

Physics of Planetary Systems — Exercises — Set 3

Problem 3.1

(3 points)

You can find an RV data set for the star 51 Peg (with $\mathcal{M} = (1.16 \pm 0.05) \mathcal{M}_{\odot}$) here: <https://cloud.uni-jena.de/s/253iTQjiGGnt5PQ>. Use these data to derive the system velocity, as well as the likely orbital period and the minimum mass of the companion. Plot a phase-folded RV curve, including your best fit. *Hint: the linked folder also contains pieces of Python code that you can use.*

Bonus problem 3.2

(1 extra point)

Give the uncertainty range for the mass estimate from Prob. 3.1.

Bonus problem 3.3

(1 extra point)

Why is the residual scatter in Prob. 3.1 wider than the nominal measurement uncertainties?

Problem 3.4

(2 points)

A rotating molecular core with a specific angular momentum $L = 10^{21} \text{cm}^2/\text{s}$ collapses to form the protosun with $R = R_{\odot}$. Using that, estimate the rotation period of the protosun and show that without the angular momentum transport the protosun would break apart.

Bonus problem 3.5

(2 extra points)

The (inward) flow of mass per time at distance r in a viscous accretion disk is given by $\dot{\mathcal{M}}(r) = 2\pi r \Sigma v_r$, where Σ is the common surface mass density (i. e. mass per projected disk area)

and v_r the radial drift velocity. Derive the rate (and direction) of the corresponding local flow of angular momentum. *Hint: assume conservation of angular momentum.*



Figure 1: Host site to HARPS, the most successful radial velocity instrument: ESO's 3.6-m telescope on Mt La Silla, Chile. (Credit: ESO)