AbsParEB and InPeVEB: Software for the calculation of absolute and orbital period changes parameters of eclipsing binaries

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Abstract

The software **AbsParEB** (Absolute Parameters of Eclipsing Binaries) calculates the absolute parameters and their formal errors for three different modes: a) for a double line spectroscopic eclipsing binary, b) for a single line spectroscopic eclipsing binary, and c) for an eclipsing binary for which there is no spectroscopic information. In addition, the positions of the binary's members on the Mass-Radius and Color-Magnitude diagrams can also be plotted. **InPeVEB** (Interpretation of Period Variations of Eclipsing Binaries) calculates the parameters as well as their formal errors of several orbital period modulating mechanisms of eclipsing binaries (i.e. LITE, Applegate's mechanism, mass transfer/loss, apsidal motion, magnetic braking) using the results derived by their O-C diagram analysis. Both programs are available online (free of charge) in a Graphical User Interface (GUI) form and they were built using PYTHON .

Development

Both software were built using the PYTHON programming language (v.2.7). They contain menu with introduction and description submenus, in which all modes and mechanisms (inc. literature references) are explained in detail. The current versions for both software are 1.1.

Requirements and availability

Running tests were made under Windows 32-bit OS (i.e. XP, Vista, 7, and 8) without any problems. Both software are in executable format (exe), there is no need of installation and all necessary libraries are already included. They are available online (free of charge) at http://alexiosliakos.weebly.com/software-development.html.

AbsParEB

This software calculates the absolute parameters (masses, radii, log*g*, semi-major axes, luminosities and bolometric magnitudes) of the members of an eclipsing binary (hereafter EB) and their positions on the Mass-Radius (*M-R*) and Color-Magnitude (*C-M*) diagrams. According to the information provided by the user, there are three available modes for the calculations:

1. **Information from photometry and spectroscopy (full):** Applies to double-line spectroscopic EBs. The user should provide the radial velocities, the temperatures, and the relative radii of the stars, as well as the orbital period, the eccentricity, and the inclination of the system.
2. **Information from photometry and spectroscopy (limited):** Applies to single-line spectroscopic EBs. The user should provide the radial velocity of the hotter component, the temperatures, and the relative radii of the stars, as well as the orbital period, the eccentricity, the photometric mass ratio, and the inclination of the system.
3. **Information from photometry only:** Applies to an EB for which there is no spectroscopic information. The user has to assume the mass of the primary component and temperatures of both stars, and should provide the relative radii of the stars, as well as the orbital period, the eccentricity, the photometric mass ratio, and the inclination of the system.

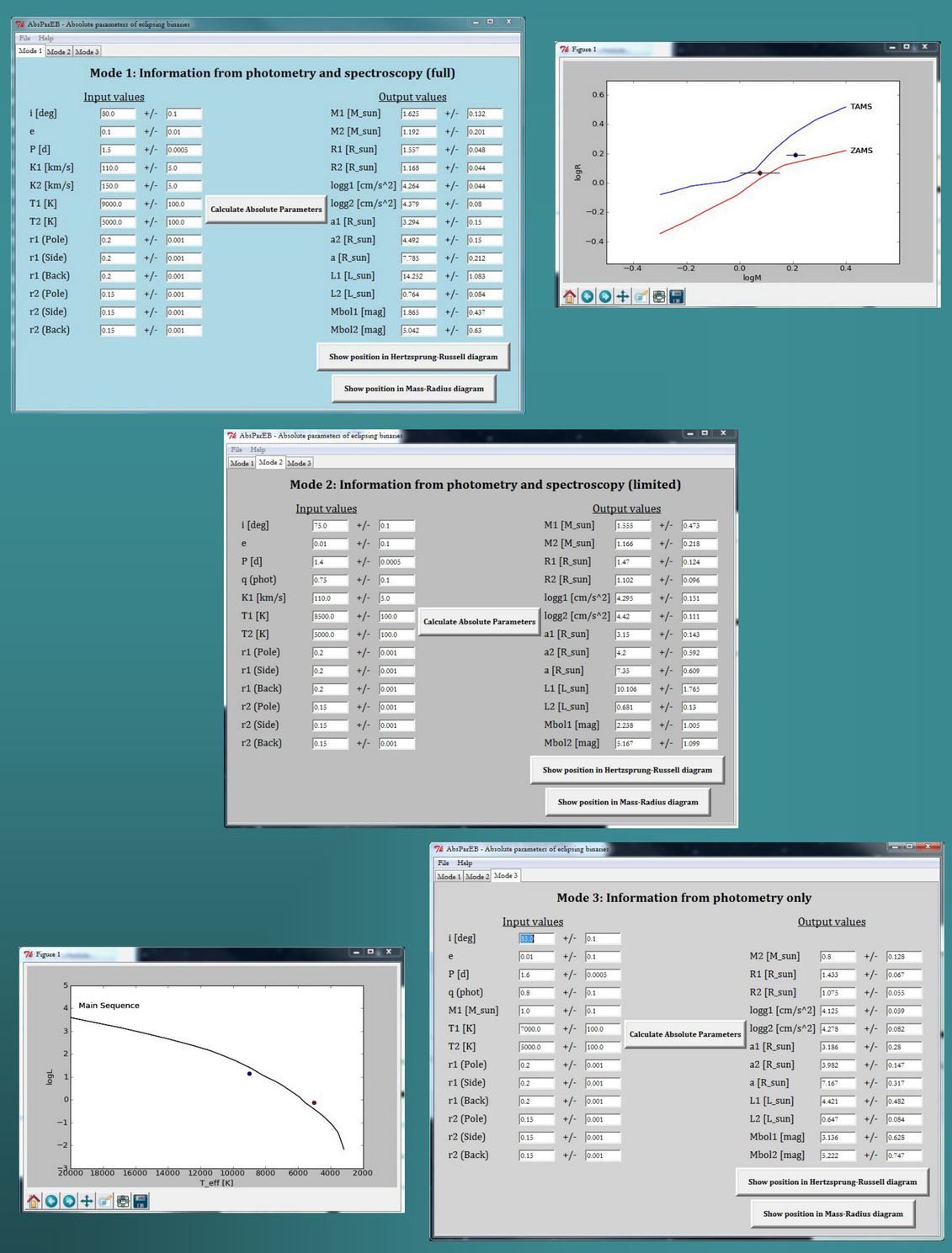

Figure 1. Snapshots from the AbsParEB software showing the input and output parameters of each calculation mode and the positions of the EB's components on the *M-R* and *C-M* diagrams.

InPeVEB

This software calculates the quantities of various orbital period modification mechanisms that may occur in an EB. The input values are usually obtained through the O-C diagram analysis of the system. The mechanisms can be related either to periodic variations of the times of minima (O-C points) or to secular changes of the orbital period. The software performs calculations for the following mechanisms:

1. **Light-Time Effect:** Applies to periodic modulations of the orbital period. The user should provide the masses and the luminosities of the EB's members, the period and the distance of the system, and the masses and periods of up to two additional bodies. As output results are derived the luminosity contribution of each additional body, their magnitude difference with the EB, the semi-major axes of their orbits, and their angular separation. Moreover, the user is able to test the dynamical stability of the multiple system.
2. **Applegate's Mechanism:** Applies to periodic modulations of the orbital period and tests if the quadrupole moment variation of the magnetically active component of the EB is able to modify the orbital period of the system. The user should provide the mass, radius, and relative radius of the component , the period of the system, and the period(s) of the cyclic modulation(s) of the orbital period as well as their respective O-C amplitude(s).
3. **Secular changes:** This mode concerns two hypotheses: 1) the conservative mass transfer or mass loss and 2) the non-conservative mass transfer and mass loss due to magnetic braking. For both cases, the user should provide the masses of the components, the period of the system and the parabolic coefficient. For the 2nd hypothesis, the user should also provide the values of the semi-major axis of the EB, the gyro constant coefficient, the Alfven radius and the mass transfer rate. The output results are: the orbital period variation rate (both hypotheses), the mass transfer rate and its direction (1st hypothesis), and the mass loss rate (both hypotheses).
4. **Apsidal motion:** Applies to eccentric systems. The user should provide the orbital period of the EB and the variation rate of its argument of periastron. As results the anomalistic period of the system and the apsidal motion's period value are derived.

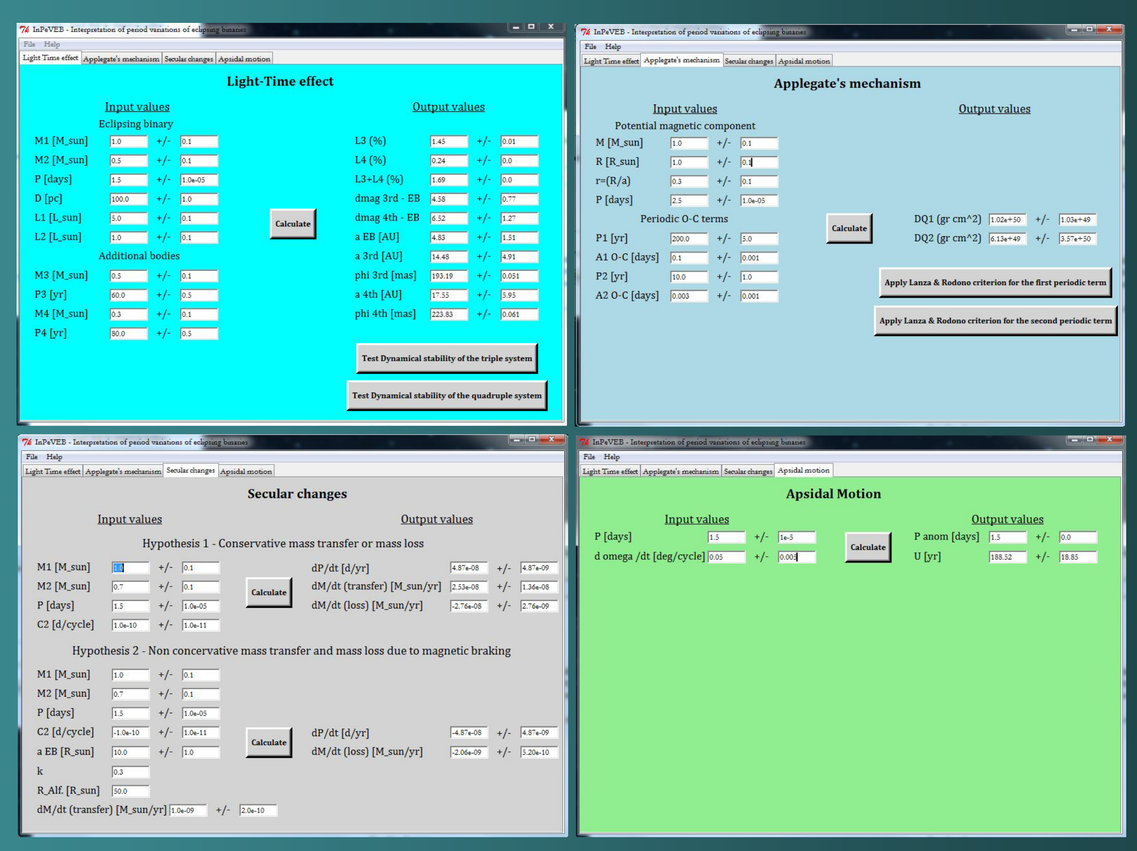

Figure 2. Snapshots from the InPeVEB software showing the input and output parameters of each orbital period modulating mechanism.

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