Observational Astrophysics 2 (2010): Exercises on Polarimetry and Spectroscopy (Due on 8 April 2010 at 09:15)

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1 Polarimetry

1.1 Photons

Think of quasi-monochromatic, partially polarized light in terms of photons. Photons have spin 1, and since they have no mass, their spin needs to be parallel to the propagation direction. This means that a photon can be considered to be either left- or right-circularly polarized. Describe four independent properties of these photons that completely characterize the polarization properties.

1.2 Zeeman splitting

The energy difference due to the Zeeman effect in the Hamiltonian describing an atom in a magnetic field is given by

$$\Delta E_{NLSJ}(M) = \mu_0 g_L B M \tag{1}$$

where μ_0 (Bohr magneton) and g_L (Landé-factor) are constants, B is the magnetic field strength, and M is the quantum number of the z-component of the total angular momentum. Rewrite this splitting equation in terms of wavelength. Discuss the optimum wavelength for Zeeman measurements.

2 Spectroscopy

2.1 Bandpass shift

The bandpass profile of an interference filter changes with the inclination angle ϕ. It can be modeled as a Fabry-Perot with a cavity material that has an effective index of refraction of n_e. In which direction in wavelength does a filter bandpass shift when the inclination is different from 0? What is the dependence with the inclination angle? Remember that the angle θ is measured inside the cavity.

2.2 Grating order overlap

The various orders m of a grating overlap each other in the spectrum. Show that a wavelength interval which does not overlap with itself is limited by $\Delta\lambda < \lambda/m$