Probing the symbiotic nebulae by the multicolour photometry

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Symbiotic stars are long-period interacting binary systems, which comprise a late-type cool giant and a hot compact star, most probably a white dwarf (WD), which accretes from the giant’s wind. Accretion process makes the WD very hot and luminous. Its radiation thus ionizes a fraction of the circumstellar medium, giving rise to a strong nebular emission spectrum. In this contribution we introduce a method of disentangling the composite spectrum of symbiotic binaries on the basis of simple multicolour photometry. After correcting observed $UBV$ flux-points for the interstellar extinction and the influence of strong emission lines, we modelled the total flux in the continuum, considering contributions from the nebula and the giant. In this way we determined the electron temperature and emission measure of the nebula as well as the $V$ magnitude of the giant. We applied the method to classical symbiotic stars AX Per, AG Dra, AG Peg and Z And, the symbiotic novae RR Tel and V1016 Cyg and the classical nova V1974 Cyg during its nebular phase. We found that during quiescent phases the electron temperature was around of 20000 K and emission measure of $\sim 10^{59}$ cm$^{-3}$, while during active phases both parameters increased to $\sim 30000–40000$ K and $\sim 10^{60}$ cm$^{-3}$, respectively. For the symbiotic novae we obtained higher values of emission measure, in order of $\sim 10^{61}$ cm$^{-3}$. Our results are in a good agreement with those obtained independently by a precious modelling the UV-IR SED. In general, this method of disentangling the $UBV$ magnitudes can be applied to any spectrum composed from a nebular and stellar component of radiation.
I. Symbiotic stars

Symbiotic stars are long-period (8-15 years or more) interacting binary systems, which comprise a late-type giant and a hot compact star, most probably a white dwarf (WD), which accretes from the giant’s wind. Accretion process makes the WD to be very hot and luminous. Its radiation thus ionizes a fraction of the circumstellar medium, giving rise to a strong nebular emission spectrum. In this contribution we introduce a method of disentangling the composite spectrum of symbiotic binaries on the basis of simple multicolour photometry. We applied the method to classical symbiotic stars AX Per, AG Dra and Z And. Our results are in a good agreement with those obtained independently by a precious modelling the UV-IR SED (spectral energy distribution). In general, this method of disentangling the UBV magnitudes can be applied to any spectrum composed from a nebular and stellar component of radiation.

II. Disentangling UBV magnitudes

The aim of this poster is to introduce a method of disentangling photometric UBV magnitudes of symbiotic stars into their individual components. This means to determine physical parameters of their radiation. In our approach we assume that the contribution from the hot stellar source can be neglected within the optical. This assumption can be applied for systems during quiescent phases, while during active phases, it is valid for non-erupting binaries. For eclipsing systems it can be used only during eclipses.

We applied the method to the 1994 eclipse, observed during the 1985-1986 active phase of AX Per, active as well as quiescent phase of AG Dra, and a quiescent phase of Z And. Results are shown in Fig. 3. More examples can be found in Cariková & Skopal (2010). During quiescent phases we found the electron temperature of the symbiotic nebula, $T_e \sim 30000 - 40000 \ K$. During quiescence the emission measure was in the order of $10^{54} \ cm^{-3}$; while during activity it identified as high as $10^{59} \ cm^{-3}$.

III. Application to selected symbiotics

We apply the method to the quiescent phase of the 1960 symbiotic star AG Dra, to the quiescent phases of AX Per and AG Dra, and to the active phase of Z And. Results are shown in Fig. 2. More examples can be found in Cariková & Skopal (2010). During quiescent phases we found the wind temperature of the hot component increases, and can temporarily exceed $10^6 \ K$. During active phases of symbiotic binaries the hot wind temperature, the WD’s surface temperature, and luminus WD is capable of ionizing neutral wind from the hot star at the boundary in symbiotic binaries calculated for $T_e \sim 30000 - 40000 \ K$.

IV. Conclusion

In this contribution we presented a method of disentangling the composite spectrum of symbiotic binaries on the basis of simple multicolour (UBV) photometric measurements. Our method allowed us to determine the physical parameters of the main source – the hot stellar component and the nebula. Our model parameters were well comparable with those determined independently by another method, e.g. by a precise modelling the UV-IR SED as introduced by Skopal (2005). This approach thus provides a good estimate of the physical parameters of contributing sources of radiation within the optical on the basis of a simple UBV photometry. Finally, we note that our method of disentangling the UBV magnitudes can be applied to any spectrum composed from a nebular and stellar component of radiation.

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References

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