THE ENERGY DISTRIBUTION OF SIRIUS B

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The DA white dwarf Sirius B has gained special interest because of the unexplained observed X-rays (Mewe et al. 1975). Coronal emission, accretion and normal photospheric radiation have been discussed as sources.

A DA white dwarf with $T_{eff} \sim 28000K$ (Savedoff et al. 1976, 1978, Koester 1979) should not have a corona (Böhm and Cassinelli 1971, Fontaine 1973). For accretion we do not see where the accreted mass should come from. Normal photospheric radiation requires an effective temperature around 32000K or higher (Shipman 1976). All possibilities to explain the X-rays therefore encounter severe problems.

In any case if the X-rays are due to coronal emission one might hope to see chromospheric emission lines in the UV. If the X-rays are due to accretion there might be a chance to see the resonance lines of CII or CI in the Sirius B UV spectrum, or to see perhaps some lines of the circumstellar material which could be accreted. In order to study these questions we took a low resolution short wavelength IUE spectrum of Sirius B with the help of A. Holm at the IUE observatory. We also wanted to determine T_{eff} independently since IUE permits the taking of a Sirius B spectrum for a longer wavelength region and with less scattered light from Sirius A than was possible with the Copernicus satellite.

The spectrum for the wavelength region between 1150Å and 1980Å is reproduced in Böhm-Vitense et al. 1979. In addition to the spectrum of Sirius B we see a broad tail on the one side of the spectrum which we attribute to the scattered light from Sirius A. The energy distribution across the spectrum perpendicular to the direction of dispersion is shown in Figure 1 for several wavelengths in the neighborhood of 1960Å. The pixel with the maximum intensity was always assigned the number 6. The tail due to scattered Sirius A light is seen at pixels No. 11 to 16. At pixels 9 and 10 we see a hump which I attributed to an additional light source (Böhm-Vitense et al. 1979). It is however, severely influenced by a calibration error in the IUE data (NASA letter of July 17, 1979) and may not be real. The scattered light contribution from Sirius A was extrapolated to lower pixel

https://doi.org/10.1017/S0252921100075795 Published online by Cambridge University Press

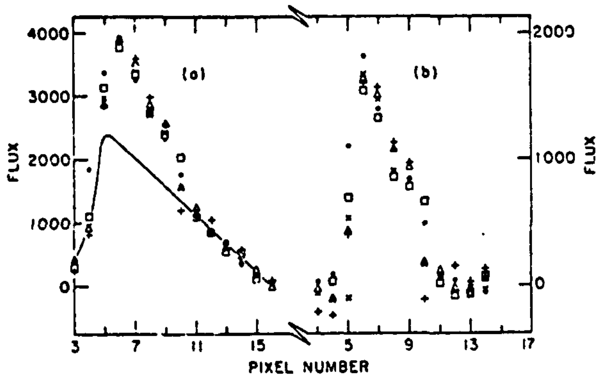

Fig. 1. The energy distribution across the spectrum (perpendicular to the direction of dispersion) of Sirius B for different wavelengths around 1960Å.

numbers as shown by the solid line in Fig. 1, left-hand side. After subtraction we obtain the Sirius B intensity profiles shown on the right-hand side of Fig. 1, from which the spectral intensities can be obtained as a function of wavelength. The energy distributions obtained are shown in Fig. 2, upper half. The dots show the contributions of the scattered light, the solid curve shows the Sirius B spectrum. Around 1900Å Sirius A and B contribute about equal amounts to the light while around 1300Å the Sirius A contribution is small. For these short wavelengths errors in the scattered light corrections should therefore have little influence. In the Lyα region we have essentially no contribution from Sirius A.

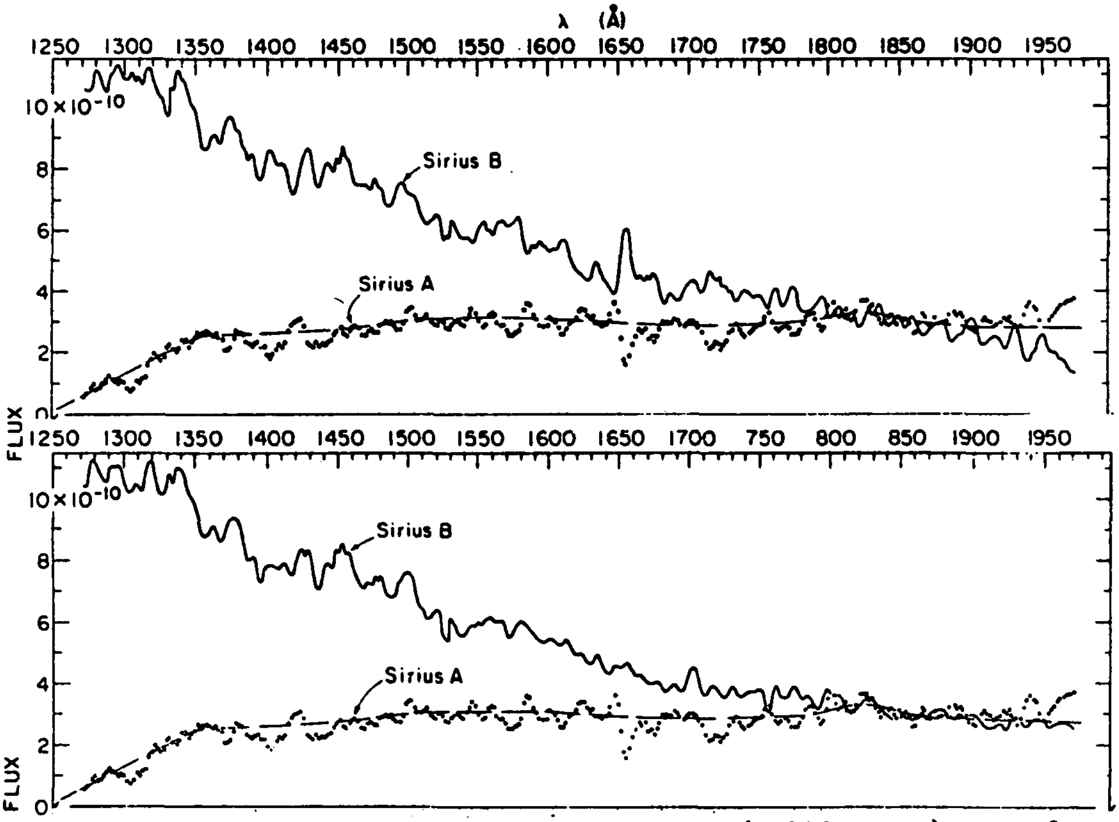

Fig. 2 . The energy distribution of Sirius B (solid curve) as a function of wavelength. Also shown is the correction for scattered light from Sirius A (dots). The upper half shows results obtained with the Sirius A scattered light corrections as originally determined for each wavelength. The lower half refers to results obtained with a smoothed scattered light correction as indicated by the solid line through the dots.

There are a large number of wiggles in the short wavelength spectrum. I do not know whether they are real. I could not identify any dips with any known strong lines. For the long wavelengths the fluctuations are a mirror image of the Sirius A scattered light corrections, indicating that a smoothed scattered light correction, as indicated by the solid line through the dots, would have been better. The energy distribution obtained with the smoothed correction is shown in Fig. 2, lower half. For the short wavelengths the fluctuations are now even larger. I do not know how to decide whether this is just noise or actually lines.

We have compared the continuous energy distribution with model atmosphere energy distributions computed by Wesemael (Savedoff et al. 1978). With a distance for Sirius of 2.65 pc and an assumed radius of 5.08 x 10^8 cm according to the theoretical mass radius relation (Hamada and Salpeter 1961) for a $1.05 M_{\odot}$ star the best agreement is obtained for T_{eff} = 26500°K (Böhm-Vitense et al. 1979).

We have also compared the measured Lyα profile with theoretical profiles as computed by Wesemael (Savedoff et al. 1978). For the same radius and mass the best agreement is obtained for $T_{eff} \sim$ 25500K (Böhm-Vitense et al. 1979).

We therefore confirm the earlier conclusions by Savedoff et al. 1976, 1978, and by Koester 1979 that T_{eff} of Sirius B is not high enough to explain the observed X-rays as normal photospheric radiation. We also have not found any clear evidence for emission lines indicative of any chromosphere, corona or disk (except possibly for the hump which needs further study). In the high resolution Sirius A spectrum we saw, however, a funny looking feature which occurred in two overlapping orders of the echelle spectrum in the neighborhood of the CI 1657 line. It is shown in Fig. 3. If real, this is the only indication of a possible emission line. Additional Sirius A spectra are also inconclusive. The origin of the X-rays still remains a puzzle.

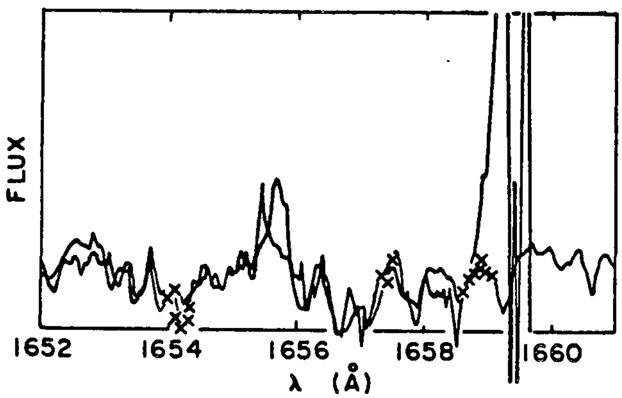

Fig. 3. The "emission" feature seen in two overlapping orders of the high resolution echelle spectrum of Sirius A. If real it might indicate an emission line in the neighborhood of the CI 1657 line.

https://doi.org/10.1017/S0252921100075795 Published online by Cambridge University Press

Acknowledgment: We are very much indebted to the IUE observatory staff whose continuous help and advice made this study possible and especially to Dr. A. Holm with whose help the final Sirius B spectrum was obtained.

This research was in part supported by NASA grant NSG 5240.

REFERENCES

Böhm, K.H. and Cassinelli, J.C. 1971, Astron. Astrophys., 12, 21.

Böhm-Vitense, E., Dettmann, T. and Kapranidis, S. 1979, Ap.J. Letters, Sept. 15.

Fontaine, G. 1973, Thesis, University of Rochester.

Hamada, T. and Salpeter, E.E. 1961, Astrophys. J., 134, 683.

Koester, D. 1979, Astron. Astrophys., 72, 376.

Mewe, R., Heise, J., Gronenschild, E.H.B.M., Brinkman, A.C., Schrijver, J., den Boggende, A.J.F. 1975, Astrophys. J., 202, L67.

Savedoff, M.P., van Horn, H.M., Wesemael, F., Auer, L.H., Snow, T.P. and York, D.G. 1976, Astrophys. J., 207, L45.

Savedoff, M.P., Wesemael, F., Auer, L.H., Kerridge, S.S. and van Horn, H.M. 1978, B.A.A.S., 10, 637.

Shipman, H.L. 1976, Astrophys. J., 206, L67.