# PROPERTIES OF COOL STELLAR COMPONENTS IN S-TYPE SYMBIOTIC STARS

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In 1975 Webster and Allen (1975) divided all symbiotic stars into two groups-those in which the 1-4 $\mu$m continuum show only the presence of a cool star (type S),and those in which dust emission dominates (type D). With the exception of some of yellow symbiotic stars, the dust presence in others correlates with the spectral type of their cool components. That is why one can say that S-type symbiotics contain red giants with spectral type earlier than M6-M7.

At the IAU Colloq. N 70 Allen (1982) noted that it is difficult to escape the conclusion that symbiotic stars contain normal cool giants. Nowadays it is certaiu to be correct because the modern observations of S-type symbiotic stars have not yet discovered any specific distinctions between their cool stellar components and normal red giants. At the same time it should be noted that some of these, for example, Z And, CI Cyg may be interacting binaries in which the cool component apparently fields its Roche lobe and unstable accretion of gas from the red giant onto its hot companion leads to the out bursts of the latter (Kenyon and Webbink 1984; Yudin 1987).

IR brightness of the cool components in S-type symbiotics fluctuate intrinsically but with small amplitude ($\Delta J \sim 0^m.5$). No definite connection has yet been found between light variation of the hot emission sources exceeding for example, $2^m$ in the U filter for BF Cyg, AG Dra and Z And in 1980 ,and the variations in the brightness of cool stellar components. However, it should be pointed out that the unusually prominent minimum in visual brightness of the cool component of Z And was observed half a year before the outburst of its hot companion in March 1984 (Yudin 1985). Such phenomenou was also observed before the out burst of the recurrent nova T CrB in 1946. It was supposed that this event was connected with the development of dynamical instabilities in the cool star at-



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mosphere resulting in dynamical ejection of a blob of gas by the latter and to accretion-powered outburst of its hot companion (Webbink 1976). However, before other outbursts of Z And its cool component did not demonstrate the essential decrease in its visual brightness.

It is possible that variations in IR brightness in the eclipsing binary CI Cyg have a regular component with $P = P_{orb}/2$, due to ellipsoidal deformation of its tidally distorted red giant (Taranova 1987). This giant has a very strong 2.3 μm CO absorption band (Kenyon and Gallagher 1983) and thus it may have bright giant dimensions and fills its tidal lobe. On the other hand Kenyon and Fernandez-Castro (1987) possibly detected the periodic changes in the spectral type of CI Cyg's red giant determined by TiO and VO absorption bands in the red with $P = P_{orb}$, due to heating of its hemisphere facing towards its hot companion. Verification of existence of these effects requires further systematic observations, since in other similar symbiotic stars they have not been yet detected,with the only one exception of AG Peg in which the effect of heating of one hemisphere of the cool star by its hot companion is definitely observed. So, our spectrophotometric observations of AG Peg show that, when its cool giant lies in front of or behind the hot component, the depth of TiO absorption bands in the red is comparable to that found in normal red giants having spectral types slightly later than M3 or earlier than M2 respectively (see also Kenyon and Fernandez-Castro 1987). As mentioned above, the same phenomenon is possibly observed in CI Cyg although in this binary system the disk-like gas envelope surrounds its hot component sothat the latter cannot directly illuminate the cool companion. Therefore, the reasons of heating of the red giant's hemisphere facing towards the hot companion may be partly different in AG Peg and CI Cyg, if of course this phenomenon really exists in the latter.

Comparing red giants' spectral types derived for five symbiotic stars both from two-micron and optical spectroscopy Allen (1980) noted that the agreement between them is not as good as one might hope, the optical types being later. Our photometric and spectrophotometric observations of symbiotic stars also show that, as a rule, the estimates of the red giants' spectral types in S-type symbiotics, determined using TiO absorption bands in the red and the (R-J) colour index, turn out to be later than thein (J-K) colour estimates (Taranova and Yudin 1987). Similar result (Fig. 1) can be derived proceeding from the works of Kenyon and Gallagher (1983), and Kenyon and Fernandez-Castro (1987).

Determination of the luminosity of the cool components in S-type symbiotics using their spectral parameters is of great interest but it is still open to question. It is clear that optical spectra cannot provide an accurate estimate for the luminosity of the red giants in symbiotic stars. The chemical composition of their cool components may be also different. Therefore, it is not surprising that the yellow giant in the high latitude star AG Dra is classified by Huang (1982) as K0Ib. Preliminary attempts to derive luminosity classes for the same symbiotics' cool components by measuring the strength of the 2.3 $\mu$m CO band have been carried out by Kenyon and Gallagher (1983). They showed that Z And, CI Cyg and T CrB possibly contain luminosity class II bright giants. On the other hand, the presence of the strong CaII triplet in absorption in the spectra of AG Peg and EG And possibly indicates that their cool components are of luminosity class III (Andrillat 1982).

However, as mentioned above, the works in this direction are only at their begining and they must be certainly continued. Therefore, at present we should try to find some indirect approach in solution of the problem of determination of the luminosity of symbiotic's cool component.

Its luminosity can be calculated for the symbiotic systems with known binary period in which the cool component fills its tidal lobe. Thus, the problem to be solved consists in determination of such a parameter in symbiotic star's emission which should be necessary condition for filling by the cool component its tidal lobe.

On our opinion, the recurrent nova-like outbursts observable on the light curves of a number of symbiotic stars, such as Z And, CI Cyg, AG Dra, AX Per, BF Cyg, may be such parameter (Yudin 1987), It is nova-like Z And type outbursts that are distinct and determing feature of the subgroup of the so-called classical symbiotic stars among the objects classified by their as symbiotic.

Briefly speaking, the time-dependent and energetic characteristics of these outbursts demonstrate that their energy source appears to be the gravitational energy of the matter accreted by the hot component. Therefore, their appearance is connected with a sharp increase of the mass transfer in a binary system ($\dot{M} \geqslant 10^{-6}$ $M_{\odot} yr^{-1}$). However, since the hot component of the classical symbiotic stars is the source of fast wind itself with $\dot{M}_h \cdot v_h \sim \dot{M}_e \cdot v_e$ ($L_{h,bol} \sim L_{e,bol}$ between outburst for above mentioned symbiotic stars), then it cannot accrete matter from the stellar wind of its companion. Therefore, the cool components of classical symbiotic stars with necessity must fill tidal lobes, and this property appears to be an inalienable signpost distinguishing them from other symbiotic stars.

Taking into account this hypothesis one can understand why in such symbiotic systems as Z And, AG Peg, EG

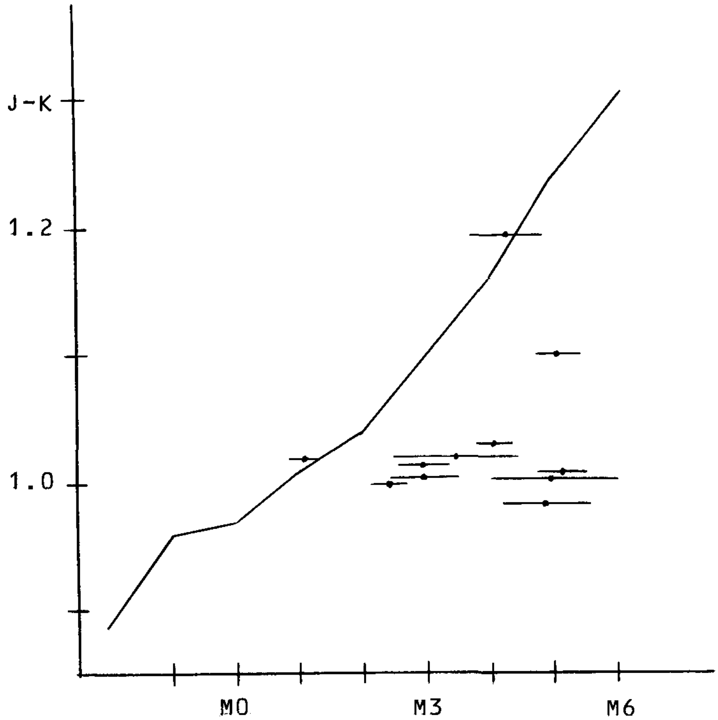


Figure 1. Plots of colour index (J-K) against spectral type for S-type symbiotic stars. (J-K) colour indices are from Kenyon and Gallagher (1983). Spectral types derived using TiO and VO bands in the red are from Kenyon and Fernandez-Castro (1987). The continuous curve is the intrinsic field giants.

And, which are similar in many respects, the recurrent nova-like outbursts of the hot component are observed only in Z And. All this becomes clear if we assume that the cool component in Z And has the luminosity class II, that is classified as asymptotic branch giant M3 II, whereas in AG Peg and EG And as M3 III.

IRAS pointed observations of five S-type symbiotic have shown that EG And, T CrB, RS Oph, AR Pav, AX Per have had IR energy distributions which are very similar to those of normal M giant (Kenyon et al. 1986). The same result have been received for Z And (Schaefer 1986). However, it should be noted that the ground-base observations of CI Cyg, Z And, BF Cyg, V443 Her have revealed at some moment the presence of a small IR excess at 10 $\mu$m due to emission from the dust (Taranova and Yudin 1983).

Finally, now that we have yet no systematic photometric and spectroscopic data on the cool stellar components in the majority of S-type symbiotic stars, we should turn our attention to them.

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