Spectral modelling of massive binary systems

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Context: The spectra of massive binaries may be affected by interactions between the stars in the system. These are believed to produce observational phenomena such as the Struve-Sahade effect.
Aims: We simulate the spectra of massive binaries at different phases of the orbital cycle, accounting for the gravitational influence of the companion star on the shape and physical properties of the stellar surface.
Methods: We used the Roche potential modified to account for radiation pressure to compute the stellar surface of close circular systems. We further more used the tidal interactions with dissipation of energy through shear code for surface computation of eccentric systems. In both cases, we accounted for gravity darkening and mutual heating generated by irradiation to compute the surface temperature. We then interpolated non-local thermodynamic equilibrium (NLTE) plane-parallel atmosphere model spectra in a grid to obtain the local spectrum at each surface point. We finally summed all contributions, accounting for the Doppler shift, limb-darkening, and visibility to obtain the total synthetic spectrum. We computed different orbital phases and different sets of physical and orbital parameters.
Results: Our models predict line strength variations through the orbital cycle, but fail to completely reproduce the Struve-Sahade effect. Including radiation pressure allows us to reproduce a surface temperature distribution that is consistent with observations of semi-detached binary systems.
Conclusions: Radiation pressure effects on the stellar surface are weak in (over)contact binaries and well-detached systems but can become very significant in semi-detached systems. The classical von Zeipel theorem is sufficient for the spectral computation. Broad-band light curves derived from the spectral computation are different from those computed with a model in which the stellar surfaces are equipotentials of the Roche potential scaled by the instantaneous orbital separation. In many cases, the fit of two Gaussian/Lorentzian profiles fails to properly measure the equivalent width of the lines and leads to apparent variations that could explain some of the effects reported in the literature.

Reference: Astronomy & Astrophysics
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1302.5201

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