent HIRES data, and we have produced new robust constraints on WDM