Non-perturbative static 3D modelling of close binaries and its impact on the observations of low-mass and RGB binaries

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Abstract

In close binary systems, tidal interactions and rotational effects can strongly influence stellar evolution and observations. Current models of binary stars are relying either on the so-called " Roche model " or the perturbative approach that in each case results on several assumptions concerning the gravitational, tidal and centrifugal potentials.
To study the consequences of these assumptions we developed a new non-perturbative method to compute precise structural deformation of binary system in three dimensions that is even valid in the most distorted cases.
In this talk we are going to show that in the most distorted cases both Roche and perturbative models are significantly underestimating the deformation of binaries. In particular for low-mass and RGB stars we respectively found a 80% and 35% deformation increase compared to the Roche model. For the observations of close eclipsing binaries, these corrections are important as both stellar contours and gravity darkening are noticeably modified. In addition, basic astrophysical laws are impacted by the redistribution of mass in the bodies resulting from the deformations. We saw a deviation from the 3rd Kepler's law of a few percent adding uncertainties on the determination of the orbital and stellar parameters from observations. Asteroseismic studies of such bodies would also be importantly impacted by the deformations discrepancies found as their whole structural depiction is modified.

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