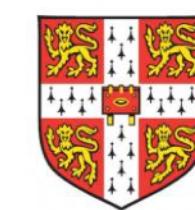
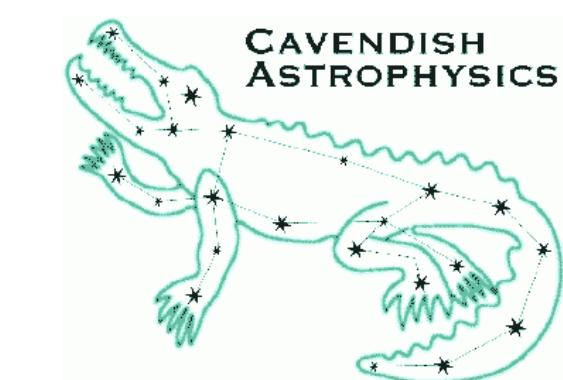


21-cm Cosmology and REACH

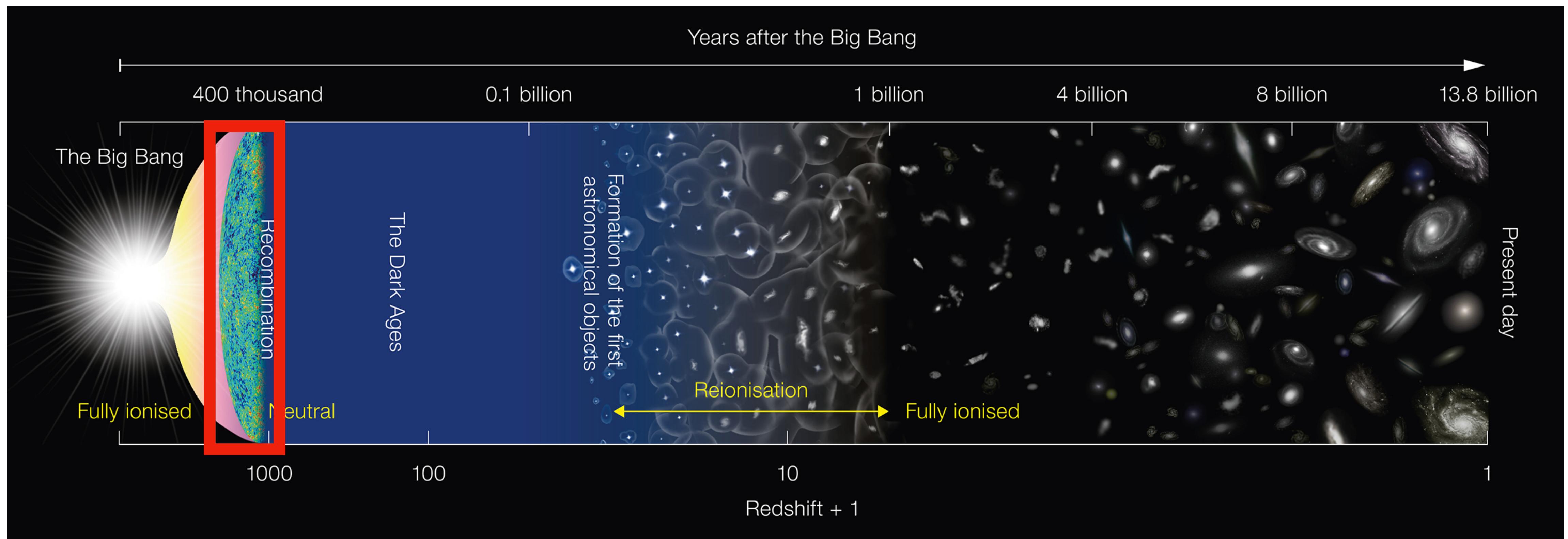
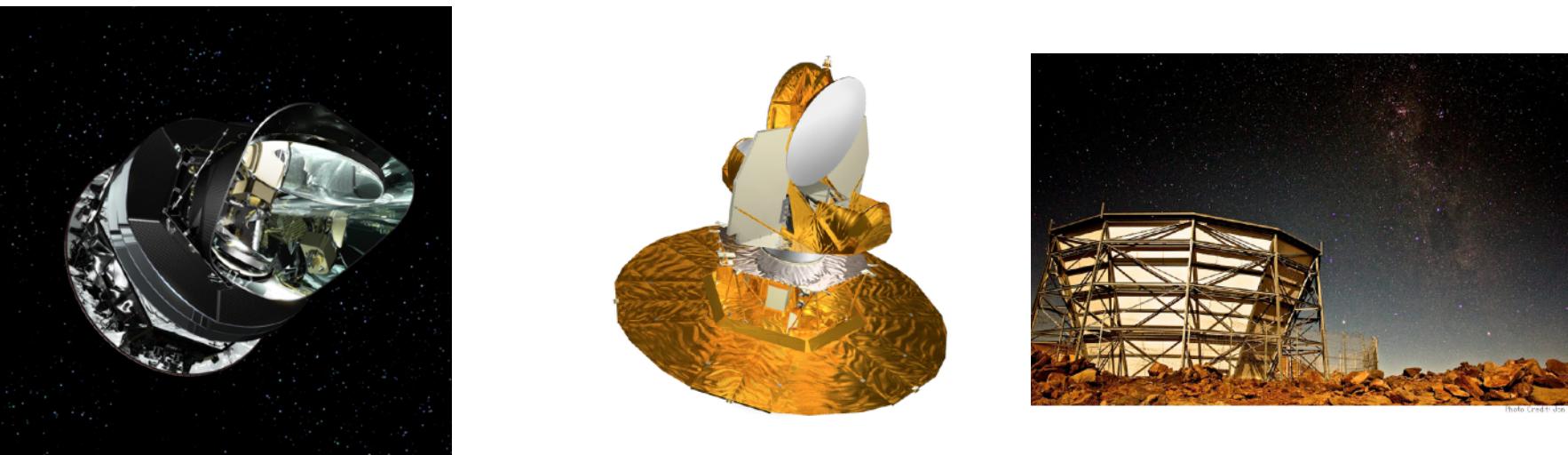
Harry T. J. Bevins



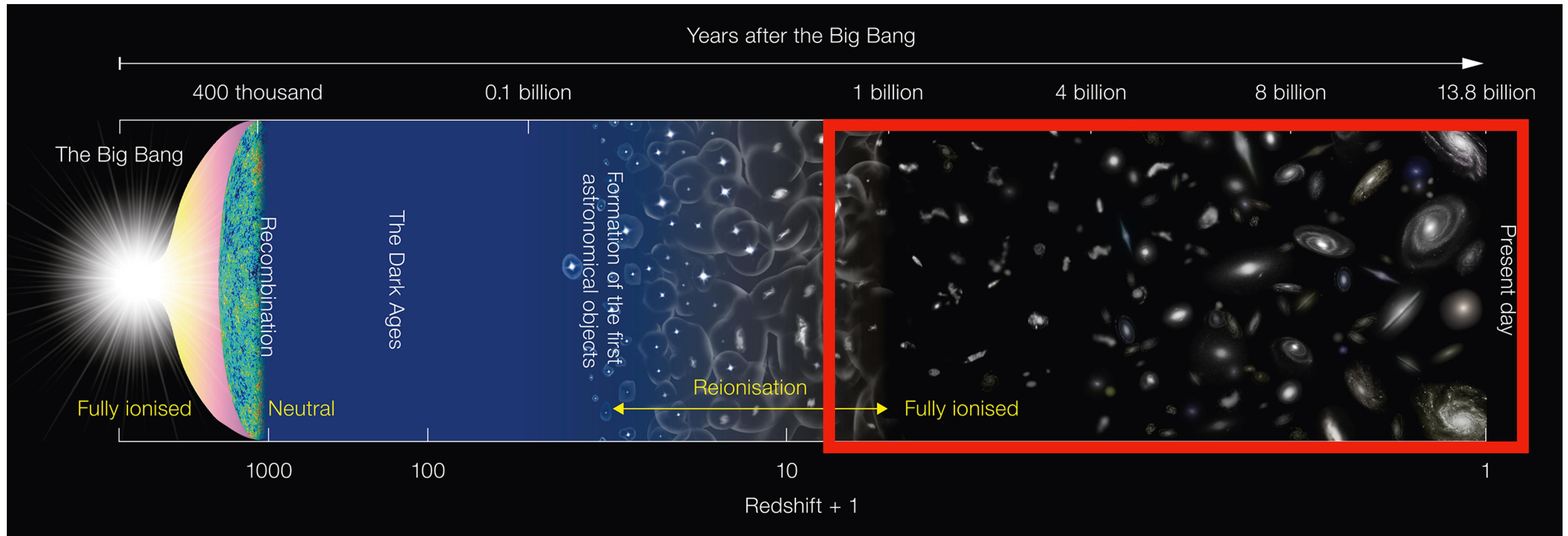
UNIVERSITY OF
CAMBRIDGE



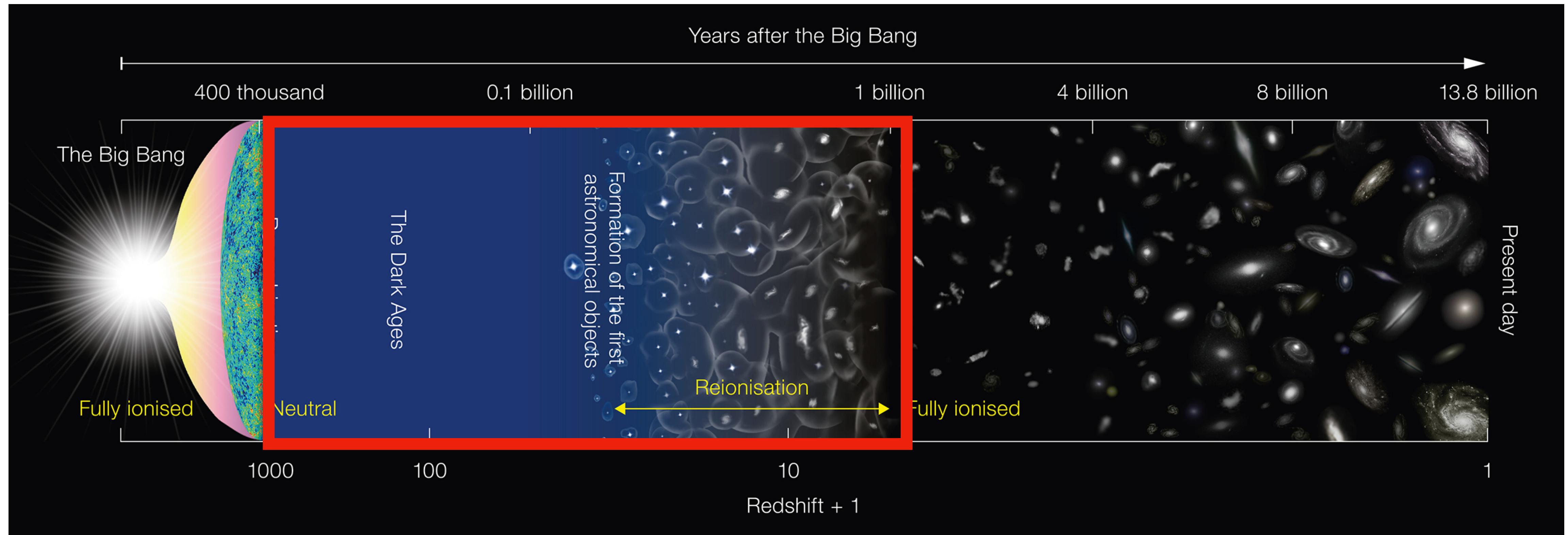
A brief history of the universe



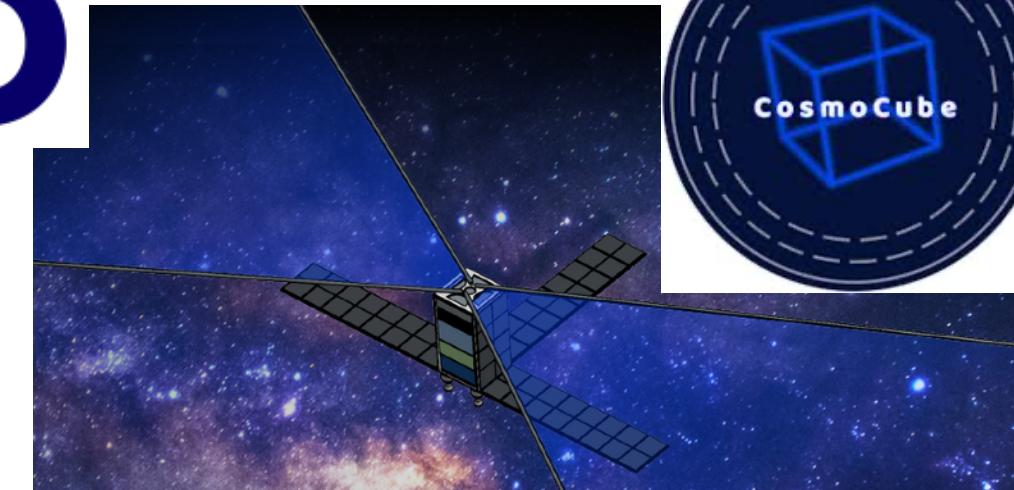
A brief history of the universe



A brief history of the universe



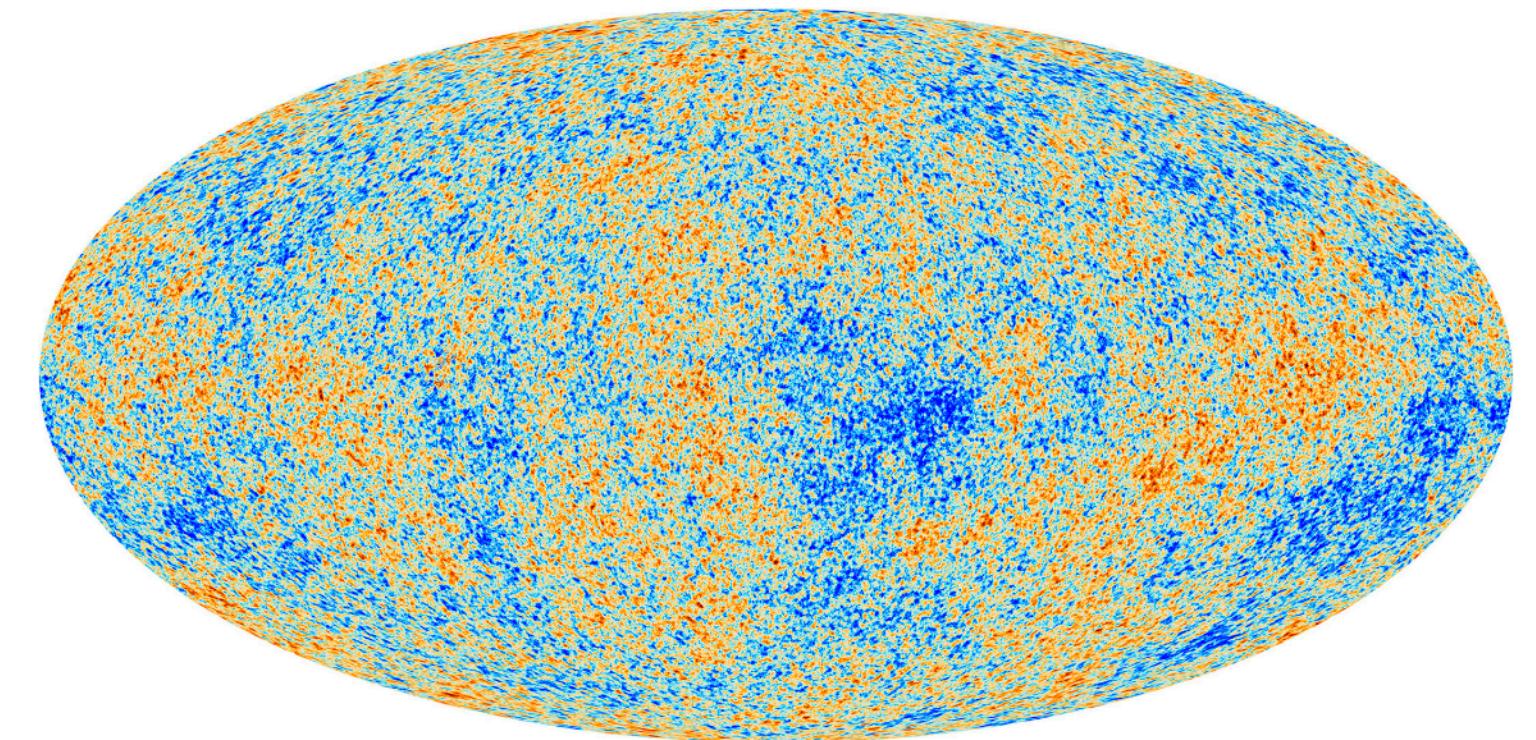
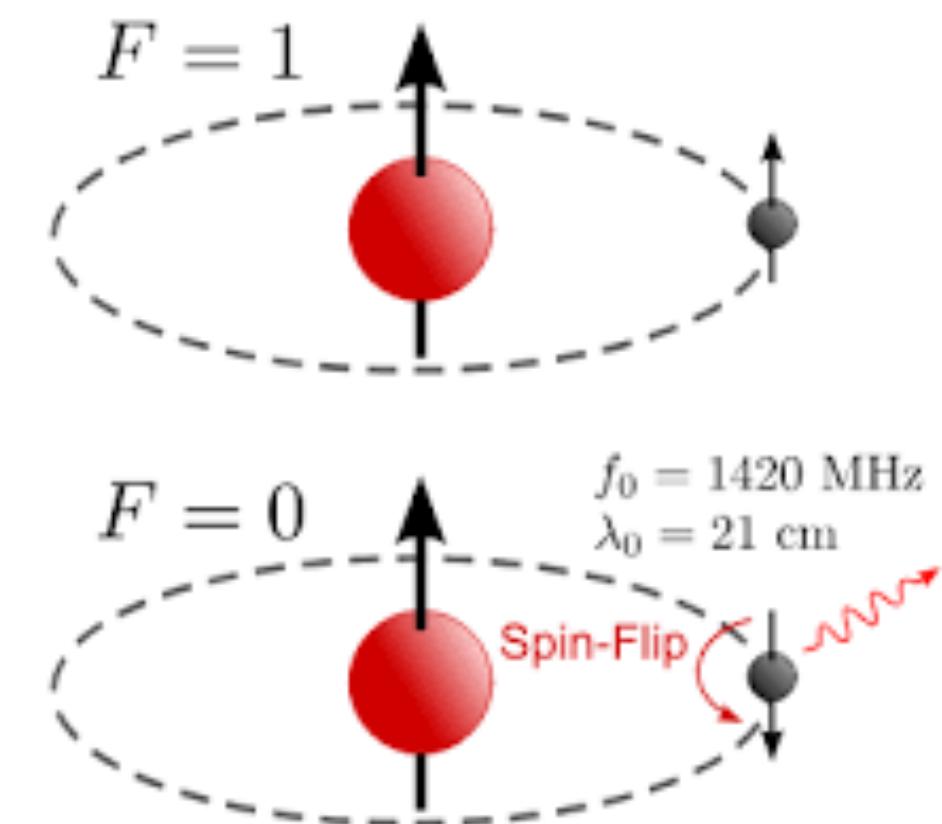
21-cm Cosmology



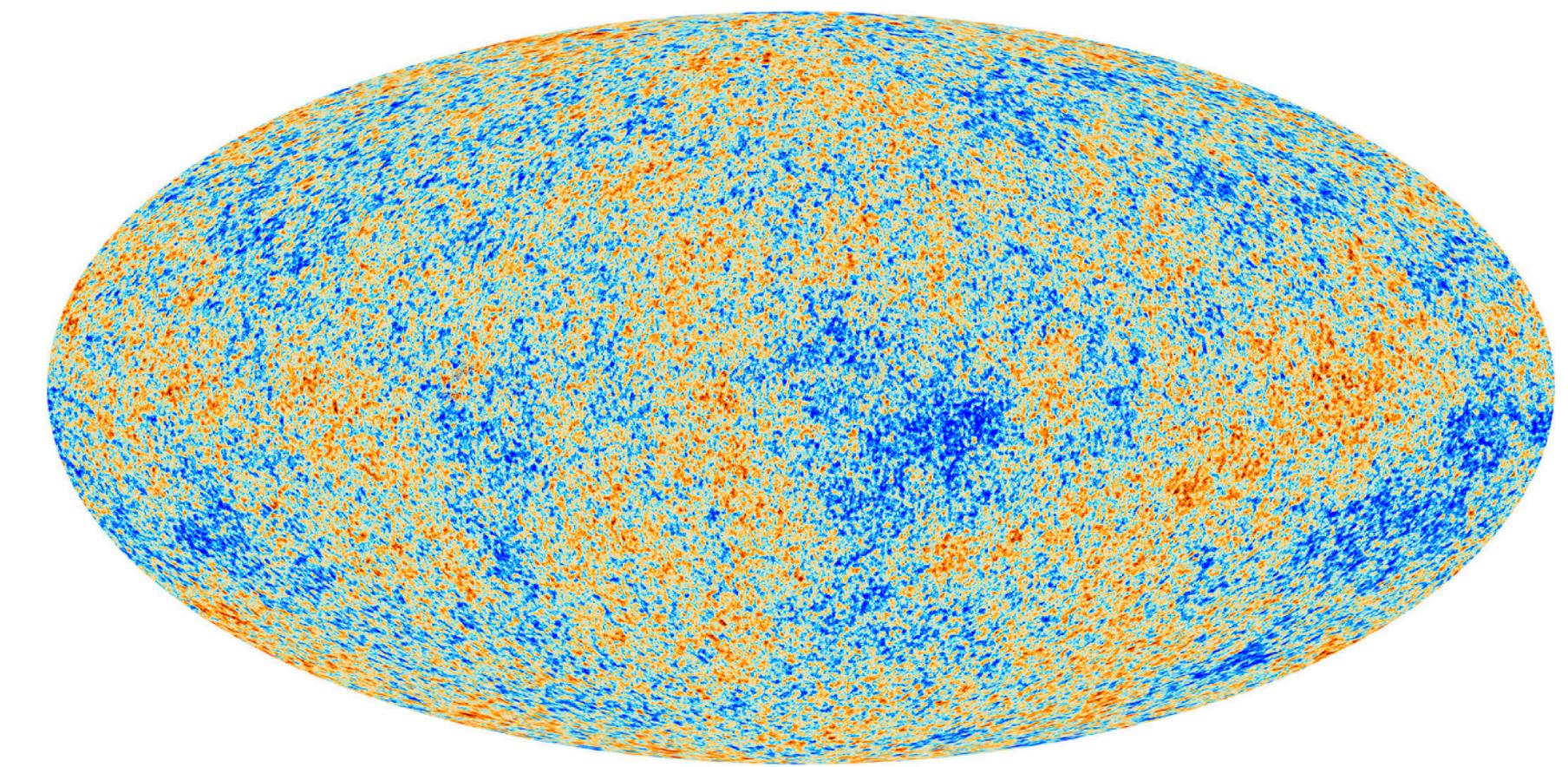
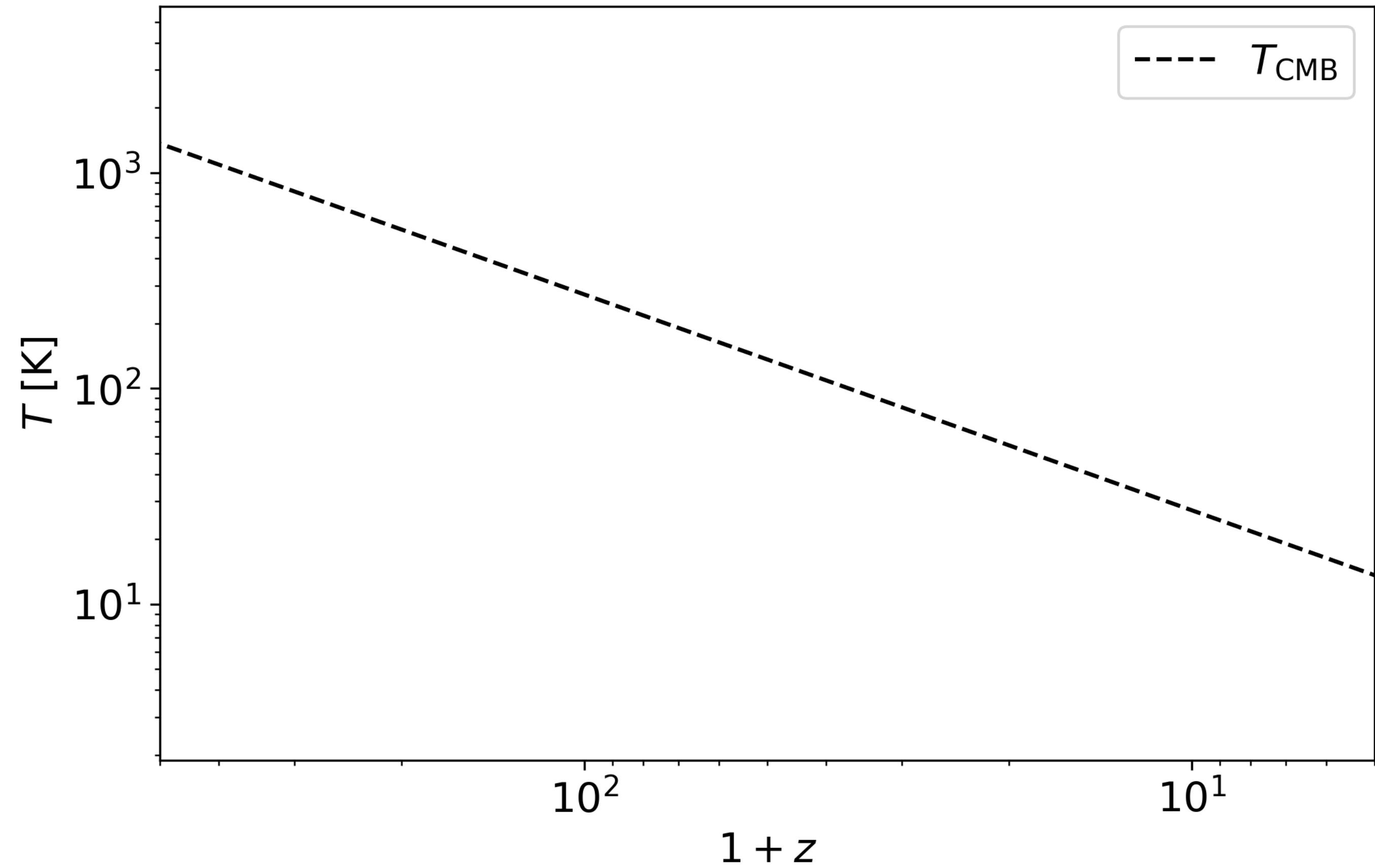
- Spin-flip transition in neutral hydrogen
- Forbidden transition that can't be seen in the lab
- Define the spin temperature

$$\frac{n_1}{n_0} = 3 \exp\left(-\frac{T_*}{T_s}\right)$$

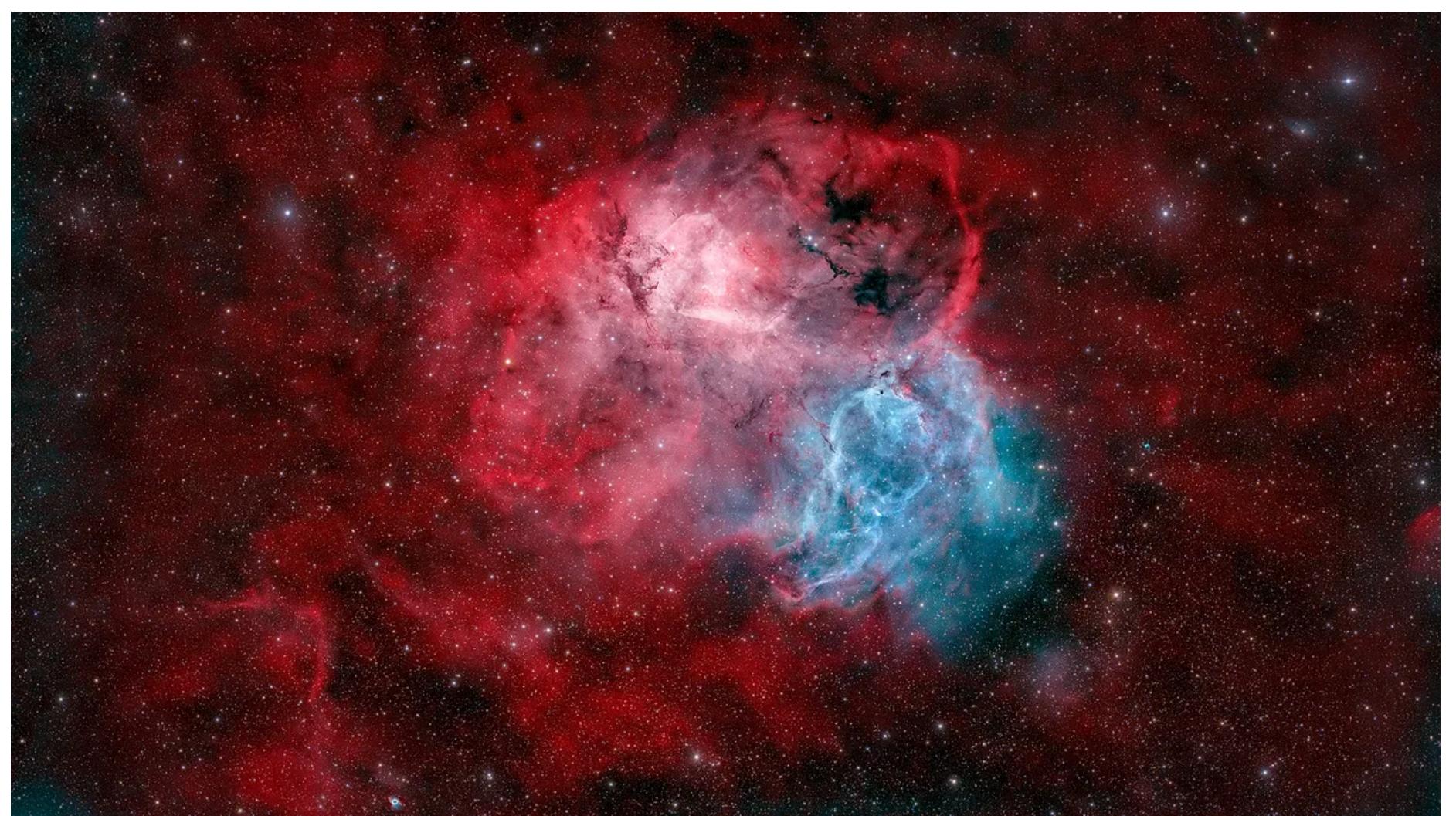
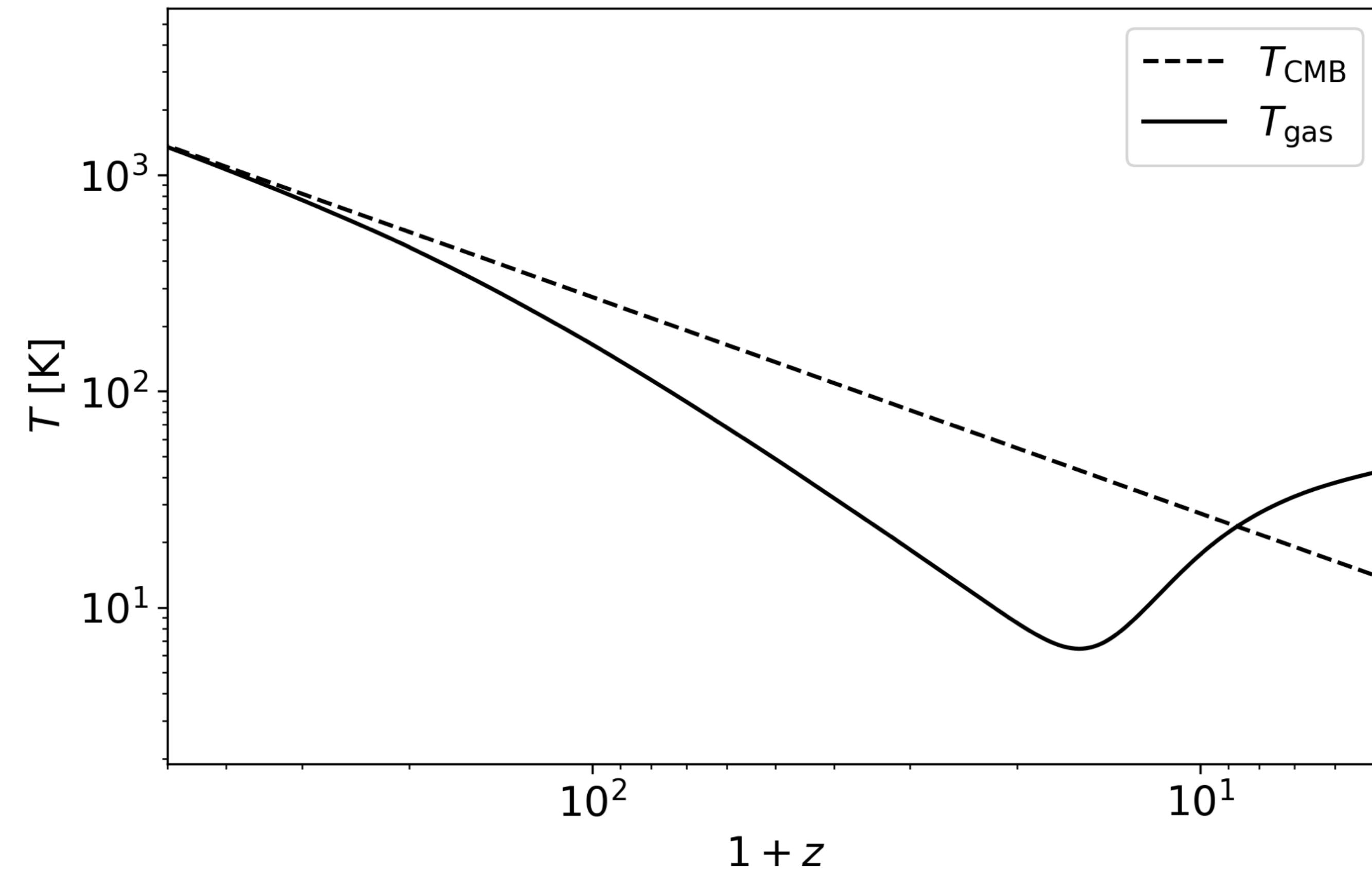
- Measure relative to the radio background



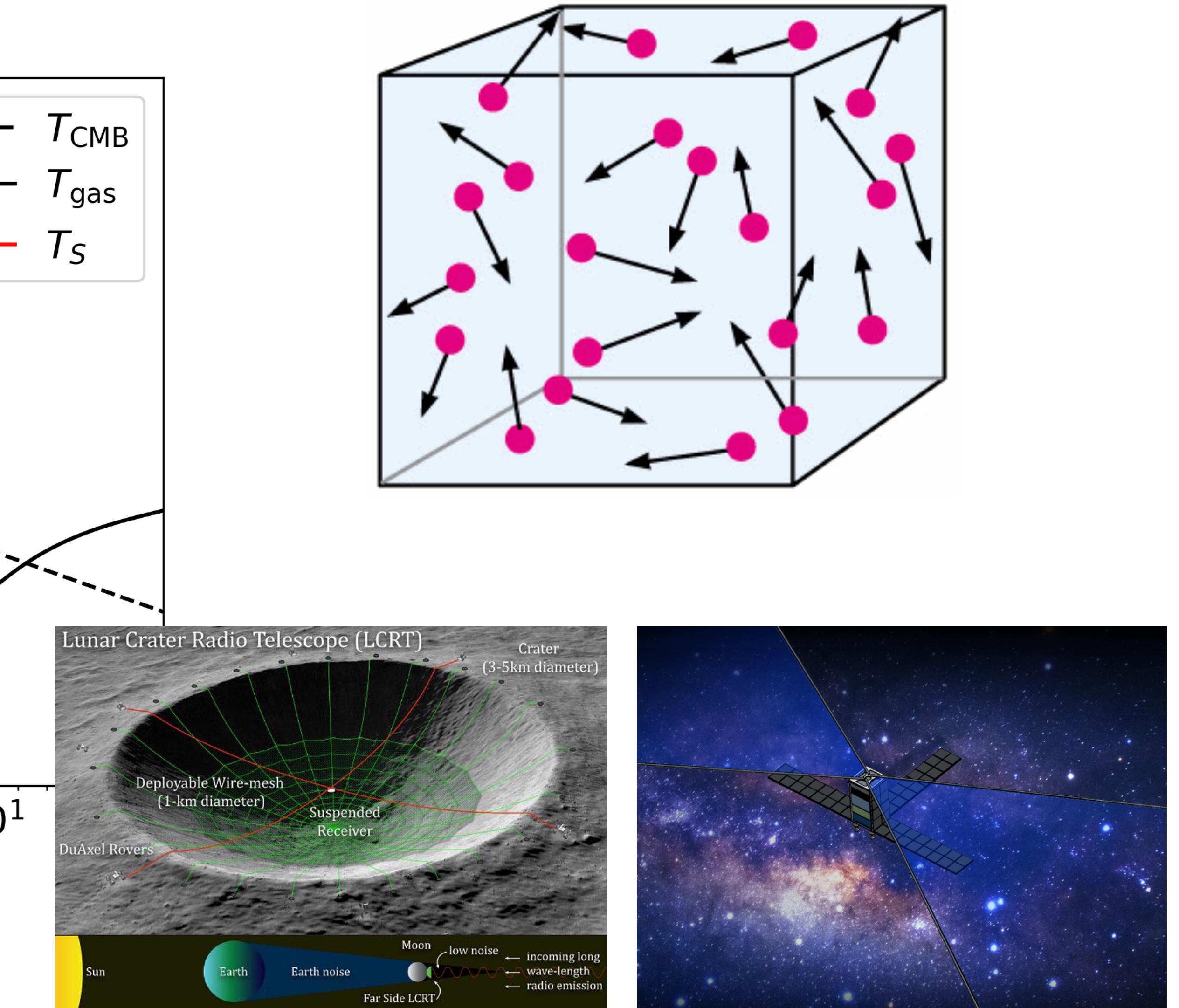
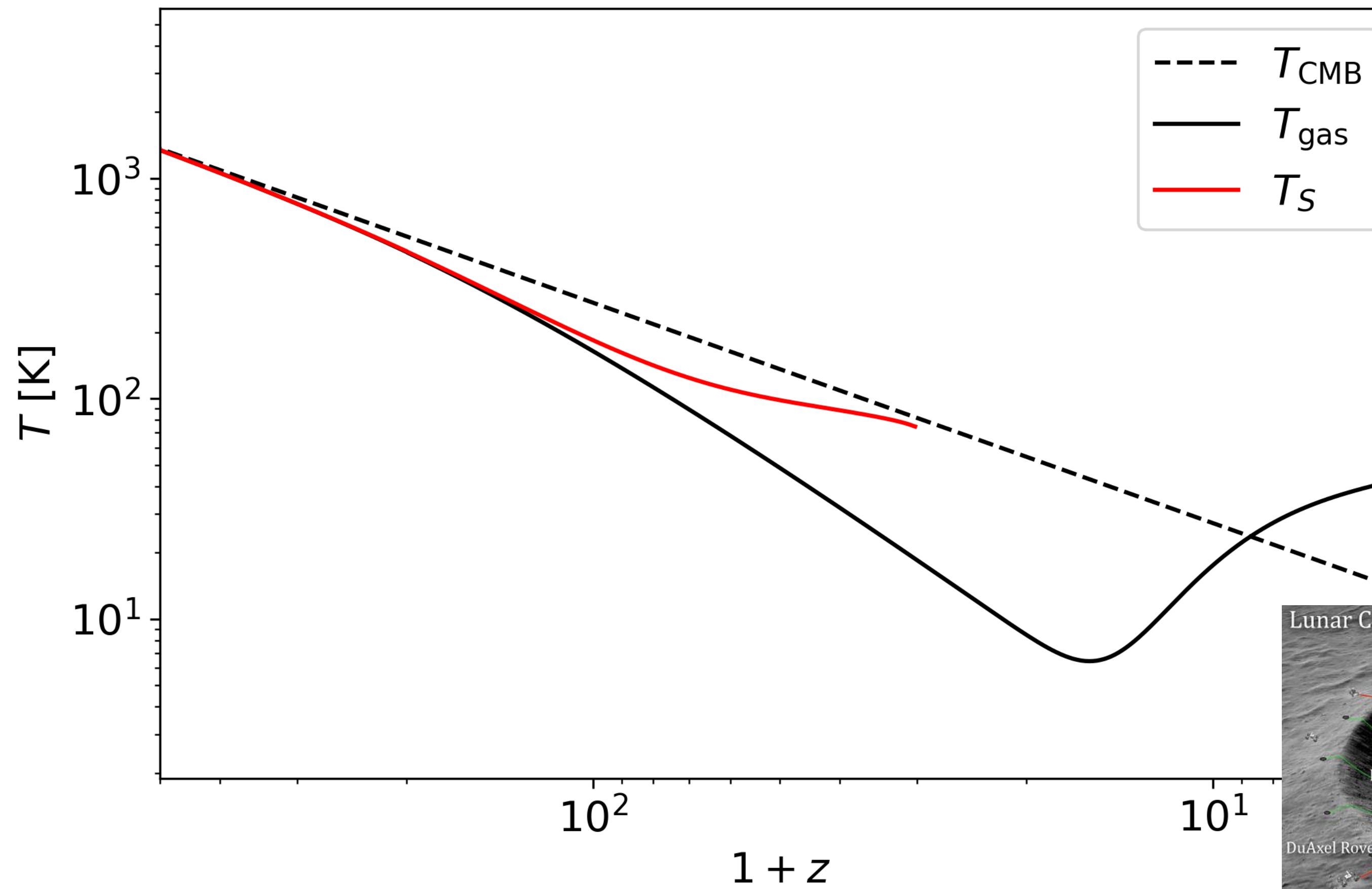
21-cm Cosmology



21-cm Cosmology

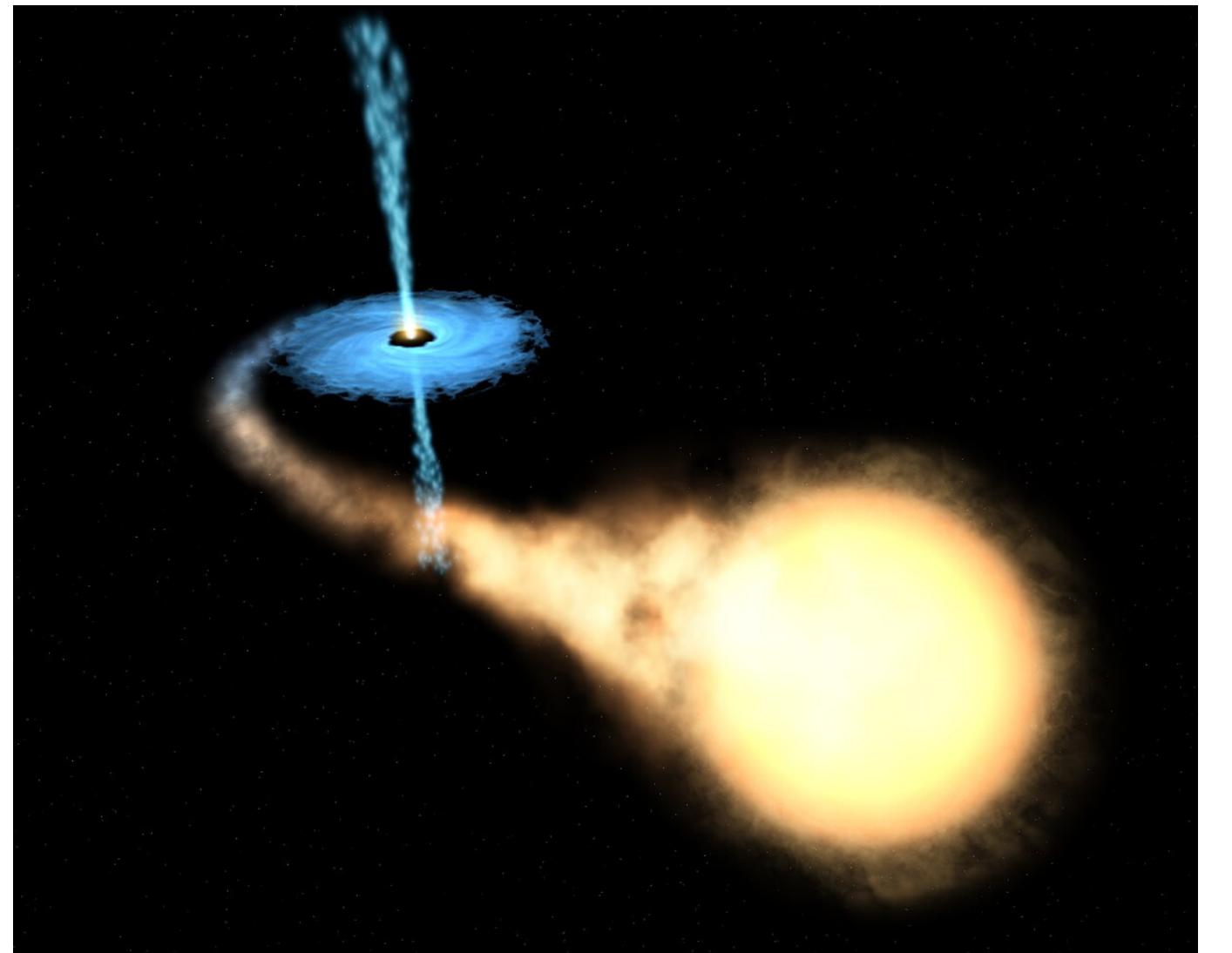
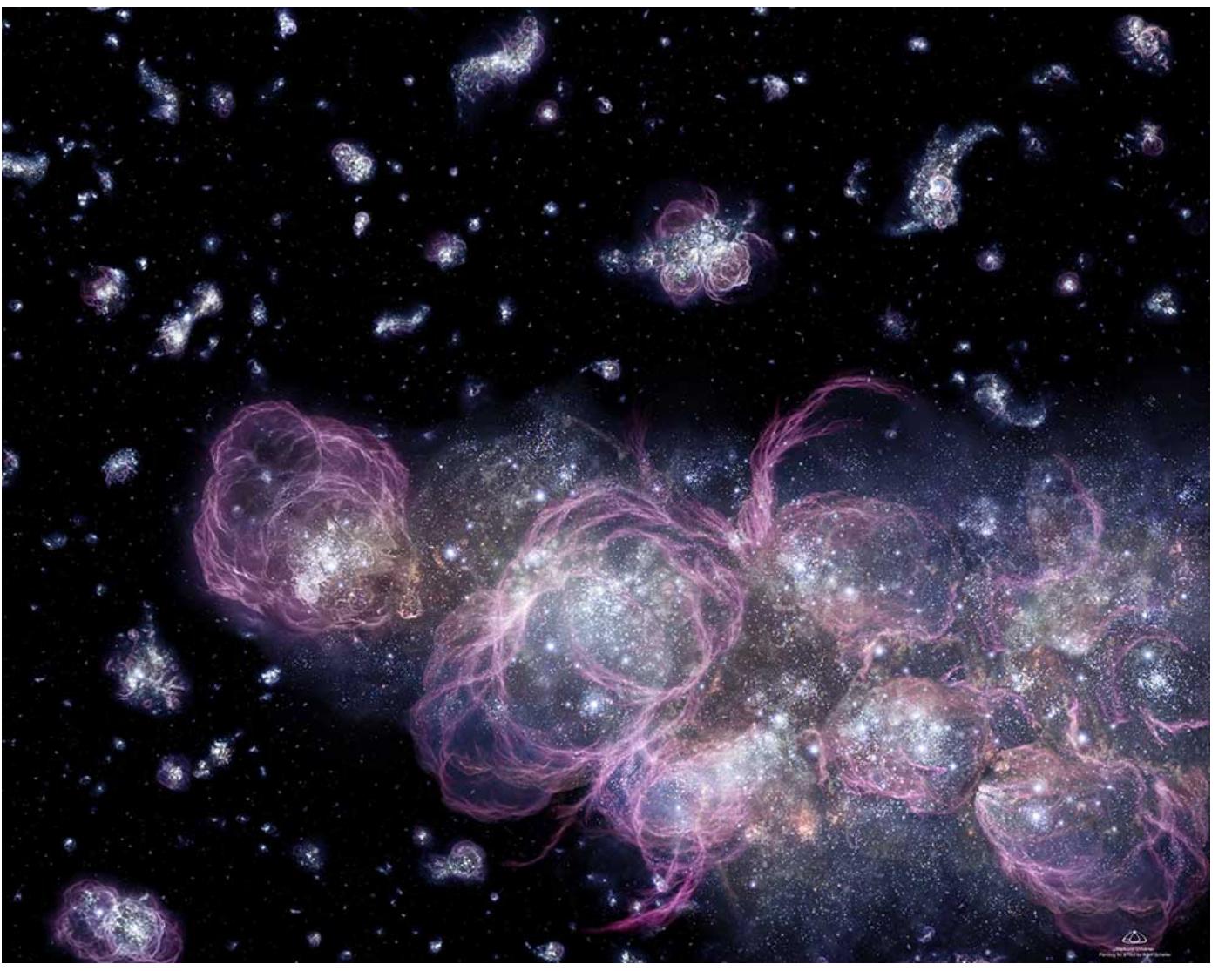
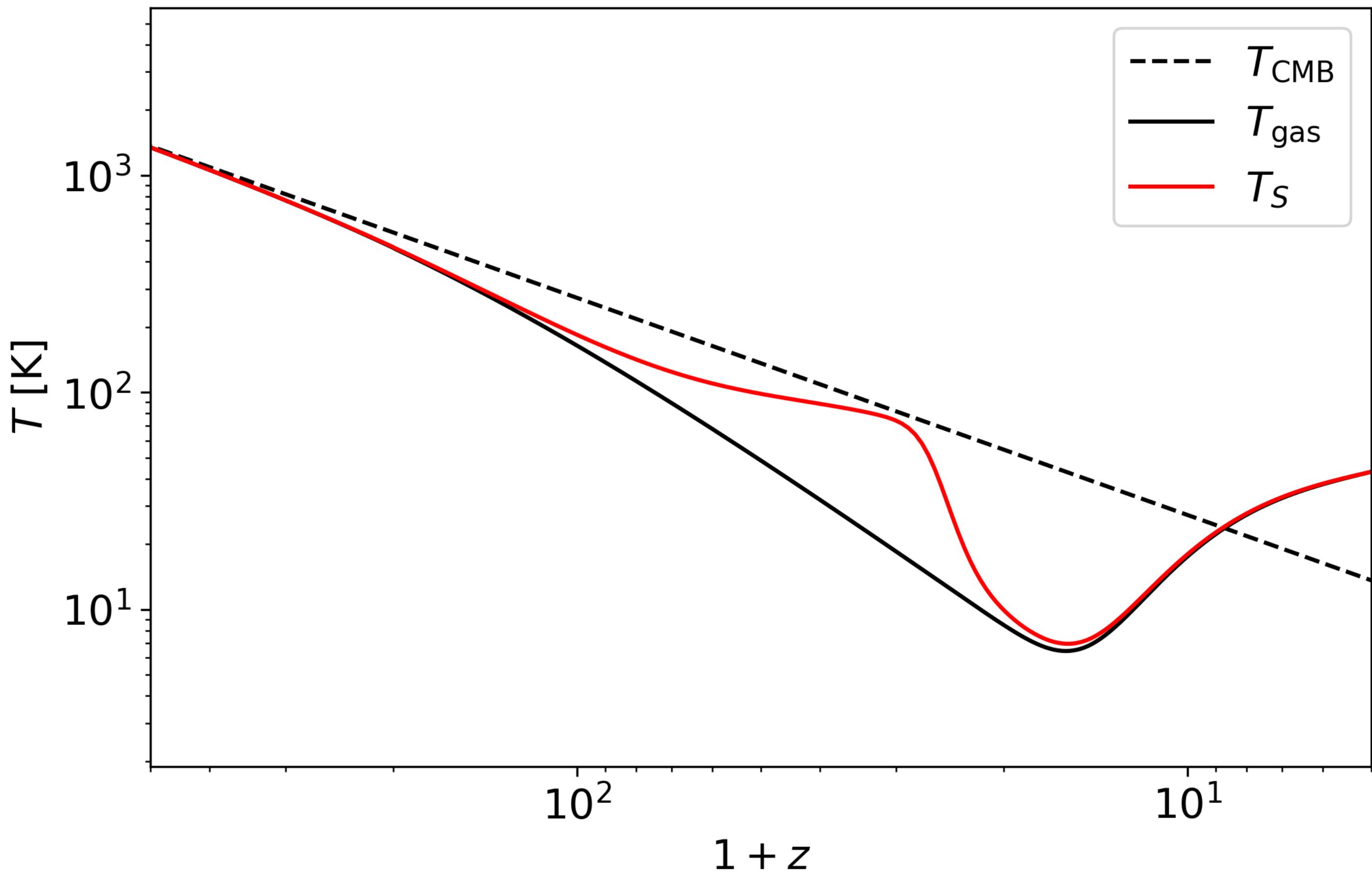


Dark Ages ($z \lesssim 30$; $t \lesssim 0.5$ Gyr)

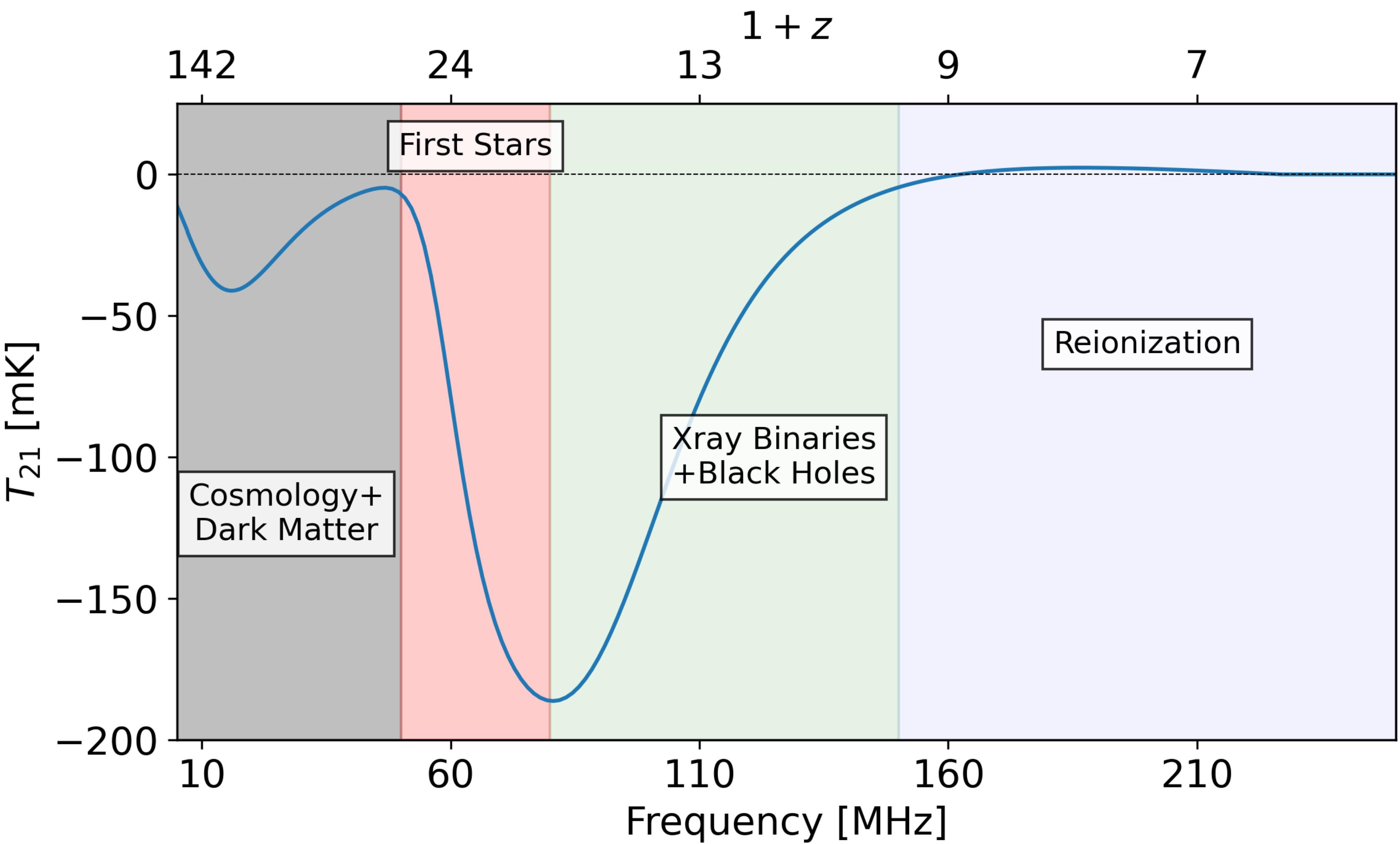


Cosmic Dawn and Reionisation

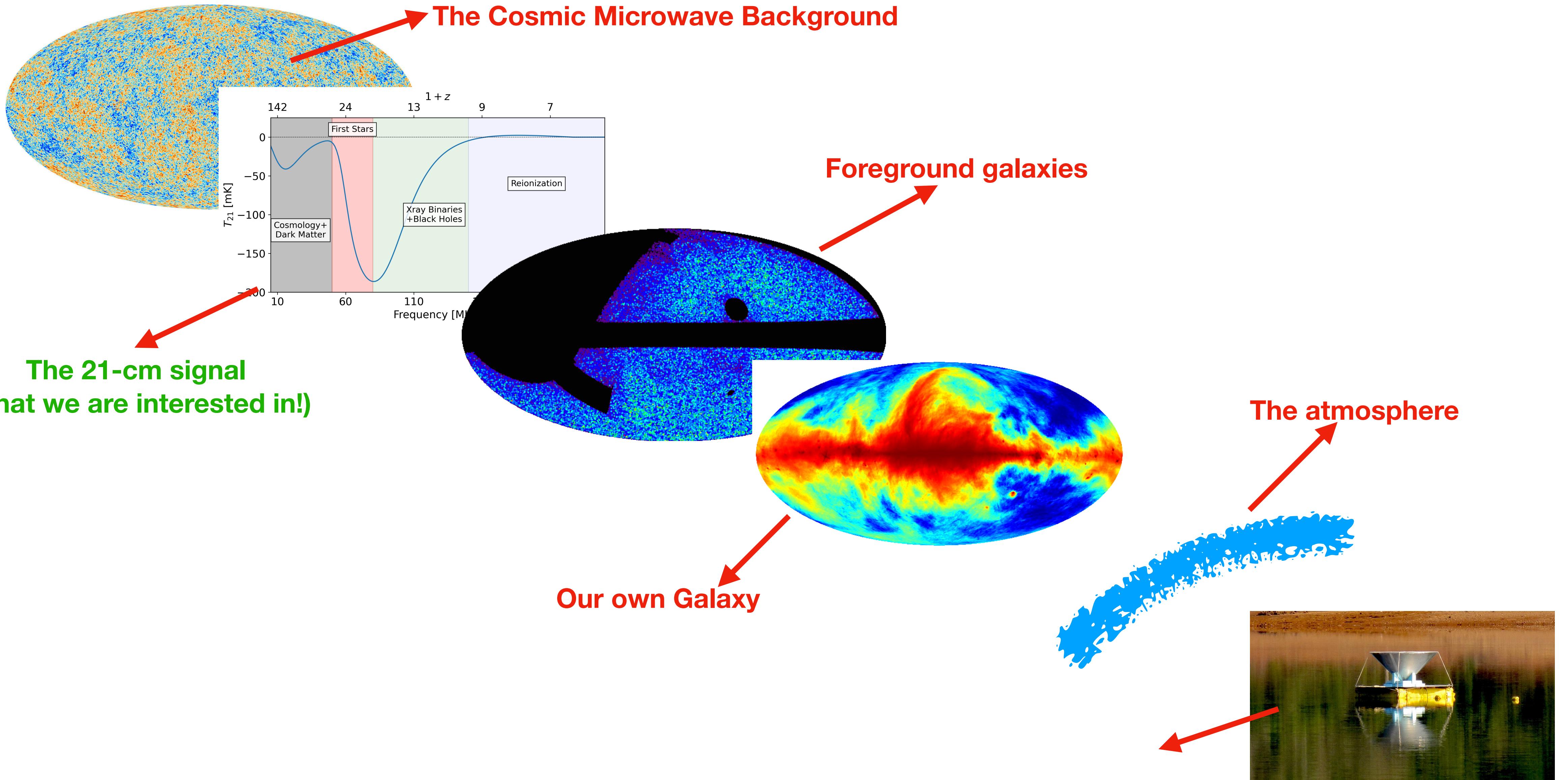
($30 \lesssim z \lesssim 5$; $t = 0.5 - 12.5$ Gyr)



Sky Averaged 21-cm Signal



The 21-cm Line



21-cm Cosmology

- Powerful probe of cosmology and astrophysics of the first stars
- Challenging observation
- Requires novel analysis tools and specialised antennas

