Eccentric Standards for Radial Velocity Jitter

Claire Rogers[1], Paul Robertson[1], B.J. Fulton[2], Arvind Gupta[3], Howard Isaacson[4], Jacob Luhn[5]

[1] University of California, Irvine; [2] California Institute of Technology; [3] NSF NOIRLab; [4] University of California, Berkeley;

[5] NASA Jet Propulsion Laboratory

Problem: RV jitter is known to correlate with stellar activity (e.g. [1], [2]), but the correlation is not well-constrained because it is difficult to measure RV jitter without additional effects from instrumental noise and from compact systems of unresolved small planets [3].

Goal: Characterize the activity-jitter relationship across the range of stellar activity spanned by a typical magnetic activity cycle.

Approach: Following the strategy exemplified in [4], we assembled a sample of stars spanning a range of activity levels comparable to the range spanned by a typical FGK star's magnetic activity cycle [5] and the range covered by typical RV surveys for Earth analogs (e.g. [6]) that are known to host massive, eccentric planets. After verifying that these planets would destabilize smaller planets in the system, we can subtract out the orbits of the known planets to measure the jitter due to the stars alone.

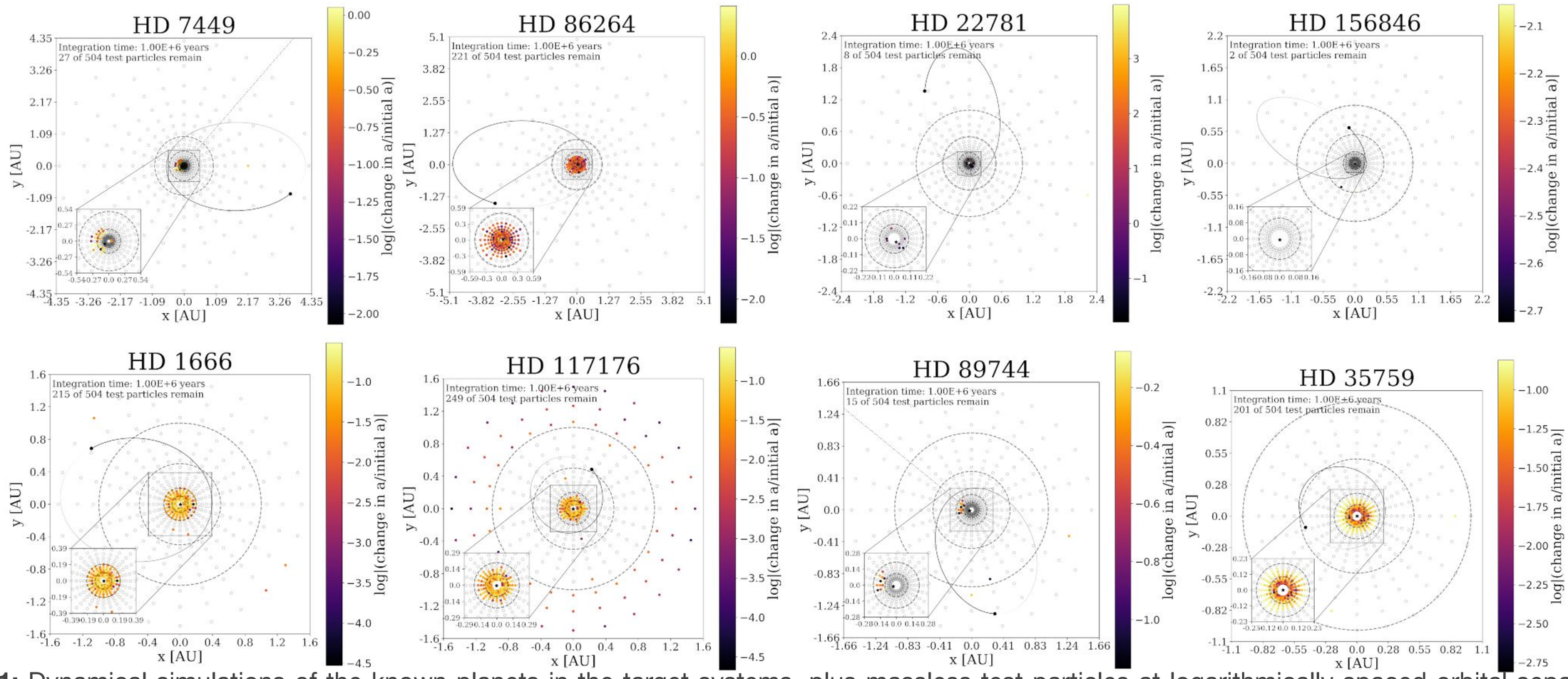

Figure 1: Dynamical simulations of the known planets in the target systems, plus massless test particles at logarithmically spaced orbital separations. Empty circles show locations where test particles were initialized and, after 1 million years, had collided with the star or planet or been ejected from the system. Surviving test particles are colored by the change in their semimajor axis. Even surviving test particles in these systems are significantly disrupted by the eccentric planets. Orbits of 1 AU, 0.5 AU, 0.2 AU, and 0.1 AU are indicated by dashed lines.

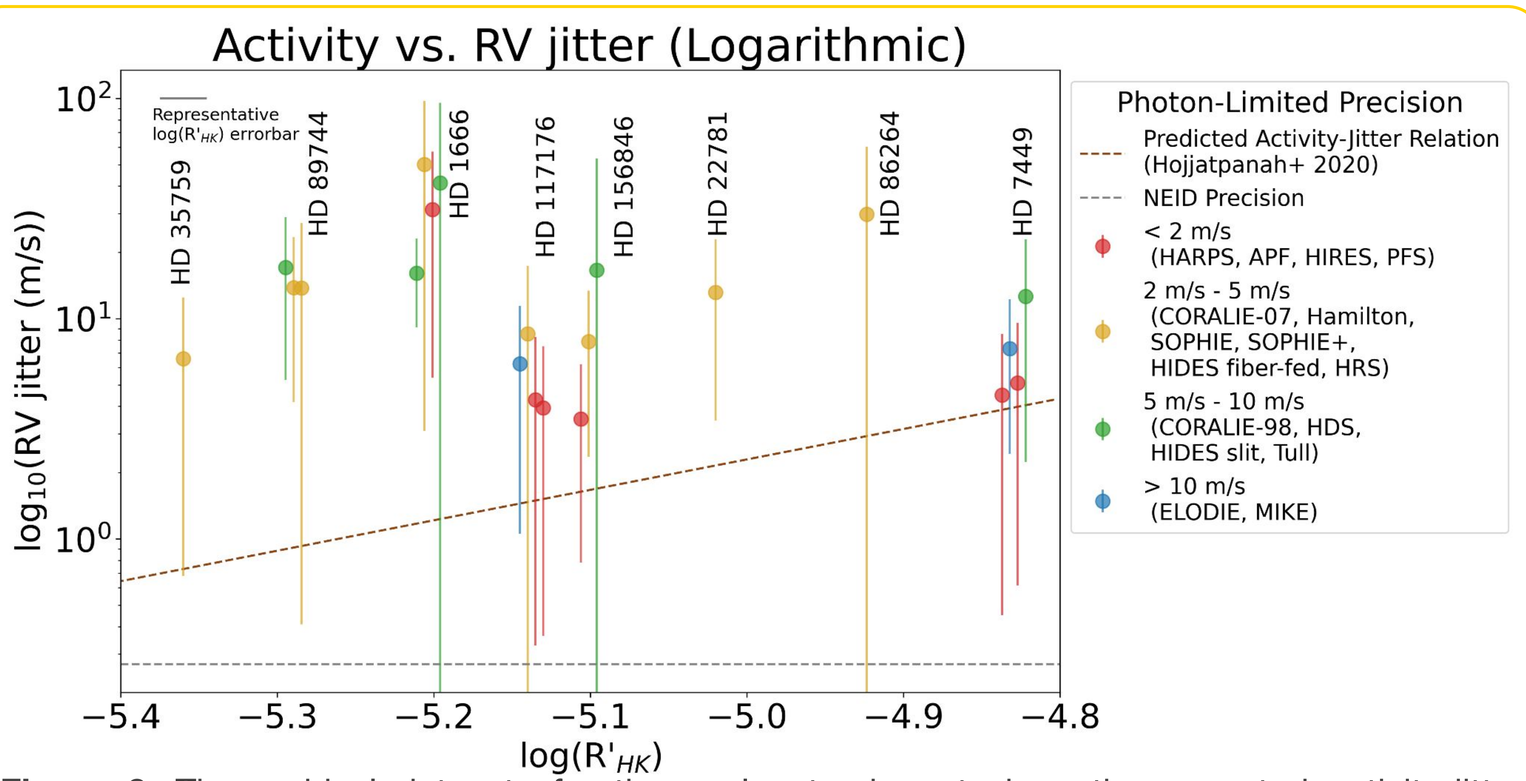

Figure 2: The archival datasets for these planets do not show the expected activity-jitter relation as predicted by [1], even though they should be unaffected by additional unresolved planets. We expect this is due to poor instrumental precision, uncertainty in the planet orbits and, in the cases of HD 7449 and HD 89744, uncertainty in the orbits of additional longer-period companions.

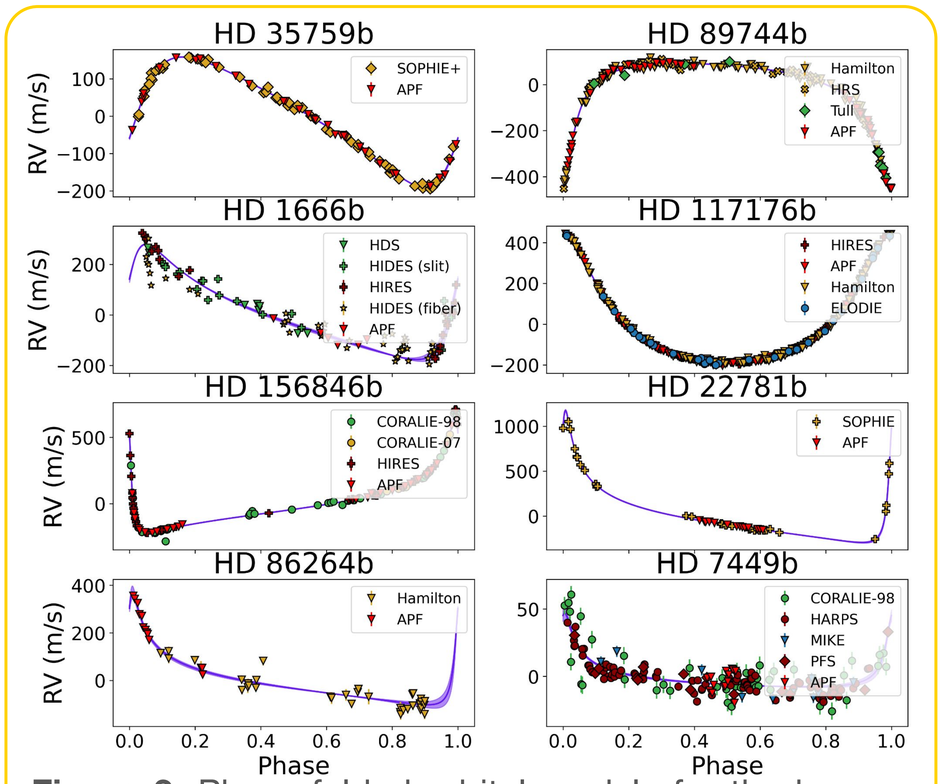

Figure 3: Phase-folded orbital models for the known eccentric planets, with archival data and new APF data. Model uncertainties due to uncertainty in eccentricity, semiamplitude, and argument of periastron are indicated by the shaded regions.

References: **[1] Hojjatpanah, S. et al.** A&A 639, A35 (2020). **[2] Wright, J. T.** PASP 117, 657 (2005). **[3] Meunier, N. and Lagrange, A.-M.** A&A 628, A125 (2019). **[4] Brewer, J. M. et al.** AJ 160, 67 (2020). **[5] Baum, A. C. et al.** AJ 163, 183 (2022). **[6] Gupta, A. F. et al.** AJ 161, 130 (2021).