# Plots for Assignment 2

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## Question 1

All plots are for the exoplanet *V830 Tau b*. The parameters used are $K_* = 75.0$ m/s, $a = 0.057$ AU, $t_p = 0.0$, $P = 4.93$ days. The true anomaly was calculated from the eccentric and mean anomalies by solving Kepler's equation iteratively. The plots are as below:

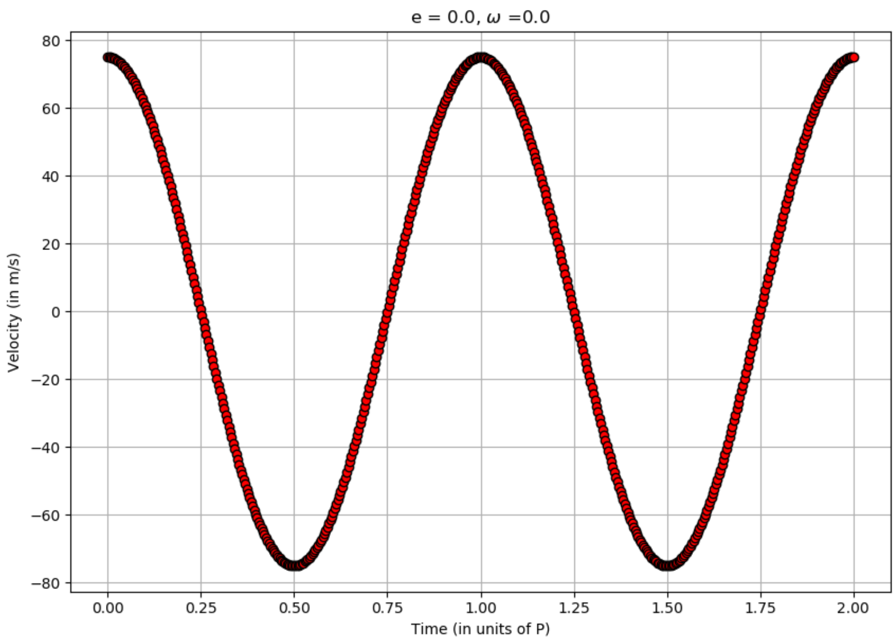


Figure 1: Plot of radial velocity curve for e = 0.0, $\omega = 0.0$

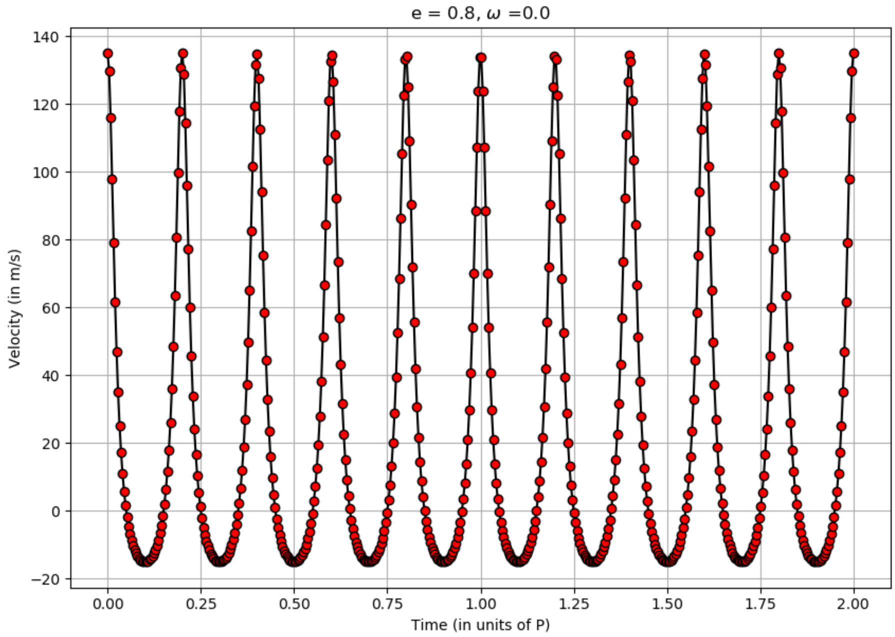


Figure 2: Plot of radial velocity curve for e = 0.8, $\omega = 0.0$

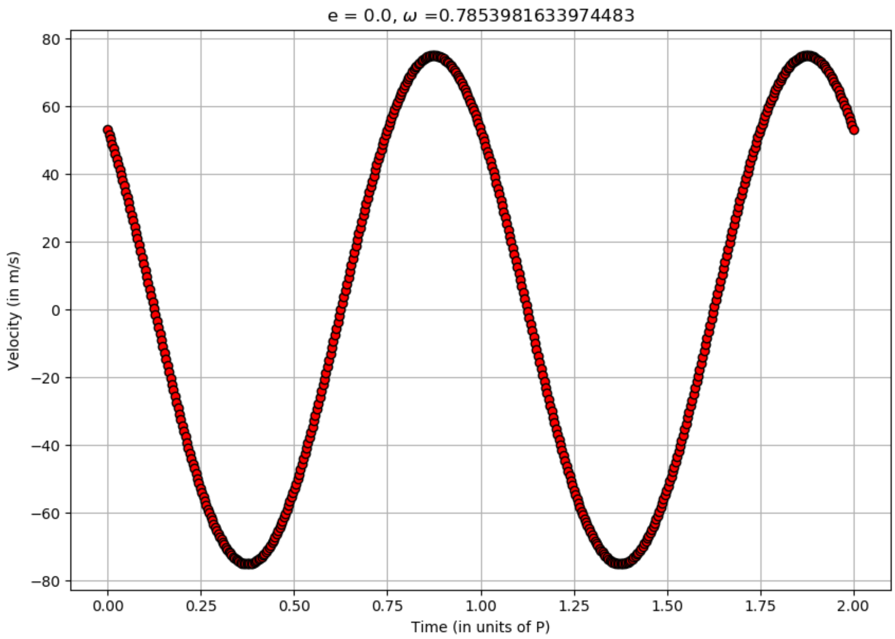


Figure 3: Plot of radial velocity curve for e = 0.0, $\omega = 45°$

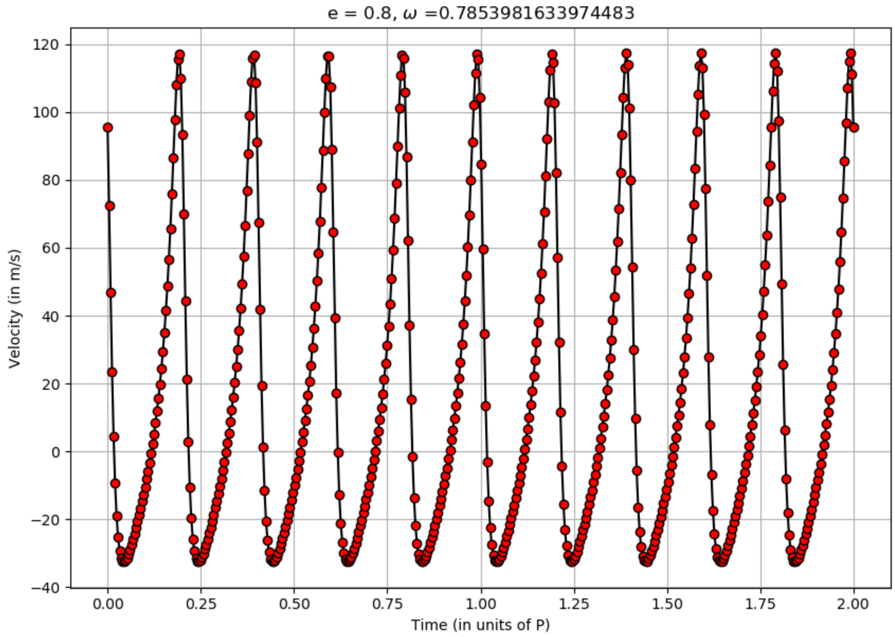


Figure 4: Plot of radial velocity curve for e = 0.8, $\omega = 45°$

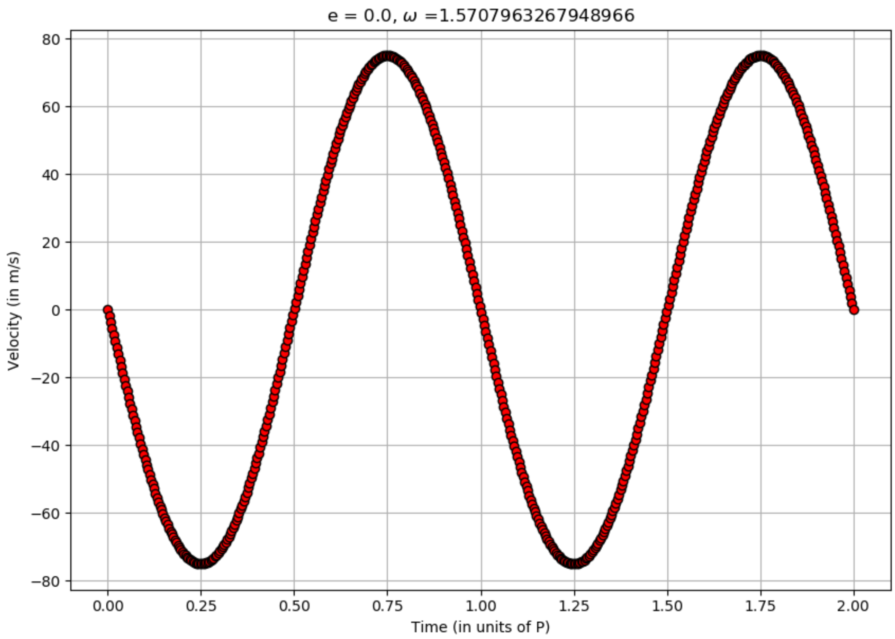


Figure 5: Plot of radial velocity curve for e = 0.0, $\omega = 90°$

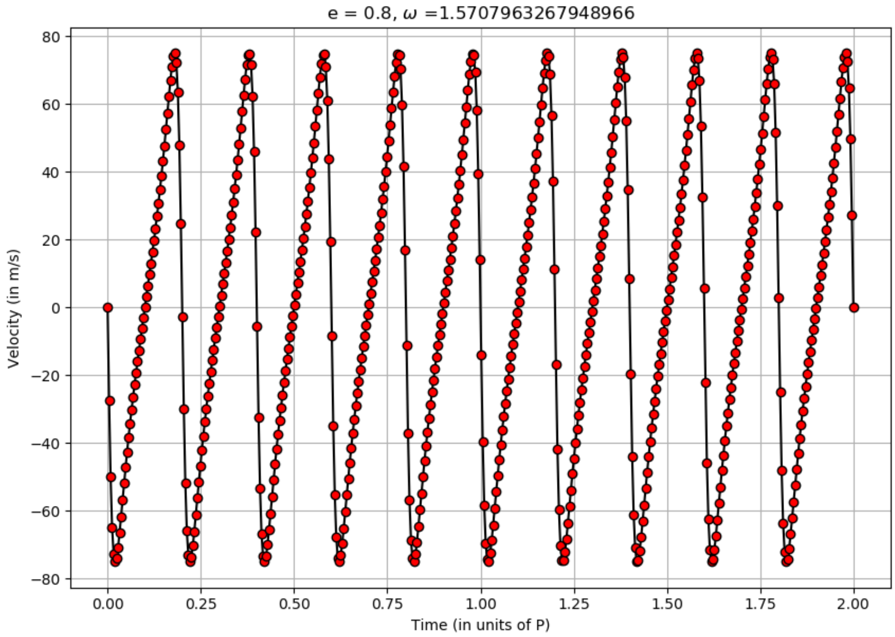


Figure 6: Plot of radial velocity curve for e = 0.8, $\omega = 90°$

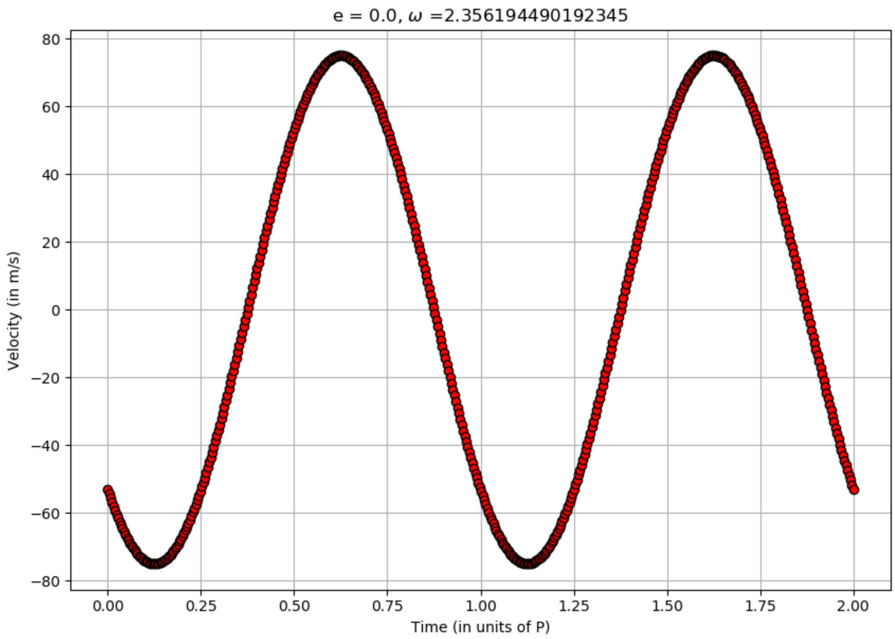


Figure 7: Plot of radial velocity curve for e = 0.0, $\omega = 135°$

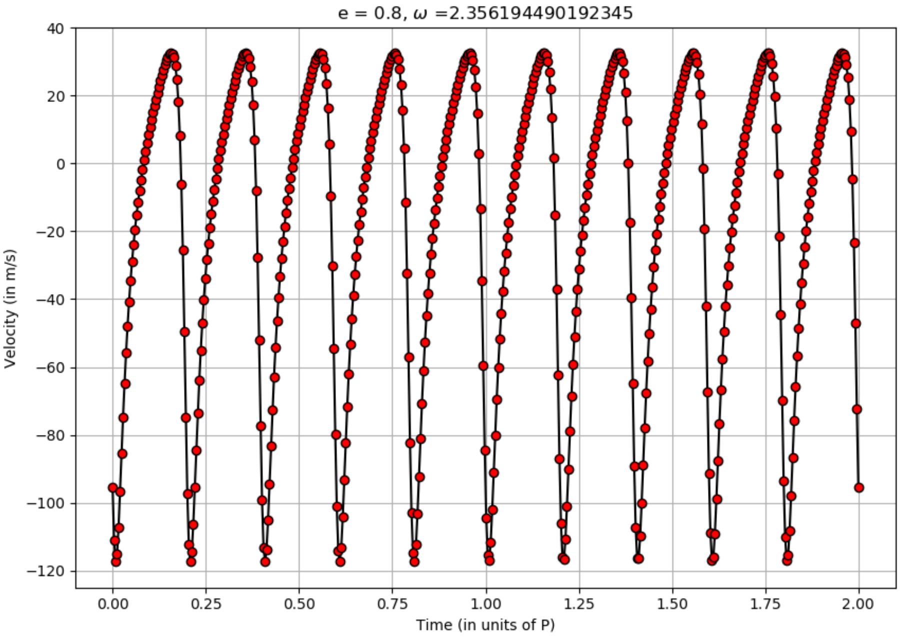


Figure 8: Plot of radial velocity curve for e = 0.8, $\omega = 135°$

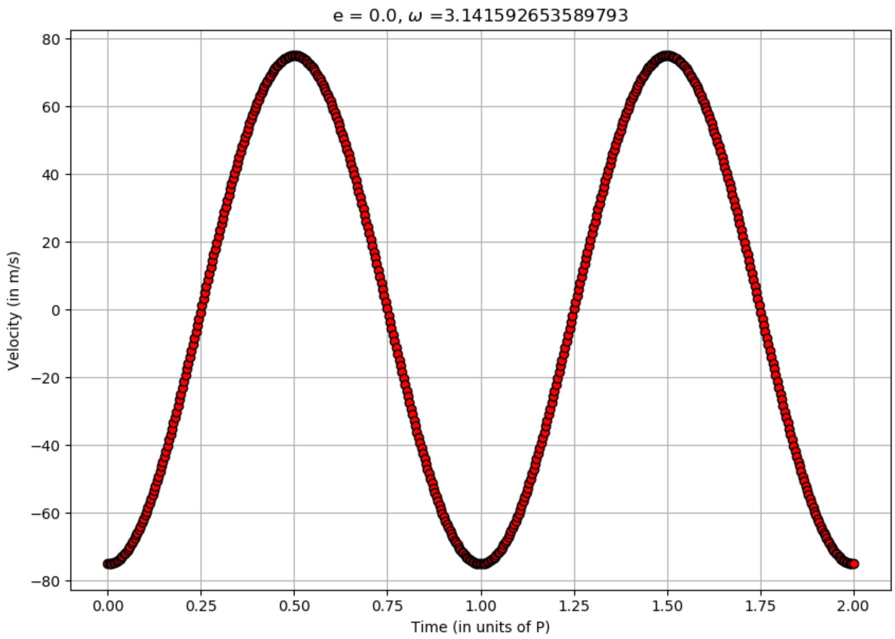


Figure 9: Plot of radial velocity curve for e = 0.0, $\omega = 180°$

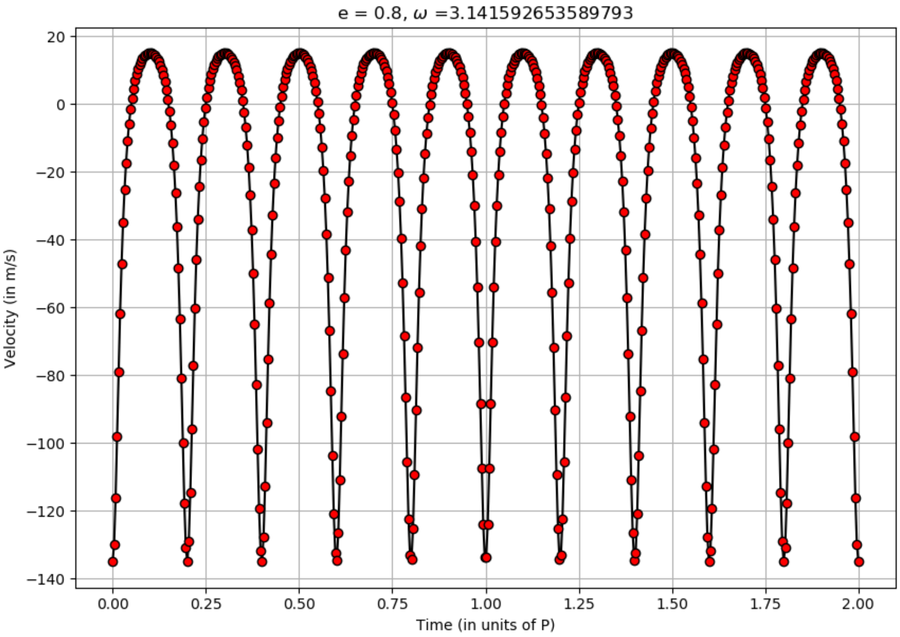


Figure 10: Plot of radial velocity curve for e = 0.8, $\omega = 180°$

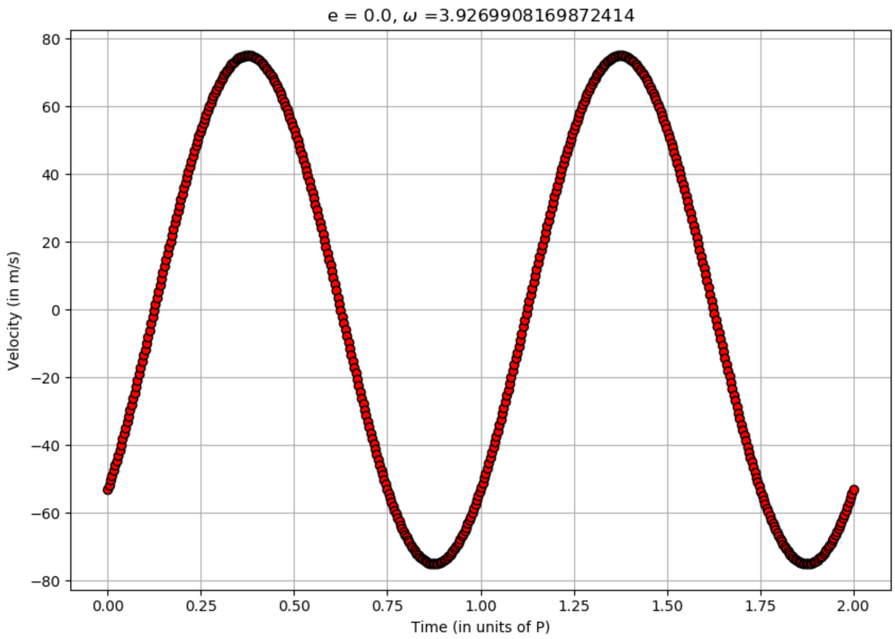


Figure 11: Plot of radial velocity curve for e = 0.0, $\omega = 225°$

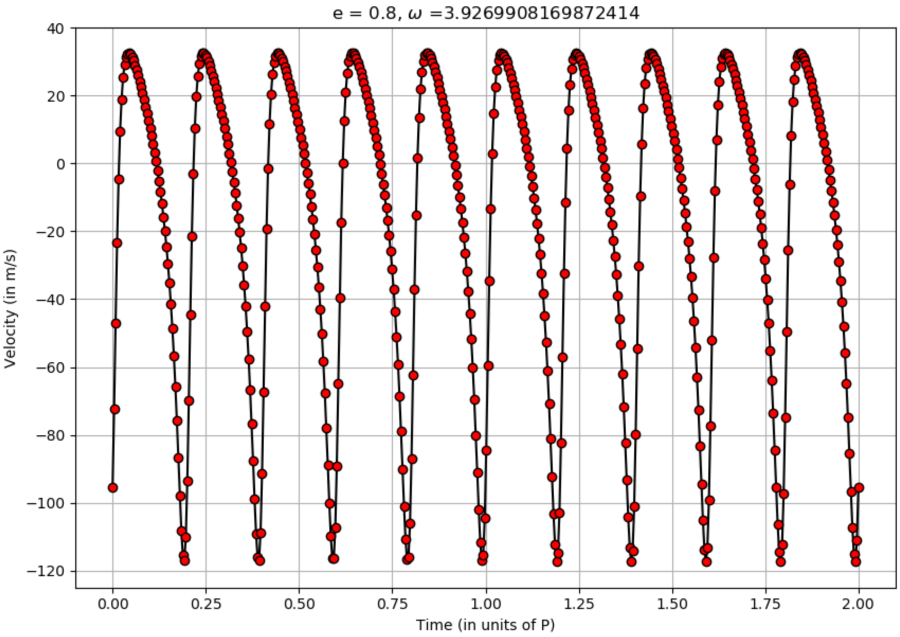


Figure 12: Plot of radial velocity curve for e = 0.8, $\omega = 225°$

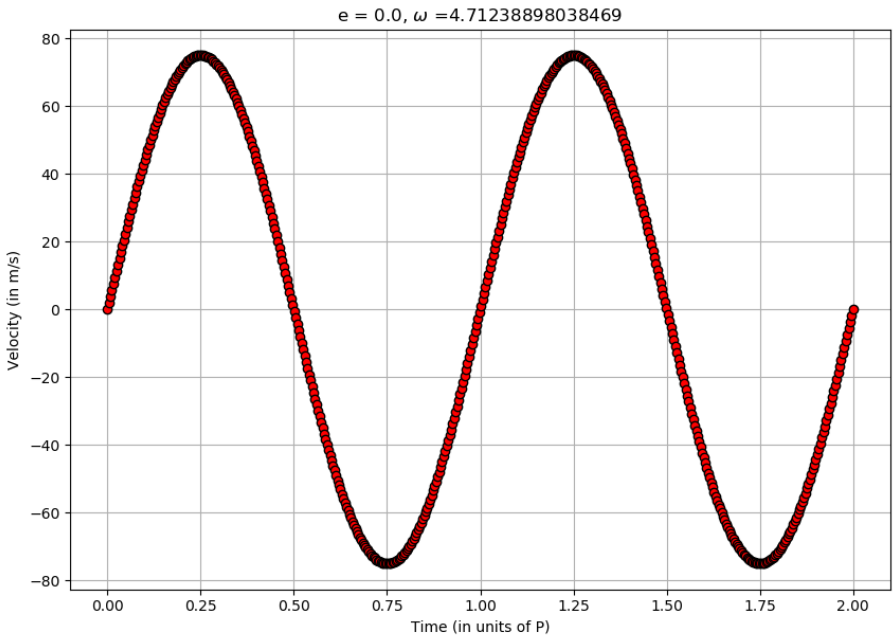


Figure 13: Plot of radial velocity curve for e = 0.0, $\omega = 270°$

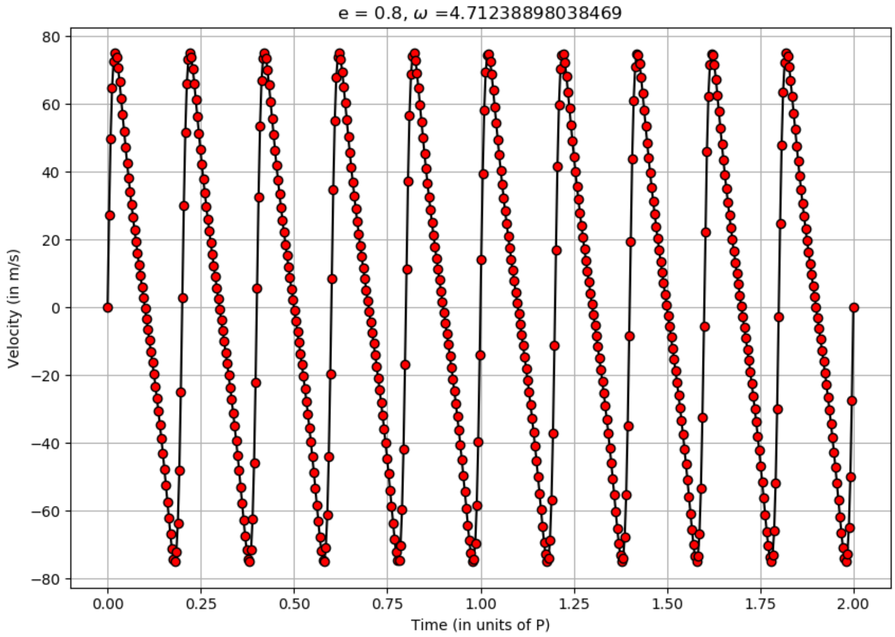


Figure 14: Plot of radial velocity curve for e = 0.8, $\omega = 270°$

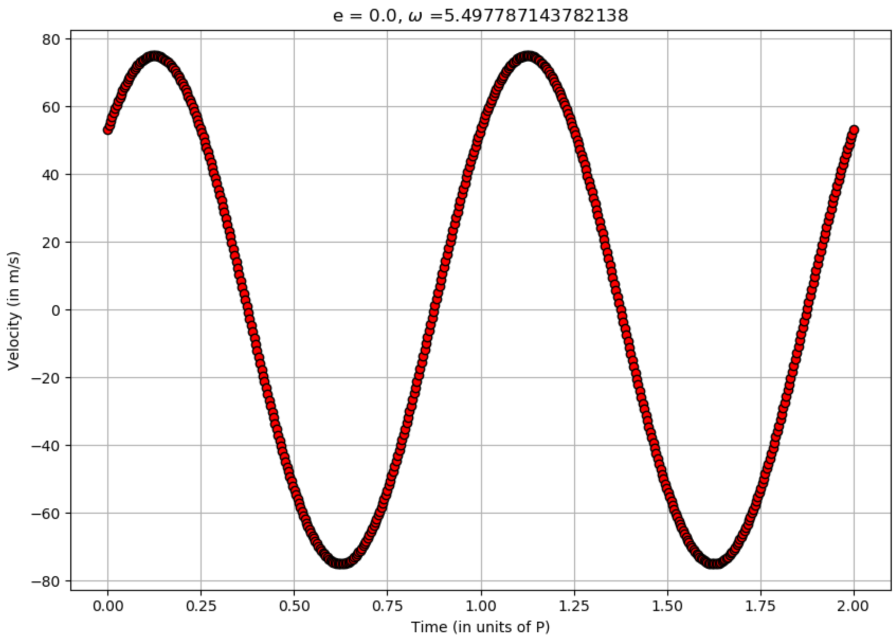


Figure 15: Plot of radial velocity curve for e = 0.0, $\omega = 315°$

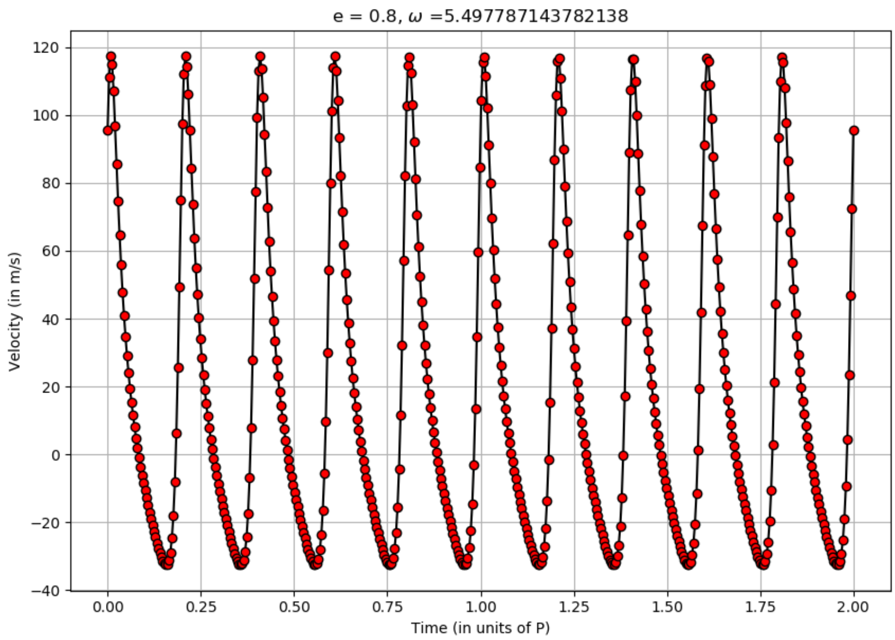


Figure 16: Plot of radial velocity curve for e = 0.8, $\omega = 315°$

As seen from [1] and [2], the radial velocity of the actual exoplanet V830 Tau b corresponds to an eccentricity of 0.0, upon filtering. This agrees with the value given in the Exoplanet database, and also the behaviour as seen in the plots above.

# Question 2

The plots are as given below. In the plots, the angle $i_{min} = \arccos\left(\frac{R_{star}+R_{planet}}{a}\right)$

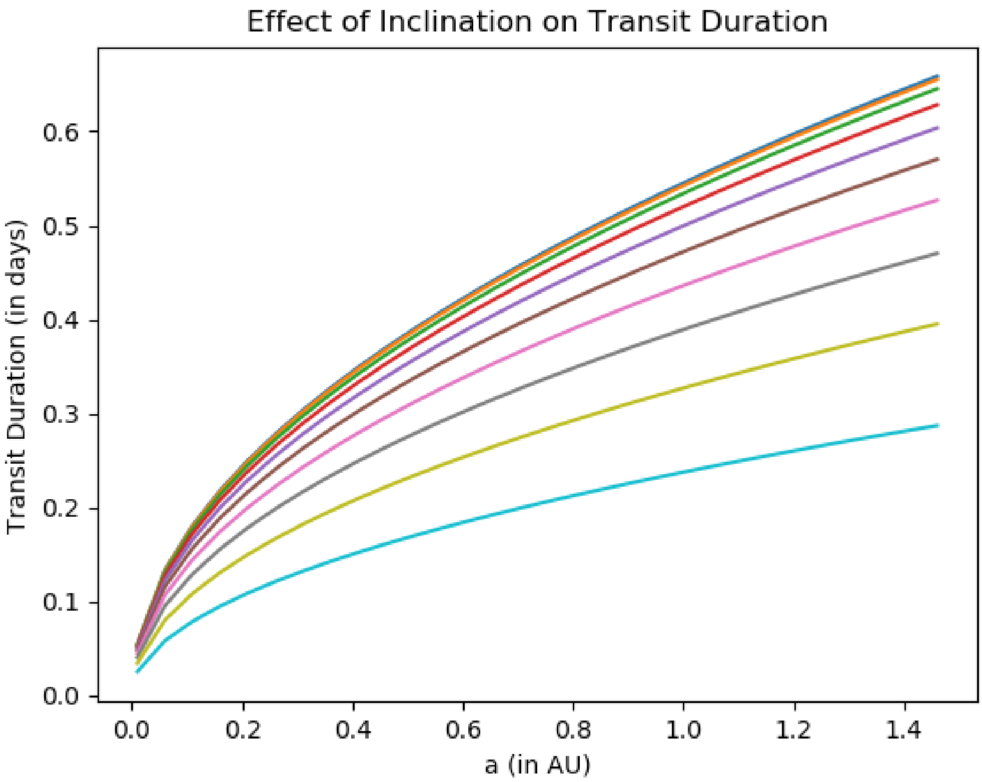


Figure 17: Variation of Transit Duration with the semi-major axis, for an Earth-sized planet around a Sun-type star. Note that the inclination, for a given $a$, varies from $i_{min}$ to $90°$, along increasing y.

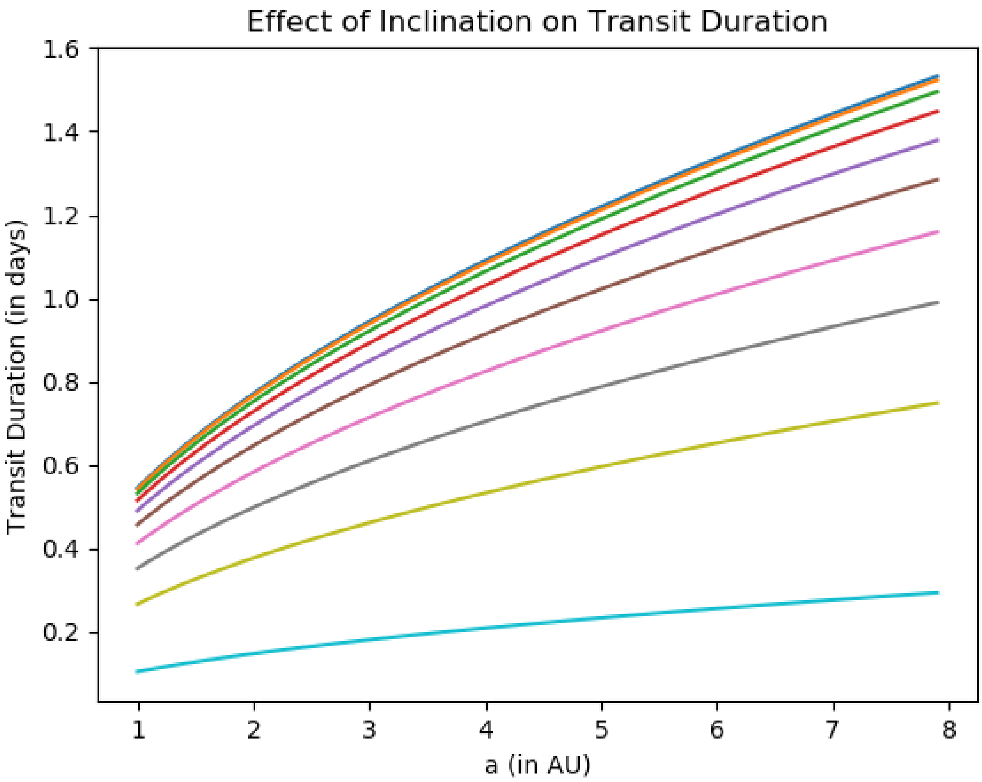


Figure 18: Variation of Transit Duration with the semi-major axis, for an Jupiter-sized planet around a Sun-type star. Note that the inclination, for a given $a$, varies from $i_{min}$ to 90°, along increasing y.

We see that the curves for the Earth-sized planet around a Sun-type star bunch together at smaller semi-major axis values, and thus determining the inclination is tougher. This is not the case for the Jupiter-sized planet around a Sun-type star. Further, as expected, the largest transit durations are obtained for inclinations close to 90 deg, and the maximum possible transit duration (given best inclination, semi-major axis etc.) increases when the mass of the planet increases. Hence, finding Jupiter-sized planets via the transit method is easier than as compared to Earth-sized planets around a similar Sun-type star.

# References


- Donati, J.-F., et al. "The Hot Jupiter of the Magnetically Active Weak-Line T Tauri Star V830 Tau." Monthly Notices of the Royal Astronomical Society, vol. 465, no. 3, 10 Nov. 2016, pp. 3343–3360, 10.1093/mnras/stw2904. Accessed 20 Sept. 2019.

- Donati, J. F., et al. "A Hot Jupiter Orbiting a 2-Million-Year-Old Solar-Mass T Tauri Star." Nature, vol. 534, no. 7609, June 2016, pp. 662–666, 10.1038/nature18305. Accessed 20 Sept. 2019.