Radio Recombination Lines from Rydberg atoms

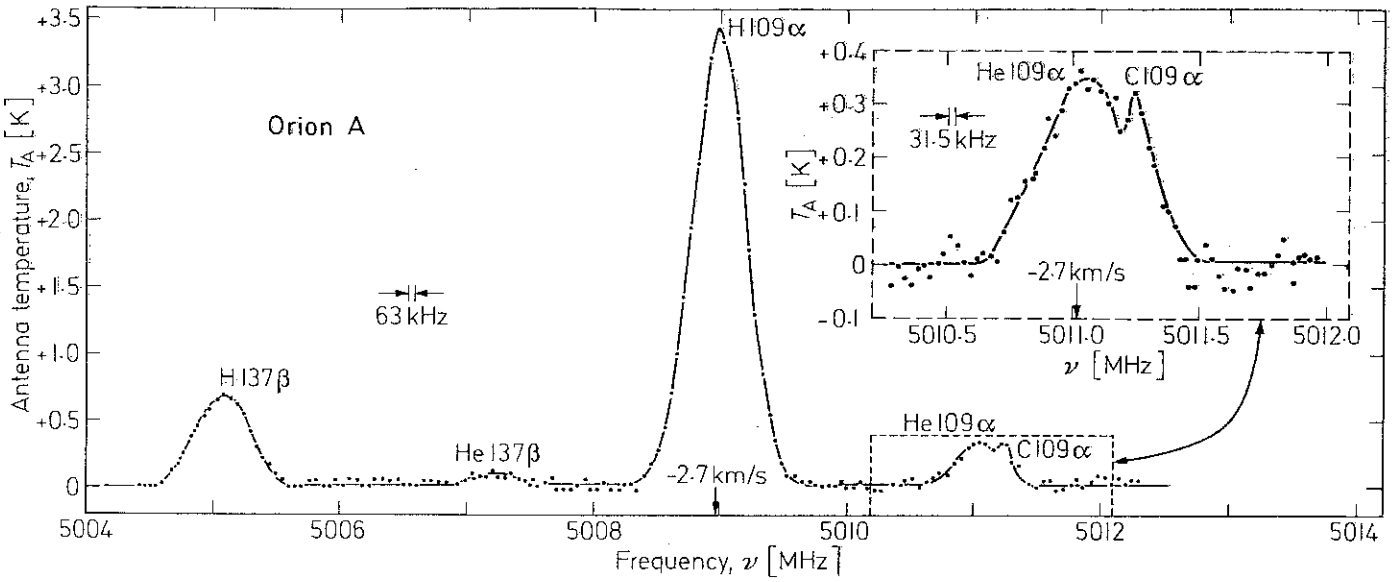


Fig. 12. Broadband spectrogram of the 109α region of the spectrum of the Orion Nebula. The frequency resolution is 63 kHz for the broadband spectrogram and 31.5 kHz for the narrow band spectrum centered on the He 109α line. (After CHURCHWELL and MEZGER, 1970, by permission of Gordon & Breach Science Publishers)

Hydrogenic atoms' wavelengths $\frac{1}{\lambda} = \boxed{\frac{\mu e^4}{4\pi\hbar^3 c}} \left(\frac{1}{n^2} - \frac{1}{m^2}\right)$

n = lower level

m = upper level

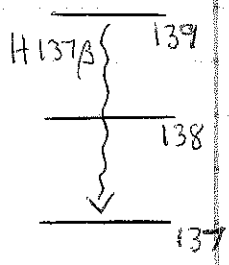
μ = reduced mass

where $\mu = \frac{m_e m_p}{m_e + m_p}$ for hydrogen

$\mu = m_e$ for infinite mass nucleus

Rydberg constant $R_H = \frac{\mu e^4}{4\pi\hbar^3 c} = 109677.60\ cm^{-1} = \frac{1}{912\ Å}$

Rydberg constant $R_\infty = \frac{m_e e^4}{4\pi\hbar^3 c} = 109737.31\ cm^{-1}$



For example, $n = 109$, $m = 110$ line is called H109α

$\nu = c/\lambda = 5008.92$ MHz for hydrogen ($\lambda = 5.985$ cm)

$\nu = c/\lambda = 5011.65$ MHz for infinite mass nucleus