Analysis of Sodium Spectral Lines: D-Lines (Doublet) and S-Lines

# 1. Sodium D-Lines (Doublet):

Origin: The D-lines result from transitions between the 3p and 3s energy levels of sodium atoms, influenced by spin-orbit coupling, leading to fine structure splitting.

Expected Wavelengths:  
- D₂ Line: Approximately 589.5924 nm (5895.924 Å)  
- D₁ Line: Approximately 588.9950 nm (5889.950 Å)

Intensity Ratio: The D₁ line at 589.0 nm is typically twice as intense as the D₂ line at 589.6 nm.

# 2. Sodium S-Lines:

Origin: The S-lines are ultraviolet (UV) emissions resulting from transitions from higher principal quantum numbers (n > 3) to the 3s state in sodium atoms.

Expected Wavelengths (calculated using the Rydberg formula):  
- Transition from n=4 to n=3: Wavelength ≈ 15.49 nm  
- Transition from n=5 to n=3: Wavelength ≈ 10.59 nm  
- Transition from n=6 to n=3: Wavelength ≈ 9.04 nm  
- Transition from n=7 to n=3: Wavelength ≈ 8.30 nm  
- Transition from n=8 to n=3: Wavelength ≈ 7.89 nm  
- Transition from n=9 to n=3: Wavelength ≈ 7.63 nm  
- Transition from n=10 to n=3: Wavelength ≈ 7.45 nm

Experimental Considerations:  
- Spectrometer Calibration: Ensure that your Czerny-Turner spectrometer is properly calibrated to accurately measure the wavelengths of both D and S lines.  
- Detection of S-Lines: Given their position in the UV spectrum, detecting sodium S-lines requires a spectrometer equipped with a detector sensitive to UV wavelengths.  
- Expected Observations: With appropriate experimental conditions and equipment, you should observe the D-lines in the visible spectrum and, if your setup allows, the S-lines in the UV range.