POLARIZATION OBSERVATIONS OF U CEPHEI

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ABSTRACT

Polarimetric and photometric observations of U Cephei during the 1974-75 outburst are discussed. An optically thin envelope or disk cannot explain the observations. The polarization too small by a factor of 10, when compared with the amount of additional light during the totality of the eclipse of the B-star. This suggests that most of the additional light came from optically thick matter around the B-star, i.e. the effective radius of the photosphere of the B-star, r_B, was increased by 15-20 % during the period of high mass transfer. The polarization observations could then be explained by a simple model containing an optically thin spherical envelope of outer radius 1.1 r_B and an equatorial disk of outer radius 1.7 r_B surrounding the expanded B-star. The mean electron density is about 1.4×10^{12} e/cm^3 in the spherical envelope and 1.6×10^{12} e/cm^3 in the preceding and 0.9×10^{12} e/cm^3 in the trailing side of the disk, the thickness of which is assumed to be 0.1 r_B normal to the orbital plane. The variations in the position angle can be explained if the inclination of the orbit is about 83°. The details will be published elsewhere.

COMMENTS FOLLOWING PIIROLA

Poeckert: I feel it is an important feature that there is very little polarization structure at times when no mass transfer is taking place. The fact that the photosphere of the B star is not strongly polarized is important. This fact suggests that high polarization is a consequence of the disk alone, not the stellar photosphere or any extended spherical photosphere.

Piirola: It is simply impossible to produce the observed polarization curves with a model containing an equatorial disk only. Especially in the case of the parameter P_y, which shows changes of opposite sign before and after mid-eclipse, the spherical envelope-type component and i ≈ 83° give a good fit to the observations.

M. J. Plavec, D. M. Popper and R. K. Ulrich (eds.), Close Binary Stars: Observations and Interpretation, 249–250.

Mitrofanov: I think that the observed polarization may also be explained if the possible nonsphericity of the B-star envelope is taken into account.

Piirola: Yes, I think that an ellipsoidal envelope would give practically the same results

Budding: Your figures appear to show higher densities towards the preceding hemisphere than the trailing hemisphere of the primary, yet the usual picture is that the action of the Coriolis force is to accumulate matter toward the following hemisphere. Have you any remarks about this?

Piirola: I remember computations of Prendergast and Taam which indicate that the circumstellar matter tends to have greater extension and density in the preceding side of the primary, just as we observe.

Plavec: I notice that the electron densities you give for the "envelope" and for the "disk" are actually the same--so is it necessary to distinguish two structures?

Piirola: The use of spherical envelope- and equatorial disk-components is for computing purposes only. One could try also with an ellipsoidal envelope.

Rucinski: You encountered problems in that the optically thin disc would give too much polarization; have you attempted to use the optically (and perhaps geometrically) thick disc to model your observations?

Piirola: Not yet. Calculations involving multiple scattering in optically thick envelopes will make the modeling rather complicated.

Smak: Why do you put most of the blame on the B star rather than on the disk?

Piirola: The model only assumes that most of the additional light comes from optically thick matter around the B star, i.e. the effective radius of the photosphere of the star is increased. This can be caused either by accumulation of matter around the star, expansion of the star itself or both. The crucial point is that more or less spherical structure around the B star seems necessary to explain the polarization curves.