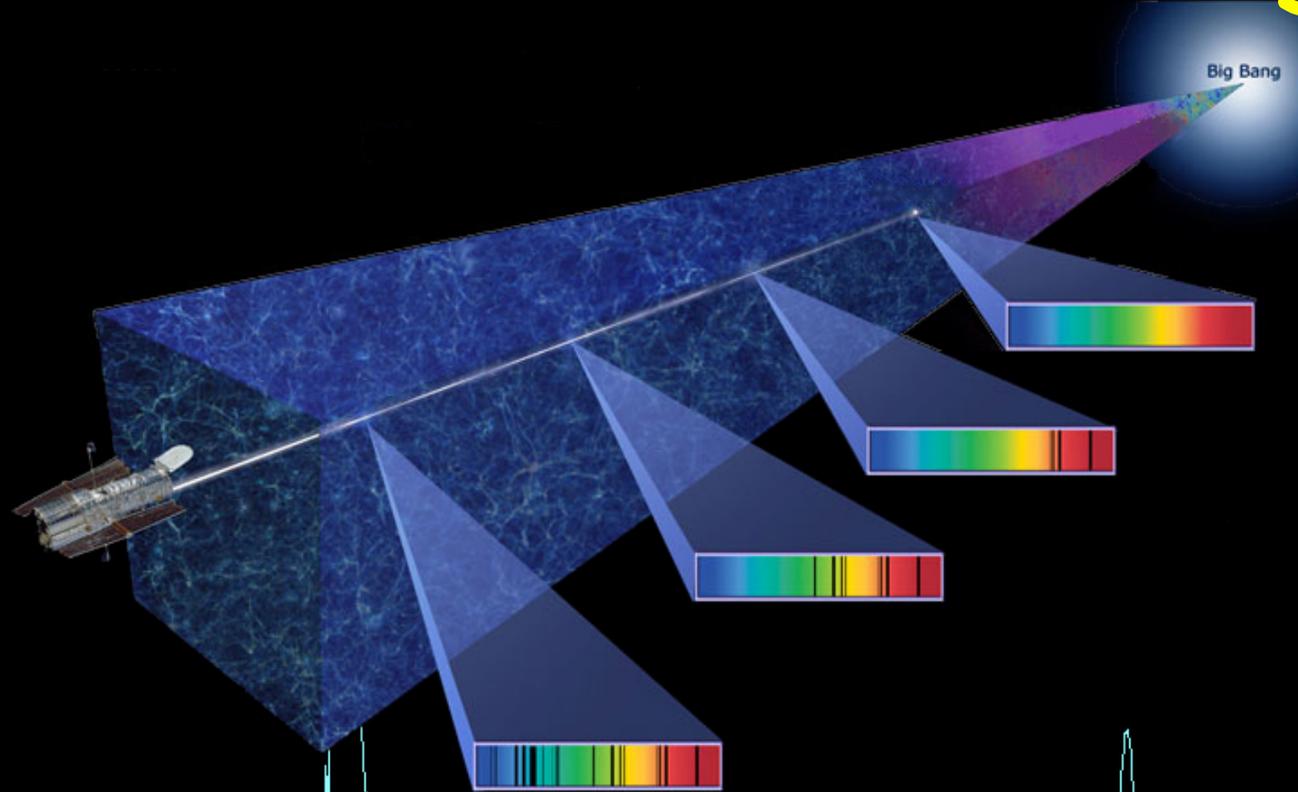
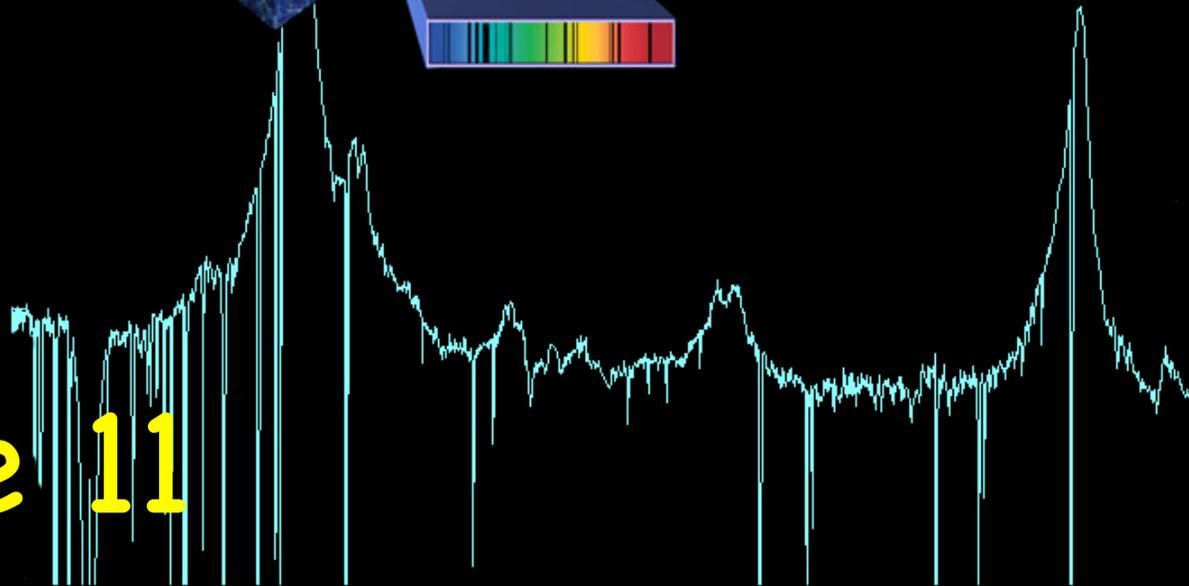


# Introduction to Cosmology

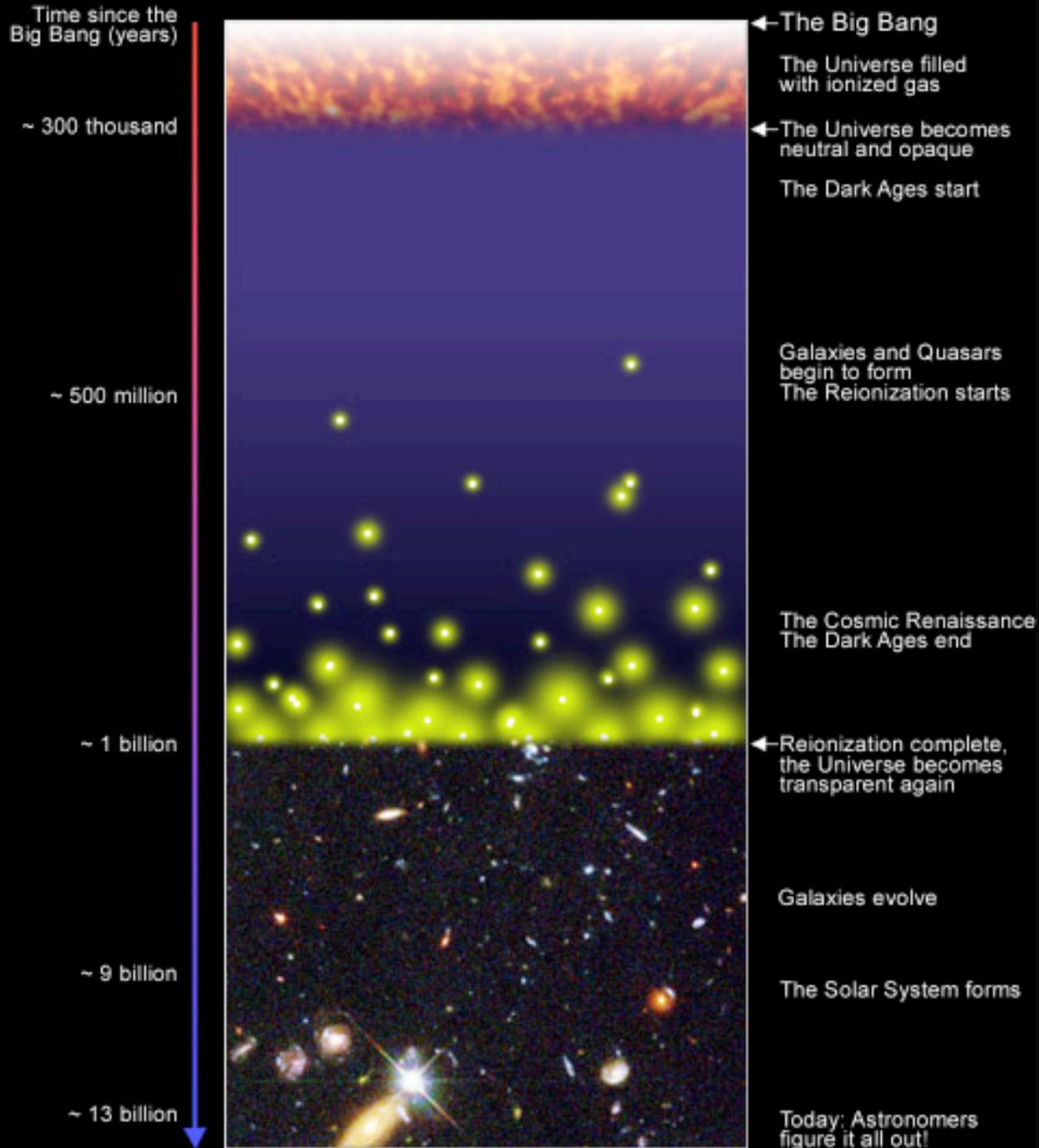


Lecture 11

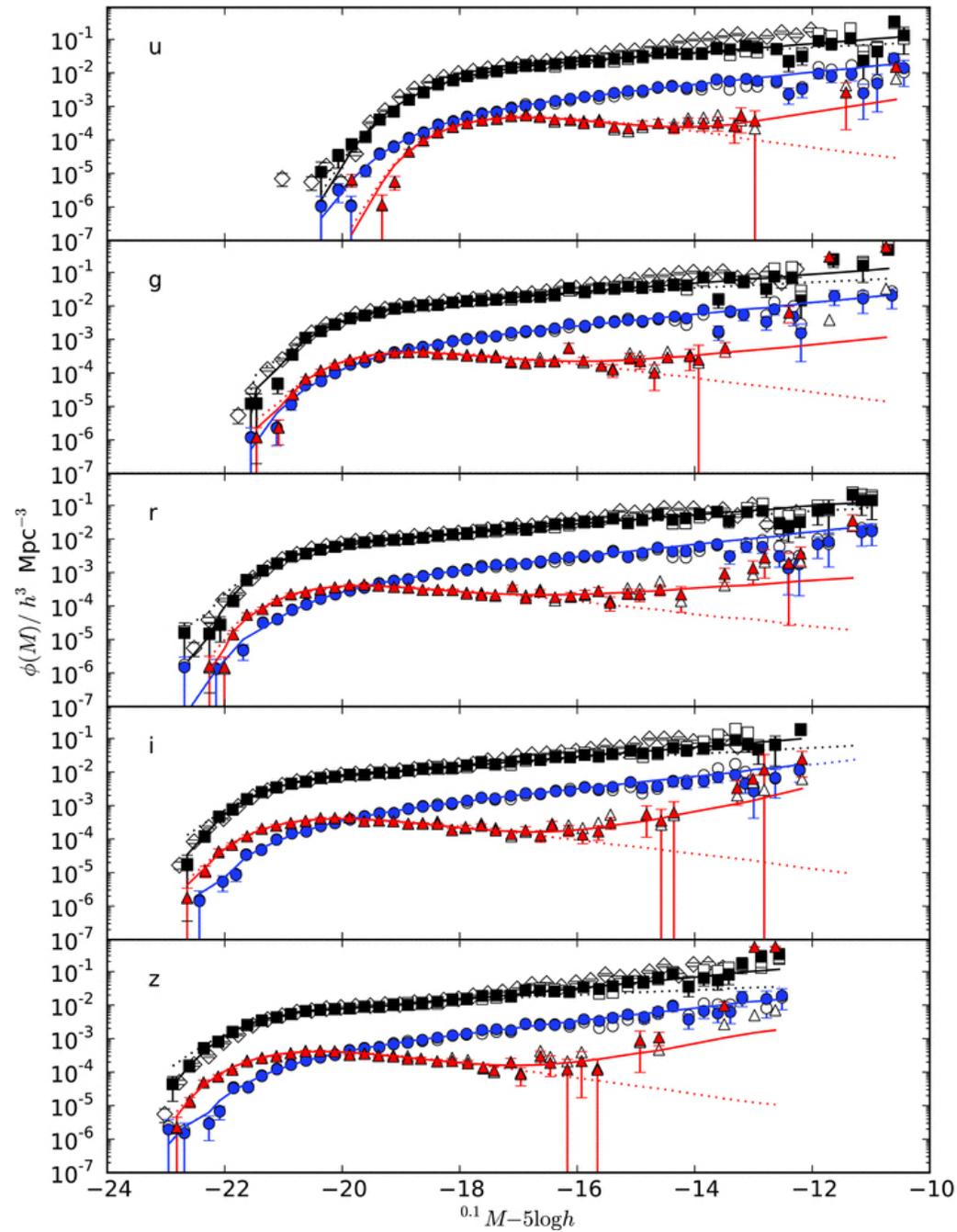


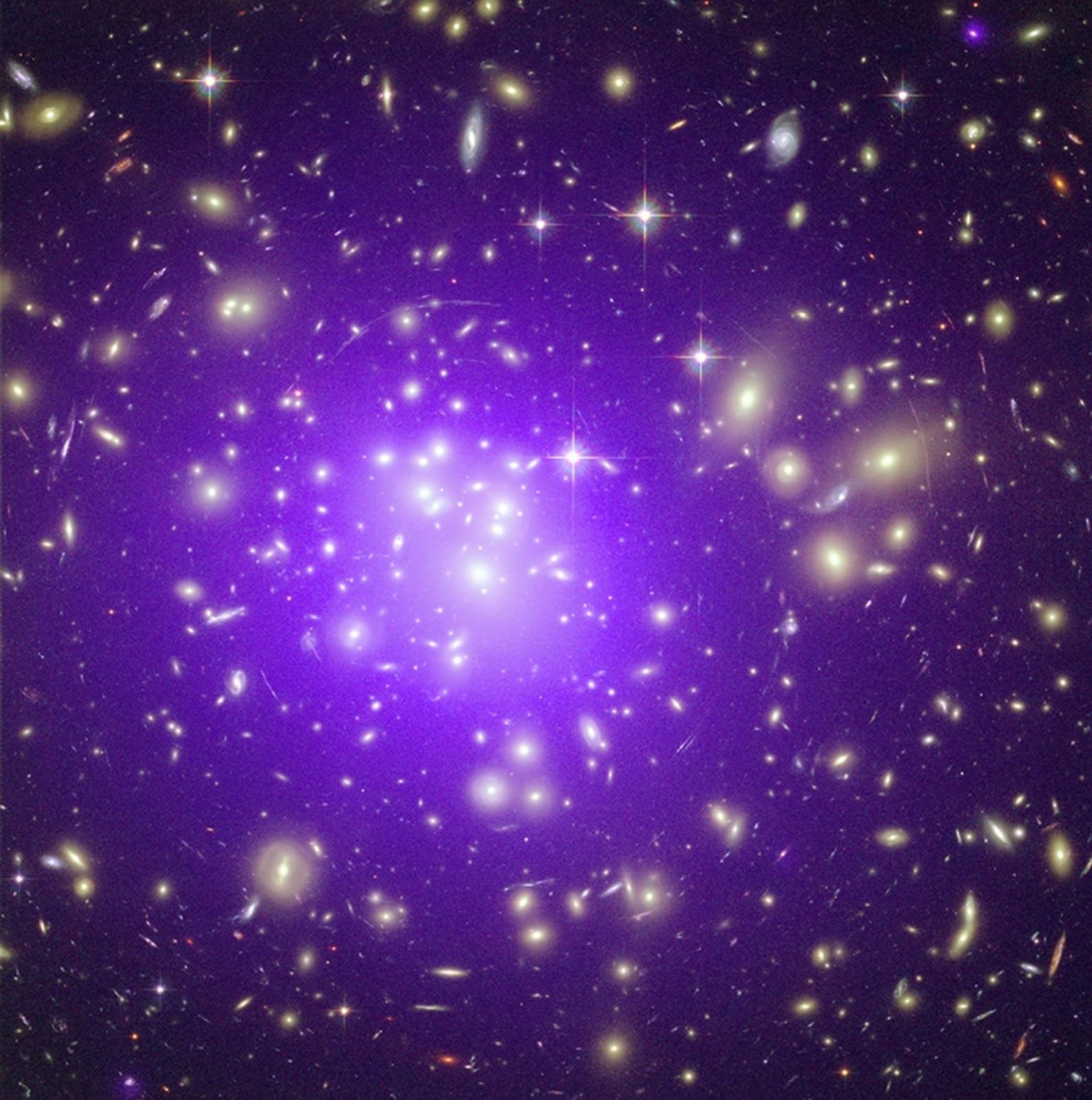
# What is the Reionization Era?

A Schematic Outline of the Cosmic History



# Galaxy Luminosity Functions

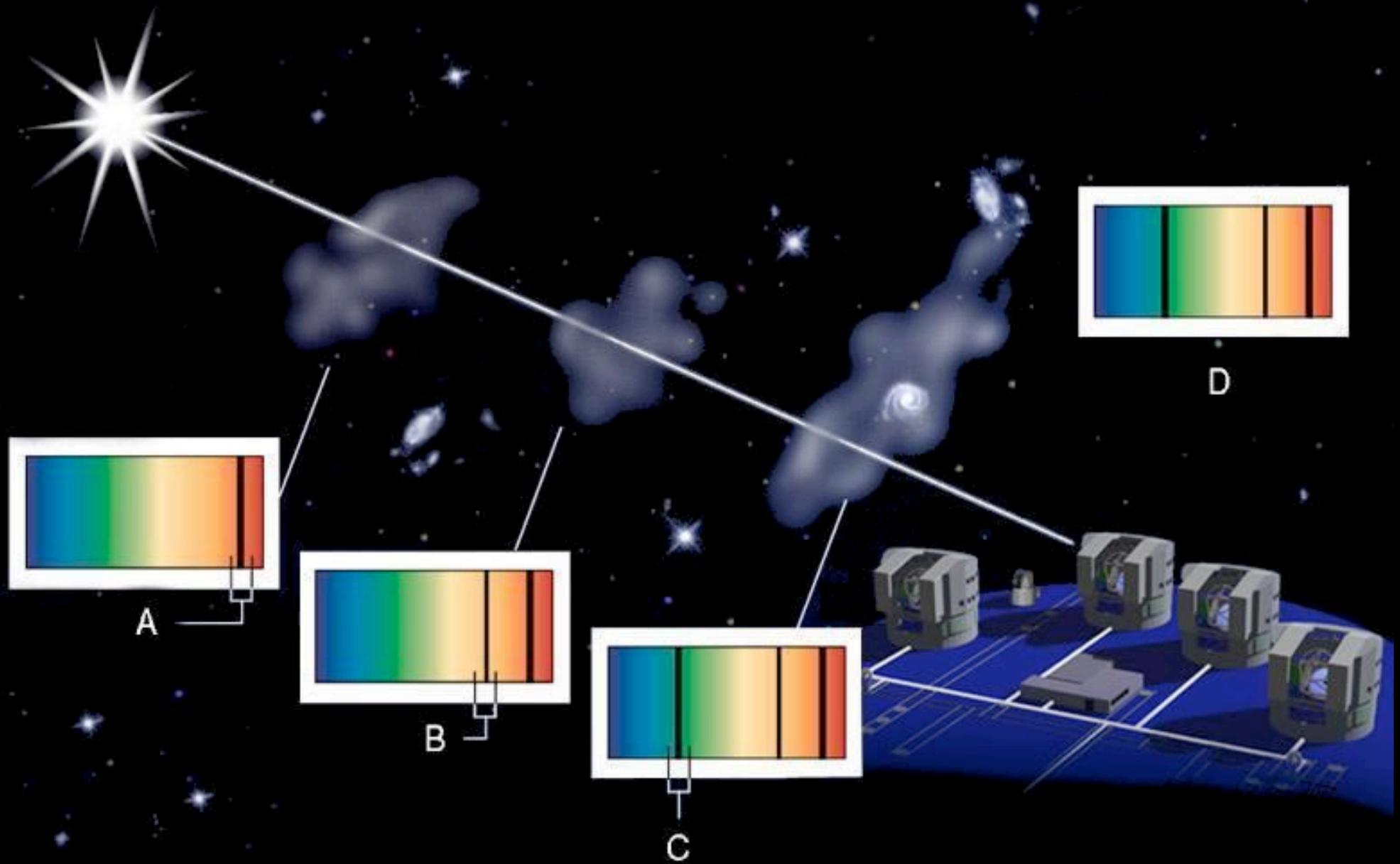




Abell 1689

$z = 0.18$

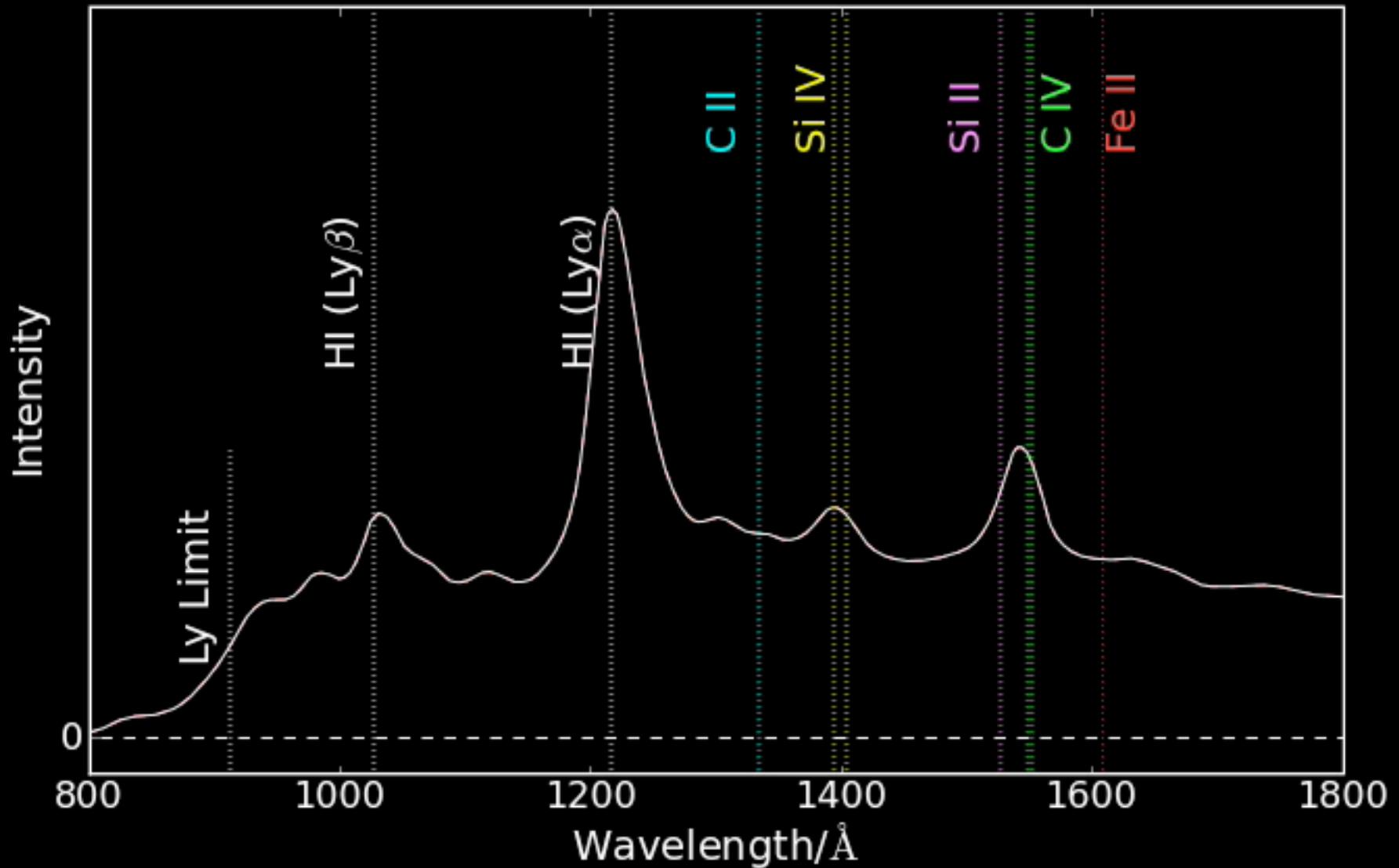
X-ray (Chandra)  
+ optical (HST)



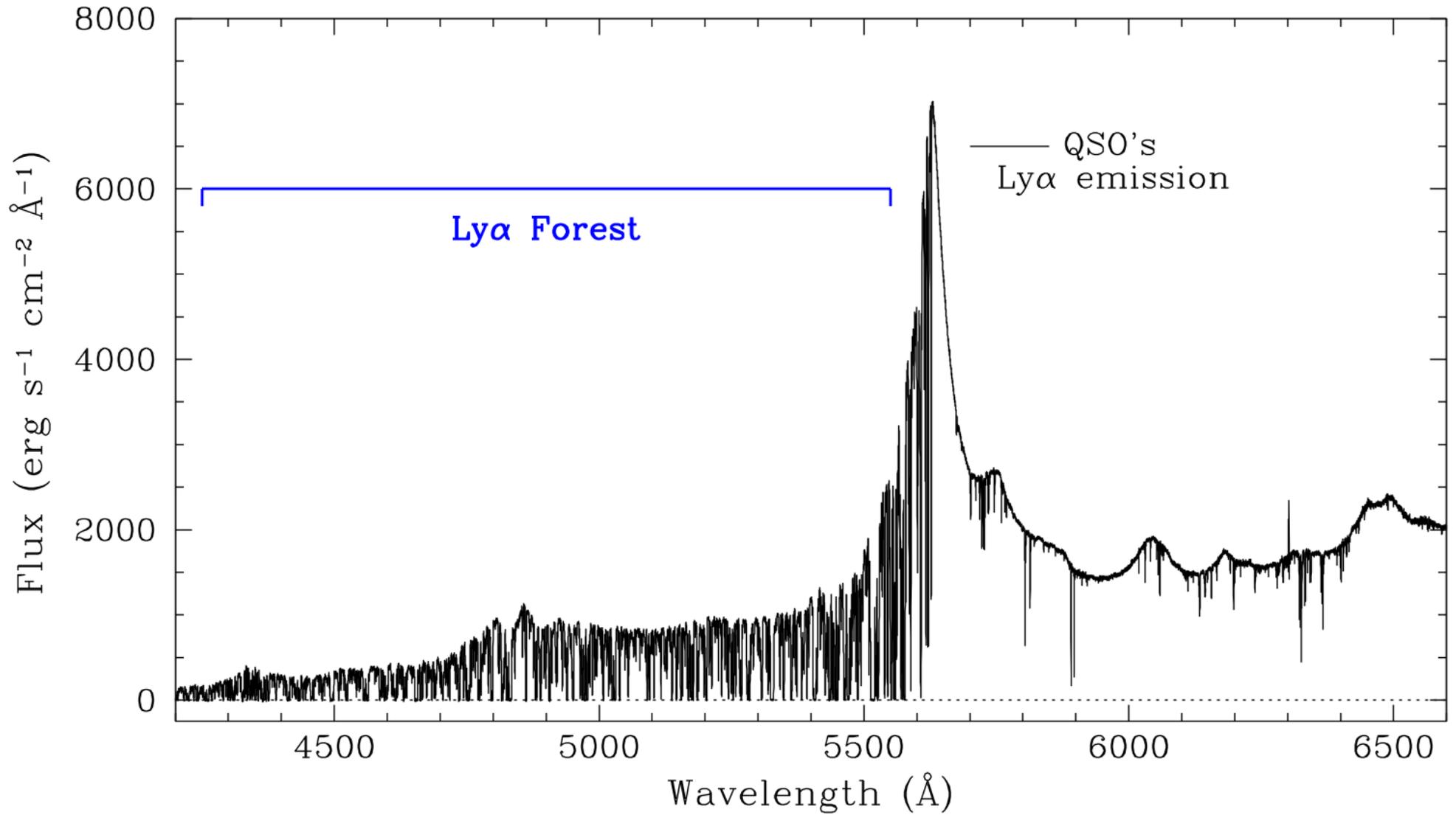
Quasar



Intergalactic “Clouds”



Q1422+231  $z_{\text{em}} = 3.625$

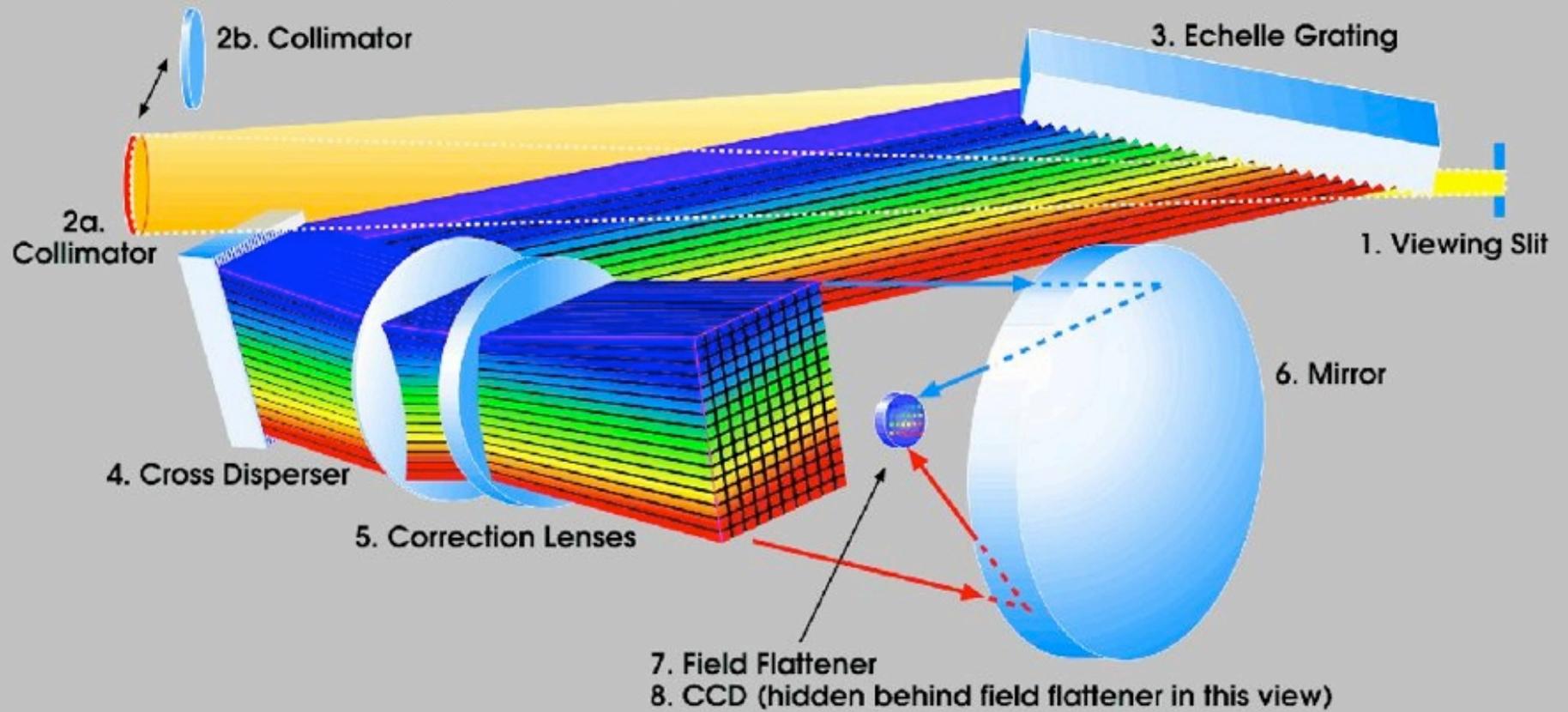


18.8 hours with HIRES (Keck I)

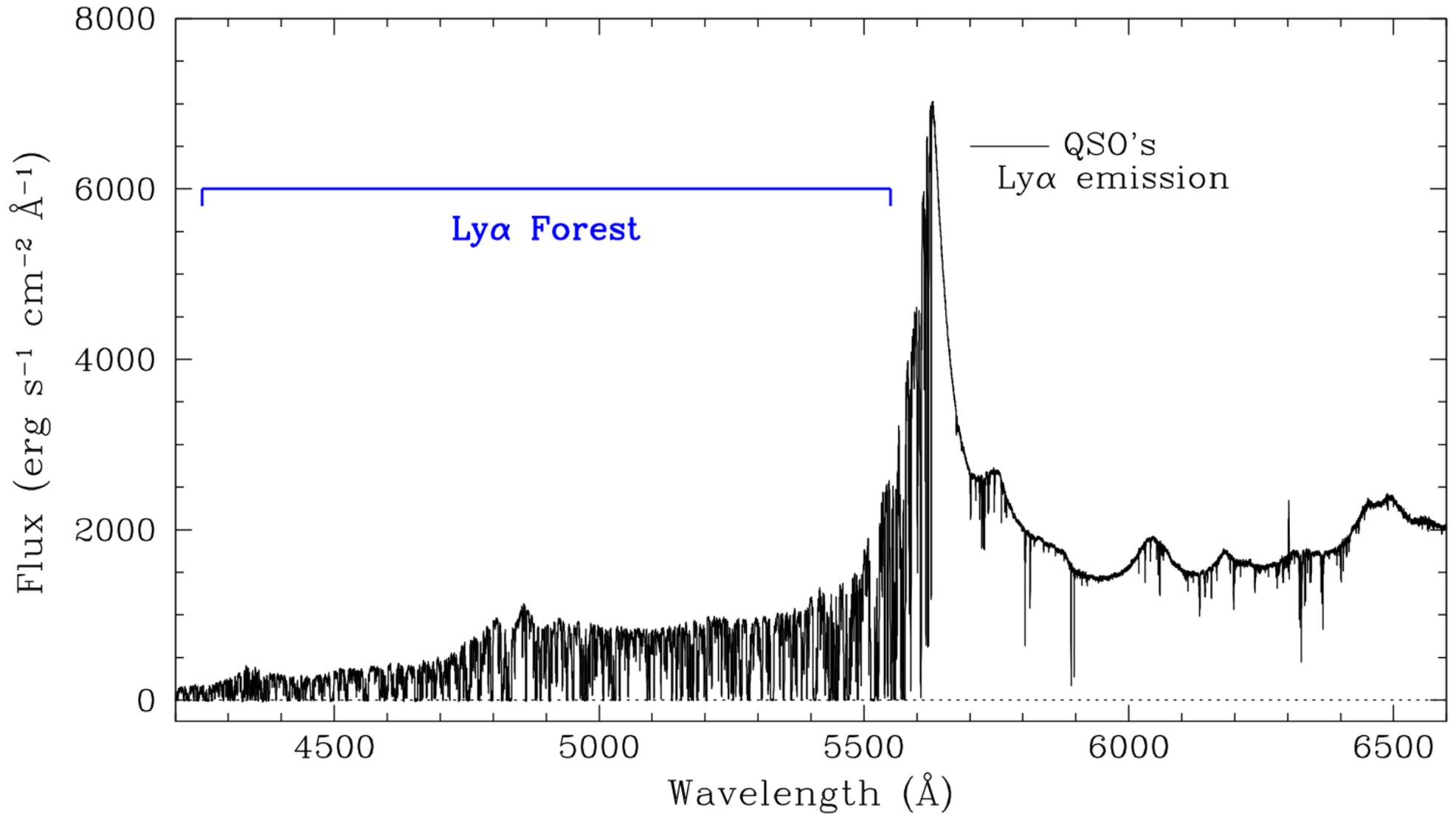




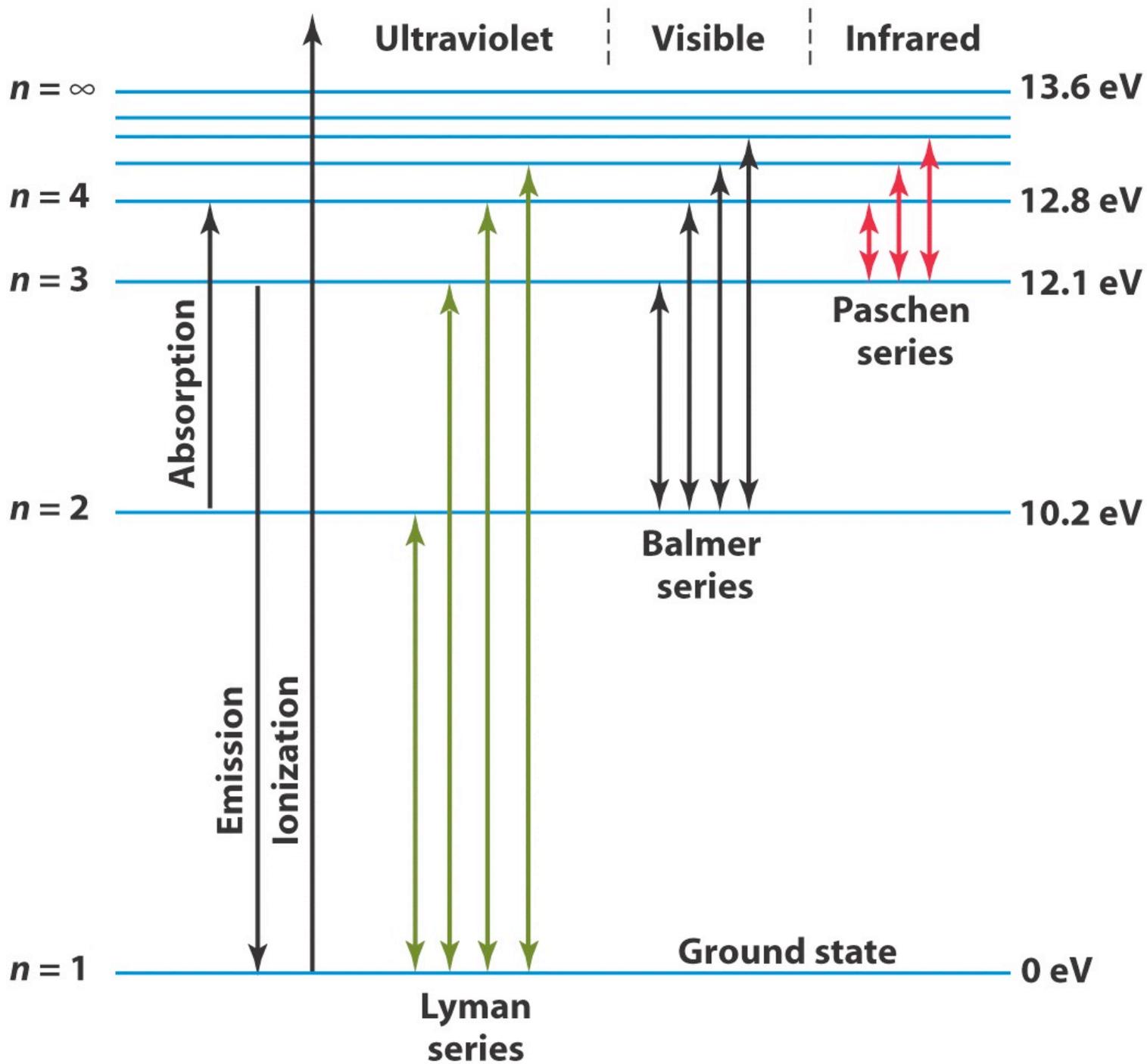
### The Light Path of the High-Resolution Echelle Spectrograph



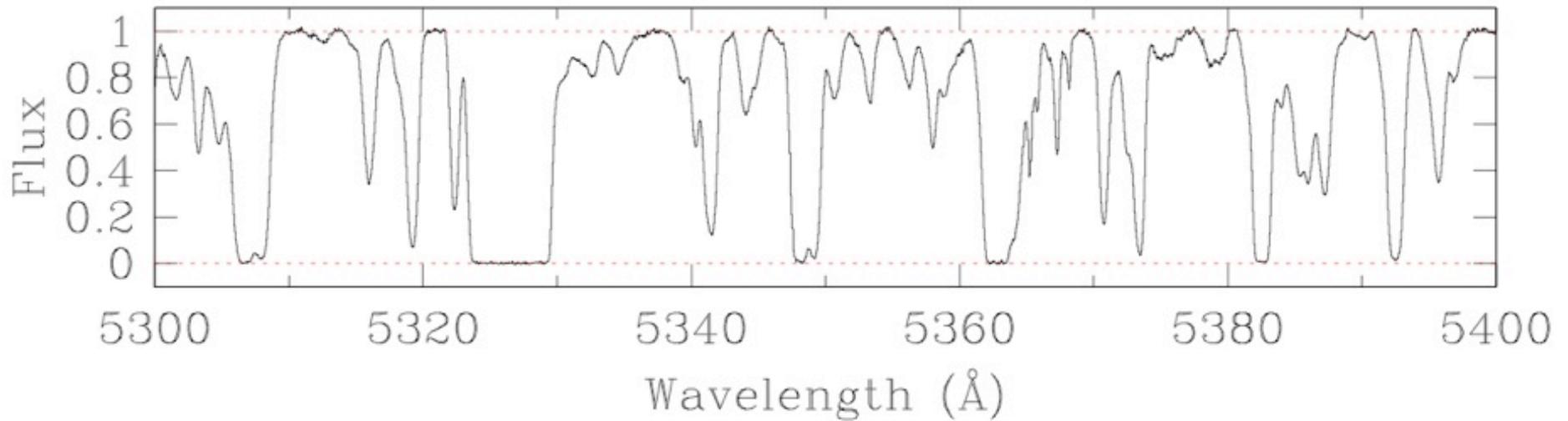
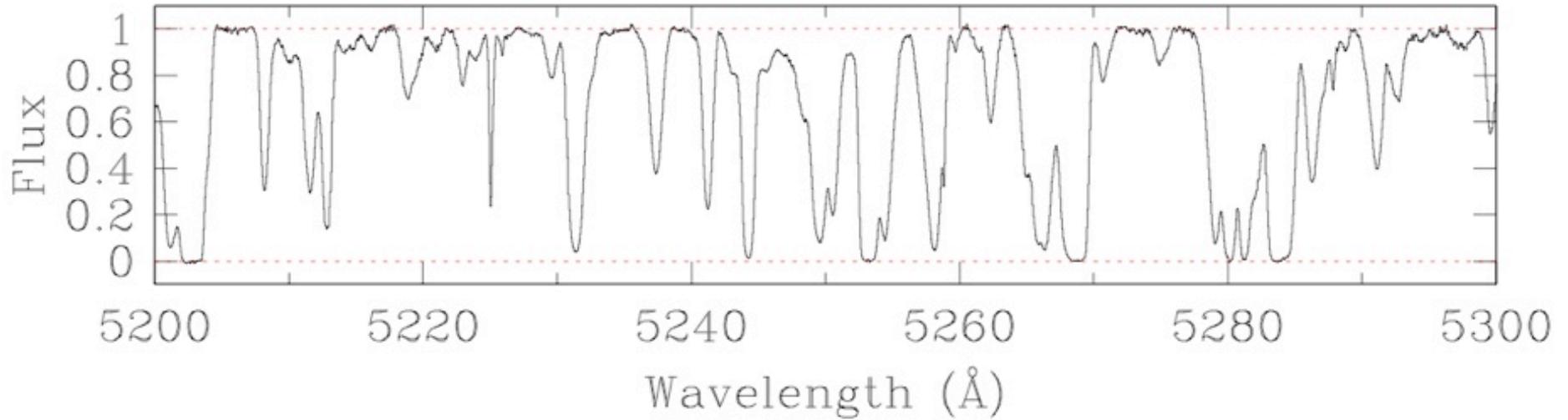
Q1422+231  $z_{\text{em}} = 3.625$



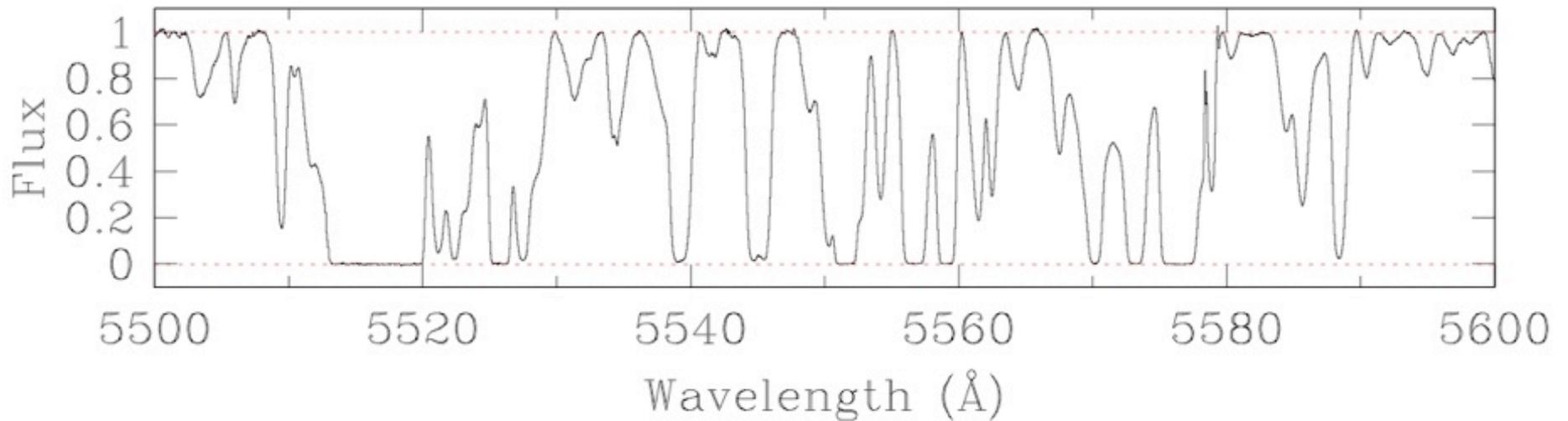
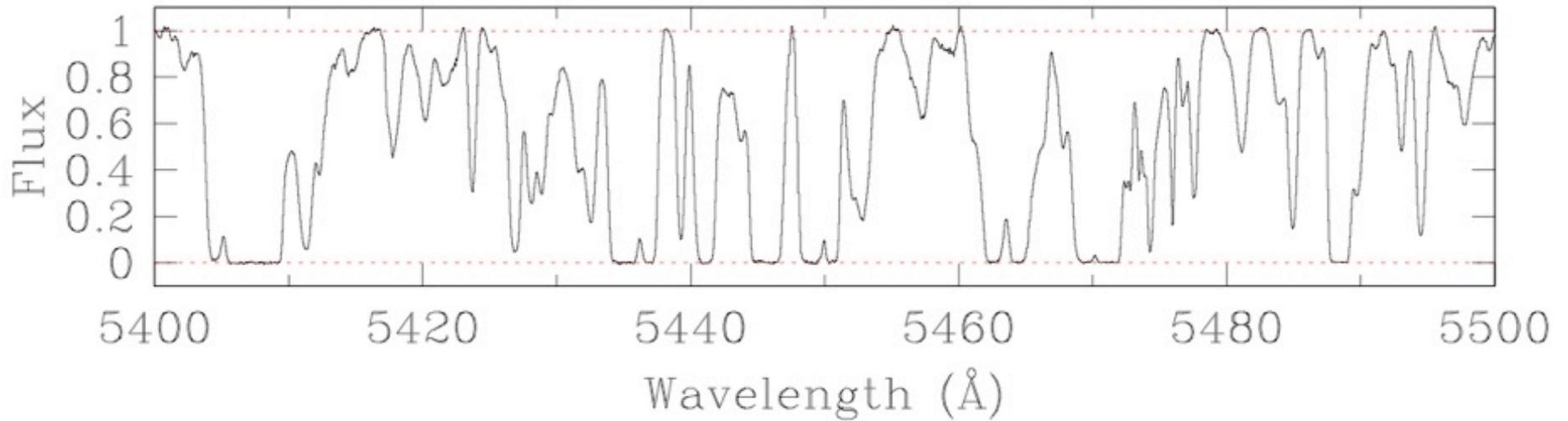
18.8 hours with HIRES (Keck I)



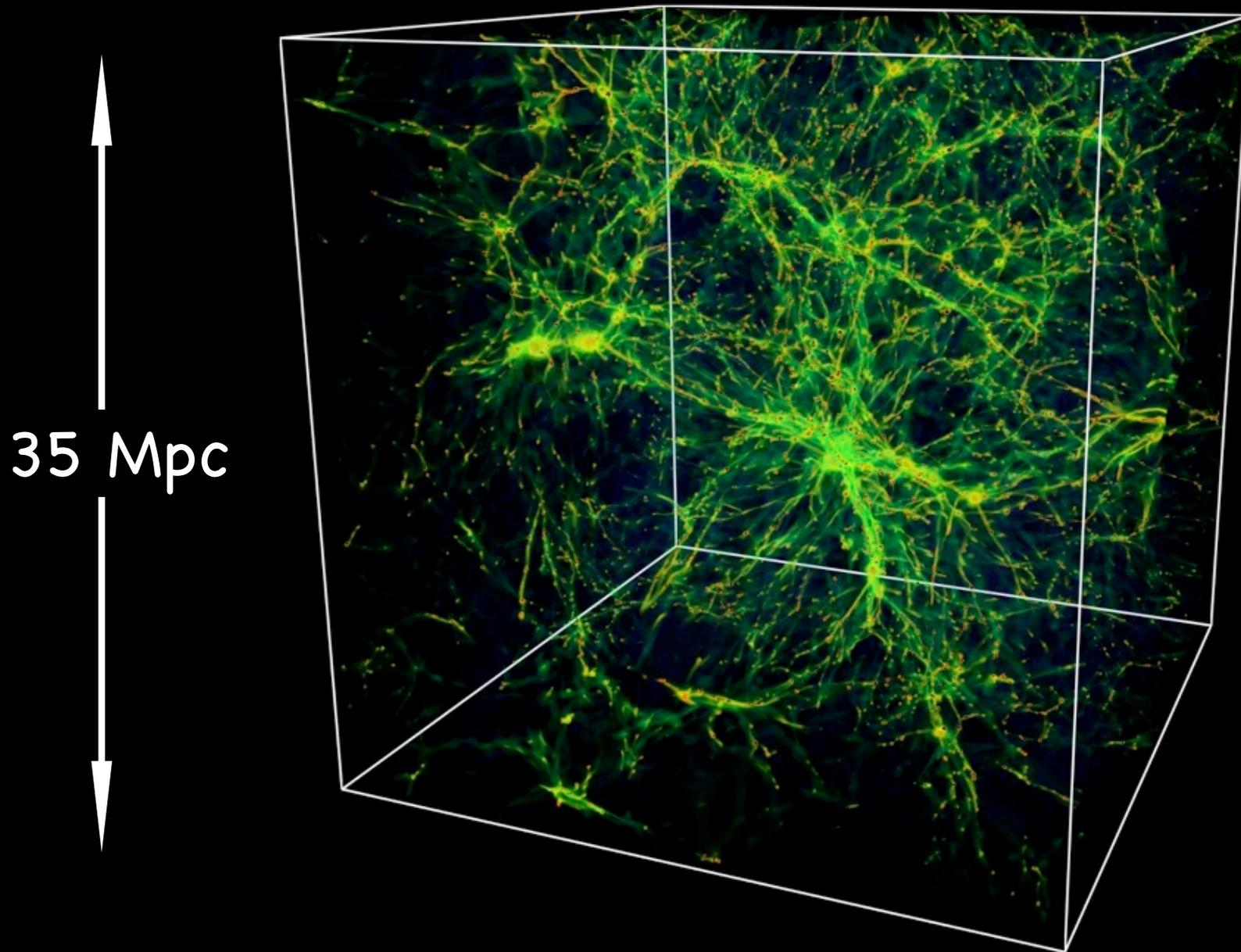
# The Ly $\alpha$ forest at high spectral resolution



# The Ly $\alpha$ forest at high spectral resolution

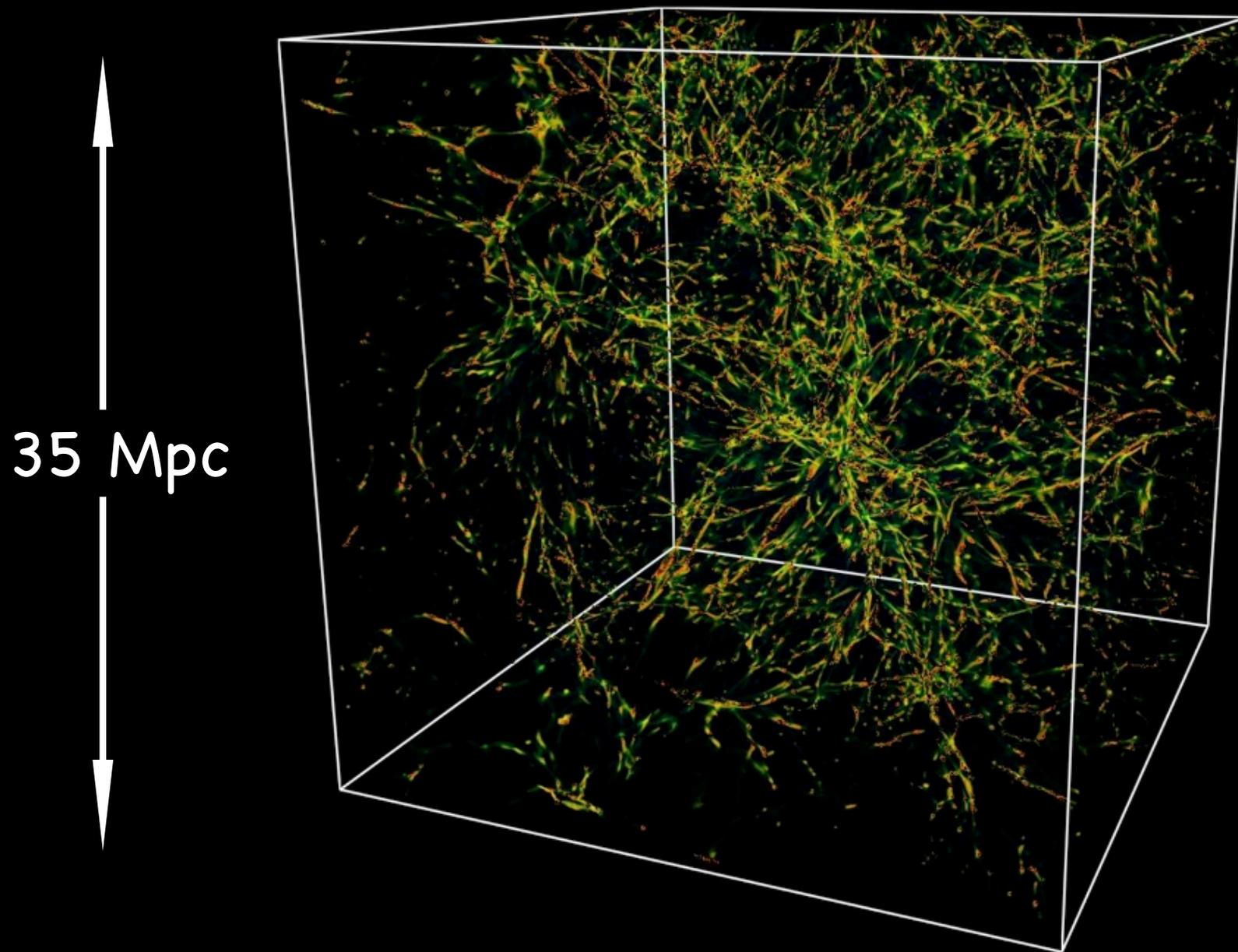


# Distribution of gas at $z = 3$



R Cen

# Distribution of neutral gas at $z = 3$



R Cen