KEPLERIAN VERSUS DYNAMICAL MODELLING OF RADIAL VELOCITIES

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Scientific rationale

Radial velocities variations due to interactions between planets are usually below the detectability threshold of current RV facilities. Will they pose a problem for next-generation velocimeters?

We performed an analysis on three systems with planets in their habitability zone and likely targets of next-generation RV instruments: **LHS1140** (Dittmann et al. 2017), **Proxima Cen** (Anglada-Escude et al. 2016) and **TRAPPIST-1** (de Wit et al. 2016, Gillon et al. 2017)

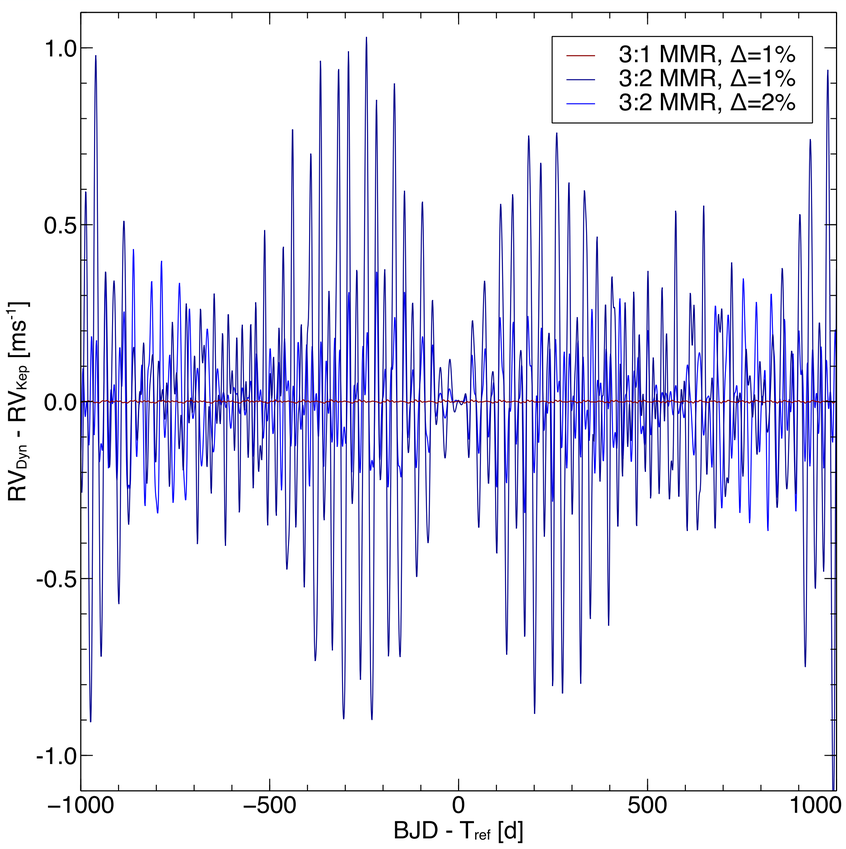
Methods

We followed these steps:

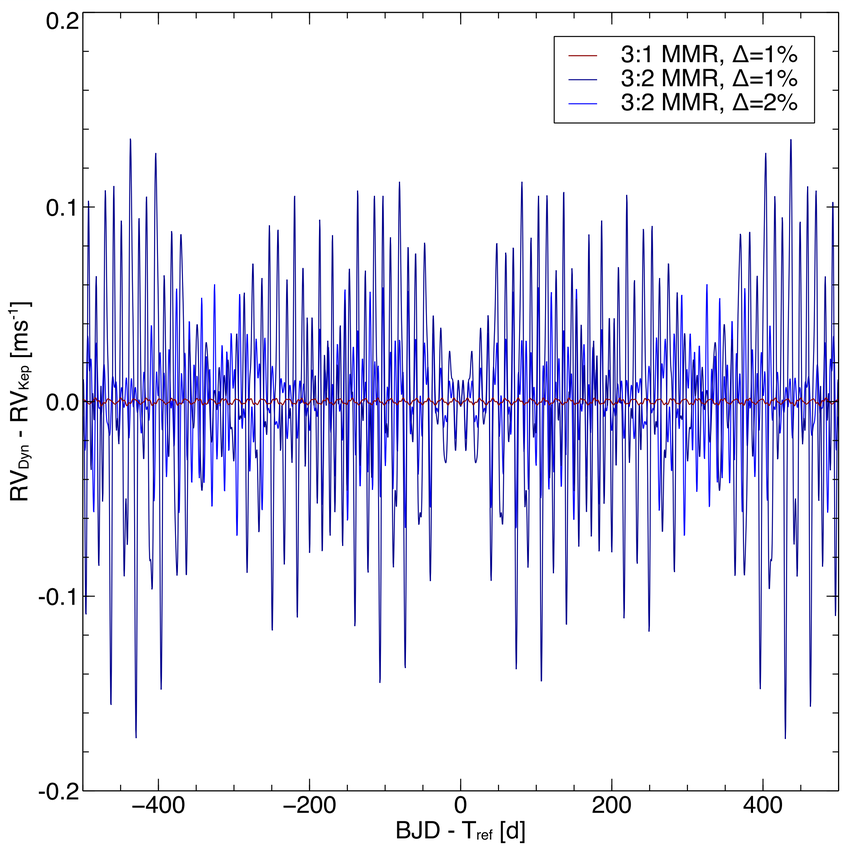
1. We use the orbital parameters in the literature to perform a Dynamical integration using TRADES (Borsato et al. 2014)
2. From the Dynamical integration we computed the linear ephemeris of each planet
3. We computed the Keplerian RVs using period and time of transit of each planet from the linear ephemerides
4. The difference between the Dynamical RVs and the sum of the Keplerian RVs of the individual planets is shown below

For **LHS1140** and **Proxima Cen** systems we added a second planet with mass $M_c=2M_b$ and $M_c=10M_b$ respectively. We tested several Mean Motion Resonance (MMR) configurations and fractional distances from the nearest MMR ($\Delta = P_c/P_b*J/K-1$ for J:K MMR, as defined by Hadden and Lithwick 2016). Of the many possible combinations, we decided to show three representative outcomes. For **TRAPPIST-1** we just used the literature parameters.

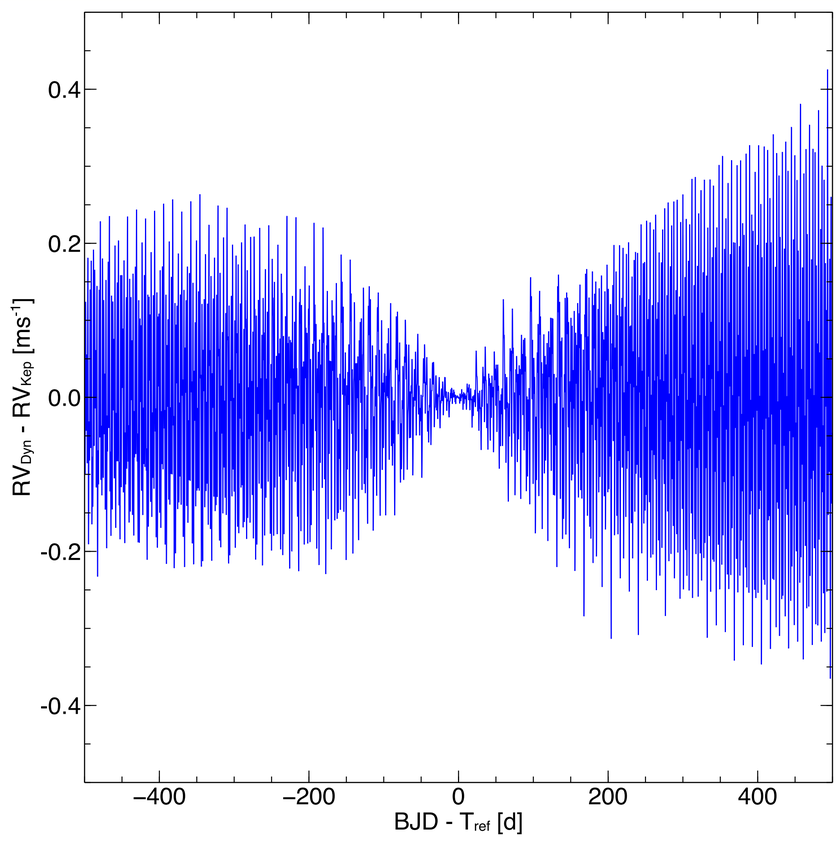
LHS1140



Proxima Cen



TRAPPIST-1



Results

In system very close to 3:2 MMR (Δ≈1%) the difference between Keplerian and Dynamical RVs can be already appreciated with current facilities

In other cases, ΔRV depends on the period and mass of the planet involved, and may pose a threat for next-generation RV instruments

Dynamical and Keplerian RVs are almost indistinguishable in systems far from MMRs (but checking is always worthy)

ΔRV is not coherent with time and can be easily mistaken for stellar activity or instrumental noise when the physical model is imprecise.

LHS1140 b
P = 24.7371 d
M = 6.65 M_E

ProximaCen b
P = 11.186 d
M = 1.27 M_E

All the code used in the analysis is available at
https://github.com/LucaBorsato/ and https://github.com/LucaMalavolta/
ESPG site http://groups.dfa.unipd.it/ESPG/

Measuring ETA_EARTH: Characterization of Terrestrial Planetary Systems with Kepler, HARPS-N, and Gaia
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