Level 2 Stars

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Problem Set S.2

(1) How does the period of a binary system depend on the separation between the two stars? Calculate the period of a binary system with two solar mass stars separated by 10 AU. [3 marks]

Solution

$$P^2 = \frac{4\pi^2 a^3}{G(m_1 + m_2)} \qquad \text{P=22.4 yr}$$

[1 mark for formula, 2 marks for numerical result – needs to be given in years]

(2) List four possible signatures that a stellar system actually consists of two or more stars. [4 marks]

Solution

Spatially resolved stars (visual binaries)
Astrometric wobbles (astrometric binaries)
Doppler wobbles (spectroscopic binaries)
Eclipses (eclipsing binaries)

[1 mark for each valid answer]

(3) In an eclipsing binary system, the time taken for the light to drop from uneclipsed to fully eclipsed is 7 hrs. The relative velocity for the smaller star with respect to the larger star is 80 km s^{-1}. What is the radius of the smaller star? [3 marks]

Solution

$$R = \frac{v \times t}{2} = 1.00 \times 10^9 m$$

[2 marks for method, 1 mark for the correct numerical result]

[mass of Sun = 1.99×10^{30} kg, astronomical unit (AU) = 1.50×10^{11} m; G = 6.67×10^{-11} m^3 kg^{-1} s^{-2}]