Solar Physics 2005-2006: Exercises to Lecture 6

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1 Derivation of the Landé Factor

Derive the equation for the Landé factor in LS coupling,

$$g_L = 1 + \frac{J(J+1) + L(L+1) - S(S+1)}{2J(J+1)} \tag{1}$$

Hint: Since $\vec{J}$ and $\vec{S}$ are both changing in time, project these two vectors first onto the direction of $\vec{J}$.

2 Maximum value of the Landé Factor

What is the maximum effective Landé factor for a spectral line?

3 Splitting

We saw that the energy difference due to the Zeeman effect is given by

$$\Delta E_{NLSJ}(M) = \mu_0 g_L B M \tag{2}$$

Rewrite this splitting equation in terms of wavelength. Discuss the optimum wavelength for Zeeman measurements.

4 Strength of Spin-Orbit Interaction

The upper level of the sodium D doublet is split into two levels corresponding to total angular momenta $j = \frac{3}{2}$ (NaI D_2, 589.0 nm) and $j = \frac{1}{2}$ (NaI D_1, 589.6 nm). The splitting is caused by the magnetic moment due to the electron spin being subject to the magnetic field induced by the orbital motion (spin-orbit coupling). Estimate the internal magnetic field generating this splitting and discuss its impact on the assumption of LS coupling.

5 Problem 3.21 from Stix's Book