

Computed linear and circular polarization rates of solar spectral lines after Delbouille's atlas in the frame of the weak field theory from λ 3700 Å to λ 8800 Å

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Abstract

We present in this paper a computation of the polarization rates of solar spectral lines from λ 3000 Å to λ 8800 Å using Delbouille's atlas (at disk centre) and the weak field theory of the Zeeman effect. Linear and circular polarization profiles and rates are calculated in the frame of this theory using equivalent Lande factors g^* . Lines are identified by the Moore table.

Keywords

Solar spectrum, visible, disk centre, linear polarization, circular polarization.

Description of the spectra

We used the solar atlas of Delbouille *et al* (1973), from λ 3000 Å to λ 10000 Å (step 2 mÅ) at disk centre ($\mu = 1.0$), taken at the Jungfrauoch station (Switzerland, a very high and dry site). We restricted the wavelength range to λ 3700 - 8800 Å for which we have the line identification provided by the Moore table (Moore *et al*, 1966) and the equivalent Lande factors g^* . We quantified the sensitivity to the Zeeman effect using the weak field theory (Landi, 1992, Stenflo, 1994). In that frame, the Stokes V and $(Q^2+U^2)^{1/2}$ profiles are given by:

for a longitudinal field (along the line of sight):

$$V(\lambda) = - \Delta\lambda_B (dI/d\lambda)$$

for a transverse field (orthogonal to the line of sight):

$$(Q(\lambda)^2 + U(\lambda)^2)^{1/2} = 1/4 \Delta\lambda_B^2 |d^2I/d\lambda^2|$$

where $\Delta\lambda_B = [e / (4\pi m C)] \lambda^2 g^* B = 4.67 \cdot 10^{-13} \lambda^2 g^* B$ (numerically with B in Gauss and λ in Angström) is the Zeeman splitting (which must be small in comparison to the Doppler width of the considered line).

The circular polarization rate is V/I ; it is maximum (in absolute value) at the inflexion points of the line profiles. The linear polarization rate is $(Q^2+U^2)^{1/2}/I$; it is maximum in the line centre.

The spectra are displayed by pages of 100 Å, each displaying bands of 10 Å. Delbouille's spectrum is shown in **black**. Intensities are normalized to the adjacent continuum I_c . The **blue numbers** are equivalent Lande factors g^* . The line identification follows the convention of the Moore *et al* (1966) table (slash for main contributors in case of a blend, dash for blends, parenthesis for masked lines, p for predicted line, see page XVIII of their book for details). The circular polarization spectrum V/I is drawn in **red** ; it was calculated using the first formula above for $B = 1000$ G (10^{-4} T) and for $g^*=1.0$; the **red vertical bars** provide the minima and the maxima of V/I (located at line inflexion points) for $B = 1000$ G and take into account the equivalent Lande factor g^* of each line (V/I is proportional to g^* and to B). The linear polarization spectrum $(Q^2+U^2)^{1/2}/I$ is drawn in **green** ; it was computed using the second formula above for $B = 1000$ G (10^{-4} T) and for $g^*=1.0$; the **green vertical bars**

provide the maxima of $(Q^2+U^2)^{1/2}/I$ (located at line centre) and use the equivalent Lande factor g^* of each line ; $(Q^2+U^2)^{1/2}/I$ is proportional to g^{*2} and to B^2 and is, in general, much smaller than V/I . For a given magnetic field B , the maximum polarization rates of V/I and $(Q^2+U^2)^{1/2}/I$ can be easily deduced from the plots : just multiply by the factors $(B/1000)$ or $(B/1000)^2$, respectively.

This PDF document is based on 2280 x 3324 pixel images and must be zoomed to see the details. Original plates (GIF format) are available here:

<https://www.lesia.obspm.fr/perso/jean-marie-malherbe/spectrevisible/spectreZE/index.html>

The spectra are displayed below from 3700 Å to 8800 Å, by pages of 100 Å bandpass, each page showing 10 bands of 10 Å.

Wavelength intervals [λ_1 , λ_2] (in Å), see **page number** :

3700-3800 : **3** / 3800-3900 : **4** / 3900-4000 : **5**

4000-4100 : **6** / 4100-4200 : **7** / 4200-4300 : **8** / 4300-4400 : **9** / 4400-4500 : **10**

4500-4600 : **11** / 4600-4700 : **12** / 4700-4800 : **13** / 4800-4900 : **14** / 4900-5000 : **15**

5000-5100 : **16** / 5100-5200 : **17** / 5200-5300 : **18** / 5300-5400 : **19** / 5400-5500 : **20**

5500-5600 : **21** / 5600-5700 : **22** / 5700-5800 : **23** / 5800-5900 : **24** / 5900-6000 : **25**

6000-6100 : **26** / 6100-6200 : **27** / 6200-6300 : **28** / 6300-6400 : **29** / 6400-6500 : **30**

6500-6600 : **31** / 6600-6700 : **32** / 6700-6800 : **33** / 6800-6900 : **34** / 6900-7000 : **35**

7000-7100 : **36** / 7100-7200 : **37** / 7200-7300 : **38** / 7300-7400 : **39** / 7400-7500 : **40**

7500-7600 : **41** / 7600-7700 : **42** / 7700-7800 : **43** / 7800-7900 : **44** / 7900-8000 : **45**

8000-8100 : **46** / 8100-8200 : **47** / 8200-8300 : **48** / 8300-8400 : **49** / 8400-8500 : **50**

8500-8600 : **51** / 8600-8700 : **52** / 8700-8800 : **53**

References

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