On the magnetic field of roAp star Gamma Equulei

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Abstract.

HD 201601 or HR 8097 ($V = 4.^{m}69$) is a very sharp-lined chemically peculiar star of spectral class near F0 V. It is remarkable also as a member of the rapidly oscillating CP2 (roAp) stars. Kurtz (1983) discovered oscillations with a period of 12.44 min and an amplitude in B color of Johnson system which was variable between 0.5 and 1.5 mmag from night to night. Zeeman observations from the early 1950s (Babcock & Cowling, 1953) to the late 1980s (Mathys, 1991) showed a longitudinal magnetic field which slowly changed from +500 G to —1000 G. Bonsack & Pilachowscki (1974) proposed a 72-year magnetic period for HD 201601 which is supported by Leroy et al. (1994) on the basis of polarimetry. A sine fit to all published longitudinal magnetic field values by the same authors results in a period of 77 ± 10 yr, which makes HD 201601 the slowest known rotator among the CP stars. A rigidly rotating F0 star with a 77 yr rotation period has a v_e = 0.003 km s^{-1}, which presently cannot be confirmed even with the highest spectral resolution available to us. However, most spectral lines in HD 201601 appear to be broadened, and all published estimates for v_e range between v_e < 3km s^{-1} (Preston, 1971) and v_e = 8km s^{-1} (Renson et al., 1991).

The present spectroscopic analysis of HD 201601 is based on high resolution, high signal-to-noise ratio CCD and Reticon spectra. We derived the following atmospheric parameters: T_{eff} = 7700 K, lg g=4.20. A microturbulence and v sin i cannot be determined reliably, but they must be close to zero, because line broadening can be modelled by magnetic field effects alone. Synthetic spectrum calculations were performed for a few Fe I and Fe II spectral lines which show partially resolved Zeeman pattern. The best fit to the observations was obtained for the mean magnetic field modulus B = 4.0kG and for the mean angle $\phi \approx$ 130° (or 50°) between the line of sight and the magnetic field vector. This value exactly coincides with the angle between the line of sight and the negative magnetic pole as inferred from the dipolar model, proposed by Leroy et al. (1994) for HD 201601. It is not surprising because our observations were obtained near the negative magnetic extremum, and it confirms a dipolar configuration of the magnetic field in HD 201601. Leroy et al. (1994) used a mean value of the surface magnetic field (or magnetic field modulus) B = 3.5kG for their model. If we accept B = 4.0kG and take the observed effective magnetic field B_e =-1.1 kG near the negative magnetic extremum then we obtain the angle between the line of sight and the negative magnetic pole ≈ 120°. Being not too far from $\phi \approx$ 130° obtained from the best fit to the line profiles, it provides a worse agreement between the observations and calculations. Fig.1 shows a comparison between the observed and computed line profile of Fe I λ4705 Å line for both values of the angle ϕ.

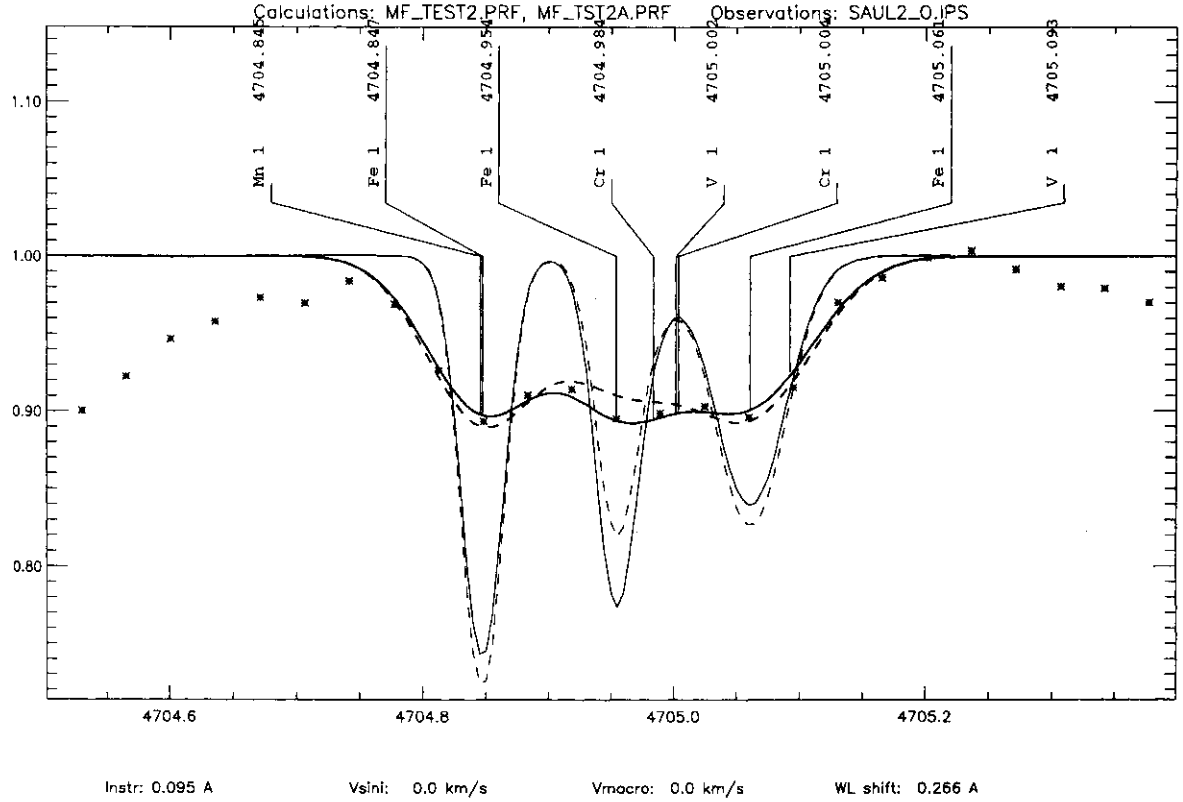

Figure 1: Comparison of the observed (asterisks) and synthesized line profiles for Fe I λ 4705 Å: heavy line – $\phi = 130°$, dashed line – $\phi = 120°$. The pure synthetic spectrum with Doppler broadening only is shown by a thin line.

It is shown that we do not need any rotational broadening to model the observed line profiles, and that the magnetic broadening is totally responsible for non-zero rotational velocities obtained by other authors.

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