SPECTROSCOPIC OBSERVATIONS OF AG DRA

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AG Dra is an interesting symbiotic star, on account of its very high negative velocity and its earlier spectral type among the symbiotic stars. This star has been classified as dG7 (Wilson,1943), K1 II (Roman,1953) and K3 III (Boyarchuk,1966). It has a variable radial velocity.

During summer 1981, spectroscopic observations of AG Dra were performed at the Haute-Provence Observatory using the Marly spectrograph with a dispersion of 80 A mm^{-1} at the 120 cm telescope and using the Coudé spectrograph of the 193 cm telescope with a dispersion of 40 A mm^{-1}. Professor Ch. Fehrenbach very kindly given me a plate of the star which he had taken in July,1966, using the coudé spectrograph of the 193 cm telescope with a dispersion of 40 A mm^{-1}.

The actual outlook of the spectrum of AG Dra is very different from what it was in 1966 in the sense that only a few intense absorption lines remain, the heavy emission continuum masking the absorption spectrum, while on the 1966 plate, about 140 absorption lines have been measured. They were due to FeI, TiII, TiI, CaI, CrI, SrII, CeII and BaII,etc. Perhaps SmII was present. The lines of TiII, SrII and BaII were relatively strong, showing very high luminosity star features. There was also a sharp intense absorption at λ 3933 of the interstellar K line with a radial velocity of about -38 Kms^{-1} which still exists with the same radial velocity. A number of coudé plates of giant and supergiant standard stars of early K and late G types were obtained in 1981, the TiII, SrII and BaII lines clearly show luminosity effects in these stars. The 1966 spectrum of AG Dra matches well enough that of the KOIb Star, 12 Peg. (Fig.1).

Numerous emission lines have been measured, most of them, present in 1981, could also be detected in 1966. They are due to H, HeI and HeII. The Balmer lines are recorded in emission as far as H24. The HeII 4686 A is always strong. A few Pickering lines have been detected. We have found also a very strong line at 3203 A of HeII (3-5) on the Marly spectrograph plates. There is evidence that the HeI and fluorescence lines

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of O III are more intense in 1981. On the 1981 plates, we have found also emission lines of OII multiplet (1). We have not seen any one of the three nebular lines of [OIII].

The emission continuum which heavily veils the absorption spectrum in 1981 in the photographic region was much weaker in 1966. The Balmer emission continuum was as strong in 1966 as in 1981. On the Marly spectrograph plates, the stellar spectrum in ultraviolet can be traced beyond λ 3200 A (Fig.1). However, it seems there was not much changes in the ultraviolet region between 1966 and 1981 as shown by the comparison of two coudé plates taken in 1966 and 1981 in Fig.1.

The velocities obtained by us are summarized in Table 1, n is the number of the lines. The absorption mean velocities were derived essentially from lines of FeI.

Table 1. Radial Velocities for AG Dra

1966			1981			1966		1981	
em.	V	n	em.	V	n	absorp.V	n	absorp.V	n
H	-158,2±2.6	21	H	-146,0±2.8	20	-149,8±1.5	41	-157,9±7.2	5
HeI	-163,0±3.4	7	HeI	-154,4±3.0	15				
HeII	-149,9±2.7	3	HeII	-164,8±4.9	5				
OIII	-139,7±1.1	2	OIII	-153,0±1.7	5				
			OII	-165,1±5.1	3				

From the data of Wilson (1945) and Roman (1953) and ours, there is no reason to have doubts about the variability of the radial velocities of the star. The emission variations seem to be periodic with a period of about 35 years. This is shown in Fig.2. The absorption line velocity which has been derived from the very few available absorption lines when the spectrum of the star was too much veiled by the emission continuum is not sure.

In conclusion, AG Dra could be classified as supergiant K0Ib, according to the relative intensities of TiII, SrII, BaII and CaI on the 1966 plate. The velocity variations of emission lines suggest a period of about 35 years. But more spectroscopic and photometric observations are necessary to confirm the period. It would be interesting to learn more about the blue emission continuum which greatly enhanced in 1981, while there was no conspicuous changes in ultraviolet continuum between 1966 and 1981. As to the strong emission line HeII 3203 A, it may be recalled that Y. Andrillat (1979) drew attention to the emission line HeII 10124 A (4-5) in some Of stars. Like HeII 10124 A in Of stars, the formation

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Figure 1 : AG Dra and comparison stars

The spectrograms of AG Dra ,taken on July 23rd 1966 and on August 16th 1981, as well as the spectrograms of comparison stars 12 Peg K0 Ib and ηCyg K0 III, were obtained with Coudé Spectrograph of 193cm telescope. The others were taken with Marly spectrograph.

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of HeII 3203 A in AG Dra also could involve chromospheric phenomena.

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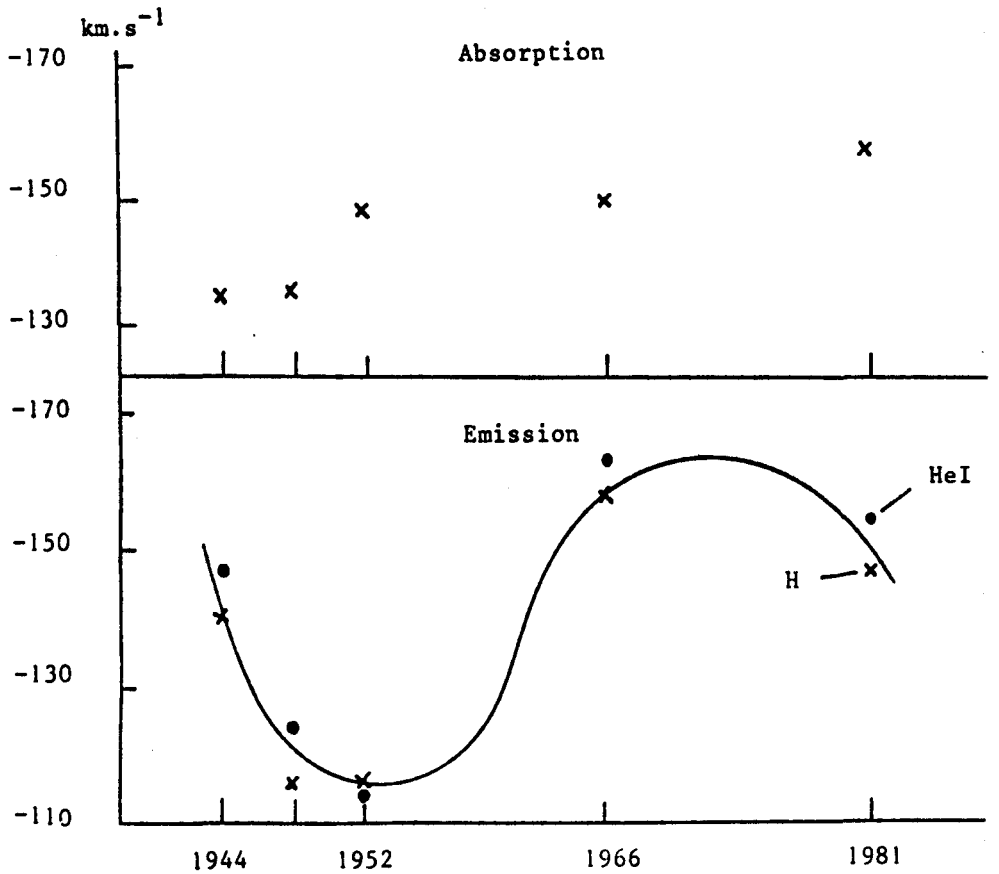

Figure 2.

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DISCUSSION ON AG DRACONIS

Plavec: (to Oliversen) I notice that the light curve you are using is in the U filter. I believe that one of the biggest blunder in astronomy was the introduction of the U filter defined so that its sensitivity extends to both sides of the Balmer jump or, rather, the use of this filter for binary star work. In particular, if continuous bf + ff hydrogen radiation is present, variable Balmer emission will dominate the U magnitude. From the scans Keyes and I have, we concluded that this H emission is strong. Therefore the U-light curve will reflect predominantly the behaviour of circumstellar gas. Thus, you have justly concluded the the light curve cannot be interpreted to mean that you are dealing with a contact binary.

Fehrenbach: AG Dra has a strong Balmer discontinuity, whose variations should explain that of U. The radial velocities of the emission and absorption lines are of the order of -150 km s^{-1}, and unchanging. The period of 20 years suggested by Huang is the result of an attempt.

Slovak: AG Peg shows a 820^d sinusoidal variation in its light, ascribed to the heating of the secondary by the hot primary. The variations in AG Dra may arise from a similar situation, if indeed it is a binary system.

Oliversen: Our model does not rule out a binary model. Modulation of U could be produced by rotation of the cool star or by the binary period of the hot object. Let me just state that the U-light curve is not probably produced by an eclipse solely of the hot object, since the separation is too great.

Keyes: Our simultaneous IUE and ground-based scans covering 1200-7000 A in May and October 1980 (both pre-outburst; the latter within two weeks of outburst) show no continuum variation; however H, HeI and HeII have increased by ~ 20 % in October, possibly an outburst precursor. It should be noted that for the densities quoted by Altamore et al. the lack of [OIII] 4363 + 5007 is most likely only a contrast effect because of the optical continuum which is considerably brighter at 4300 A relative to λ 1660 A (OIII]) than in most symbiotic stars.

Fehrenbach: There are lines with P Cygni profile in the ultraviolet?

Viotti: Only NV λ1238 presents at high resolution a P Cygni profile with an absorption component shortward shifted by about -100 km s^{-1}. CIV appears symmetric only in emission. Note that the presence strong interstellar lines in MgII with a radial velocity difference of $+110$ km s^{-1} with respect to the emissions could be erroneously interpreted as inverse P Cygni profile.