AG Peg - OBSERVATIONS AND PROSPECTS

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Abstract

New spectroscopic observations of the symbiotic star AG Peg are briefly presented. Radial velocities from four spectra were measured and the general view of the spectrum in the blue region was compared with spectra from 1970 – 71. By adopting of the 812.9 day period from photometry the orbital elements of the cool component were calculated.

1 Introduction

AG Peg is one of the well and often observed symbiotic stars. It is rather convincingly proved that there is a spectroscopic binary in which no eclipses occur and the changes of brightness are caused by refection of radiation of the small hot WN6 star in the atmosphere of the cool M-giant (Belyakina 1970). Dimensions of the system are of that sort that the primary M3 III component does not fill the Roche lobe (Chochol 1988). Most of the spectroscopic observations were carried out by Merrill (1929, 1932 ,1942, 1951, 1959) who has discovered a period of about 800 days in radial velocities. This value of the period was later demonstrated also in the photometry (Belyakina 1968). The general view of the spectrum is changing continuously since the times of Merrill's observations in the first place by increasing of ionisation.

The nature of the hot secondary component is, however, not yet known. The brightening of the system about 1855, the secular changes of the amplitudes and mean values of radial velocities and the secular photometric changes are also still waiting for the explanation.

2 Observations

Nine medium dispersion spectrograms were obtained at the coude-focus of the 2-m telescope at Ondřejov in autumn of 1989 (Table 1). Four spectra were taken in the blue region 3660 – 4930 Å and five in the red region 4500 – 6700 Å. For the present four spectra were measured to obtain radial velocities – three (plates 4854, 4860, 4864) with the aid of an oscilloscopic comparator and one (plate 4861) on the Abbe comparator. From the best spectra in the blue and red region (plates 4860 and 4864) were made rectified normalized intensity tracings with the dispersion of 2 Å/cm for comparison of the view of spectra in 1989 and in 1970 – 71 and for identification of spectral lines. On the blue spectrum were identified about 120 emission and 60 absorption lines, on the red region 40 emission and 60 absorption lines.

3 Spectrum in 1989

The spectrum of AG Peg in 1989 is very similar to the spectra obtained in 1970 – 71 by Hutchings and Redman (1972) only with some differences (Fig. 1 – 5).

The lines of the Balmer series are sharp and intense, visible on the good exposed spectrum (plate 4860) to H29. These sharp hydrogen lines are blended with the broad lines of the Pickering series of He II to H10. The H8 line is strongly blended with He I 3888 and more weakly blending is also by the following lines: H11 and N III 3771, H15 and O III 3712, H16 and O III 3702.

Radial velocities from the Balmer lines (Table 2) agree well between plates measured oscilloscopically (plate 4854 – 7 lines and 4860 – 22 lines) but the value from the plate 4861 is much lower because it was measured on the Abbe comparator only from 3 lines which were possible to measure on the underexposed

plate. There is a possibility that on the plate 4860 the Balmer progression is observable like on the plate 3 in the paper of Hutchings and Redman (1972) (Fig. 6).

The He I lines are also sharp and intense, but for example the He I 3926 line is now stronger than in 1970 – 71 and the differences of the radial velocities between singlets and triplets are little (Table 2). Only the value of the radial velocity from He I 3 on the plate 4854 is considerable different from the He I 1 velocity where were 3 lines measured.

Table 1

SPECTROGRAPHIC OBSERVATIONS OF AG PEG

Plate	Date	Middle of exp.		Exp.t.	Disp.	Region	Rem.
No.	D-M-Y	UT	J.D. hel.	(min.)	(A/mm)	(A)	
		h m	2400000+				
4854	18-09-1989	23 49	47788.497	360	17	3660-4930	u
4856	19-09-1989	23 40	47789.491	246	34	4500-6700	u
4860	22-09-1989	22 00	47792.421	360	17	3660-4930	
4861	2-10-1989	20 16	47802.349	90	17	3660-4930	u
4864	5-10-1989	21 15	47805.390	360	34	4500-6700	
4961	10-11-1989	20 03	47841.337	311	17	3660-4930	
4972	16-11-1989	18 20	47847.265	196	24	4500-6700	u
4978	18-11-1989	19 02	47849.294	300	24	4500-6700	
4986	28-11-1989	17 48	47859.241	180	24	4500-6700	u

Remark: u underexposed

Table 2

RADIAL VELOCITIES

Plate	RV (Km/s)										
No.	H	HeI1	HeI3	HeII	NIII	MII	OIII	CIII	[OIII]	SiI,II	Abs.
4854	-20.8	-16.9	-6.7	-13.5	-13.0	-15.3	-24.6		-20.8		
4860	-21.1	-16.3	-17.1	-12.3	-19.9	-16.8	-20.2	-13.7	-26.8	-19.9	-16.5
4861	-7.3	-14.2	-12.6	-9.9	1.3						
4864		-11.9	-10.2	-3.8						-9.2	-19.1

The He II lines are very broad and the strongest one is He II 4686 but its width is three times smaller then in the 70's. The He II 3923 line before not observable is now weak but presented. Radial velocities from He II agree approximately with the values derived from the He I lines. A larger difference is on the plate 4864 where only the He II 5411 line was measured.

From the nitrogen lines only the N III lines are presented. N III 3938, 4097, 4103, 4634, 4640, 4641 are sharp and intense like H or He lines but weaker and there are further weaker lines: N III 3754, 3771, 3934, 4510, 4514, 4518 and 4200. The N III 4634, 4640, 4641 lines are stronger than in the epoch of 70's. The N III 3938 is now sharp and intense while in the 70's was not visible. The He II and N III 4200 blend is now narrower and weaker than in the 1970 – 71. An interesting phenomena is the fact that the N IV 4058 line which was very intense and broad in the past is not seen in these present spectra (Fig. 2).

From the metal lines are the most numerous those of Fe II, Ti II and Si II. The Fe II 4351, 4629 lines decreased since the last epoch and the Ti II 3900 line on the contrary is now more intensive. The Si II 3856, 3862 lines were considerably weaker than He I 3867 but in the present epoch these lines are almost of the same intensity as the He I 3867 line.

The Si I 3905 line was stronger then Si II 3862. Now these two lines have almost the same intensity. What is considering of the forbidden lines only the [O III] 4363 is certainly presented but it is weaker than in the 1970 – 71 when it was stronger than He I 4387 and now is less intense than this line.

Radial velocities measured on the four plates are summarized in Table 2. From two plates were radial velocities of the cool component obtained (absorption lines). These were added to the previous published velocities of the cool star (Hutchigs and Redman 1972, Cowley and Stencel 1973, Hutchings et. al. 1975) and new orbital elements of the circular orbit of the M-star were computed. At the same time 25 values

Fig. 1

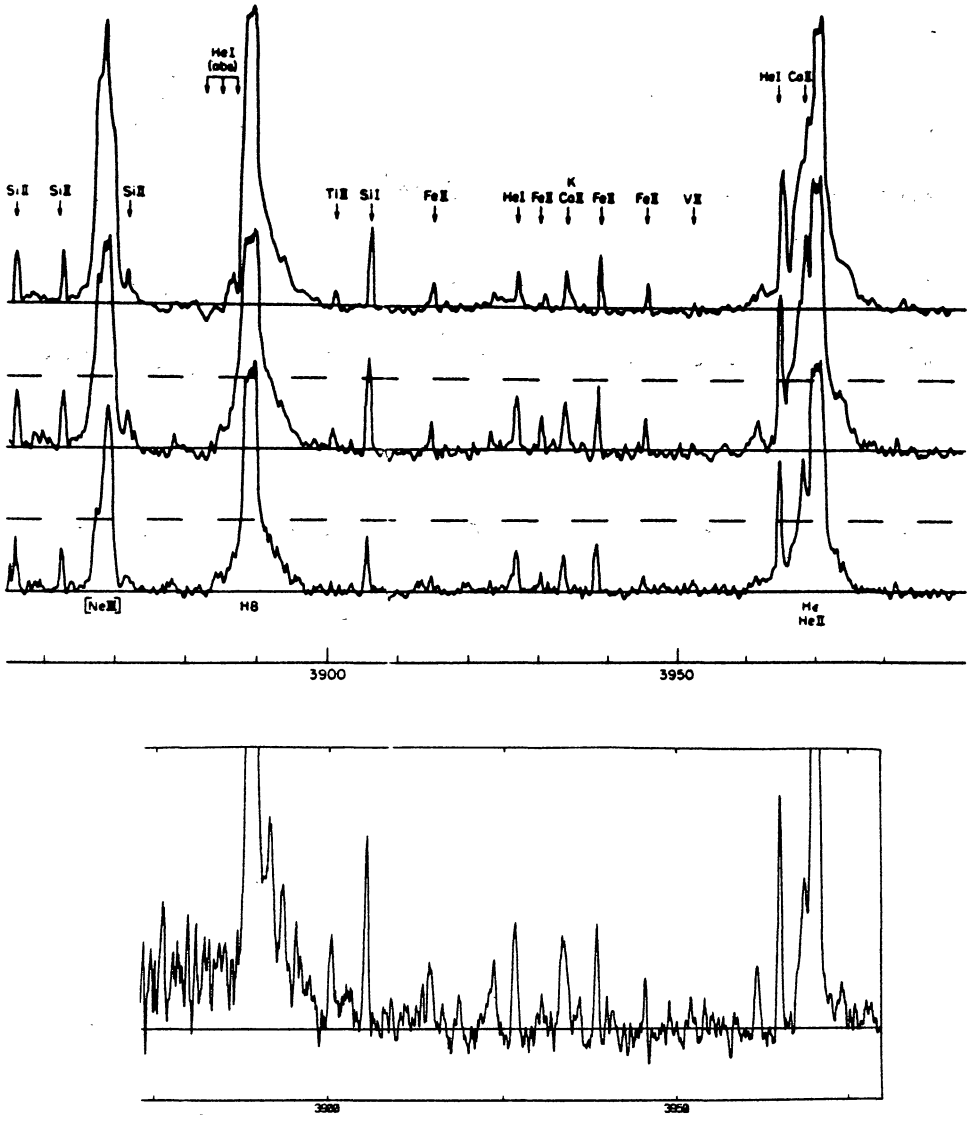


Fig. 2

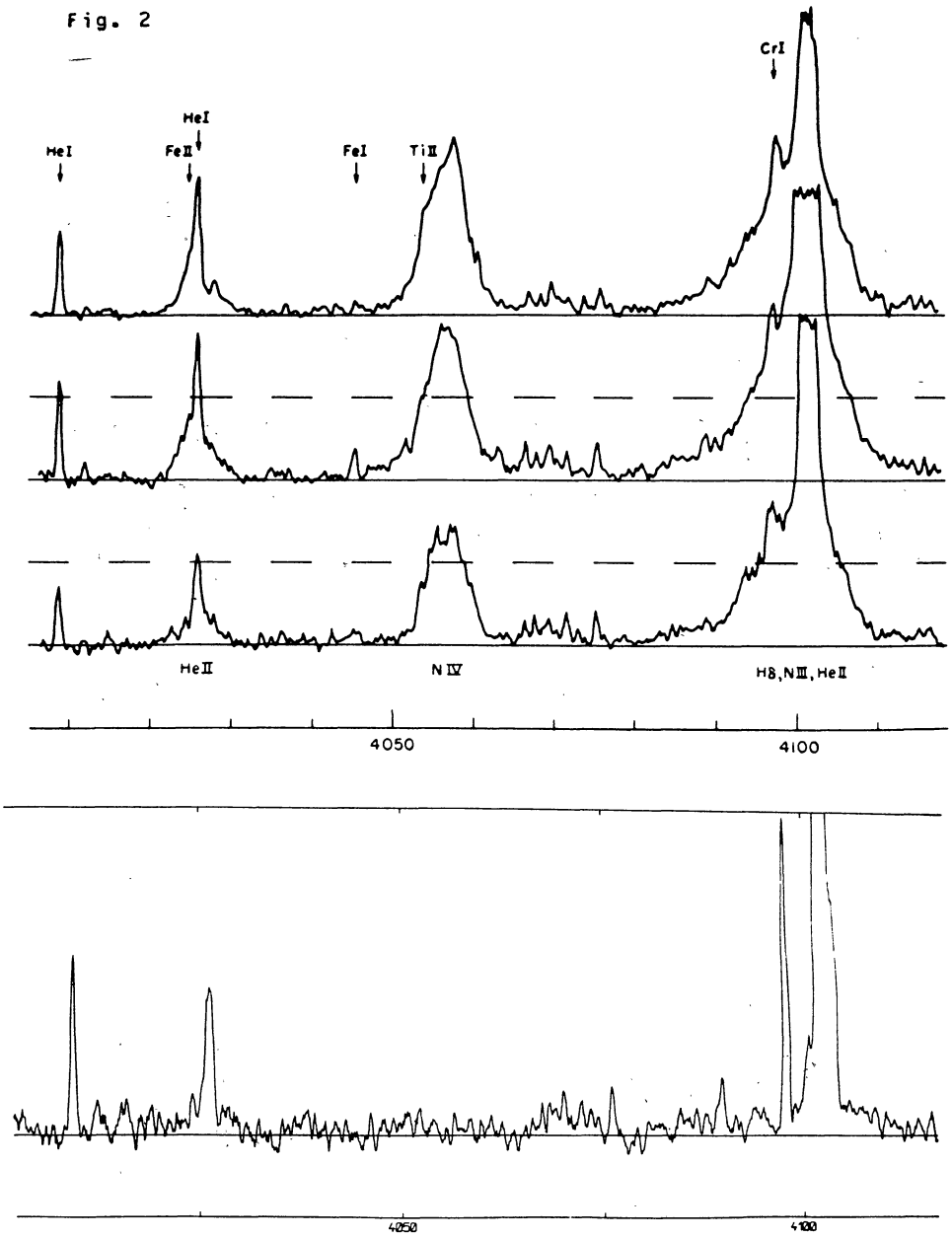


Fig. 3

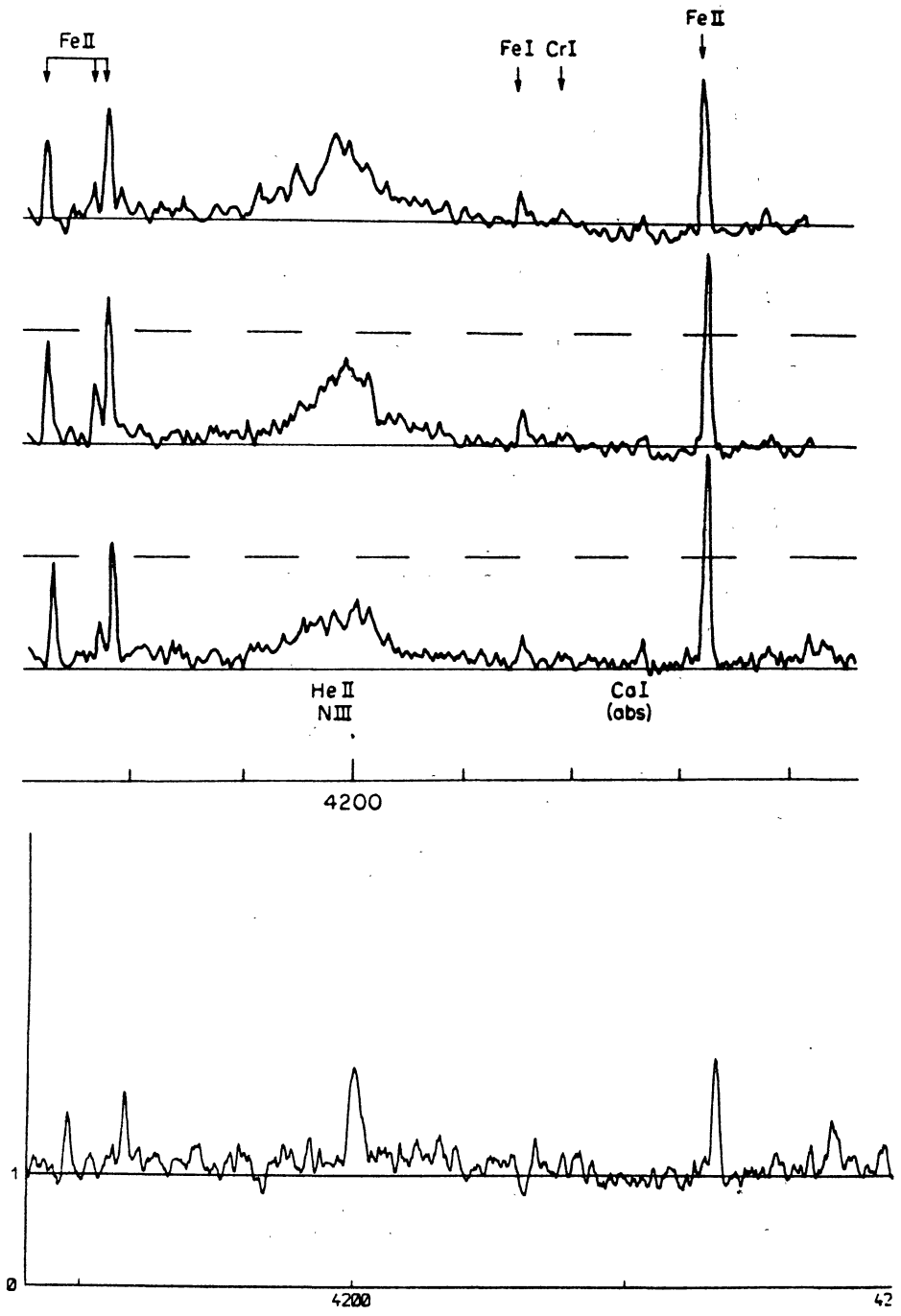
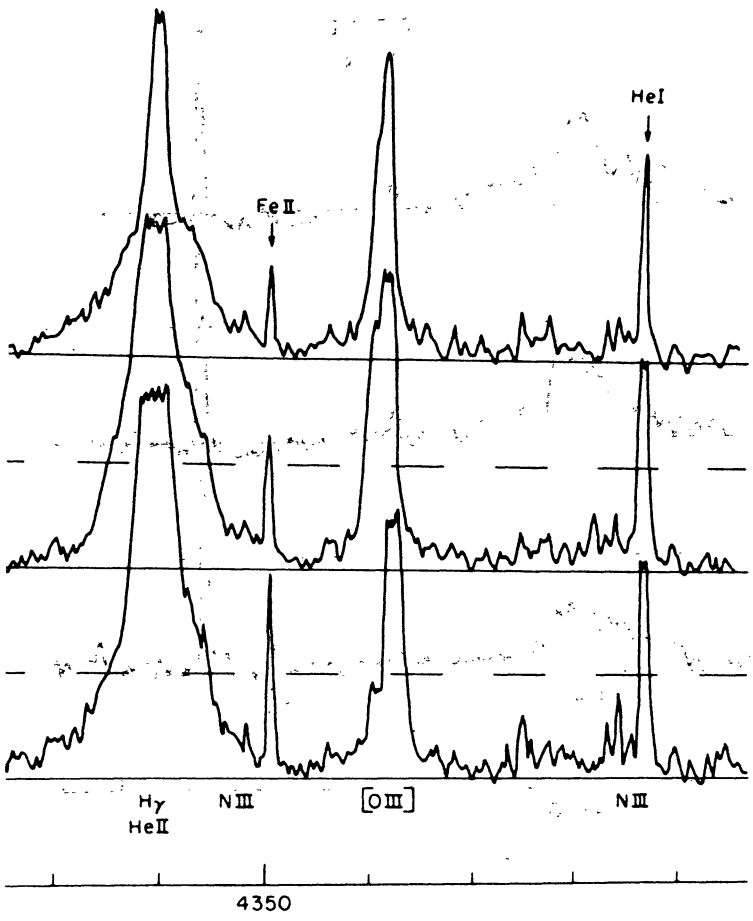


Fig. 4



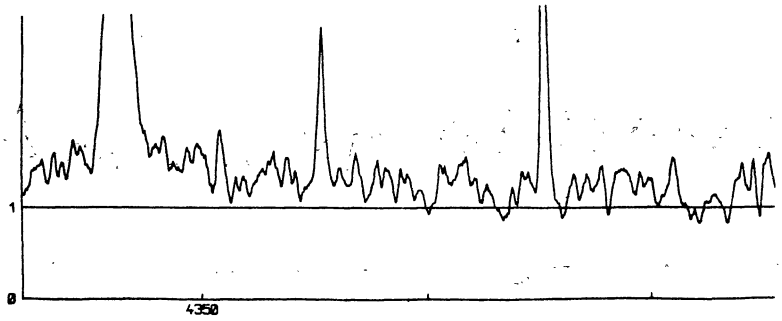
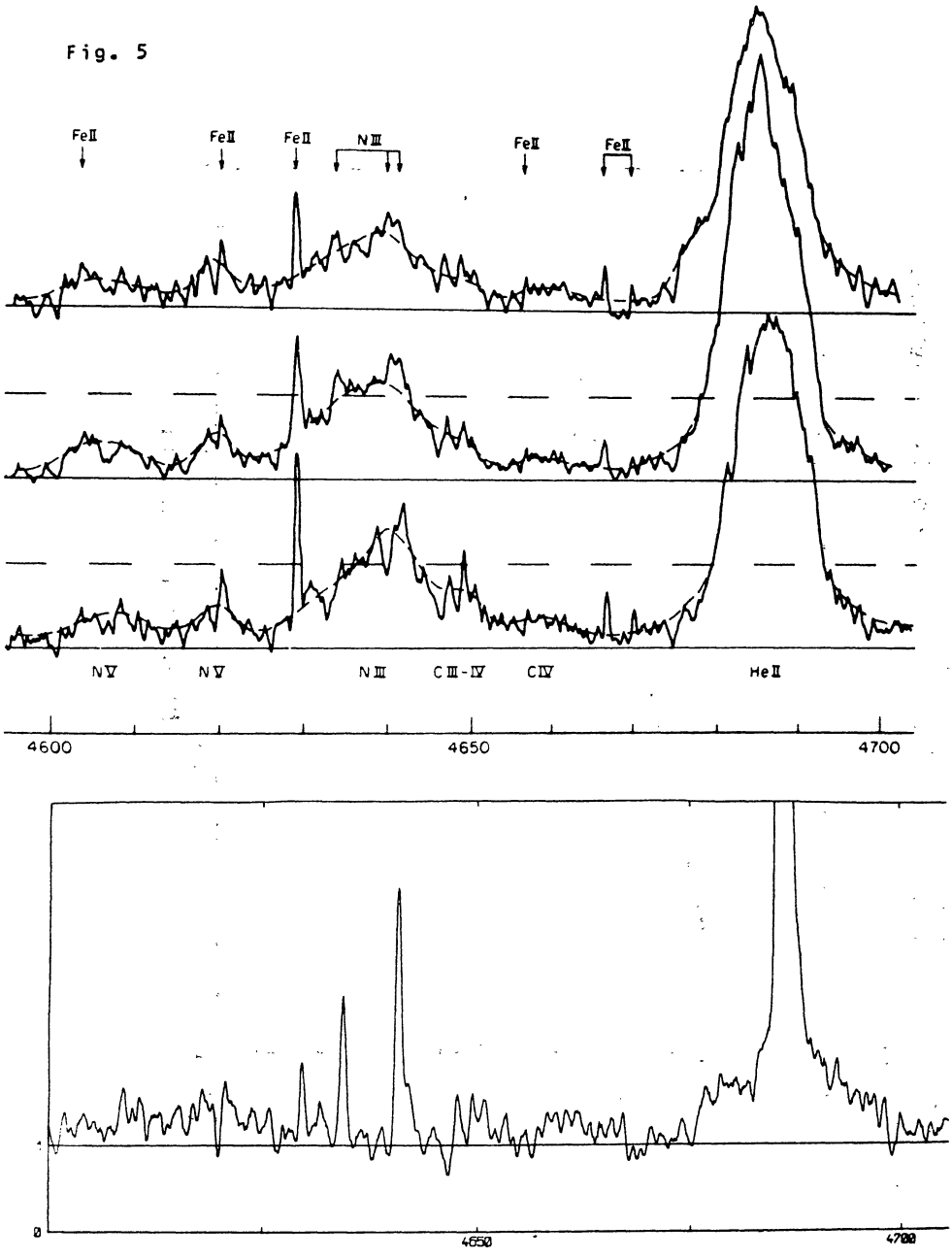


Fig. 5



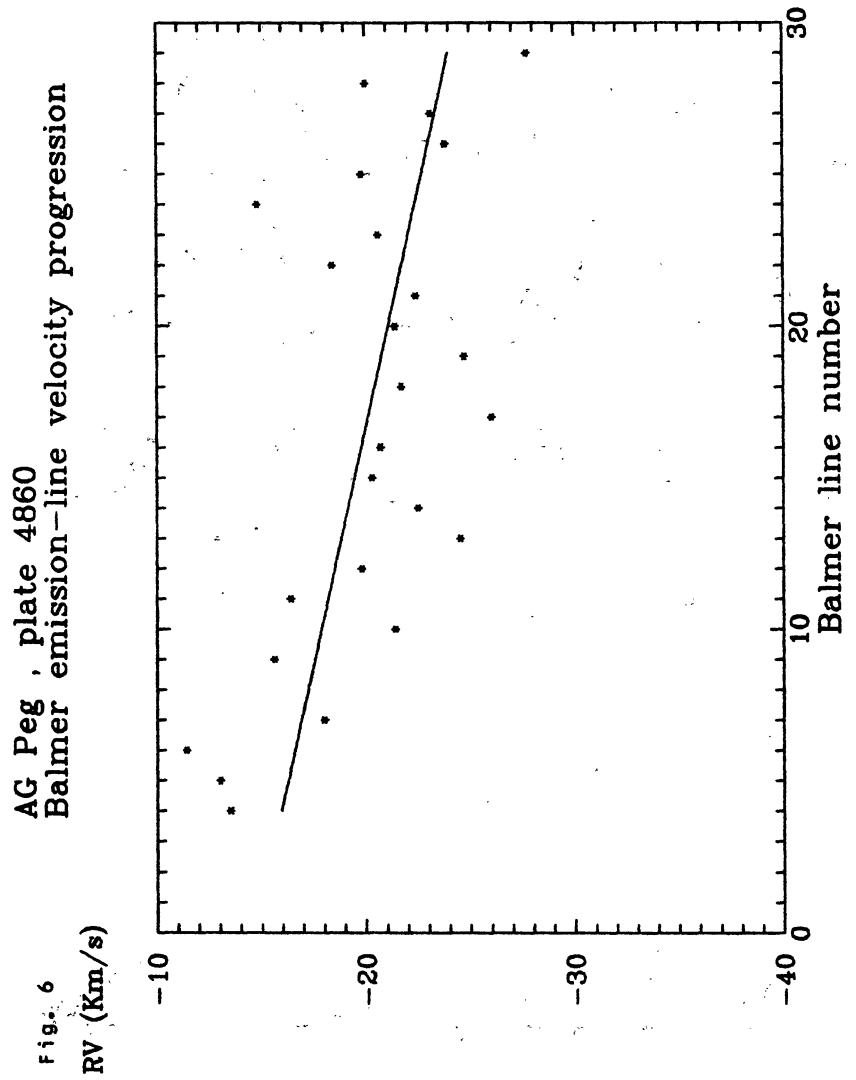


Fig. 6

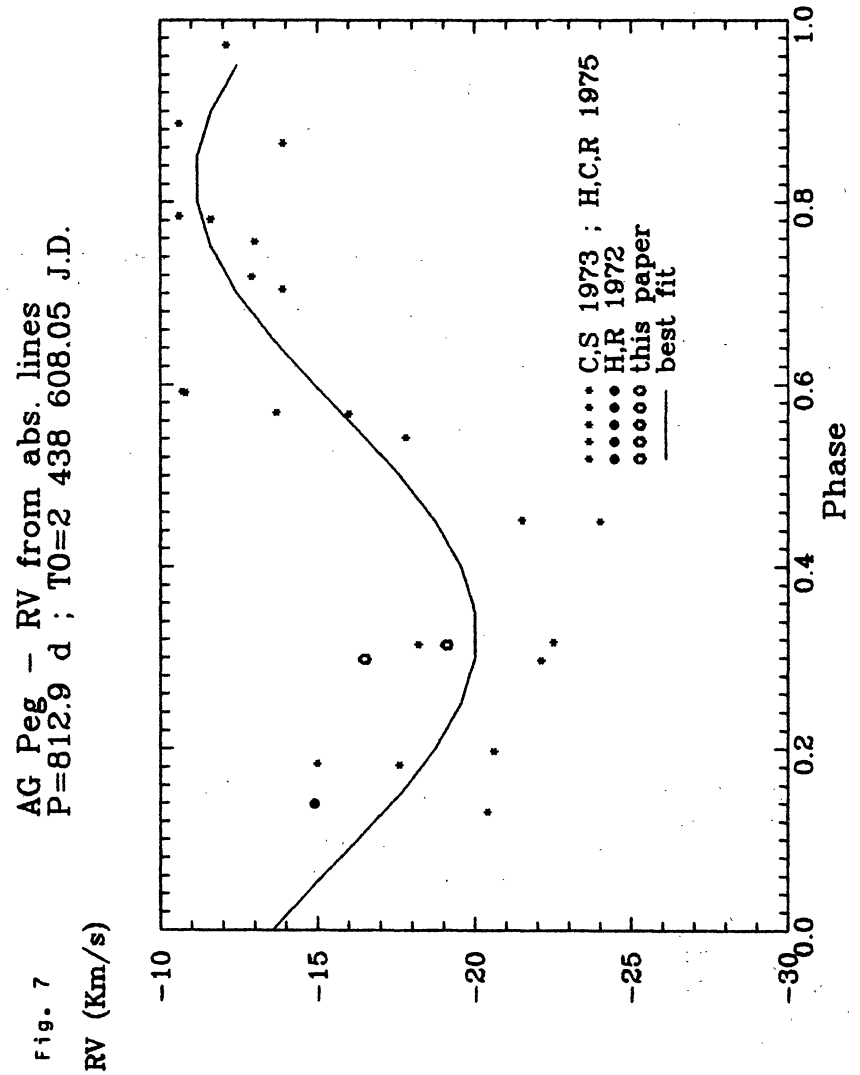


Fig. 7

of the radial velocities were used, one measurement from J.D. 2441618.74 (Hutchings at. al. 1975) and two values from J.D. 2440854.8 and 2440919.6 (Hutchings and Redman 1972) were omitted because of the large deviation by the O – C computing from the elements in Table 3. The elements were computed by assuming of the 812.9 day period derived from photometry (Komárek 1990). Zero phase on Fig. 7 corresponds to J.D. 2438608.05 (maximum of light) and the best fit is the radial velocity curve computed according to the elements in Table 3.

Table 3

Orbital Elements of the Cool Component of AG Peg

P = 812.9 d (assumed)	T_0 = 2440904.8±15.6 J.D.
K = 4.5±0.5 km/s	$a.\sin i = 71.6\ R_\odot$
V_0 = -15.6±0.4 km/s	$f(M) = .0075\ M_\odot$

T_0 is the time of the radial velocity maximum

4 Prospects

The spectrum of AG Peg still continues in the development which is demonstrated by the secular changes in the view of the spectra. Therefore we plan to obtain at Ondřejov Observatory further spectra in the blue region where is sufficient number of lines and better dispersion for determining of the behaviour of radial velocities of different ions, line-formation regions and secular changes in the spectrum. For this purpose we will use also 26 high dispersion UV spectra from the IUE satellite mainly from the short wave region where is larger number of spectral lines.

Further spectroscopic observations and processing of already existing data should contribute to the disclosing of the nature of the hot component, photometric and spectroscopic secular changes of the whole system AG Peg.

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