Binary Stars: An Astronomical Laboratory

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An open source Python code, Binary_Orbit_Solver, was developed to determine orbital elements of a star in a spectroscopic binary system. The code was applied to a compilation of radial velocity time series published over the past 50+ years to create an improved orbit for the long-period (10.3 yrs) eclipsing red supergiant binary 31 Cygni. The code, given a series of radial velocity measurements as a function of time, returns six orbital parameters to the user. These elements are the long term average radial velocity, the velocity amplitude, the argument of periastron, the eccentricity, the date of periastron, and the orbital period referred to by $\{\gamma,K,\omega,e,T_0,P\}$ respectively. Also returned to the user is the semi-major axis - inclination angle value, $a_1\sin(i)$ and the mass function, f(M). A determination of the orbital parameters of a primary star and its companion star is valuable as these parameters can be used to determine the masses of the stars. To solve for these parameters, the given data is fit using the Levenberg-Marquardt algorithm. This implementation of the Levenberg-Marquardt algorithm, the preliminary procedure of estimating the parameters, and the improved orbit found for 31 Cygni are presented.