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THE EXTREMELY LARGE COMPLEX MAGNETIC FIELD OF THE HE-RICH STAR HD 37776

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ABSTRACT. *A study of HD 37776 has shown that some lines in its spectrum are broadened and splitted. This broadening may be of a magnetic nature, however a very strong magnetic field* B_s *~ 70-80 kGs should be supposed.*

Helium-rich stars are a well defined class of objects with anomalous helium-to-hydrogen ratios and effective temperatures in the range 18000 K to 25000 K, or they are roughly of B2 spectral type. HD 37776, a member of Ori 0B1 association, was found by Nissen (1976) as a He-rich star. Pedersen and Thompsen (1977) discovered helium spectrum variability of He-rich stars. HD 37776 was found by Pedersen (1979) to be both a helium spectrum variable from HeI λ4026 photometry and a low-amplitude light variable from the UVBY photometry with a period of 1.5385±0.003 days. Walborn (1982) found antiphase variations of SiIII and HeI lines.

A longitudinal magnetic field of about 2 kGs was detected in this star by Borra and Landstreet (1979) from photoelectric measurements of circular polarization in the wings of H_β. Later, a double-wave variability was found by Thompson and Landstreet (1985) with the 1.5385-days period. They conclude that HD 37776 has a field geometry which is essentially quadrupole and differs from the usual dipole field distributions in other magnetic stars. Several helium-rich stars have emission in H_α while others do not (Walborn, 1974)). There is no evidence of H_α emission exceeding a few percent of the continuum of HD 37776. The first report on UV line profile variations in the helium-rich stars was made by Shore and Adelman (1986). The IUE study of the CIV and SiIV resonance lines demonstrates that the profiles vary on the rotation timescale. Studying HD 37776 Shore and Adelman (1990) have found that SiIV variations are poorly correlated with those of CIV and their amplitude is somewhat smaller. They conclude that the details of CIV line profile changes are complex and appear to be only slightly dependent on the peculiar magnetic geometry. From the IUE observations they find the effective temperature 22500 K, $R=3R_\odot$, $i=47^\circ$, Early theoretical works on the helium-rich stars explain the origin of helium abundance anomaly in the frames of diffusion model for chemically peculiar stars, originally developed by Michaud (1980). Vauclair (1975) was the first to present the model of a stellar wind rising the atmospheric helium, which is concentrated in a cloud at small optical depth. Nakajima (1985) argues that the hydrogen Balmer emission arises from the trapped, co-rotating magnetosphere above the magnetic equator and has modelled the line profiles. Shore and Brown (1990) propose that circumstellar plasma is trapped in the stellar magnetosphere near the magnetic equator, or is channelled to form jetlike outflows from the magnetic polar regions.

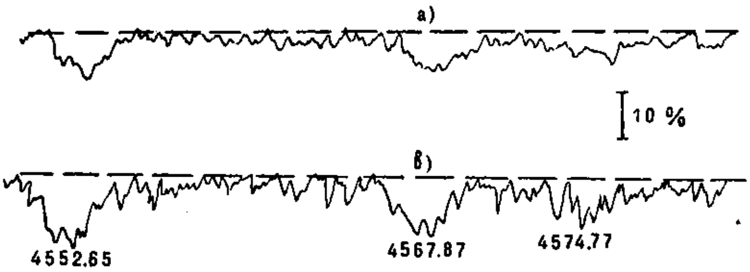

Fig. 1.

In our work three Zeeman spectra of the helium-rich star HD 37776 obtained on Kodak IIaO plates with the 6 m telescope during 1987-1988 are available, and we found that the upper limit of Zeeman shift (which indicates the presence of the dipole field longitudinal component) is 5 kGs. The observations had remained unreduced in more detail until Bohlender and Landstreet (1990) discovered a very large component (about 60 kGs) of the quadrupole component of the magnetic field of the star. Results of our investigation are presented in the Figures. Microdensitometer tracings of the star spectra at two different phases of the period (Fig. 1 a and b) of the spectral region $\lambda\lambda$ 4550-4580 Å, which contains three magnetic sensitive lines: λ 4552 Å with Lande z-value z=1.25, λ 4567 Å with z=1.75, and λ 4574 Å with z=2.00 show the strong enhancement of line widths with z, indicating the presence of a 80 kGs magnetic field. Fig. 2 shows the profiles of SiIII (λ 4552 Å) a), MgII (λ 4481 Å) b), and CII (λ 4267 Å) c) in the right- and left-circularly polarized spectra. The spectra differ strongly, which gives evidence, as we suggested, for the presence of a complex and very strong magnetic field.

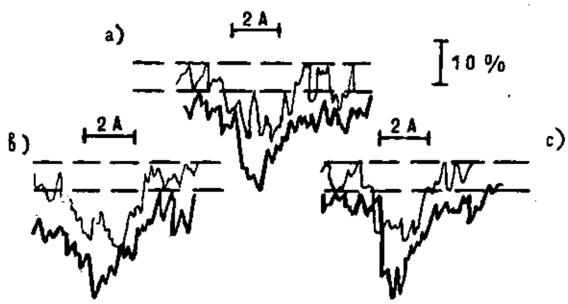

Fig. 2.

Additional high resolution observations with the 6 m telescope are needed. We pro pose to investigate also H_α emision.

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