CIRCUMSTELLAR ENVELOPE OF THE SUPERGIANT 89 HERCULIS

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A bright enigmatic supergiant, 89 Her (HD 163506; F2Ia, $M_{bol}=-7^m.5$), exhibits the light variations (Percy et al. 1979, Fernie 1981, 1983) as well as the changes of radial velocities and structures of Balmer and sodium lines. Sargent and Osmer (1969) have given some evidences for the existence of expanding circumstellar envelope around 89 Her and have discovered 24 emission lines of neutral metals in its spectra.

We have undertaken the complex study of the nature of 89 Her basing on our spectroscopic observations carried out at the Dominion Observatory starting from 1970. The aim of the present paper is a discussion of narrow emission lines originated in the envelope of 89 Her. We have discovered 10 new narrow emission lines, as follows: λλ 4952.36 (NiI), 5587.36 (FeI), 5591.322 (ScI, FeII), 5702.666 (TiI), 5711.0735 (MgI), 5796.757 (CrI), 5846.306 (VI), 6270.238 (FeI), 6303.41 (EuII), 6325.22 (TiI) and probably FeII 6247.562 and CrI 6657.54 Å. The equivalent widths of the all 34 emission lines measured on our spectrograms, taken in 1970, 1975, 1977 and 1978, exhibit the significant (up to a factor of eight) irregular time variations. The profiles of these lines are usually single but sometimes some of them are splitted into two components.

We have measured the radial velocities of these emission lines using the "Arcturus" oscilloscope machine in Victoria as well as those of absorption lines in order to explain a general nature of 89 Her. The changes of the average radial velocities of absorption and emission lines with the phase of binary system estimated from absorption lines are shown in Fig.1. The radial velocities of absorption lines undergo long-term periodic changes indicating the binary nature of 89 Her. The best fitting of all our measured radial velocities reveals 221.93 day orbital period and $\gamma = -27.99 \pm 0.56$ km/s (Smoliński et al. 1980). The binary nature of 89 Her was supported by Arellano Ferro (1984) who obtains a longer orbital period, i.e. 285.8 days. On the other hand, the daily average radial velocities of the emission lines seem to exhibit only random fluctuations with the range of 6 km/s. It is worthwhile to underline a fact that the average value of all measured radial velocities of the emission lines, i.e. $V_r^{em}=-27.94 \pm 2.28$ km/s, is equal

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to the γ-value of the binary system. Therefore, the emission lines are the recombination lines formed in a common envelope of the binary system. Probably they originate due to the density enhancement and adiabatic cooling appearing in the process of mass loss from the star.

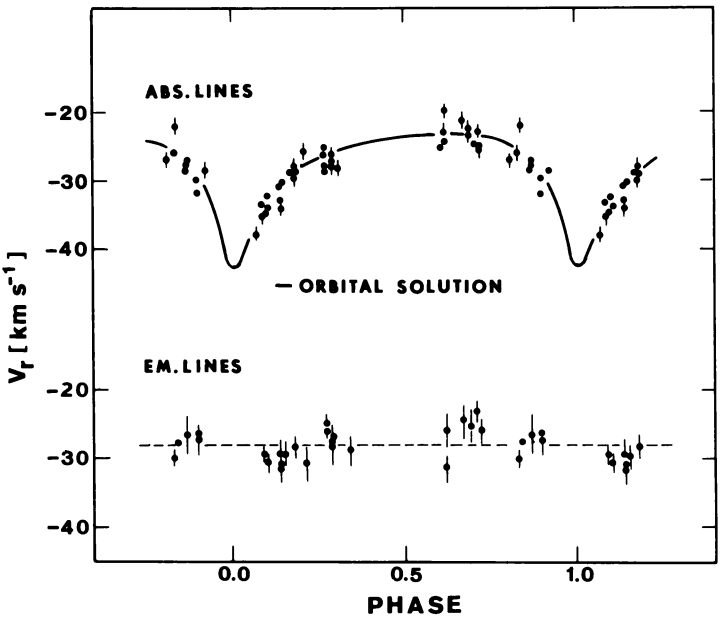

Fig.1 The changes of radial velocities of absorption and emission lines with the phase of binary system.

Their steady occurence indicates the significant mass loading into the envelope supported by a behaviour of the circumstellar lines of hydrogen and sodium (D_1D_2) and by existence of the infrared excess (Humphreys and Ney 1974).

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