THE CIRCUMSTELLAR MATTER IN THE BE + K BINARY KX AND SEEN IN THE UV SPECTRA*

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KX And (HD 218393) belongs to well-known and often observed Be stars. The periodicity of spectroscopic characteristics as well as other observations led to the conclusion that the star is a peculiar interacting binary (Harmanec et al. 1980). The aim of this paper is to present the phase-dependent behaviour of the UV spectrum of the star.

Almost all (i.e. 12 SWP, 8 LWR and 1 LWP) available high-resolution IUE spectra of the star were analysed. The radial velocities of the optical shell lines - presented for comparison with the UV spectra - are based on the measurements of 60 high-dispersion blue spectra obtained with the Ondřejov 2m telescope. The UV spectra were secured 1979 to 1983, the optical spectra in the period 1972 - 1981. The identification of the absorption lines in the UV region, rectification of the spectra and determination of T_{eff}, log g and v sin i were carried out with the help of computed synthetic spectra. A computer code, kindly provided by Dr. I. Hubený, was used in the LTE regime and using LTE model atmospheres and solar abundances (Kurucz 1979). The problems concerning a simulation of the subionized Be envelope by the synthetic spectra under the above assumptions were discussed in detail by Hubený et al. (1985). The phases of the observations were computed according to the ephemeris derived from the radial velocities of optical shell lines (Štefl et al. in preparation). Phase zero corresponds to the velocity maximum.

It is known that optical shell lines reach their intensity maximum near the phase 0.0 and minimum near 0.5. The ultraviolet line spectrum, which shows much weaker intensity variations, may be roughly simulated by the synthetic spectrum computed for the model atmosphere with T_{eff} = 9000 K, log g = 2.0 and v sin i $\simeq$ 40 km s^{-1} in any phase. The largest deviations from the computed spectrum can be observed near phase 0.0, because of the more complicated shell-line profiles. The considerable departures from the computed spectrum appear in the region C IV (UV 1) doublet, but the presence of the true C IV lines in the KX And spectrum remains uncertain. The strong resonance lines with P-Cyg profiles are the most striking features in the UV spectrum;

* Based on data from International Ultraviolet Explorer, de-archived from the Villafranca Data Archiv of the European Space Agency.

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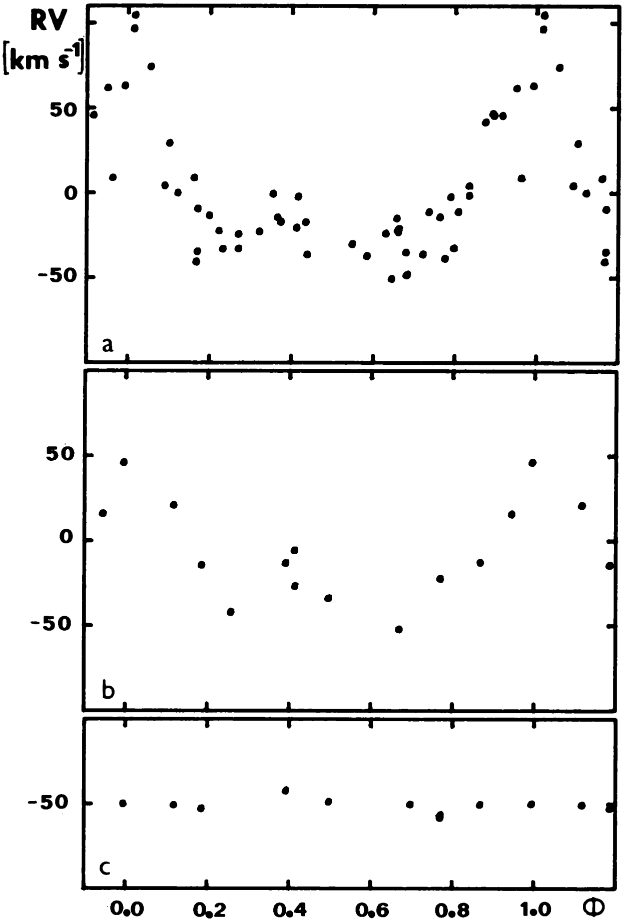

Figure 1. Radial-velocity curves of a) the optical metallic lines, b) of the UV subordinate shell lines of Fe II, Ni II, Ti II, Ca II Mn II, Mg II and Al II in the region of SWP IUE camera, c) of Fe II (UV 1,2,3) resonance lines.

the emission components of Mg II (UV 1) and C II (UV 1)being the most intensive ones. The asymmetry of the short wavelength wings of absorption components varies from ion to ion but it seems to be more pronounced in phases 0.25-0.70 in general.

Radial velocities were determined for all identified UV absorption lines. The mean values were computed for selected sets of lines using the methods of robust statistics (with an error of about 1%). Figure 1 shows the radial-velocity dependence for the UV subordinate metallic lines in the region of SWP camera, for the resonance lines Fe II (UV 1,2,3) and - for comparison - for the optical metallic shell lines. The plots illustrate the following conclusions valid for all regions of SWP and LWR cameras: a) The UV subordinate lines follow the double-wave radial-velocity curve of the visual shell lines (though with a lower amplitude). b) Radial velocities of the UV resonance lines are almost phase-independent. In case of Fe II (UV 1,2,3), Fe III (UV 34), Si II (UV 1,2,3) and Si IV (UV 1) lines the largest deviations from the constant velocity can be seen near phase 0.4. Interestingly enough the most striking feature at the radial velocity curve of the UV resonance lines thus coincides with inconspicuous secondary maximum in the radial velocity curve of optical and UV shell lines. The amplitude of the radial velocity of the resonance lines is - with the exception of Si IV (UV 1) lines - smaller than 15 km s^{-1}. Neglecting this possible phase-dependent variations the radial velocity probably increases with the ionization potential - see Fig.2.

Most of features seen in the ultraviolet line spetrum between about 1290 and 3100 A probably originate in the subionized circum-

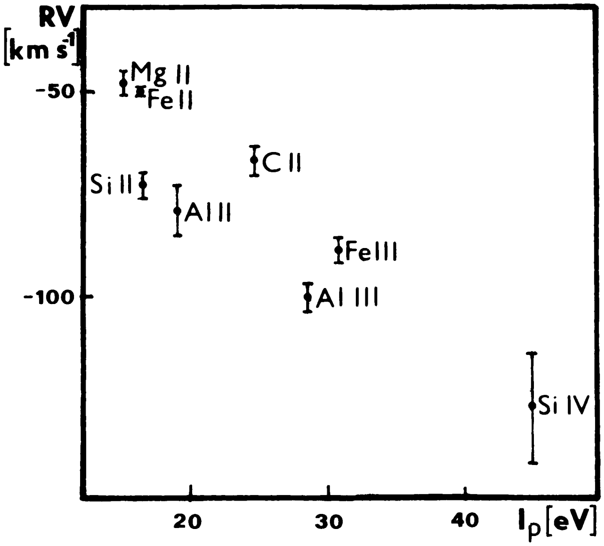

Figure 2. Radial velocity of the UV resoance lines versus ionization potential. The sum of the ionization and the excitation potential is used for the subordinate Fe III (UV 34) lines. These lines originate from the metastable energy levels and are thus formed similarly as resonance lines.

stellar envelope. The photosphere of the hot primary seems to be almost completely obscured by this envelope. Yet, considering a rather low number of strong non-resonance lines present in an early B-type UV spectrum, one cannot safely exclude the presence of some possibly dumped photospheric lines. The case of KX And demonstrates that circumstellar matter around hot stars, which is optically too thin to be observed in the optical spectra, can be detected in the ultraviolet.

In conclusion; the observed data seem to suggest that the B-type star in the binary system is surrounded by a circumstellar envelope or disc, which is optically thick in the ultraviolet. The optical shell lines can be seen in phases when we can see the accretion stream, projected on the primary component. The observed radial-velocity curve reflects the binary motion but it differs from that of the primary component, especially near the velocity maximum (Barr effect). The structure of the accretion disc and the stream seem to be responsible for the secondary minimum and maximum on the radial-velocity curves of visual and ultraviolet shell lines. The UV resonance lines may originate inside the primary Roche lobe or in an envelope around the whole binary system.

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