PHASE CORRELATED SPECTRA OF MAGNETIC WHITE DWARFS

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ABSTRACT. New photometric and polarimetric observations of the magnetic white dwarfs G 99-37 and G 99-47 are in accordance with a period of 4.117h and 0.97h respectively.Spectra taken at various phases could be correlated and analyzed by model atmosphere technique.

INTRODUCTION

G99-37 and G99-47 belong to the group of white dwarfs with moderate magnetic field strengths.G99-37 shows strong spectral features of carbon (CH,C_2,CI),which can be understood with a helium-rich composition(He/C $\doteq$1000)at $T_{eff} \doteq 6000^{o}$K and B $\gtrsim 10^3$Tesla (Liebert,1977,Bues,1986a,Bues et al.1986b).G99-47 is slightly cooler and the spectrum is nearly continuous with a Zeeman split H_α line,which proposes a pure hydrogen atmosphere (Angel at al.1981) at B$\approx 1.5 \times 10^3$ Tesla.

In our spectra,taken in 1983 and 1985,slight changes and shifts of the spectral features could be observed.But it was not possible to derive a period which would be expected for a centred dipole model and could reproduce the variation with different model atmospheres.

That is why we decided to take new photometric,spectroscopic and polarimetric data in order to analyze them by improved model atmosphere technique.

OBSERVATIONS

During Nov.1987 we used the ESO 1m-telescope at La Silla for photometric measurements in the UBVRI and Strömgren system and obtained 51 and 22 observations within 3 nights and the ESO 2.2m-telescope for polarimetry with 29 observations within 3 nights and 13 in one night,respectively. The Bamberg period analysis program,normally used for binary stars,calculated periods of 4.117h for G99-37 and .97h for G99-47.

If we take the strongest linear polarization for phase 1.00,the IDS spectra of 1986 and the CCD spectra of 1987 (ESO 1.52m,114 Å/mm) can be correlated to phases as shown in Table 1 for G99-37.

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TABLE 1:Spectra and their phases of G 99-37

JD	phase	
2446712.8667	.01	IDS
2446713.8493	.74	IDS
2446714.8507	.57	IDS
2447112.8451	.16	CCD
2447113.8181	.83	CCD
2447113.8389	.95	CCD
2447114.8007	.55	CCD
2447114.8229	.68	CCD
2447266.5073	.73	CCD

The two spectra of Fig.1 demonstrate well the shift of the band heads and the variation in strengths for the C_2 (0,0),(2,2),(1,0) and (3,2)-transition.CH is less involved in phase changes.

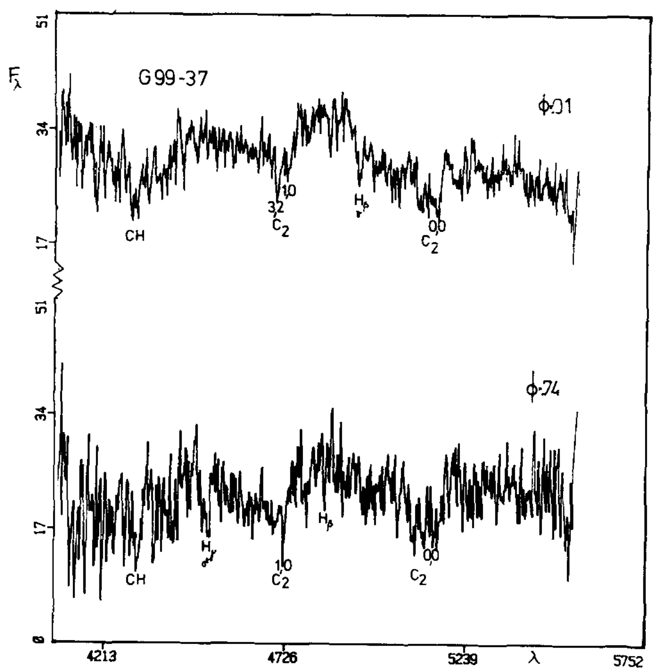

Fig.1: Two blue IDS-spectra of G99-37 with phases .01 and .74 C_2 (1,0) and H show the strongest displacements.

For G 99-47,Fig.2 shows the strongest H_γ feature with the π-component shifted by only 20Å in the lower part,which corresponds to the smallest field,the upper Zeeman triplet is correlated to the H field determined by Liebert et al.(1975) to be $5.6x10^2$Tesla.Due to the very short period and the necessary exposure times of at least 10 min,the phase

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correlation for less noisy spectra (30 min exp.time) is not of much use for a reproduction of the spectrum by model atmospheres.

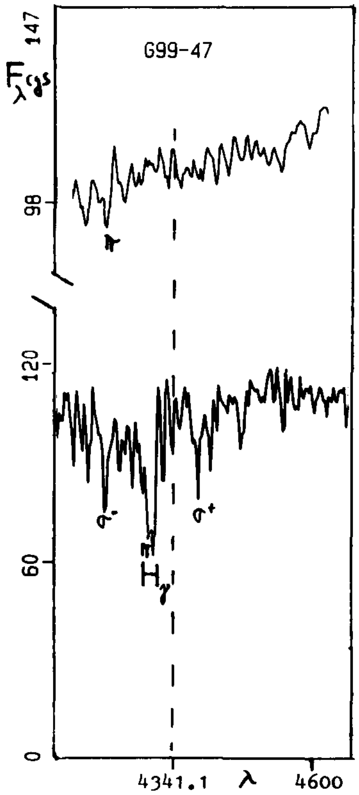

Fig.2:2 spectra of the H_γ region of G99-47 with short exposure times.The unshifted position of H_γ is indicated.

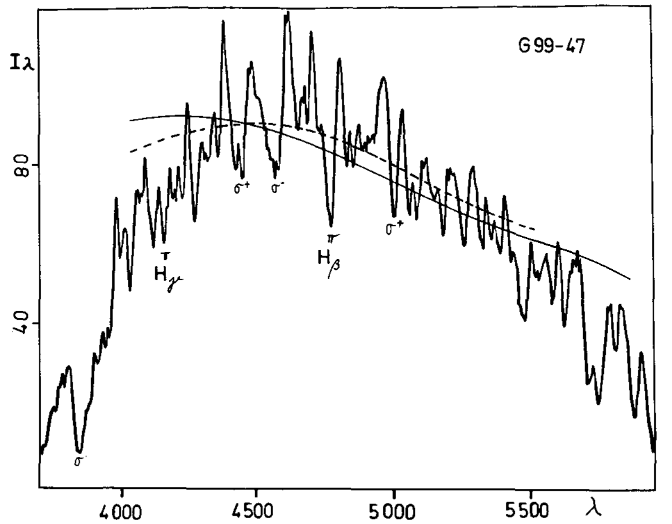

Fig.3 :Flux of a model atmosphere of 6000 K,B=10^3Tesla compared to a transformed IT spectrum(10min exposure time)

ANALYSIS

For white dwarfs with $T_{eff} \leq 7000^{0}$K and observed polarization of more than 2% line and band shifts due to the quadratic Zeeman effect are important for the Rosseland mean of the opacity since the major part of the flux is radiated in the visible region of the spectrum.A certain amount of carbon has to be taken into account already for the initial parameters like $\varkappa$ and P_g. We calculated tables for gas pressures of 10^5 to 10^{10} and temperatures of 11000^0 to 5000^0K for several magnetic fields. Model atmospheres have been computed for T_{eff}= 6000 K and 7000 K,log g

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=8 for H/He=1000 and 10^{-3}. Special emphasis is taken for the absorption of the Balmer lines,single rotational transitions of C_2 and CH,where the semiempirical parameters,derived by Pragal (1986) from our earlier spectra of G 99-37 were used.

For the combined solution of radiation and polarization in the model atmosphere a modified Unno scheme was solved by numerical integration. Fig.3 shows the result for a high field strength of G99-47,the spectrum appears to be continuous due to the high pressure.The outer structure of the hydrogen atmosphere should be calculated in more detail to obtain line profiles.

For G 99-37,Fig.4 demonstrates the behaviour of the C_2 band heads for $i=90^{o}$,where a detailed structure of (0,0),(1,1) and (2,2) is obtained for $B>10^{3}$Tesla.So we are optimistic aboutour theoretical treatment of C_2 with magnetic field strength for various phases of G 99-37 and the other stars with carbon and stronger fields to get information on field strength and composition.

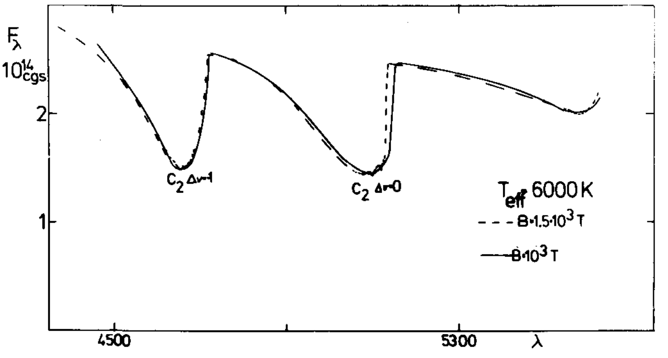

Fig.4 The flux of a model atmosphere relevant for phase .45 of G99-37 with B= 10^{3}Tesla, ≙ phase .01 with B= 1.5×10^{3}Tesla.(H/He=10^{-3},H/C=10)

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