A Search for Spectroscopic Binaries among Southern Cepheids

T. LLOYD EVANS (Pretoria)

A discussion of radial velocities determined at the Radcliffe Observatory for 20 southern Cepheids and those found in the literature for another 20 stars lead to the conclusion that 15 % of Cepheids are members of long period binary systems (1). The observational data were heterogeneous, few stars having been observed by a single observer or with the same instrument over a sufficient length of time to detect long period variations in the mean velocity.

A new search for Cepheid binaries was undertaken in 1969—70; some 600 spectra of 49 stars were obtained with the 2-prism Cassegrain spectrograph on the 1.88 m Radcliffe reflector, mainly at 49 A/mm. These have been discussed in conjunction with the 100 spectra of 20 stars obtained in 1966—67 (1) and the extensive earlier observations by JOY (2) and STIBBS (3).

Orbits have been determined for S Mus and V 636 Sco. The velocity variations of the latter were discovered by FEAST (4) and the star has been observed jointly with him. The periods are 506 days and 1318 days, respectively. Two stars, V 350 Sgr and AX Cir, are found to be binaries and four more are considered possible binaries. The percentage of binaries is 12 % giving half weight to the four uncertain cases; this would be reduced to 9 % if those stars, including S Mus and AX Cir, which were observed more intensively because of photometric or spectroscopic evidence of a companion, were omitted. The new observations indicate that V Car is not a binary, the earlier finding (1) being based on a misinterpretation of the complicated velocity curve, while no fresh evidence was found of velocity variations in Y Oph, U Sgr and Y Sgr which have long been regarded as possible binaries.

None of the new binaries or suspected binaries has a short orbital period. This re-inforces the conclusion arrived at earlier (1). The shortest orbital period now known is 506 days for S Mus ($P = 9^d.7$). This is much longer than the limiting orbital period the Cepheid could have if it just filled its Roche lobe but is in fair agreement with the value expected for a star of similar mass at the red supergiant tip. It seems likely that the proportion of Cepheids which are on their first (pre red supergiant stage) crossing of the instability strip is small.

The mass functions of the two stars for which orbits have been obtained are comparable with that of the previous best case, S Sge. The photometry (5), (6) indicates that the companion to S Mus is a late B star. If it and the unseen companions to the other two Cepheids are main sequence stars one can place upper limits on the masses of these Cepheids. Provisional values are: S Mus ($P = 9^d.7$), 10 $M_\odot$; S Sge ($P = 8^d.4$), 6 $M_\odot$; V 636 Sco ($P = 6^d.8$), 6 $M_\odot$. It is likely that $\sin i \ll 1.0$ for S Mus. It is hoped to place stricter limits on the masses later.

Spectra of AX Cir, whose companion is believed to be of type B 4 if it is a main sequence star (1), have been obtained at 16 A/mm for the range 3400 — 4000 A. Comparison with the spectra of the non-variable G0 — G2 I b stars α Aqr and β Aqr showed no sharp features attributable to the secondary; only the shallow depressions at the positions of the Balmer lines and the veiling of the lines of the Cepheid were seen. This result will apply a fortiori AW Per whose companion is relatively fainter (7), (1). Only a star with an even brighter companion, such as RW Cam (8) or KN Cen (1), may offer a chance to obtain the radial velocity curve of the companion in a binary containing a Cepheid. Such stars would be expected to have reduced light amplitudes in the blue and may be discovered among the brighter stars.

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O'CONNELL: Do I understand you to say that the shortest orbital period you have found is of the order of 500 days?

LLOYD EVANS: Yes.

PERCY: Since it is known that there are non-variable stars in the Cepheid instability strip, it may be possible that the presence of a „close" companion may inhibit pulsation, and thereby explain the absence of short-period orbital motion among Cepheids.

LLOYD EVANS: The shortest orbital period for a non variable F-G supergiant binary is about 200 days. The stars selected by spectral type form a less well defined group than classical Cepheids, so it seems likely that this is a little less massive and post red-giant tip. Cepheids in binaries do not seem to differ significantly from single Cepheids in their pulsation properties or otherwise.

FERNIE: I think the question of the repeatibility of Cepheid light- and velocity-curves is one which needs careful investigation. There are at least some Cepheids, e. g. SV Vul, in which the scatter of observed points determined in different cycles becomes significantly greater at certain phases. This is important both in itself and from the standpoint of WESSELINK radii.

LLOYD EVANS: I would like to stress the importance of intensive photoelectric observation of selected Cepheids to establish the repeatability of their light curves.

MAVRIDIS: I would like to point out that TSIOUMIS and myself have observed the Cepheids X Lac, RR Lac, Z Lac, U Vul, and CD Cyg during the years 1967—1970 using 2 comparison stars for each Cepheid. In this way very accurate and detailed light- and colour-curves (UBV system) have been obtained. The same Cepheids were observed also by BAHNER and myself in 1956—59 using the same comparison stars (BV system). A comparison of the light and colour-curves corresponding to these 2 observational series show that the light- and colour-curves of X Lac and CD Cyg show changes between the 2 series. The light- and colour-curves of RR Lac, Z Lac and U Vul on the contrary do not show any significant changes between the 2 observational series.

The Spectrum Variable a Centauri (HD 125 823)

D. A. KLINGLESMITH and P. L. BERNACCA*) (NASA, Goddard Space Flight Center Greenbelt) and H. FREY (College Park, Maryland)

Abstract

High dispersion spectra in the blue violet region and OAO II spectral scans in the UV of the star a Centauri are presented. The variation of equivalent widths and radial velocity are presented. The appearance and disappearance of the forbidden lines of helium, the change in the wing structure of λ 4471 of HeI, the strengthening of the UV resonance lines at phase 0.5 and the presence of the UV feature of λ 1720 indicate that the star's atmosphere is experiencing drastic density changes.

I. Introduction

The star a Centauri is unique in that the helium absorpion line spectrum varies in strength by at least a factor of 10 with an 8.8 day period while the other spectral features either change by a factor 2 or don't change at all (NORRIS 1968, 1971; JASCHEK, JASCHEK and KUCEWICZ 1968; and JASCHEK, JASCHEK, MORGAN and SLETTEBAK 1968). This paper will present the analysis of a series of high resolution spectra in the blue-violet spectral range

*) ESRO Associate 1971 on leave from Asiago Observatory, Italy.

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