INSTITUTO DE ASTRONOMIA, GEOFÍSICA E CIÊNCIAS ATMOSFÉRICAS, USP

AGA0506 - Transporte de Energia em Astrofísica

Lista 2

Professor : Dr. Marcos Diaz

QUESTION 1

Derive the next equation:

$$\Delta\lambda \approx \frac{\lambda^2}{2\pi c}\left(\frac{1}{\Delta t_i}+\frac{1}{\Delta t_f}\right),$$

for the uncertainty in the wavelength of a spectral line due to Heisenberg's uncertainty principle. Remember that $\Delta E \Delta t \approx \hbar$.

QUESTION 2

The two solar absorption lines given in Table 1 are produced when an electron makes an upward transition from the ground state orbital of the neutral Na I atom.

(a) Using the general curve of growth for the Sun, Fig. 1, find Na, the number of absorbing sodium atoms per unit area of the photosphere.

(b) Find the average value of Na. Use this value to plot the positions of the four sodium absorption lines on Fig. 1, and confirm that they do all lie on the curve of growth.

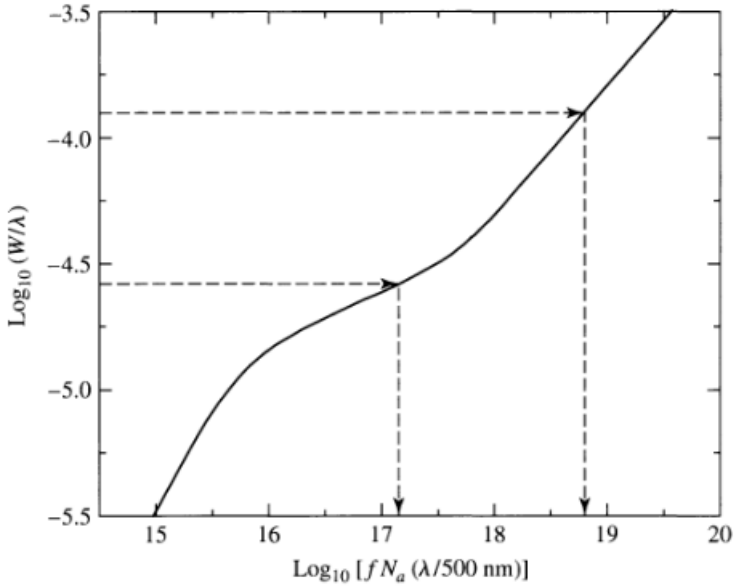

Figura 0.1: A general curve of growth for the Sun.

QUESTION 3

Pressure broadening (due to the presence of the electric fields of nearby ions) is unusually effective for the spectral lines of hydrogen. Using the general curve of growth for the Sun with these broad hydrogen absorption lines will result in an overestimate of the amount of hydrogen present. The following calculation nevertheless demonstrates just how abundant hydrogen is in the Sun.
The two solar absorption lines given in Table 2 belong to the Paschen series, produced when an electron makes an upward transition from the n=3 orbital of the hydrogen atom.

(a) Using the general curve of growth for the Sun, Fig. 1, repeat the procedure of the question 2 to find Na, the number of absorbing hydrogen atoms per unit area of the photosphere (those with electrons initially in the n=3 orbital).

(b) Use the Boltzmann and Saha equations to calculate the total number of hydrogen atoms above each square meter of the Sun's photosphere.

Tabela 0.1: Data for Solar Hydrogen Lines. (Data from Aller, Atoms, Stars, and Nebulae, Revised Edition, Harvard University Press, Cambridge, MA, 1971.)

λ (nm)	W(nm)	f
330.238	0.0088	0.0214
558.997	0.0730	0.645
330.238	0.0067	0.0049
558.997	0.0560	0.325

Tabela 0.2: Data for Solar Sodium Lines. (Data from Aller, Atoms, Stars, and Nebulae, Revised Edition, Harvard University Press, Cambridge, MA, 1971.)

λ (nm)	W(nm)	f
1093.8 (Paγ)	0.22	0.0554
1004.9 (Paδ)	0.16	0.0269