LINE BAND PROFILES IN THE SPECTRA OF COOL MAGNETIC HELIUM-RICH WHITE DWARFS

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For white dwarfs with effective temperatures smaller than 12000 K, the percentage of objects with a helium-rich atmosphere increases compared to the hydrogen-rich sequence. The carbon abundance, which can be determined from line and band strengths (Bues, 1973; Koester et al., 1982), varies by more than a factor of 1000 within this class. Moreover, for the subclass of white dwarfs with strong magnetic fields, the abundance ratio of H/He differs from that of the DB and DA sequences. The hot star Feige 7, analyzed by Liebert et al. (1977), shows lines of hydrogen and helium at a comparable strength for a moderately strong field of 10^3 Tesla. If there is any chance of finding white dwarfs which are descendants of hot, non-degenerate helium stars with rotation and magnetic fields, then it should be within these objects of mixed composition.

The most thoroughly investigated cool white dwarf of mixed composition is G 99-37 with T_{eff} around 6000 K (Bues, 1973; Liebert, 1976), with a magnetic field of moderate strength. Figure 1 shows a new spectrum taken the ESO 1.52 m telescope. It also shows the strongest bands of CH found in a white dwarf. In addition, our spectra, taken in 1984 (October) and 1985 (April), display H_β , several C I lines and variable branches of the Swan band of C_2. Figure 2 shows the v = 0 transition for 5 spectra taken on April 24th, 1985. From these spectra we derive a period of $\sim$ 4 hours.

For the analysis of the variable lines and bands, we calculated only a single flux-constant model atmosphere with a helium-rich composition, He/H = 1000, log g = 8 and T_{eff} = 6000 K. For the CH band at 430 nm the desired field strength did not vary by more than 10%, whereas for the C I lines and, especially, the C_2 branches, a factor of two is more likely. From CH, the value of 800 Tesla is derived (Rupprecht, 1983). The average field strength is nearly the same as for Feige 7 although the hydrogen abundance is smaller in G 99-37.

For the other two stars, EG 250 and EG 374, we used published spectra and polarization measurements (Landstreet, 1982). The small

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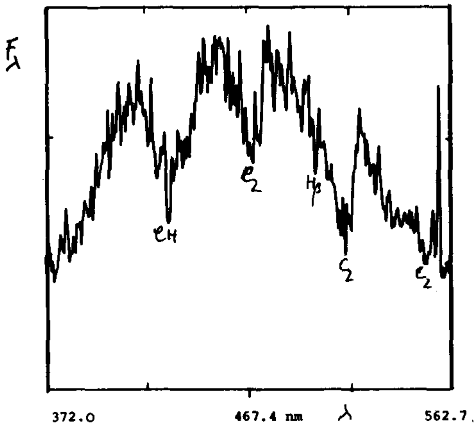

Fig. 1: Observed Flux for G 99-37

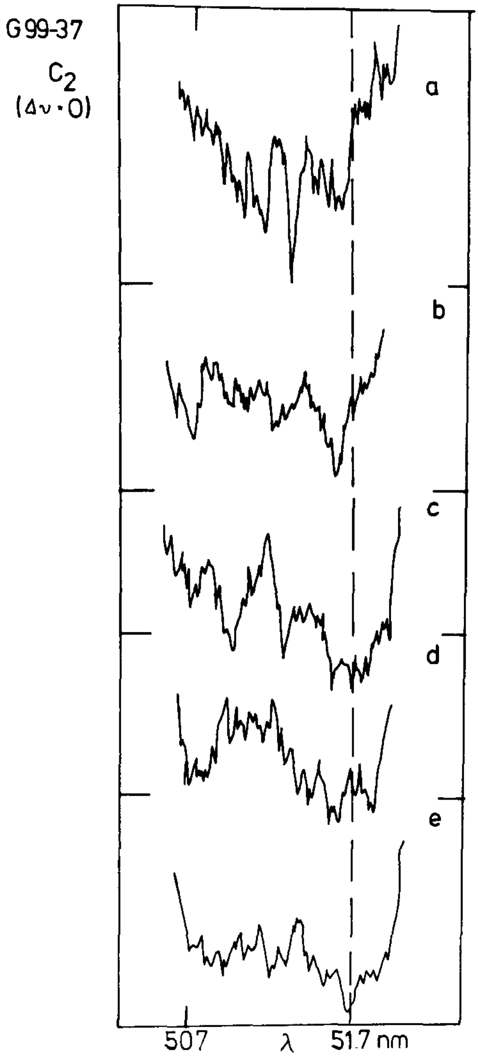

Fig. 2: Observed variation of the C_2 transition (Spectra taken with 114 Å|mm, ESO 1.52m)

field strength for one particular phase of EG 250, and the variation of polarization at the wavelengths of the CH and C_2 bands (Fig. 3), seem to confirm the previously derived abundance ratio. The same is true for the other phases with larger field strengths. In contrast, the energy distribution of EG 374 is in satisfactory agreement with theory (Fig. 4), whereas for the polarization an additional (unknown) absorber has to be assumed.

Concerning the relationship between non-degenerate helium stars and our three white dwarfs, we conclude that these two classes are probably not linked by evolution as neither masses nor magnetic fields fit.

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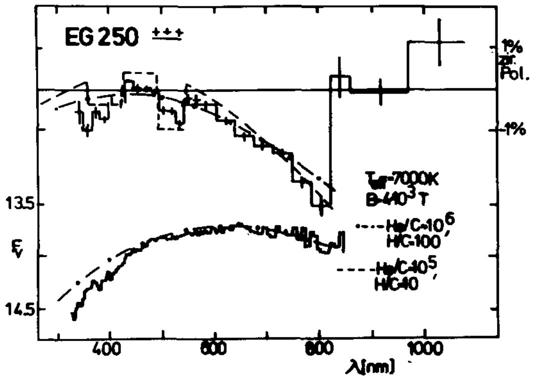
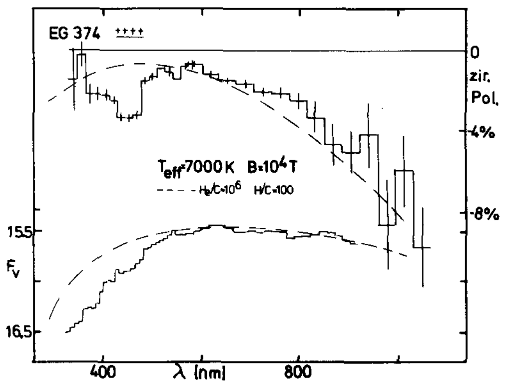


Fig. 3: Flux and circular polarization for one phase of EG 250 (model parameters are indicated, log g = 8)

Fig. 4: Flux and circular polarization for EG 374



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DISCUSSION

VARDYA: Do we see any molecules other than C_2 and CH? Like CN or CO?

BUES: No. There are definitely no traces of CN or CO in the atmospheres of cool white dwarfs with C_2 bands. We calculated the band strengths of CO in the UV region, but the molecule has not been observed. This yields limits on the abundance for O.

MICHAUD: You do not expect to see O or N since the C layer will be on top of N and O and is the most likely to leave traces in the atmosphere.

BUES: This is true for your diffusion mixture of layered envelopes. For an old (5×10^9 years) star the magnetic field should not interfere. Yet we have to keep in mind that the hydrogen abundance is larger than for normal cooled-down DB stars.

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