Optically Thin Absorption

Hα line
Gaussian Line Profile
(Thermal motions dominate)
Optically Thin Absorption

Equivalent Width Linear Growth $\tau < 1$

- $\tau = 0.1$ (red)
- $\tau = 0.2$ (green)
- $\tau = 0.4$ (blue)
- $\tau = 0.8$ (violet)
Optically Thick Absorption

Equivalent Width begins to “saturate”
Very Optically Thick ($\tau > 5$) Absorption

For a Maxwellian distribution, wings grow slowly because of exponential drop off in number of absorbers at high $v$. Must now consider natural broadening profile…

**Equivalent Width Only growth in “wings”**
Comparison Gaussian vs. Lorentzian Profiles
Comparison Gaussian vs. Lorentzian Profiles

Gaussian vs. Lorentzian Profiles

6562  6562.5  6563  6563.5  6564
Curve of Growth – Absorption Line

Figure 9.22 A general curve of growth for the Sun. (Figure from Aller, *Atoms, Stars, and Nebulae*, Revised Edition, Harvard University Press, Cambridge, MA, 1971.)
PROBLEM – Derive this expression for $N(\text{CH}^+)$

The column densities of optically thin lines given in the last columns of Tables A.1 and A.2 are derived assuming a low excitation temperature $T_{\text{ex}} = 3$ K (a valid assumption for the components associated with the diffuse gas along the LOS):

$$N(\text{CH}^+) = 3.11 \times 10^{12} \int \tau \, d\nu \, \text{cm}^{-2}$$

$\text{CH}^+ \ 1-0$
835.137504 GHz
$A_{10} \sim 6.4 \times 10^{-3} \, \text{s}^{-1}$
$g_1 = 3, \ g_0 = 1$

Falgarone et al. 2010