On the Mass of CoRoT-7b

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Just what is the mass of CoRoT 7b?

Is it 3.5 ± 0.6 M_{Earth} (Queloz et al. 2009) ?

Is it 7.12 ± 1.43 M_{Earth} (Hatzes et al. 2010) ?

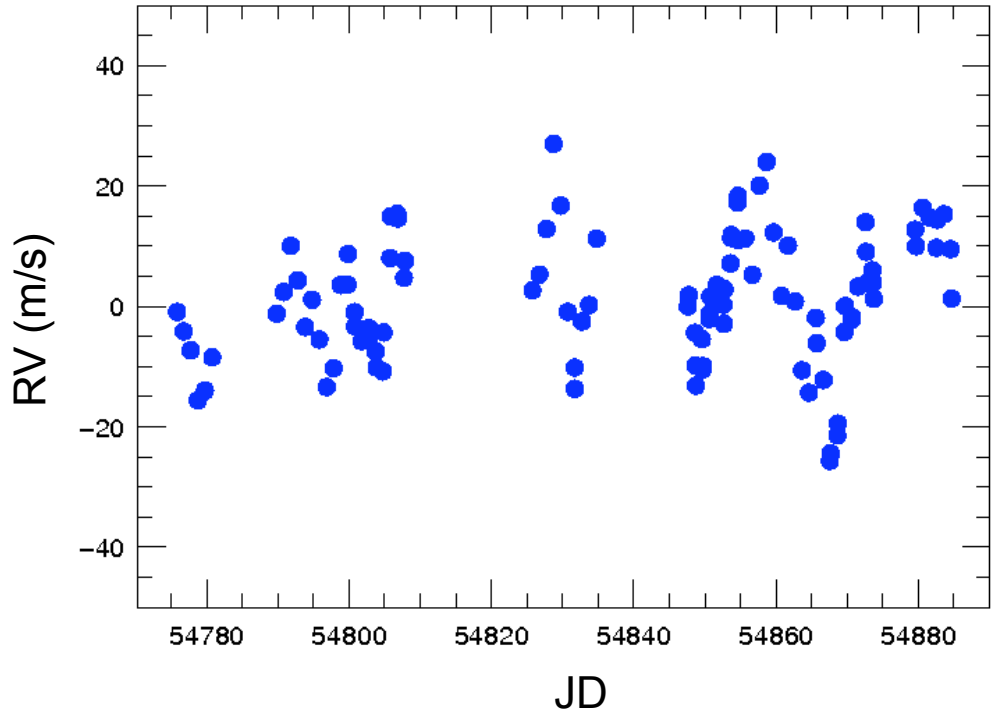
Is it 8.0 ± 1.2 M_{Earth} (Ferraz-Melo al. 2010) ?

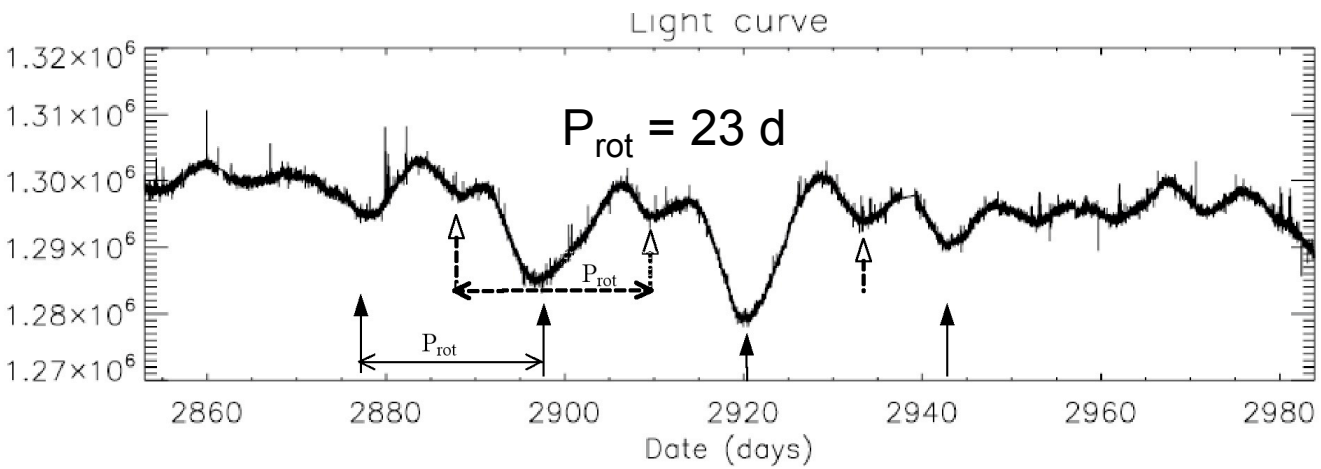
Is it 5.65 ± 1.6 M_{Earth} (Boisse al. 2010) ?

Is it 2.26 ± 1.83 M_{Earth} (Pont al. 2010) ?

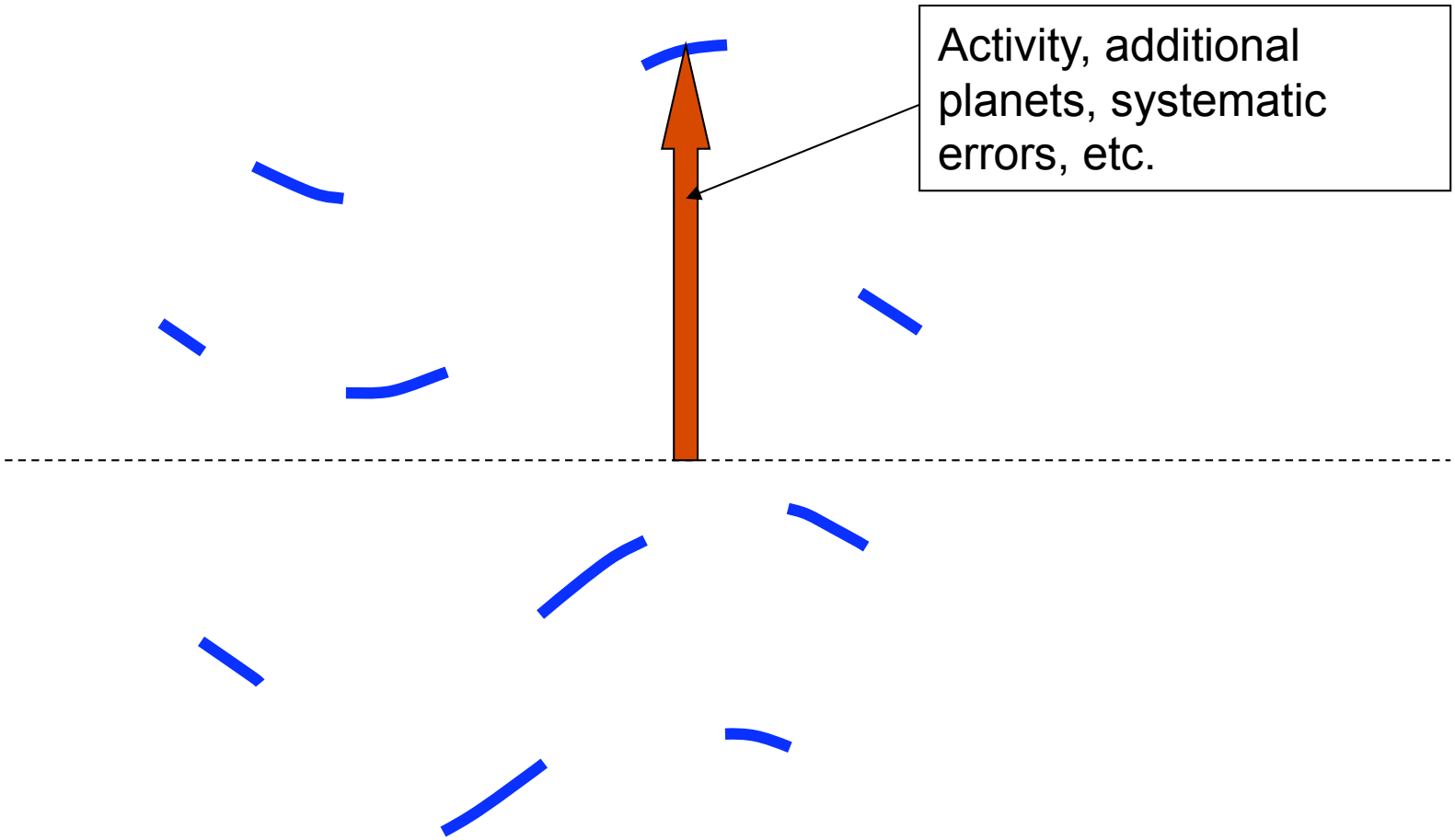
Is the RV community clueless?

Radial Velocity Measurements of CoRoT-7b with HARPS





A simple way to remove the acvitity signal



If the RV variations due to activity, additional planets, or systematic noise are constant on a given night, then these can be simply subtracted and the segments of the CoRoT-7b sine wave „stiched together“

Two simple and reasonable assumptions:

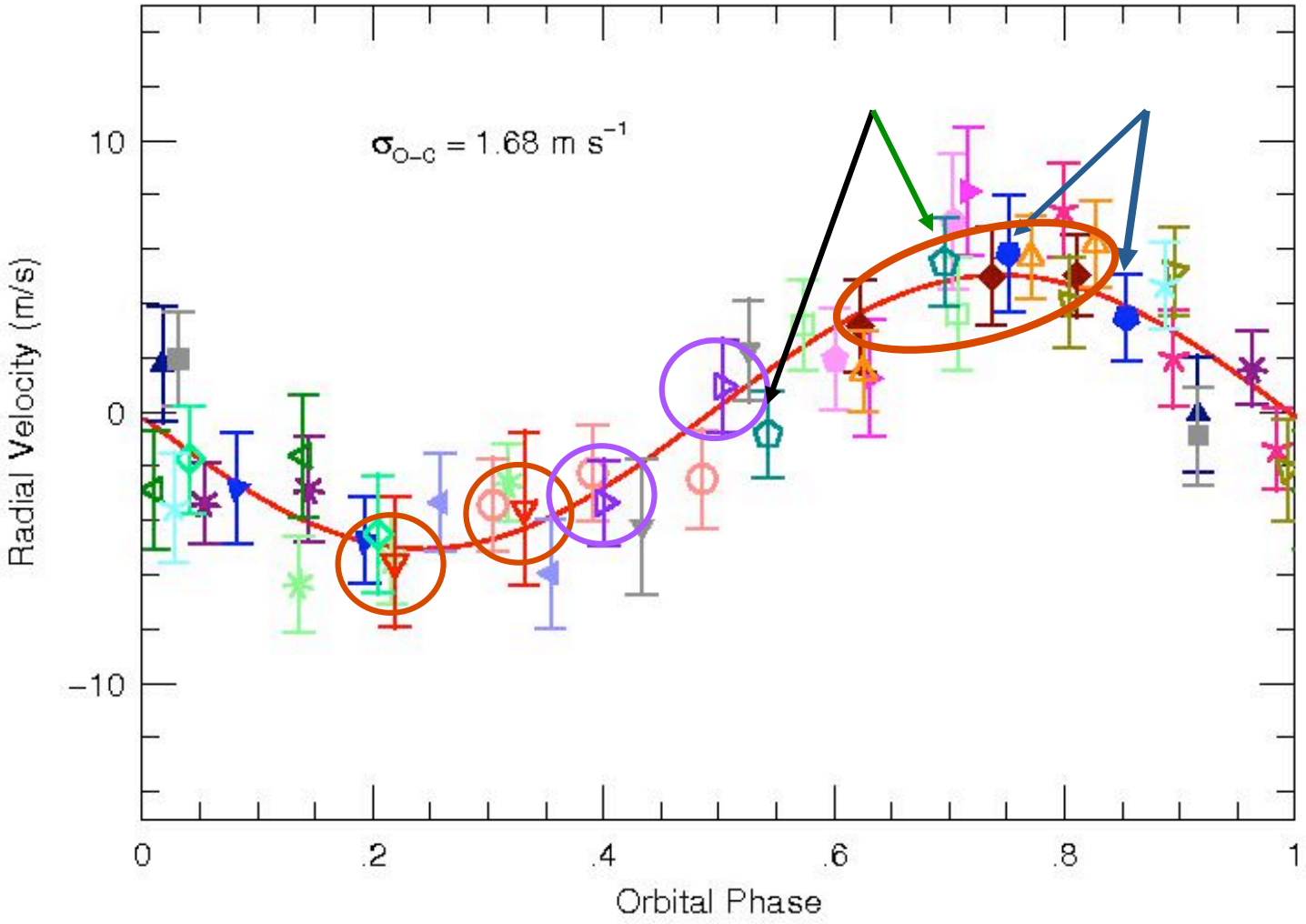
1) A 0.85 d period is present in the RV data

   - Reasonable given Leger, Rouan, Schneider et al. (2009)

2) RV Variations from other phenomena (activity, other planets, systematic errors) over $\Delta T < 4$ hours is small.

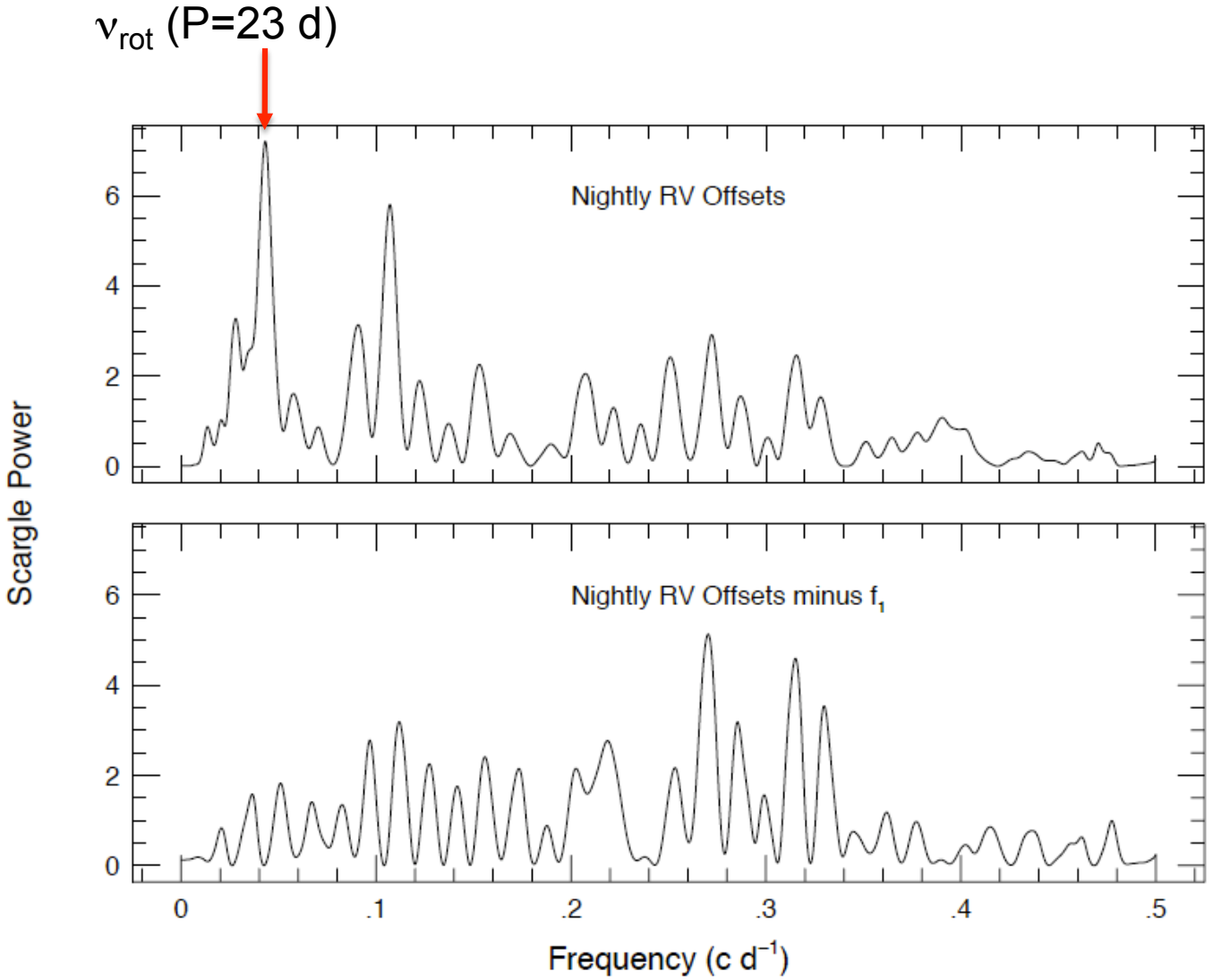
   - **$\Delta\phi_{rot} = 0.01$, $\Delta RV < 0.5$ m/s**
   - **$\Delta RV_{planets} = 0 \pm 0.9$ m/s**

Throw out half the HARPS measurements and only use those where multiple measurements are taken each night with a $\Delta T < 4$ hrs



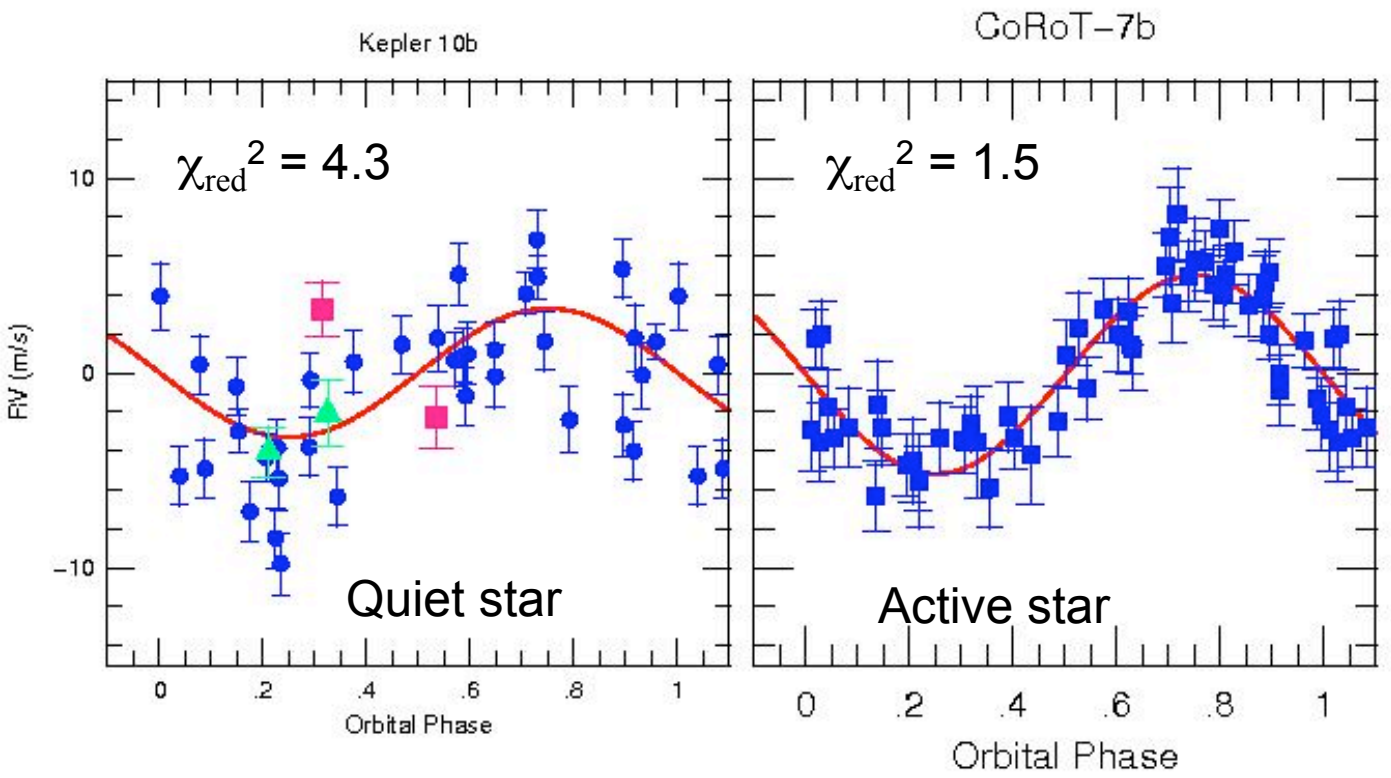
Zero point offset and phase are the only free parameters. The period is kept fixed ➔ transit phase recovered!

Sanity Check: Periodogram of the nightly offsets



Amplitude of variations ≈ 10 m/s

Kepler-10b versus CoRoT-7b



M_{star} = 0.895 ± 0.06 M_{sun}

R_{star} = 1.056 ± 0.02 R_{sun}

M_{Pl} = 4.56 ±1.23 M_{Earth}

R_{Pl} = 1.416 ± 0.025 R_{Earth}

ρ_{Pl} = 8.8 ± 2.5 cgs

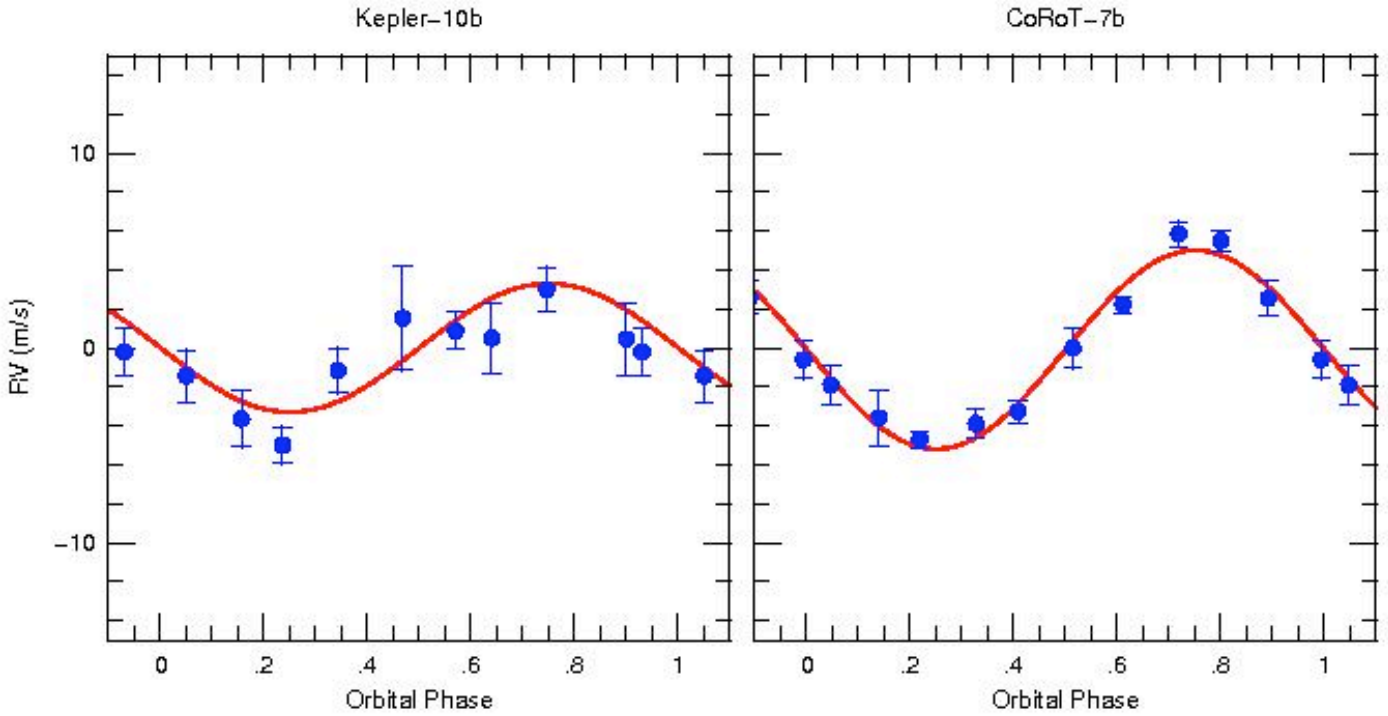
M_{star} = 0.91 ± 0.03 M_{sun}

R_{star} = 0.82 ± 0.04 R_{sun}

M_{Pl} = 7.22 ± 0.48 M_{Earth}

R_{Pl} = 1.58 ± 0.10 R_{Earth}

ρ_{Pl} = 9.9 ± 2.0 cgs


Kepler−10b
CoRoT−7b
RV (m/s)
10
0
−10
0
.2
.4
.6
.8
1
Orbital Phase
Orbital Phase

Summary

- By allowing the nightly means in the RV to float one can remove the activity RV jitter with very few and very simple assumptions

- Devise an observing strategy appropriate to the period you are trying to detect

- Absolutely ***no*** evidence for nightly systematic errors in the HARPS data. The rms scatter agrees with the estimated measurement error. Not so for Kepler-10b

- The mass of CoRoT-7b is $7.22 \pm 0.48\ M_{earth}$

- We know the mass of CoRoT-7b (6%) better than Kepler-10b (25%)

- CoRoT-7b and Kepler-10b have similar mean densities consistent with rocky planets

  - Better density for CoRoT-7b → better radius
  - Better density for Kepler-10b → better mass