

D1 - Interstellar absorption spectroscopy

Task

A UV spectrum of Delta Orionis (a nearby star) is given, showing several interstellar absorption lines of different ions and molecules. These lines arise from interstellar gas clouds between the emitting star and the earth. Using computer programs, the properties of these lines are examined and the column density of the contributing ions and molecules are calculated. With the column densities the element abundances and further physical properties are deduced.

Evaluation: Metal abundances in the interstellar gas

- Identify the lines in the spectrum using the appended line list
- Find the line center of some lines and use the shift between the laboratory (rest) wavelength and the observed line to calculate the radial velocity of the cloud (Doppler shift)
- Measure the equivalent width of the absorption lines of following ions: FeII, SiII, ArI, OI and NI. Create a growth curve for these lines and estimate the (logarithmic) column density for the elements listed before, i.e. $\log N(\text{FeII})$, $\log N(\text{SiII})$, etc. What is the Doppler parameter (b value) of the growth curve?

Evaluation

Assume that the column density of neutral hydrogen in the cloud is $\log N(\text{HI}) = 19.92$. Estimate the relative abundances of elements X in comparison to the sun,

$$\left[\frac{X}{H} \right] = \log \left(\frac{N(X)}{N(\text{HI})} \right) - \left[\frac{X}{H} \right]_{\text{sun}},$$

where the solar abundances are given by $(\text{Fe}/\text{H})_{\text{sun}} = -4.49$, $(\text{Si}/\text{H})_{\text{sun}} = -4.45$, $(\text{Ar}/\text{H})_{\text{sun}} = -5.35$, $(\text{O}/\text{H})_{\text{sun}} = -3.13$, and $(\text{N}/\text{H})_{\text{sun}} = -4.03$ [Asplund 2009 \(The chemical composition of the Sun\)](#).

The evaluation shall be done using the ESO software package *Midas* which is installed at the [Laboratory course computer](#) or can be [installed](#) at the own computer. The required data and scripts are being provided by the instructors.

Protocol

First, describe the background of this experiment. Estimate the wavelength shifts, the resulting velocity including the error margins (non-linear error propagation!). Determine the b parameters of the curve of growths and the column densities of the different elements. Use the above formula to calculate the relative abundances in respect to solar values and their deviation from those values in percent.

[Overview: Laboratory Courses](#)

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