Star-planet connection through metallicity

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Period-mass diagram and metallicity

In Figure 1 we show the RV-detected planets orbiting FGK dwarf stars (from the SWEET-Cat database - Santos et al. 2013) on the P–M_P plane in which we separate low and high-metallicity hosts at a threshold of -0.1 dex. For a fixed planetary mass, most of the planets around metal-poor stars are constrained to longer periods. This tendency appears to be valid from about 0.03 M_{Jup} to about 4 M_{Jup}. It confirms the results of Beaugé & Nesvorný (2013) obtained only for low-mass planets and extends to higher masses.

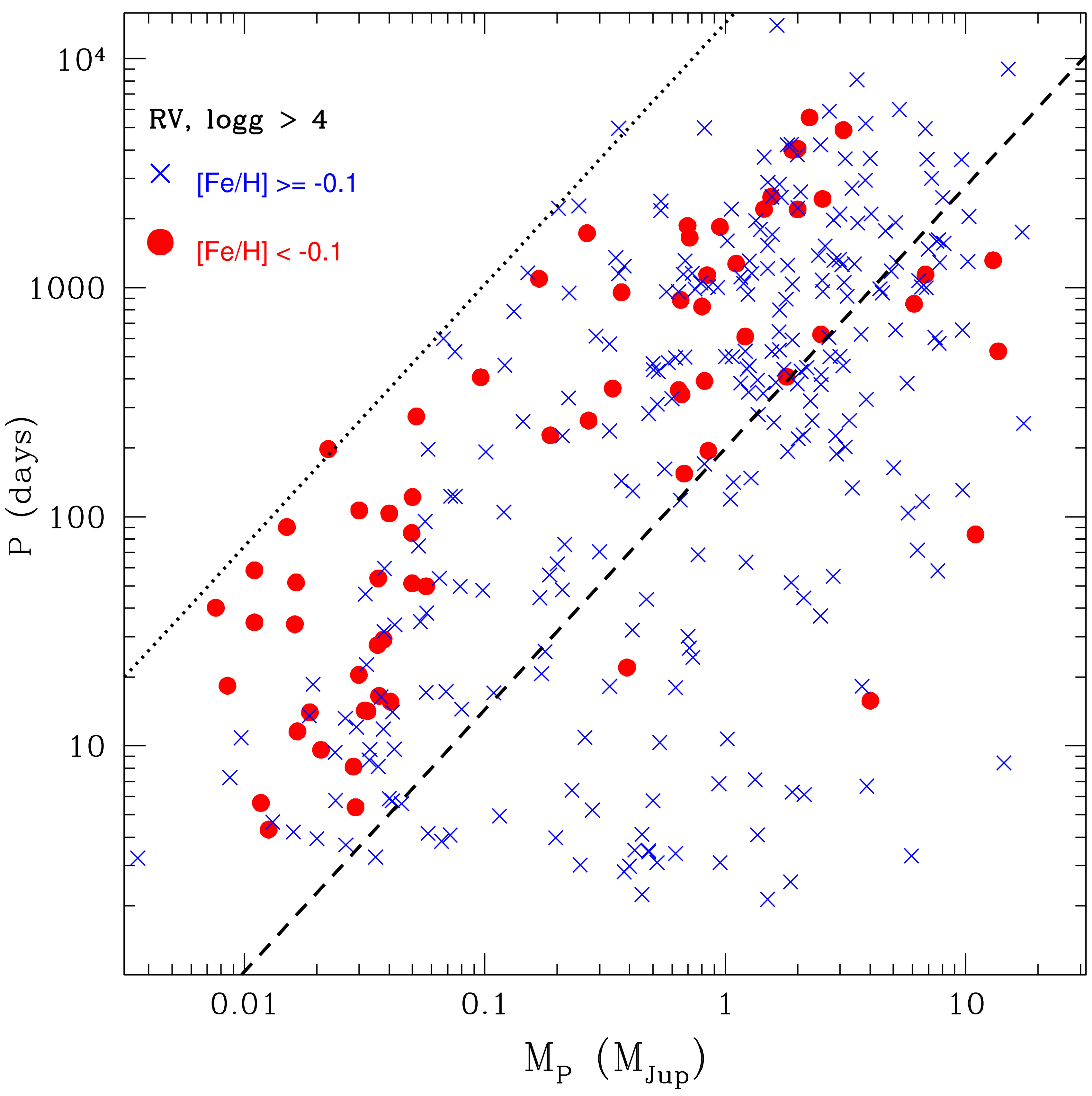

Figure 1: Planet distribution in the (P, MP) diagram. The dotted line represents the approximate (empirical) detection limit for planets, the dashed line is parallel to the detection limit line and just for illustration that most of the red circles (metal-poor systems) are above it.

Earth-like planets

We found that all the planets with masses bellow 0.03M_{Jup} (about 10$M_\oplus$) orbiting metal-rich stars have short periods fewer than 18 days (see top panel of Figure 2). There can be two reasons for this disposition: detection bias and dynamical character. In the bottom panel of Fig. 2, where we show the distribution of the planets with the longest period in the system, one can see that there are six planets orbitingmetal-rich stars without a (detected) higher-mass longer-period companion. This means that at least for the planets presented in the plot, the shorter periods are not a result of interaction with higher-mass longerperiod companions.

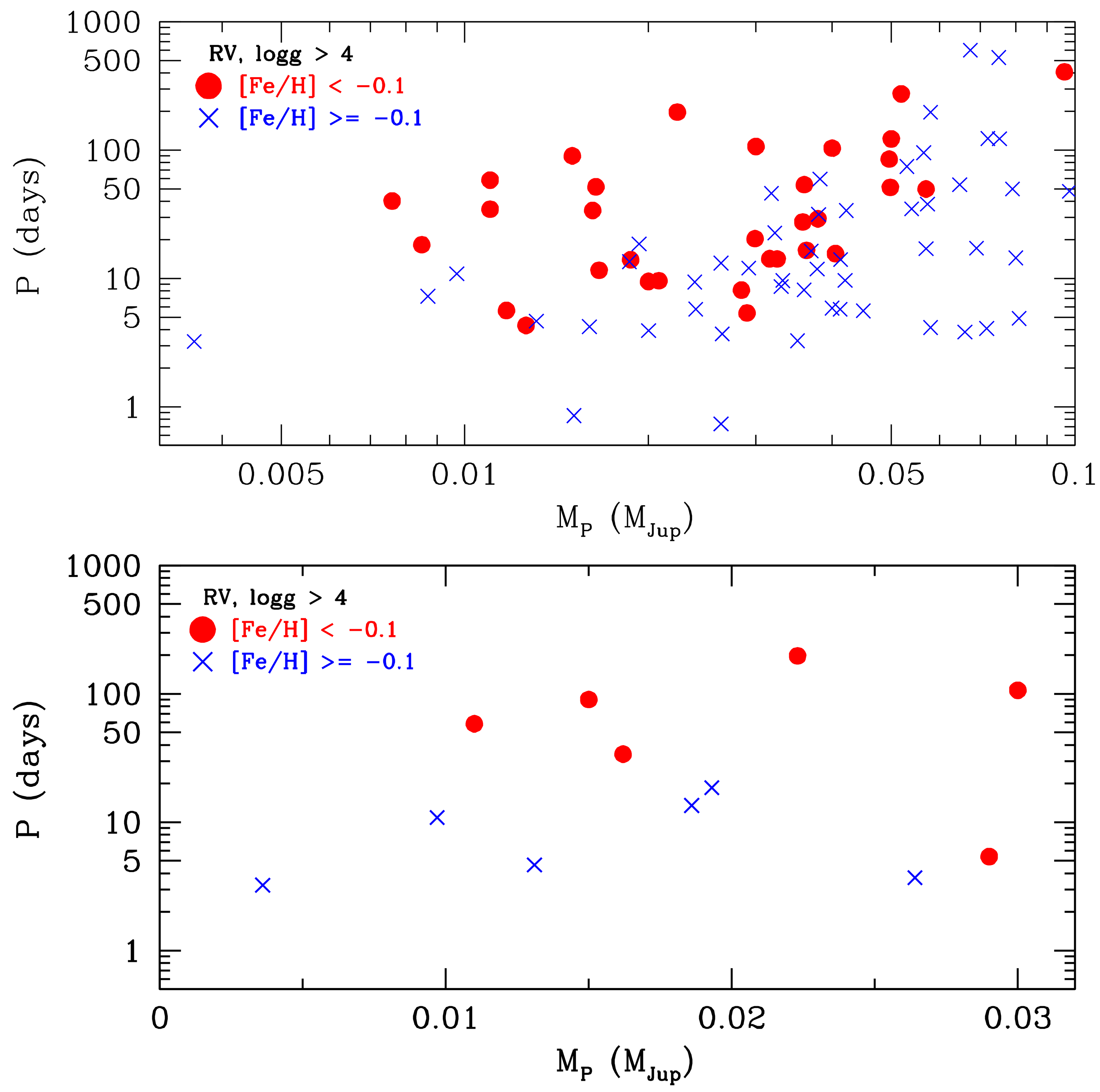

Figure 2: The (P, MP) diagram for planets with $M_P < 0.1_{Jup}$ (top-panel). The (P,MP) diagram for the longest period planet in the system with $M_P < 0.03_{Jup}$ (bottom-panel).

Conclusion

- We found that for a fixed maximum planetary mass between 10$M_\oplus$ and 4M_{Jup}, planets orbiting metal-poor stars are constrained to longer periods than those orbiting metalrich stars. This result suggests that the mechanism responsible for the separation of planets in the P – MP is operational for a wide range of planetary mass. The observed dependence can be explained by assuming that planets in a metal-poor disk form farther out from their central stars and/or do not migrate as far as planets in metalrich systems because they form later.
  This result agree with the core-accretion models (e.g. Mordasini et al. 2012).
- The Earth-like planets ($M_P < 10M_\oplus$) orbiting metal-rich stars have shorter periods than those orbiting metal-poor stars. If there is no detection bias in the sample, then the observed distributions of metal-poor and metal-rich planets in the P – MP diagram could mean that Earth-like planets orbiting metal-rich stars preferably migrate or form close to their parent stars, while planets in the metal-poor systems form at a wider range of the semi-major axis or do not always migrate.

For more results and details see Adibekyan et al. (2013).

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