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Accretion-powered symbiotic binaries: EG And and CQ Dra

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Abstract. We present the $0.12 - 0.45\,\mu$ SED of two quiet symbiotic binaries, EG And and CQ Dra. We reconstructed the observed SED by a three-component-model of radiation to isolate the stellar and nebular contributions. This analysis showed that CQ Dra can definitely be considered as the symbiotic binary and not a CV in a wide binary. Our solution suggests that the sole energy source in both binaries is accretion from the giant's wind at the rate of a few $\times 10^{-8}\,\mathrm{M}_{\odot}\,\mathrm{yr}^{-1}$ for EG And and a few $\times 10^{-9}\,\mathrm{M}_{\odot}\,\mathrm{yr}^{-1}$ for CQ Dra.

1. Introduction

Symbiotic stars are wide ($P_{\rm orb} \sim 2-3$ years or more) interacting binaries consisting of a cool giant and a hot compact star. The mass loss from the giant – being in most cases in the form of a wind – represents the primary condition for appearance of the symbiotic phenomenon. A part of the material lost by the giant is accreted by the compact companion. This process generates a very hot ($T_{\rm h} \approx 10^5$ K) and luminous ($L_{\rm h} \approx 10 - 10^4\,\mathrm{L}_{\odot}$) source of radiation, which ionizes a fraction of the circumbinary material giving rise to nebular emission. As a result the spectrum of symbiotic binaries composes from three main components of radiation – two stellar (from the cool giant and the hot star) and the nebular emission. We use this model to disentangle the composite spectrum.

There are a few symbiotic objects with hot component luminosities as low as a few $\times 1 - 10\,\mathrm{L}_{\odot}$ only. These quantities suggest that the only source of their energy is accretion. Here we illustrate this case on two quiet symbiotic binaries, EG And ($P_{\rm orb} = 482$ d), CQ Dra ($P_{\rm orb} = 1\,703$ d) and present first results.

2. Accretion process in EG And and CQ Dra

We reconstructed the composite UV/optical/IR spectrum of these stars to isolate their stellar and nebular component of radiation. The method was outlined by Skopal (2001). Corresponding parameters are in Table 1 and the model shown in Fig. 1. $\theta_{\rm h}$ and $T_{\rm h}$ stand for the angular radius and temperature of the hot star. The latter was adopted so to balance the observed emission measure, $EM_{\rm obs}$. The hot star luminosity, $L_{\rm h}$, its effective radius, $R_{\rm h}^{\rm eff}$, and $EM_{\rm obs}$ were derived for the distance of 590 pc (EG And) and 178 pc (CQ Dra), respectively.

Combining parameters derived from the SED's and the known fundamental parameters suggests accretion from the giant's wind to be the only source of the hot star energy. To derive quantities of the accretion process (Table 2) we

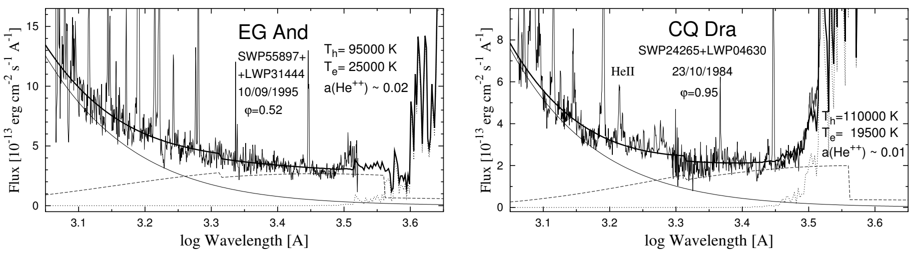

Figure 1. The SED for EG And and CQ Dra in the ultraviolet. Solid thin and dashed lines represent the hot stellar and the nebular component of radiation. The solid thick line is the resulting modeled continuum.

Table 1. Fitting and derived parameters from the SED (Figure 1)

Object	Date	$T_{\rm h}$ [K]	$\theta_{\rm h}$	$R_{\rm h}^{\rm eff}$ [$R_\odot$]	$L_{\rm h}$ [$L_\odot$]	$T_{\rm e}$ [K]	$EM_{\rm obs}$ [$\rm cm^{-3}$]
EG And	10/09/95	95 000	$1.3\,10^{-12}$	0.034	85	25 000	$4.8\,10^{58}$
CQ Dra	23/10/84	110 000	$8.9\,10^{-13}$	0.007	6.6	19 500	$2.6\,10^{57}$

Table 2. Parameters of the accretion process

Object	$M_{\rm WD}$ [$M_\odot$]	$R_{\rm WD}$ [$R_\odot$]	$\dot{M}_{\rm acc}$ [$M_\odot\,\rm yr^{-1}$]	$\dot{M}_{\rm W}$ [$M_\odot\,\rm yr^{-1}$]	$L_{\rm ph}$ [$\rm photons\,s^{-1}$]	$EM_{\rm cal}$ [$\rm cm^{-3}$]
EG And	0.6	0.009	$8.1\,10^{-8}$	$3.3\,10^{-7}$	$6.2\,10^{45}$	$4.7\,10^{58}$
CQ Dra	1.0	0.006	$2.5\,10^{-9}$	$8.2\,10^{-8}$	$4.6\,10^{44}$	$0.94\,10^{57}$

followed description on the wind accretion onto white dwarfs given by Livio & Warner (1984) for the wind velocity of $20\,\rm km\,s^{-1}$. Finally, we calculated a theoretical value of the emission measure ($EM_{\rm cal}$) according to the STB (Seaquist, Taylor, & Button 1984) ionization model and compared it to the observed emission measure ($EM_{\rm obs}$). The result is satisfactory (Table 1, 2). Therefore we conclude that parameters of the giant's wind and the hot star ionizing capacity are consistent with the basic ionization model of symbiotic binaries. This unambiguously shows that the system of CQ Dra can be considered as the symbiotic binary and not a CV in a wide binary (see also Wheatley, Mukai, & de Martino 2003).

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