An extra-solar planetary system consists of a star and just one planet. The mass of the planet is 1/1000 times the mss of the star. The distance between the two is 1000 times the radius of the star. Calculate the location of the centre of mass of the system. State whether it is inside the star or outside it?

Solution:

Let us consider the coordinate system whose origin is placed at the center of star. So, center of mass of the system "star+planet" is given by

$$x_c = \frac{x_s M_s + x_p M_p}{M_s + M_p}$$

$$= \frac{0 \times M_s + 1000 R_s \times \frac{1}{1000} M_s}{M_s + \frac{1}{1000} M_s}$$

$$= \frac{R_s}{1 + \frac{1}{1000}} = \frac{1000}{1001} R_s = 0.999 R_s.$$

Therefore the center of mass of the system "star+planet" is located inside the star.

Answers: $0.999 R_s$, inside the star.