

Research Note

Detection of a late B star companion of the bright cluster giant c Pup = HD 63032*

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Summary. IUE observations show that cPup, the central bright K giant in the open cluster NGC 2451, has a blue companion.

A fit of theoretical line blanketed model atmosphere fluxes (Kurucz, 1979) to the observed energy distribution yields reddening $E(B-V)=0.15$ (from λ 2200 Å feature), an effective temperature $T_e=10,200$ K, and an angular diameter $\theta=0.060$.

If the companion is a main-sequence star, cPup and its companion are located at a distance of 310 ± 50 pc which lends additional support to membership of cPup in NGC 2451. The evolutionary status of cPup is briefly discussed.

Key words: red giants – open clusters – stellar evolution

I. Introduction

The bright K giant cPup = HD 63032 = HR 3017 (K 5 IIa, $m_v=3.6$) is the central object in the intermediate age ($\sim 10^8$ a) cluster NGC 2451. The cluster has been studied by Feinstein (1966), Williams (1966, 1967), and Levato and Malaroda (1975).

According to proper motions and its radial velocity, cPup is probably a cluster member. Since cPup is more than 2 mag brighter than all other cluster stars, it is an interesting, rare object from an evolutionary point of view. Such luminous stars are quite rare in the collection of Harris (1976). During IUE observations with the aim to detect transition layer emission lines in red giants we found by chance that cPup has a blue companion.

In this note we use the companion of cPup to determine the distance of cPup for an independent cluster membership test.

II. Observations and discussion

cPup was on our list of “hybrid” star candidates (cf. Reimers, 1982) since a Coudé spectrum taken by D.R. with the ESO 1.5 m telescope in 1978 revealed strong Ca II H + K emission and strong circumstellar lines at Ca II H + K.

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* Based on observations by the International Ultraviolet Explorer collected at the Villafranca Satellite Tracking Station of the European Space Agency

After having taken a heavily overexposed SWP low resolution spectrum (we looked for faint emission lines) in March 82, we reobserved cPup on April 1, 1982 (SWP 16675 and LWR 12925, both 15^m in the large aperture). The observed spectral energy distribution is shown in Fig. 1. Notice that for $\lambda > 2400$ Å the LWR spectrum was saturated. The red giant begins to dominate the spectrum for $\lambda > 2800$ Å.

Effective temperature T_e and interstellar reddening are determined simultaneously by comparing the observed energy distribution with line blanketed model atmosphere fluxes (Kurucz, 1979) (for details of the method see Groote, 1982). Interstellar reddening is corrected using Seaton's (1979) formulae and was found to be $E(B-V)=0.15 \pm 0.05$. The λ 2200 Å absorption feature mainly determines reddening while the effective temperature $T_e=10,200 \pm 300$ K is fairly well defined due to the steep continuum decrease for $\lambda < 1350$ Å.

The effective temperature of 10,200 K corresponds to a spectral type of about B9. With the reasonable assumption that the cPup companion is an unevolved main-sequence star with a radius of $R=2 \pm 0.3 R_\odot$, a distance of 310 ± 50 pc is obtained.

The distance of NGC 2451 has been measured as 330 pc (Williams, 1967), 260 pc (Feinstein, 1966), and 290 pc (Levato and Malaroda, 1975). We conclude that our distance of the cPup system is fully consistent with the cluster distance. Also, a B9 main-sequence star is consistent with membership in NGC 2451 since the cluster main-sequence turnoff is at about B7.

With the additional evidence from proper motions, radial velocity, and central position in the cluster, cPup can be considered as a definite member of NGC 2451.

The evolutionary status of cPup ($M_{\text{bol}} \sim -4.7$, $\log L/L_\odot \sim 3.75$) is possibly that of a star at the base of the second giant branch of intermediate mass stars ($\sim 5 M_\odot$ according to cluster turnoff) which will finally lead cPup to the white dwarf stage (Reimers and Koester, 1982). As soon as the B star has evolved to the red giant phase, the system might appear as a symbiotic binary.

The strong Ca II H + K emission lines of cPup are probably related to the binary nature and imply that the system is fairly close.

Finally, we like to mention that in the course of this work we learned that Eggen (1974) already suspected a companion from the blue colours of cPup ($U-B \approx 0.2$ mag too blue for a red giant).

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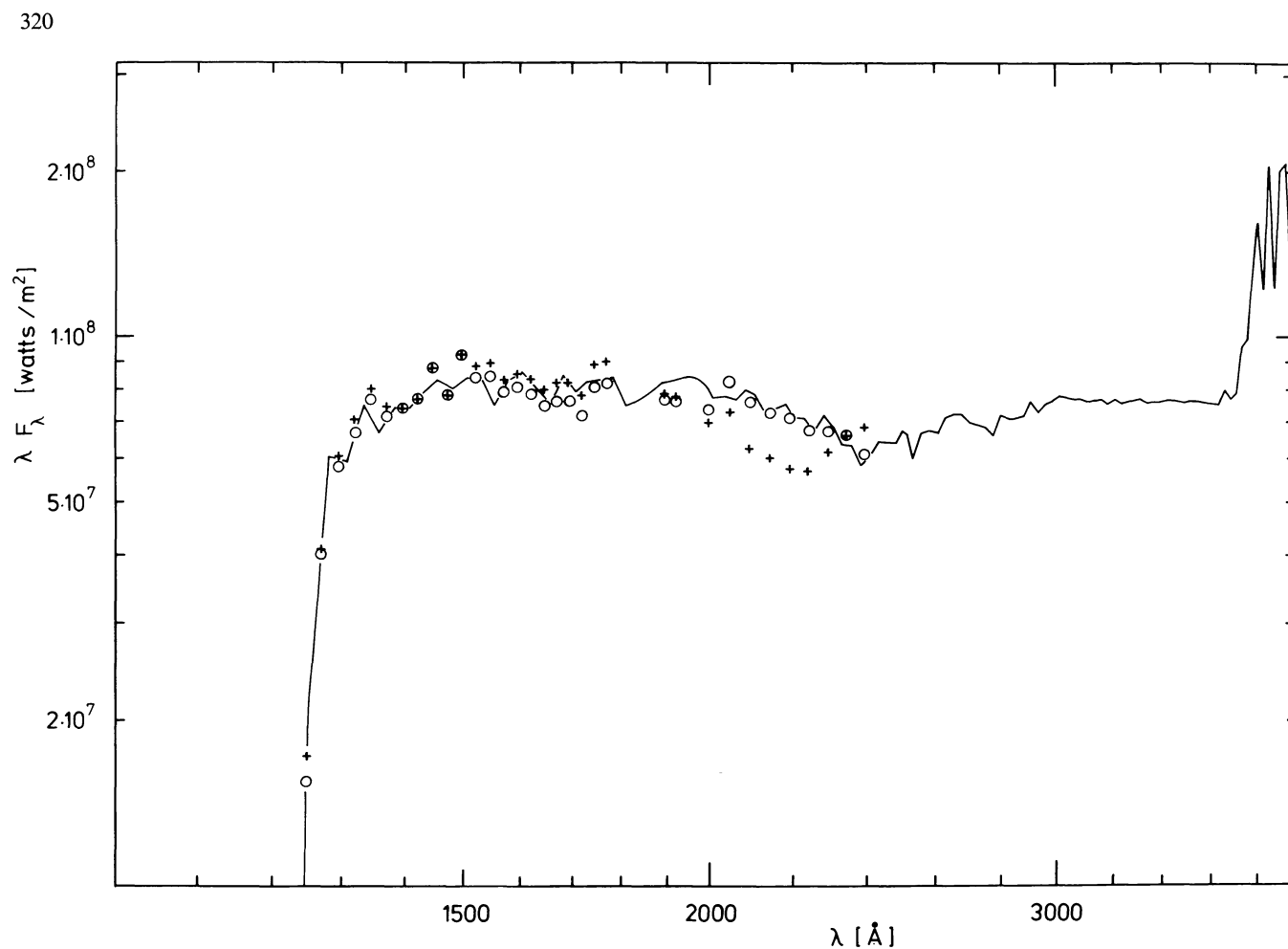


Fig. 1. Observed fluxes (+) for HD 63032 and dereddened ($E(B-V)=0.15$) fluxes (○) compared with computed fluxes of an interpolated Kurucz model ($T_e=10,200$ K, $\log g=4$). Note the $\lambda 2200$ Å feature in the uncorrected spectrum

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