Multi-Line Determination of the Turbulent Magnetic Field from the Second Solar Spectrum of MgH

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Abstract. This paper presents an analysis of the $Q_{1,2}(6-12)$ lines of the $Q$ band of the $A^2\Pi - X^2\Sigma^+$ ($0,0$) transition of MgH, whose linear polarization was measured with THEMIS, on November 21, 2004, in a quiet region of the Sun (North pole), 4” inside the solar limb. This analysis is performed as follows: a) The Hanle effect parameter, $\Gamma_H$, is derived by applying the differential Hanle effect method between the two extreme pairs of lines. Assuming no depolarizing collisions, a magnetic field strength follows, which is found to be 9.2 G, in agreement with previous observations of the same kind. b) This $\Gamma_H$ parameter is entered in a code solving the non-LTE polarized radiative transfer equations, and the other depolarizing parameter, namely the depolarizing collision rate, is then derived by adjusting the computed polarization to the observed one. Thus an average value of the rate per colliding hydrogen atom $\alpha^{(2)} = 1.20 \times 10^{-9}$ cm$^3$ s$^{-1}$ is obtained for the upper levels of the 12 lines (with a standard deviation of $0.21 \times 10^{-9}$ cm$^3$ s$^{-1}$). The corresponding model-dependent depolarizing rate is $D^{(2)} = (4.2 \pm 0.7) \times 10^7$ s$^{-1}$ at $h = 200$ km. c) This depolarizing rate is now introduced in the conversion of the $\Gamma_H$ parameter in terms of magnetic field strength: an average turbulent field strength of $29 \pm 12$ G is derived as the final value, at a height $h = 200 \pm 80$ km where the polarization is formed. The Hön-London factors of the lines under interest have been recalculated, leading to detect an error of a factor 2 in the recent literature. The derived value $B = 29 \pm 12$ G at $h = 200 \pm 80$ km is in fairly good agreement with previous determinations based on the interpretation of the Sr i 4607 Å limb polarization, which has led to fields in the range 35–60 G. Given the error bars, it seems unnecessary to put forward different formation regions for the Sr i and MgH lines. This work has been presented in detail by Bommier et al. (2006), under the title “Collisional influence on the differential Hanle effect method applied to the second solar spectrum of the $A^2\Pi - X^2\Sigma^+$ ($0,0$) band of MgH.”

References