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.

— INSTITUTE

The METEOR will take place at Université Libre de Bruxelles, on the 'La Plaine' campus, in the Institut d'Astronomie et d'Astrophysique located at Bd du Triomphe, 2, 1050, Brussels. Accomodation can be find here or here.

— THEORY

by Thibault 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 Thibault Merle

The project will consist in deriving orbital solutions of spectroscopic binaries with 2 visible components (SB2). 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

- `Tier 1`: theory and exercices
- `Tier 2`: research project
- `Tier 3`: project+oral preparation

— EVALUATION

The student's production will be evaluated according to the completion of intermediate goals defined during the development of the project.

- `Theory grade [30%]`

  The student will solve about 8 practical exercises related to the theoretical parts studied.
- `Practice grade [30%]`

  The student will write a report of the project in a research article style and will be evaluated on its initiative, progress, analysis and critical assessement of his/her results.
- `Defense grade [40%]`
  - Oral and slides quality
  - Context
  - Project / Personal work
  - Answers to questions

— BIBLIOGRAPHY & RESOURCES

- Spectroscopic binary star simulator
- Pourbaix et al., A&AS (1998)
- Merle, Bull.SteRo.Sc. Liège (2023)

— CONTACT

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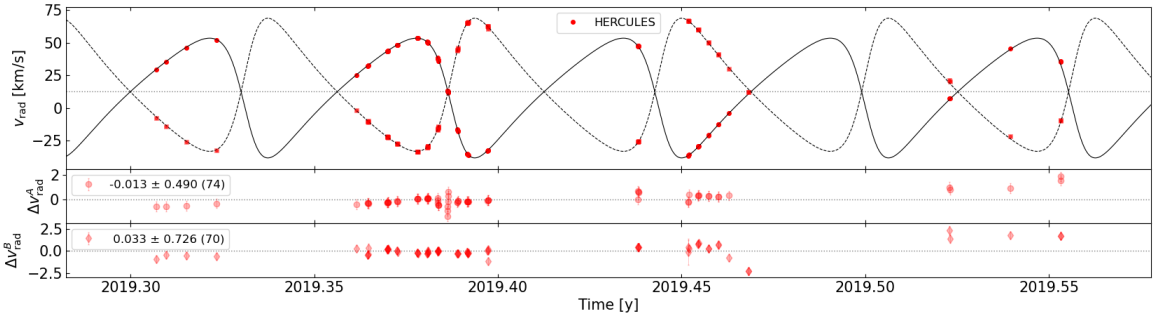

Example of the RV curves fitting of an SB2 (solid and dashed black lines).
Red points are the measured RVs.
Lower panels show the residuals (observed − calculated).