ExerciseMasses: Introduction

A third body causes periodic changes in the observed (O) minus the computed (C) epochs of an eclipsing binary. If the third body orbit is circular, the mass function of this light-time effect fulfills

$$f(m_3) = \frac{(m_3 \sin i)^3}{[m_1(1+q)+m_3]^2} = \frac{(173.15\ a)^3}{p_3^2}, \tag{1}$$

where the parameters are

i = inclination of the orbital plane of the third body

m_1 = mass of primary of eclipsing binary (units of solar mass [$m_\odot$])

$q = m_2/m_1$ = dimensionless mass ratio of secondary and primary of eclipsing binary

m_3 = mass of third body (units of solar mass [$m_\odot$])

$a = A/2$ is half of the peak the peak amplitude A of O-C modulation caused by the third body (units of days [d])

p_3 = period of O-C modulations caused by the third body (units of years [y])

ExerciseMasses: Problem

The period $p_3 = 33507$ days was detected from the O-C changes of XZ And ($m_1 = 3.2m_\odot$ and $m_2 = 1.3m_\odot$). The peak to peak amplitude of these regular O-C changes was $A = 0.086$ days. Assume that the orbit of this third body is circular, i.e. the relation of Eq. 1 is valid. Compute the lower limit for the mass m_3 of the third body by assuming that the inclination of orbital plane of this third body is $i = 90^o$. Give the result using an accuracy of two decimals, like $m_3 = 0.12m_\odot$.

The easiest solution is iterative. It proceeds through the following stages.

1. Compute the numerical value on the right side of Eq. 1.
2. Insert the known values of m_1, q and i into the left side of Eq. 1.
3. Test all m_3 values between $0.10m_\odot$ and $2.00m_\odot$. Use a step of $0.01m_\odot$ to achieve the desired accuracy. For the correct m_3 value, the difference between the left and the right side of Eq. 1 is closest to zero.
4. A short computer **python** code is the fastest way to do this. Give the name **ExerciseMasses.py** to your code.

Send your solution for m_3 and your **ExerciseMasses.py** program to the assistant.