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Search for abundance stratification in the atmospheres of HgMn stars

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Abstract. Photospheric abundance determinations for several HgMn stars were undertaken using archival ESO-UVES spectra. Unblended lines in the visible region of the spectrum of the elements Ti, Cr, Mn and Fe were used to obtain their abundance and to search for the presence of abundance stratification as a function of optical depth. Results are reported for HD 178065 and HD 175640. Of the elements studied, only Mn shows signs of abundance stratification.

Key words: stars: chemically peculiar – stars: abundances

1. Introduction

The HgMn stars belong to the CP family of stars with effective temperatures ranging from 10 000 K to 15 000 K. Hg and Mn can be overabundant by up to 6 dex and 3 dex respectively. These stars are slow rotators and do not possess magnetic fields in their atmospheres. Their characteristics suggest that their atmospheres are rather stable, and that atomic diffusion (Michaud, 1970) should be important. Here we present a careful search for Ti, Cr, Mn and Fe stratification in the atmospheres of the SB1 stars HD 175640 and HD 178065.

2. Observations and results of spectral analysis

UVES spectra of HD 175640 and HD 178065 were extracted from the ESO archive. We reduced and normalized the spectra using the UVES pipeline data reduction tool (version 2.2.0) and IRAF. We studied lines in spectral orders longward of the Balmer jump where $S/N \geq 300$.

The abundances and the optical depth of line formation were determined using Zeeman2 (Landstreet, 1988; Wade *et al.*, 2001). We characterized the optical depth by assuming the line core forms at $\tau_l = 1$ (Khalack *et al.*, 2007). We extracted the atomic data from VALD (Ryabchikova *et al.*, 1999) and the atmosphere models (12500g40 for HD 175640 and 12000g35 for HD 178065) from Atlas9. The abundances derived for Ti, Cr and Fe in HD 175640 show no significant systematic variation with optical depth. Meanwhile, the results for Mn are inconclusive for this star. In the atmosphere of HD 178065, we found that Ti, Cr and Fe show no dependence on the line core optical depth. Only Mn

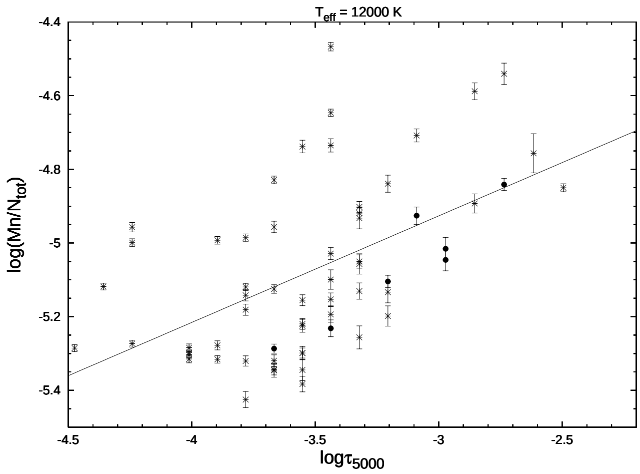

Figure 1. Dependence of the Mn abundance of HD 178065 on the optical depth of core line formation. The dots and crosses represent respectively the abundance derived from the neutral and ionized manganese. The linear fit of the data using the least squares method is represented by the solid line.

appears to be stratified in the investigated layers of HD 178065. The Mn abundance increases toward the upper atmosphere of HD 178065 from $\log \tau_{5000} = -4.6$ to -2.5 by $\approx$ 0.6 dex (Figure 1). The data fit according to the linear function $\log(\mathrm{Mn}/\mathrm{N}_{\mathrm{tot}}) = a \log \tau_{5000} + b$ reveals a highly significant slope, $a = +0.289 \pm 0.060$.

3. Discussion

The elements investigated in the atmosphere of HD 175640 show no signs of vertical stratification, except for Mn for which our results are inconclusive. In HD 178065 the elements Ti, Cr and Fe are not stratified, while the Mn abundance increases toward the deeper atmosphere of the star. This is the first report of observational evidence of Mn stratification in the atmosphere of a HgMn star.

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