GALLIUM OVERABUNDANCE IN THE Ap-Si STAR HD 25823

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Abstract : An anomalous enhancement of the resonance line of Ga II at 1414.44 Å is observed in IUE spectra of the silicon star HD 25823. High-resolution spectrum of this star is compared to synthetic spectra calculated in the range 1406-1422 Å. The LTE abundance of gallium is evaluated to log N_{Ga} = 6.3 ± 0.5 in the scale where log N_H = 12.

INTRODUCTION

The overabundance of Gallium is currently observed in the Mg-Mn stars. Heacox (1979) established abundances larger than 10^3 times the solar value for eight Hg-Mn stars, over a sample of 21 of these stars. Takada and Jugaku (1981) also deduced such overabundances from IUE ultra-violet observations of seven Hg-Mn stars. On the contrary, Gallium was generally considered as normal in magnetic Ap stars. An exceptional detection of the visible lines of Ga II has been reported in two Ap-Si stars HD 200311 (Adelman, 1974) and HD 25823 (Didelon, 1985).

It will be important to establish if the Gallium overabundance is, or not, a definite characteristic differentiating silicon and Hg-Mn stars of similar temperature : in the diffusion theory in Ap stars, an extra opacity at 1400 Å may influence the radiative forces pushing out Gallium ions in the stellar atmospheres (Michaud, private communication). The Ap-Si stars show a large depression at 1400 Å, tentatively attributed to Si II autoionization (Artru et al, 1981) and the resonance line of Ga II at

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1414,44 Å occurs exactly in this region. For six Ap-Si stars (over a sample of 12) this line appears stronger than for the comparison normal star πCeti. We present here a quantitative analysis of the Ga II enhancement in HD 25823, the Ap-Si star where it is, by far, the most important.

OBSERVATIONAL DATA

The Ap-si star HD 25823 (41 Tau, m_v = 5.19) has an effective temperature of 13000 K (Lanz, 1984) and vsini = 21 km s^{-1}. We compared the high dispersion IUE spectra of HD 25823 (image # 14956) and HD 17081 (πCeti, image # 16256) chosen as comparison stars. We show on fig. 1 the two spectra with identified lines in the spectral range 1406-1422 Å where the Ga II resonance line appears.

SYNTHETIC SPECTRA IN THE SPECTRAL REGION OF THE Ga II RESONANCE LINE

For quantitative analysis of the Ga II resonance line ($3s^2\ ^1S_0$ - $3s3p\ ^1P_1$) at 1414.44 Å, we computed LTE synthetic spectra in the spectral range 1406 - 1422 Å. A special effort was done to actualize the atomic data on individual lines of this region. As basic wavelength reference we used the experimental data compiled by Kelly and Palumbo (1973). The gf values are taken from Kurucz and Peytremann (1975) or Kurucz (1981) when no other source was available. The main lack of data occurs for other ions such Mn II, Cr II and Ni II; especially Mn II has a line at 1414.40 Å blended with the Ga II one, but probably much weaker.

The gf value of the Ga II line is well established to 1.8 ± 0.1 from different recent determinations, either theoretical (Froese-Ficher and Hansen, 1978) either experimental (Andersen, 1979). The Stark broadening was deduced from an empirical estimation (Dimitrijevic, 1985) $\gamma/ne = 2.10^{-6} s^{-1} cm^{+3}$ at 13000K.

The LTE synthetic spectrum was calculated for a blanketed model (Kurucz et al. 1975) with effective temperature T_{eff} = 13000 K and gravity g = 10^4 CGS ; the microturbulence was fixed to 3 km/s and the spectrum was degraded to the IUE resolution of 0,2 Å which is slightly larger than

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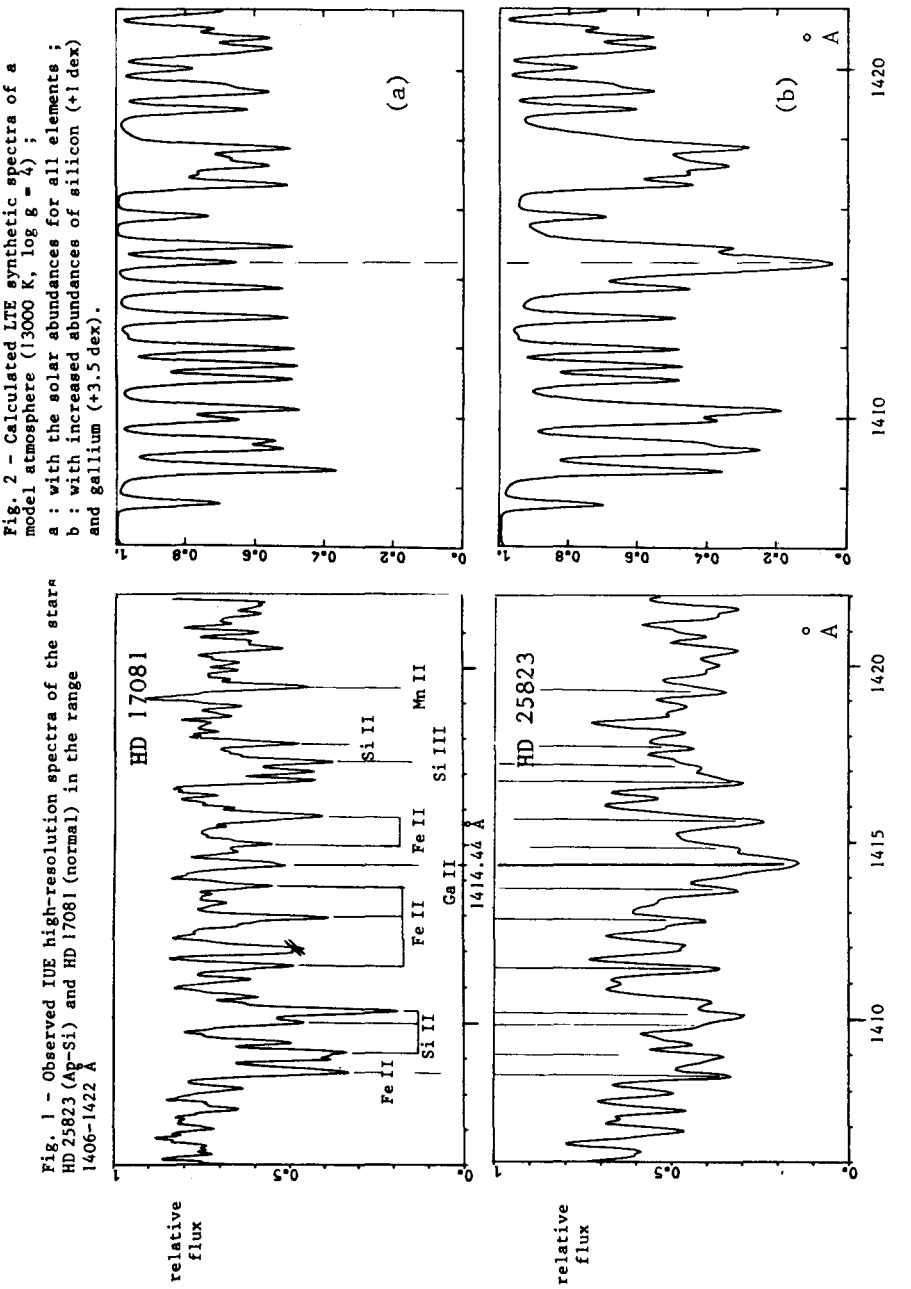

Fig. 1 - Observed IUE high-resolution spectra of the stars HD 25823 (Ap-Si) and HD 17081 (normal) in the range 1406-1422 Å

Fig. 2 - Calculated LTE synthetic spectra of a model atmosphere (13000 K, log g = 4) ; a : with the solar abundances for all elements ; b : with increased abundances of silicon (+1 dex) and gallium (+3.5 dex).

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the broadening due to the rotationnal velocity of HD 25823. The element abundances were fixed to solar values excepted that silicon was increased by a factor of 10 and gallium was varied from 1 to 10^5 times the solar value.

The two synthetic spectra shown on fig. 2 were computed with Ga/H = 1 and Ga/H = 3.10^3. Most of the observed individual lines are well reproduced in the synthetic spectrum, except in a few cases (1411.07 Ni II, 1415.50 Fe II and 1417.70 Si II). The best fit with the observed HD 25823 spectrum was obtained for an overabundance of gallium of 3000 times the solar value. We thus estimate log NGa/NH = 6.3 ± 0.5 (solar value = 2.8). Further synthetic spectra for other spectral regions, in particular those of Ga III lines, will be undertaken.

REFERENCES

- Adelman S.J., 1974, Ap. J. Suppl. Ser. 28, 51.
- Andersen, T., Eriksen, P., Poulsen, O., Ramanujam, P.S., 1979, Phys. Rev. A 20, 2621.
- Artru, M.C., Jamar, C., Petrini, D., Praderie, F., 1981, Astron. Astrophys. 96, 380.
- Didelon, D., 1985, to be published in Rev. Mex. de Astron. y. Astr.
- Dimitrijevic, M.S., Astron. Astrophys., 1985, 145, 439.
- Froese-Fisher, C., Hansen, J.E., 1978, Phys. Rev. A17, 1956.
- Heacox, W.D., 1978, Ap. J. Suppl. Ser. 41, 675.
- Johansson, S., 1978, Physica Scripta, Vol. 18, n° 4, 217.
- Kelly, R.,L., Palumbo, L.J., 1973, Atomic and Ionic Emission Lines below 2000 Å, NRL Report 7599, Naval Research Laboratory, Washington.
- Kurucz, R.L., Peytremann, E., 1975, A table of Semiempirical gf Values, SAO, Sp Rep. n° 362.
- Kurucz J.L., 1981, Semiempirical Calculation of gf Values, Fe II, SAO Sp Rep. n° 390.
- Kurucz, R.L., Peytremann, E., Avrett, E.H., 1974, Blanketed Model Atmospheres for early-type Stars (Washington, Smithsonian Institution Press).
- Lanz, T., 1984, Astron. Astrophys. in press.
- Takada, M. Jugaku, J., 1981, in Upper Main Sequence CP Stars, 23rd, Liège Astrophys. Coll., Univ. de Liège, June 1981, p.163.

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