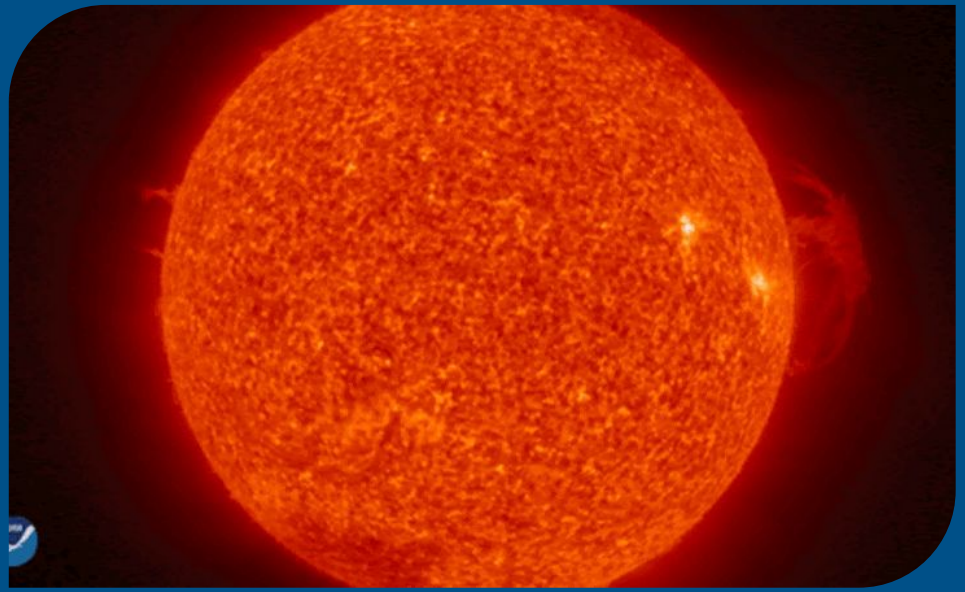
Measuring Stellar Elemental Abundances

By: D. Zurawski, V. Karkour, and J. Kamen



Introduction & Motivation

- Evaluate elemental abundances in stars
- Explore how things are done in the real world
- Compare the terminology of Physicists and Astronomers

Methods

- Normalizing and limiting raw solar spectrum
- Calculating width of sodium line
- Growth curve (Shown on the right)
- Saha equation (Shown below)
- Total column density formula

$$\frac{N_{i+1}}{N_i} = \frac{2kTZ_{i+1}}{P_e Z_i}\left(\frac{2\pi m_e kT}{h^2}\right)^{3/2} e^{-\chi_i/kT}$$

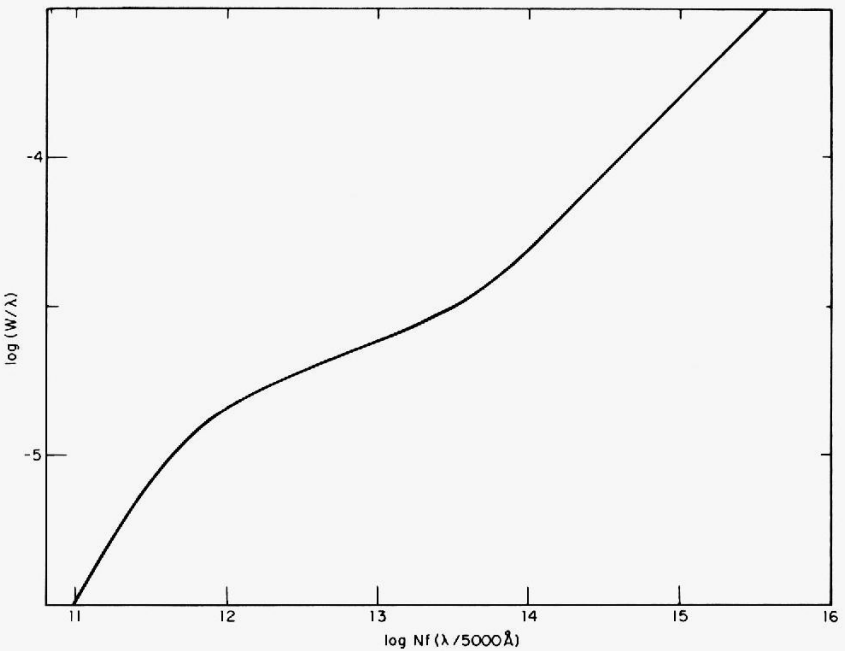
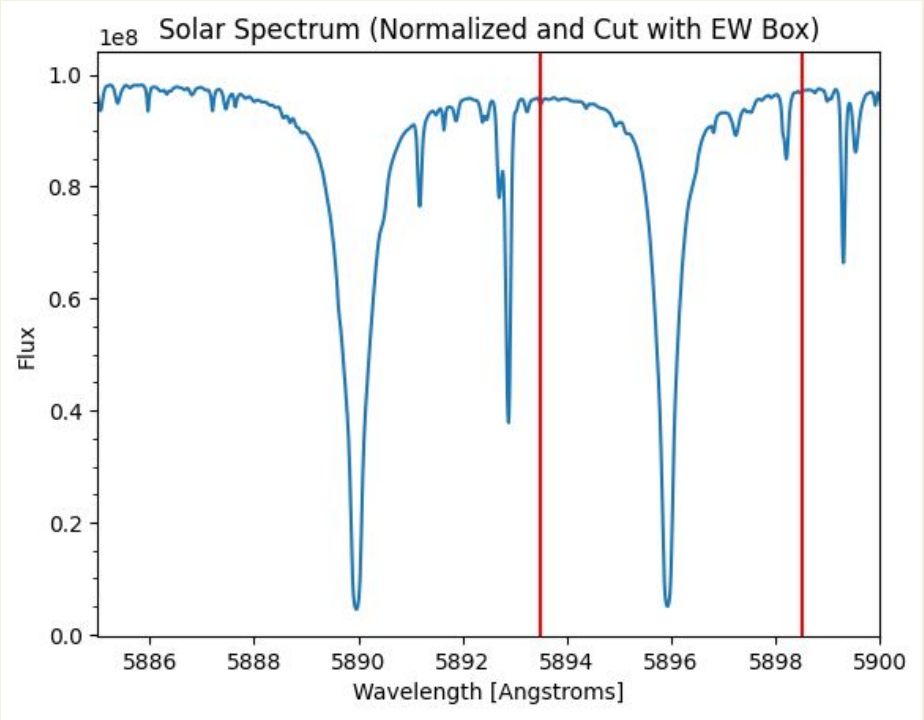


Figure 9.22 A general curve of growth for the Sun. (Figure from Aller, *Atoms, Stars, and Nebulae*, Revised Edition, Harvard University Press, Cambridge, MA, 1971.)

Graph #1

- Normalized and limited solar spectrum
- Red lines used to cut for the equivalent width
- Flux spectrum used to find sodium line width



Results

- Equivalent width of sodium doublet line (5896Å): 0.6987Å
- Number density in sodium line: 1.18×10^{15} atoms/cm^2
- Ratio of sodium atoms in the excited state compared to the ground state: 0.044
- Ratio of sodium atoms in the neutral state compared to the ionized state: 2522
- Column density of sodium atoms in the Sun's photosphere: 3.108×10^{18} atoms/cm^2

Comparing Terminology

Astronomers:

- Abundance of Sodium relative to Hydrogen is 6.673 (Galaxies)
- Abundance of Sodium relative to Hydrogen compared to the sun is 0.0 (Stellar based on the sun)

Compared with values from this paper

$$12 + \log\left(N_x/N_H\right)$$

Physicists:

- Abundance of Sodium relative to Hydrogen is 4.71212e-06

Conclusion

Conclusion:

- Motivation was successful!
- Able to communicate results in ways Astronomers and Physicists are able to understand
- Understood and used Growth model and Saha equation

Takeaways:

- Lots of information from solar spectrum
- Astronomers and Physicists analyze the same data in very different ways!