21cm and Warm Dark Matter: no problem.

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Summary

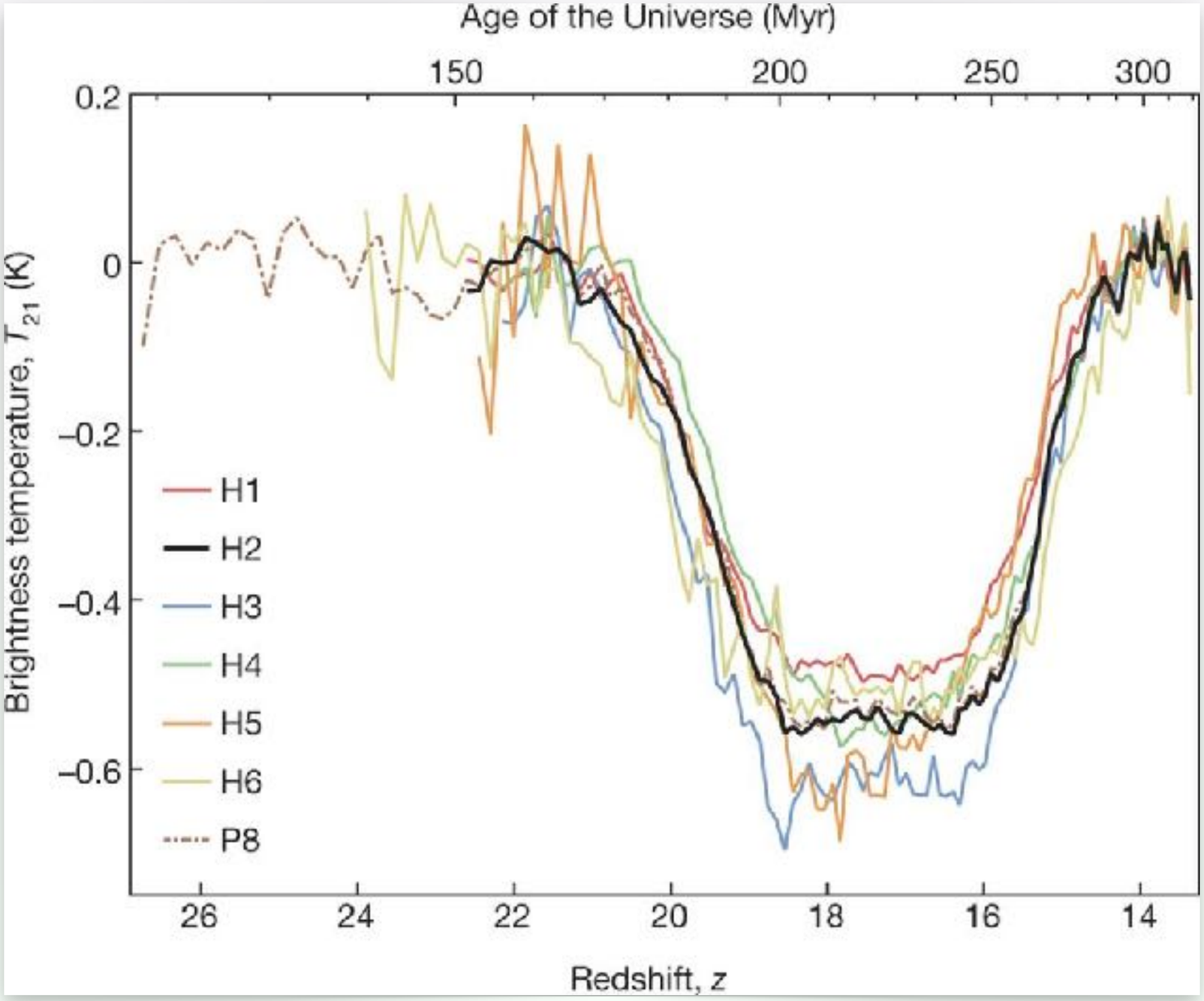
- The EDGES signal is perfectly compatible with any type of Dark Matter

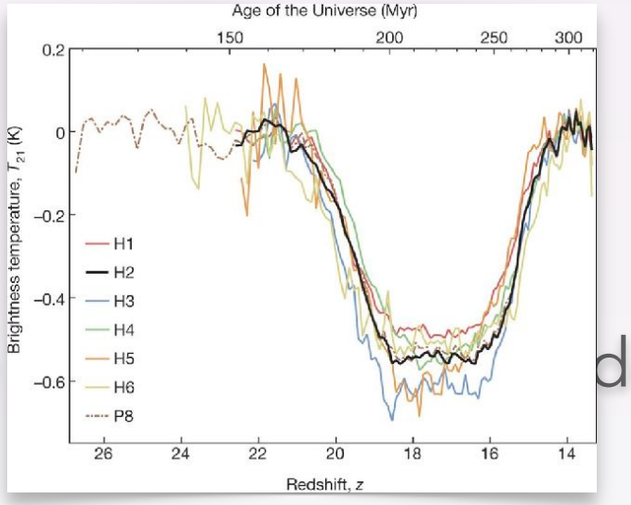
- EDGES creates link between star formation and DM temperature.

    - More info on one? Stronger prediction / constraint on the other.

EDGES

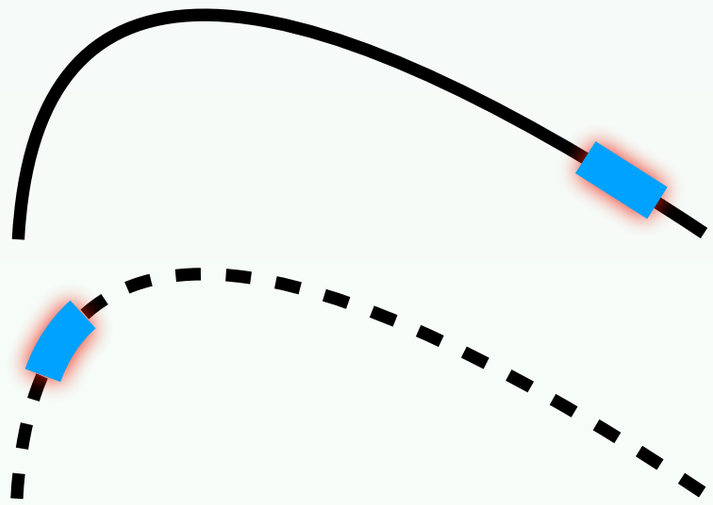
J D Bowman et al. Nature 555, 67–70 (2018) doi:10.1038/nature25792



J D Bowman et al. Nature 

doi:10.1038/nature25792

- Spin temperature: $\frac{n_1}{n_0} = \frac{g_1}{g_2} \exp - \frac{T_*}{T_{\rm spin}}$
- Gas temperature: kinetic collisions
- CMB temperature:
- Ly-α colour temperature:



EDGES

$$\frac{n_1}{n_0} = \frac{g_1}{g_2} \exp - \frac{T_*}{T_{\rm spin}}$$

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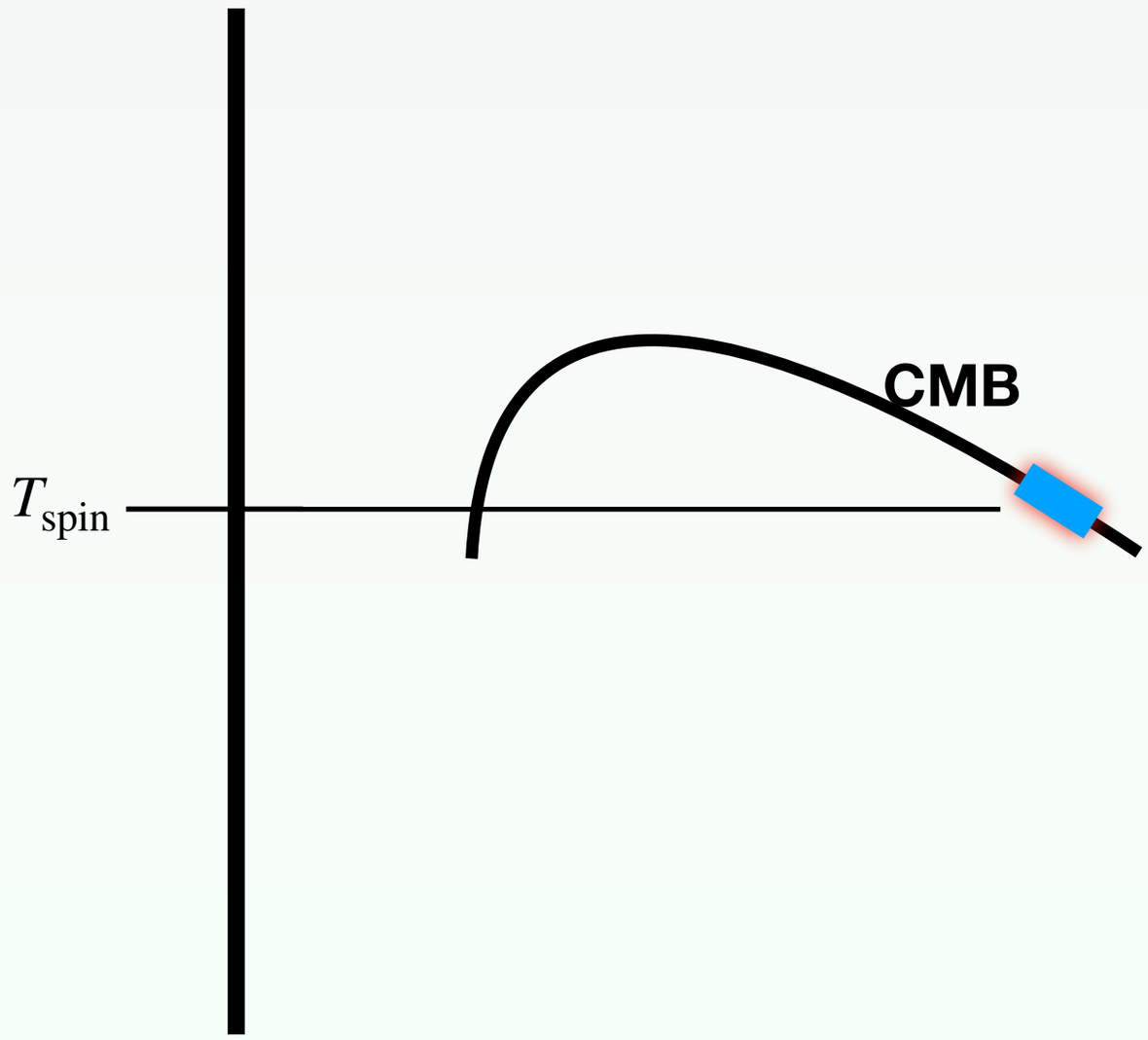

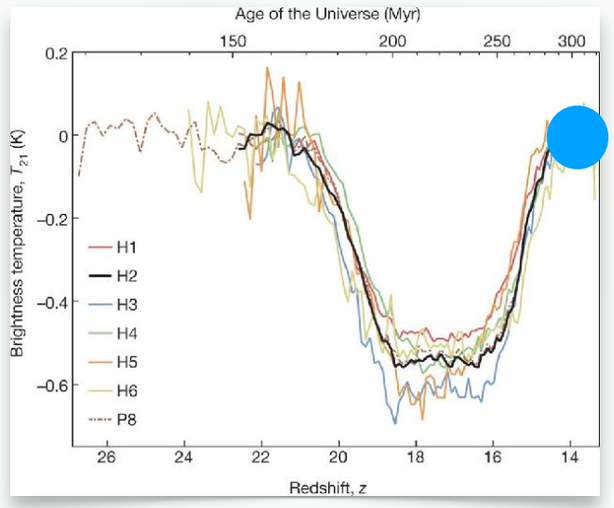

EDGES

J D Bowman et al. Nature 555, 67–70 (2018) doi:10.1038/nature25792

- *"the best-fitting amplitude of the profile is more than a factor of two greater than the largest predictions"*

- *"The low- frequency edge of the observed profile indicates that stars existed and had produced a background of Lyman-α photons by 180 million years after the Big Bang."*

- *"The high-frequency edge indicates that the gas was heated to above the radiation temperature less than 100 million years later."*

EDGES

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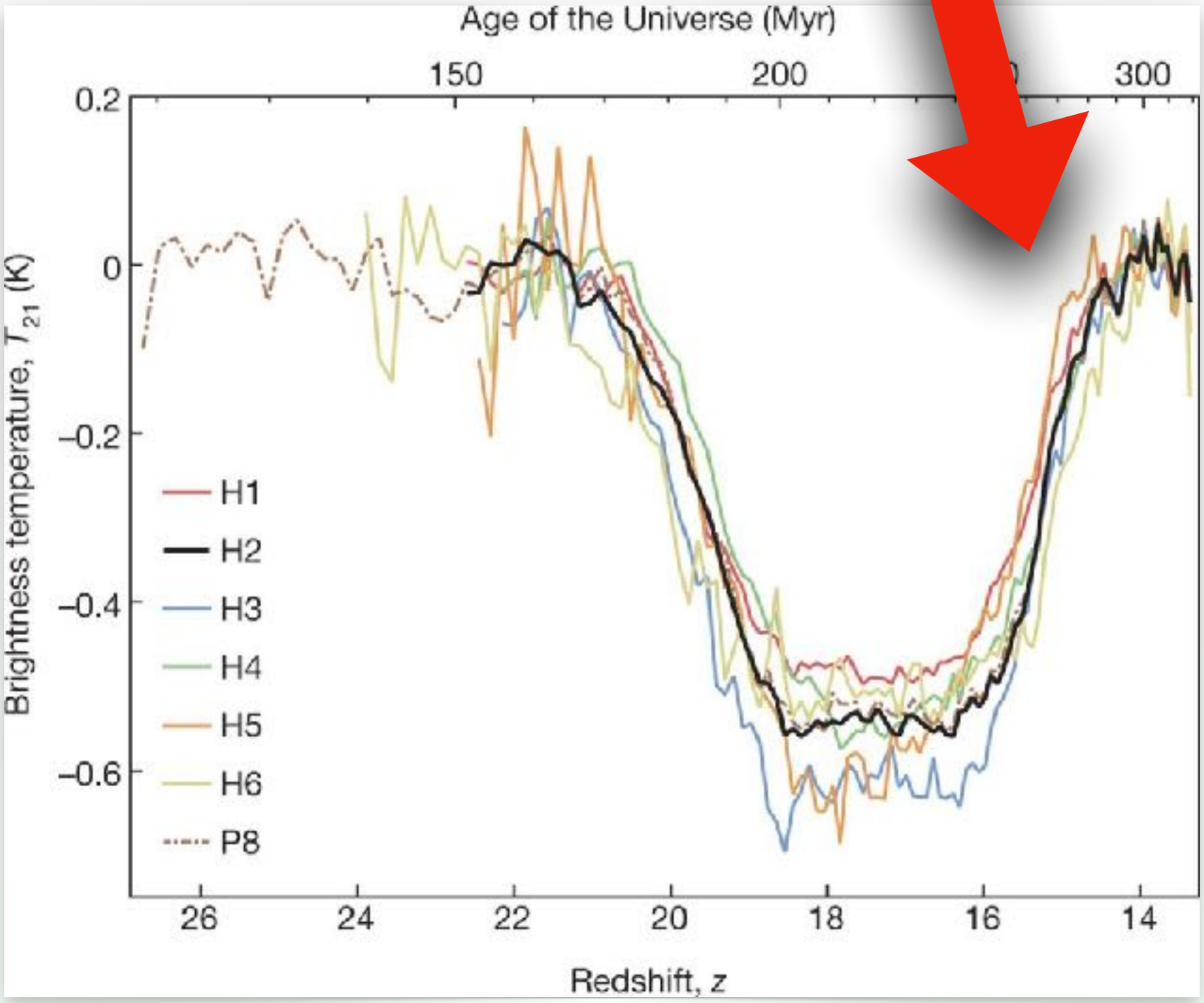
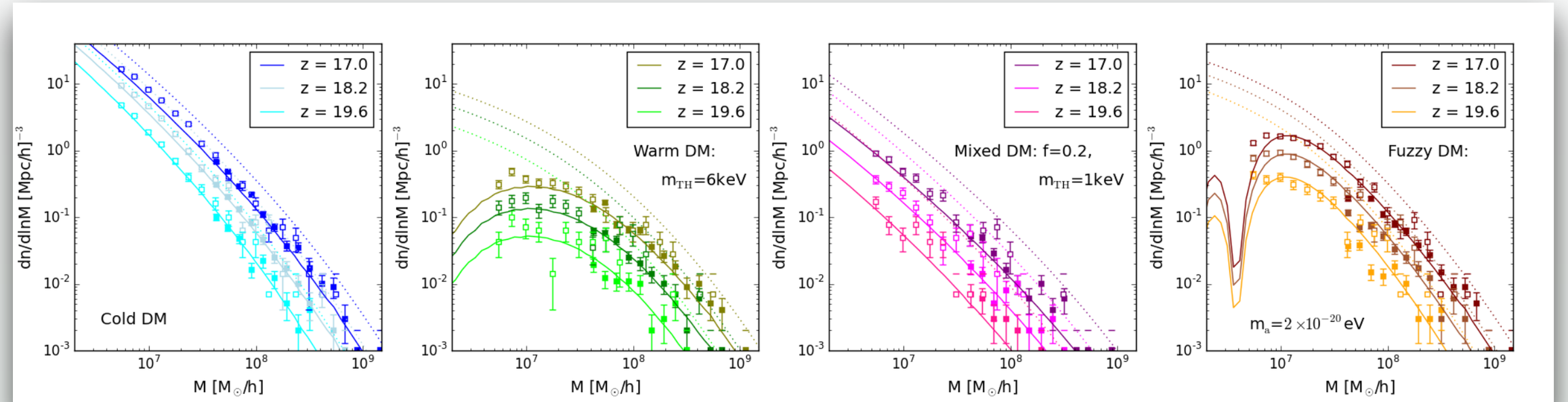
First stars!


Age of the Universe (Myr)
150
200
300
0.2
0
–0.2
–0.4
–0.6
Brightness temperature, T_{21} (K)
H1
H2
H3
H4
H5
H6
P8
26
24
22
20
18
16
14
Redshift, z

Stars and DM Haloes

- Stars form in DM haloes

Stars and DM Haloes



[A. Schneider, *Constraining Non-Cold Dark Matter Models with the Global 21-cm Signal*, 1805.00021]

Stars and DM Haloes

- Stars form in DM haloes

- No haloes **===>** no stars.

- WDM s r ut!

  [A. Schnei raining Non-Cold Dark Matter Models with the *Global 2* 05.00021]

  [A. Li d L. Hu *Implications of a Pre-reionization 21 cm Absorpt n Signal for Fuzzy Dark Matter*, 1805.01253]

Figure 6. Star formation history of the Aq-A galaxy in warm dark matter. *Left panel*: the stellar mass formed up to redshift z that resides in the spherical over

$z \sim 6$ the red line is far above the black line because *most* stars are in filaments.

. Above

mass -

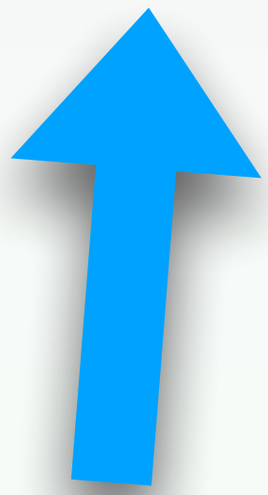
outside

the main halo to those in the main halo, as a function of redshift. The red line is above one for $z > 6$, again showing that early on most stars form in filaments, and star formation in filaments continues to at least $z = 1$. The black line is also mostly above one for $z > 6$, meaning that most stars also reside in filaments at $z > 6$.

matter models, Mon. Not. Roy. Astron. Soc. 456 (2016) 43-52, 1403.2475]

Star formation

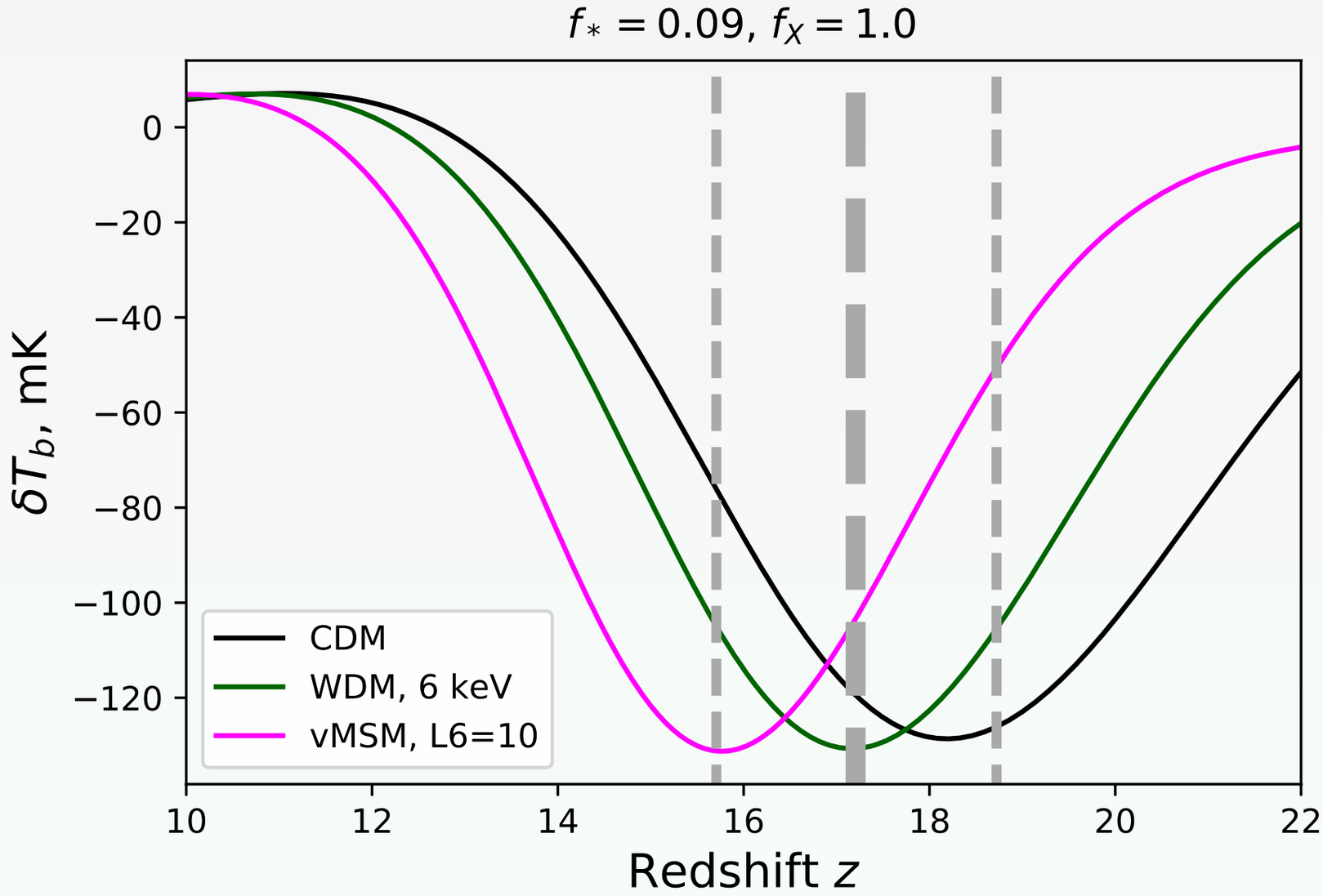
$$\dot{\rho}_*(z) = f_* \bar{\rho}_{\mathrm{b},0} \dot{f}_{\mathrm{coll}}(z)$$



0.03?

0.09!

WDM and EDGES



[Boyarsky, Iakubovskyi, Ruchayskiy, Valkenburg, in preparation]

Conclusion

- Overconfident assumptions about star formation: constrain DM model

- EDGES and DM model:
  constrain star formation.

- EDGES data do not allow for ruling out DM models.

- EDGES data shed light on star formation.

[Boyarsky, Iakubovskyi, Ruchayskiy, Valkenburg, in preparation]