Orbital parameters of binary stars

SUMMARY.
Stars like company and, unlike the Sun, half of the stars in the Milky Way have stellar companions which could significantly affect the physico-chemical properties of stellar evolution. Binarity allows to explain many astrophysical observations thanks to interactions between stellar components, such as type Ia supernovae or chemically peculiar stars. It also allows the determination of stellar masses, radii and luminosities, much more precisely than for single stars. Among binary stars, Spectroscopic Binaries (SB) are those that are detected by spectrography. In this METEOR the student will familiarise him/herself with the Radial Velocities (RV) method widely used for orbital characterization.

OBJECTIVES

The main objective is to introduce the student to the modeling of spectroscopic binaries by means of the radial velocities method to derive the orbital parameters (period, eccentricity, RV amplitude, etc.) of close binary stellar systems.

PREREQUISITES

Previous courses on General Astrophysics and Stellar Physics are recommended. Basic programming skills are needed to achieve the main goals (Python is an asset).

THEORY

by T. Merle

The gravitational two-body problem – Observing binaries (with focus on spectroscopic binaries and the method of radial velocities) – Fundamental parameters derived from binaries

APPLICATIONS

by T. Merle

The student will solve short practical exercises related to the theoretical parts studied. Then the project will consist in deriving orbital solutions of SB with 2 components (SB2) detected in large ground-based spectroscopic surveys like Gaia-ESO, APOGEE and GALAH. The student will familiarize him/herself with data reduction and analysis of high resolution spectra for some SB2 obtained with the HERMES and HRS spectrographs at Mercator (North hemisphere) and SALT (South hemisphere) telescopes. He/she will determine the RV of each component by computing cross-correlation functions of spectra with templates and compute orbital solutions for inner and outer pairs. Comparison of orbital parameters with other SB2 may also be performed.

MAIN PROGRESSION STEPS

First 3 weeks of the period: theoretical courses and short practical exercises. Other 5 weeks of the period: numerical project. Last week: preparation of the final oral presentation.

EVALUATION

Evaluation of the theoretical part(weight: 0.5). Written report on the project (weight: 0.5). The student's production will be evaluated according to the completion of intermediate goals defined during the development of the project.

BIBLIOGRAPHY & RESSOURCES

Merle et al. A&A (2017): Detection of SB in the Gaia-ESO
Pourbaix et al. A&AS (1998): Orbital determination of SB

CONTACT

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