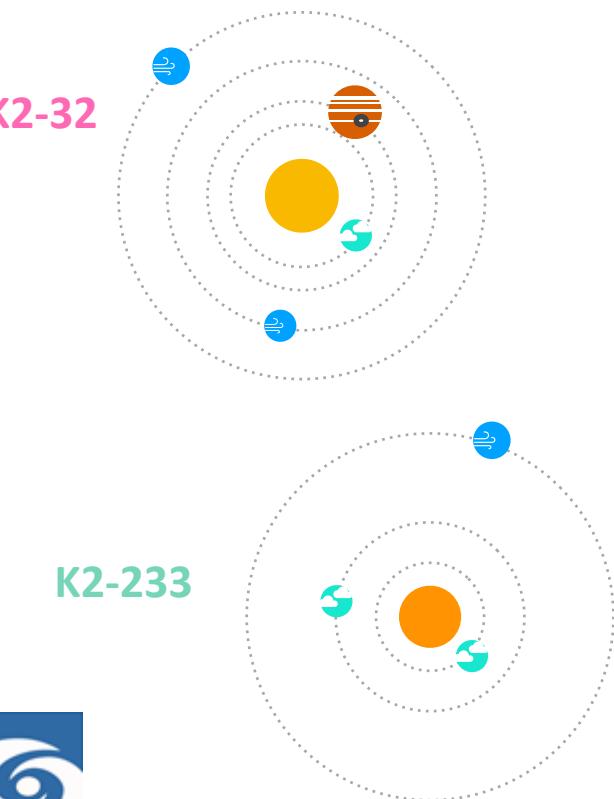


Masses for the seven planets in K2-32 and K2-233.

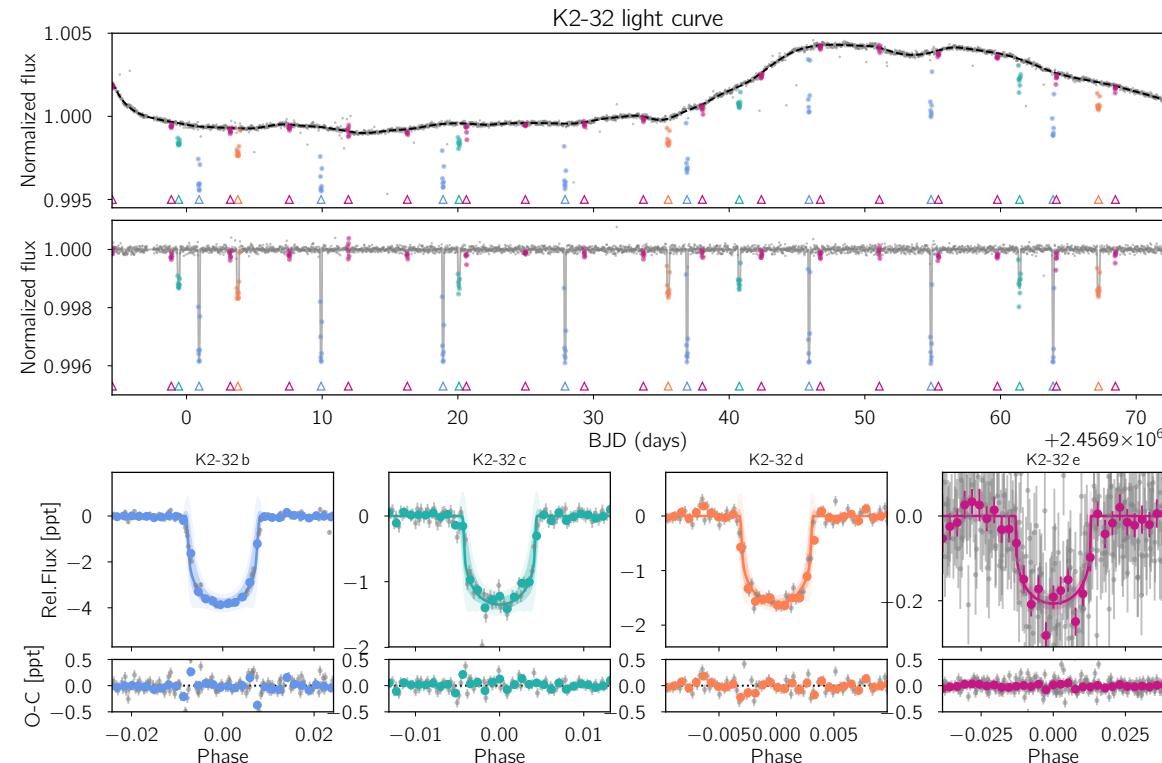
Four diverse planets in resonant chain and the first young rocky worlds

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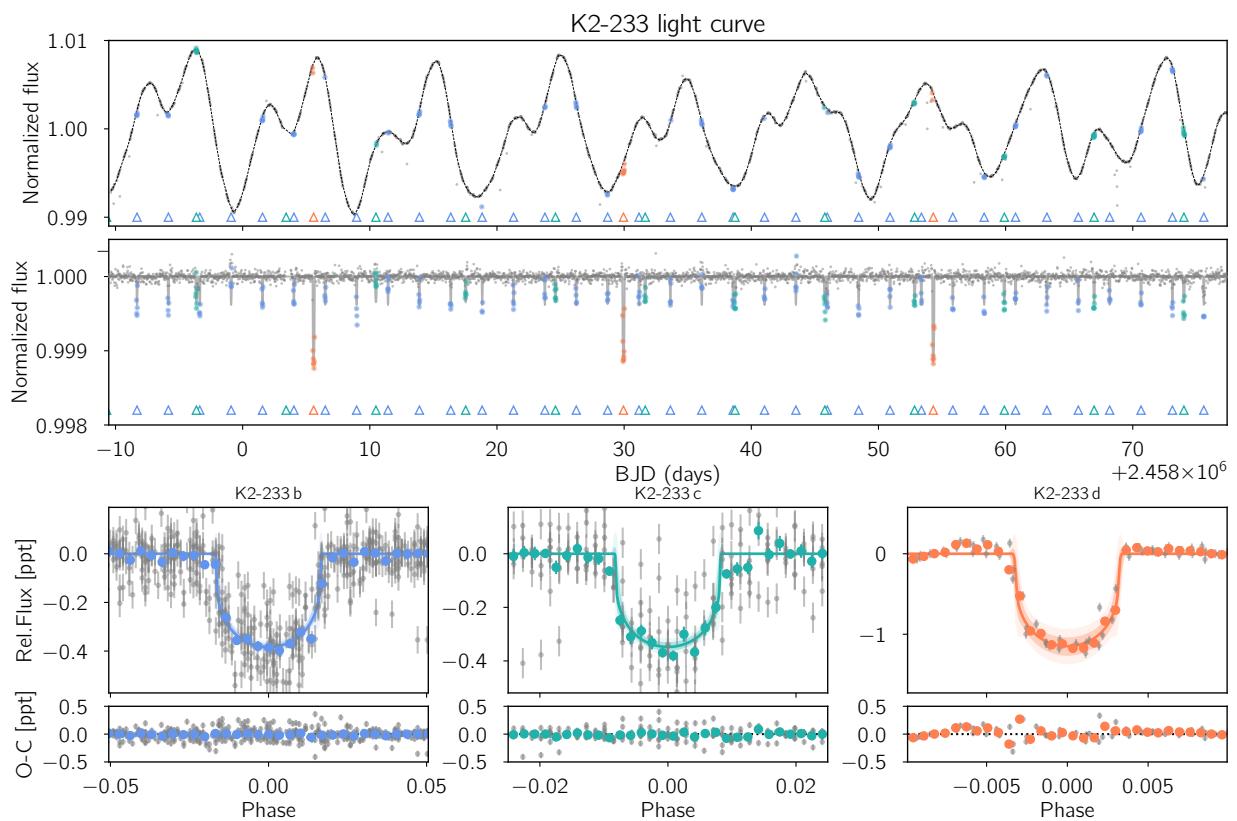
Abstract. We measure the masses and densities of a four-planet near resonant chain system (K2-32), and a young (~400 Myr old) planetary system consisting of three close-in small planets (K2-233). We find that **K2-32 is a compact scaled-down version of the Solar System's architecture**, with a small rocky inner planet followed by an inflated Neptune-mass planet and two external sub-Neptunes. K2-32 becomes one of the few multi-planetary systems with four or more planets known with measured masses and radii. Additionally, we constrain the masses of the three planets in K2-233. For the two inner Earth-size planets we constrain their masses to be smaller than $M_b < 11.3 \text{ M}_\oplus$, $M_c < 12.8 \text{ M}_\oplus$. The outer planet is a sub-Neptune size planet with an inferred mass of $M_d = 8.3 + 5.2 - 4.7 \text{ M}_\oplus$ ($M_d < 21.1 \text{ M}_\oplus$). Our observations **confirm for the first time the rocky nature of two planets orbiting a young star**, with relatively short orbital periods (<7 days). They provide key information for planet formation and evolution models of telluric planets. Additionally, the Neptune-like derived masses of the three planets K2-32 b, c, d puts them in a relatively unexplored regime of incident flux and planet mass, key for transmission spectroscopy studies.

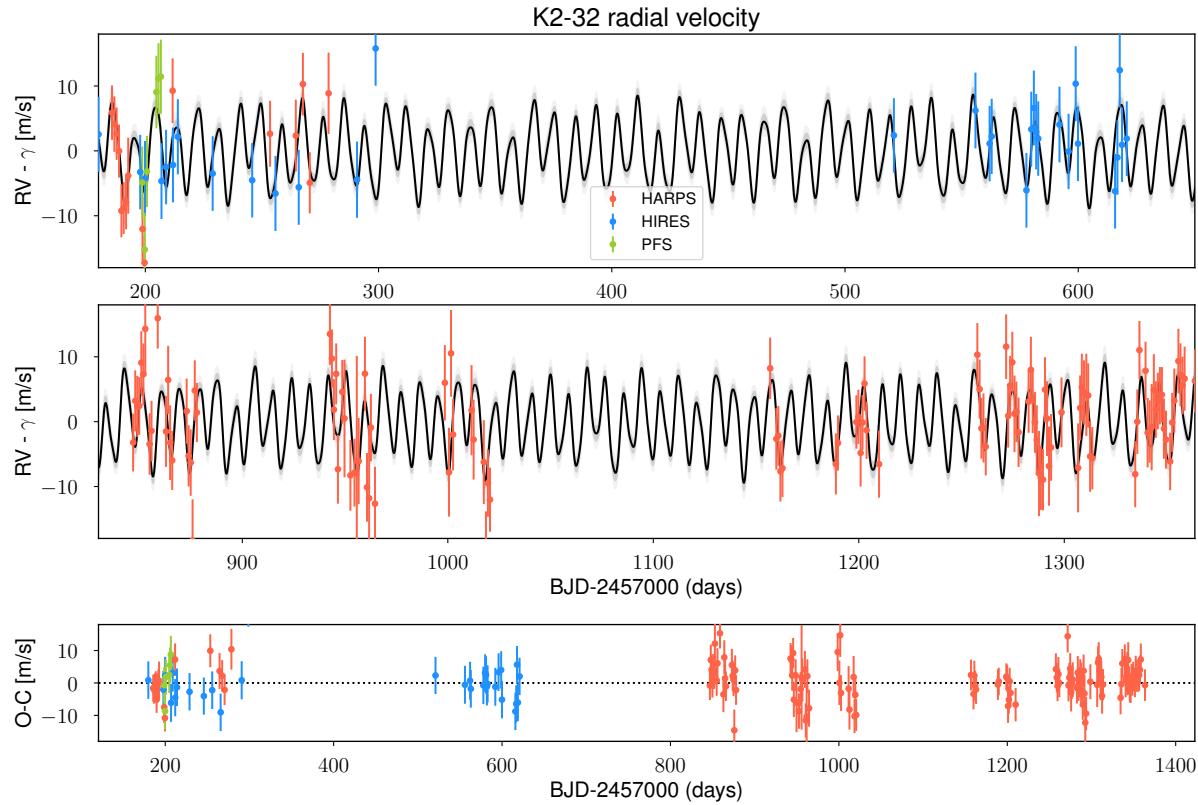
[Lillo-Box et al., 2020, A&A, in press \(arXiv:2006.01102\)](#)



... and 3 planets around the **young** star K2-33.
Two of them in the rocky-size regime and on similar
to Neptune

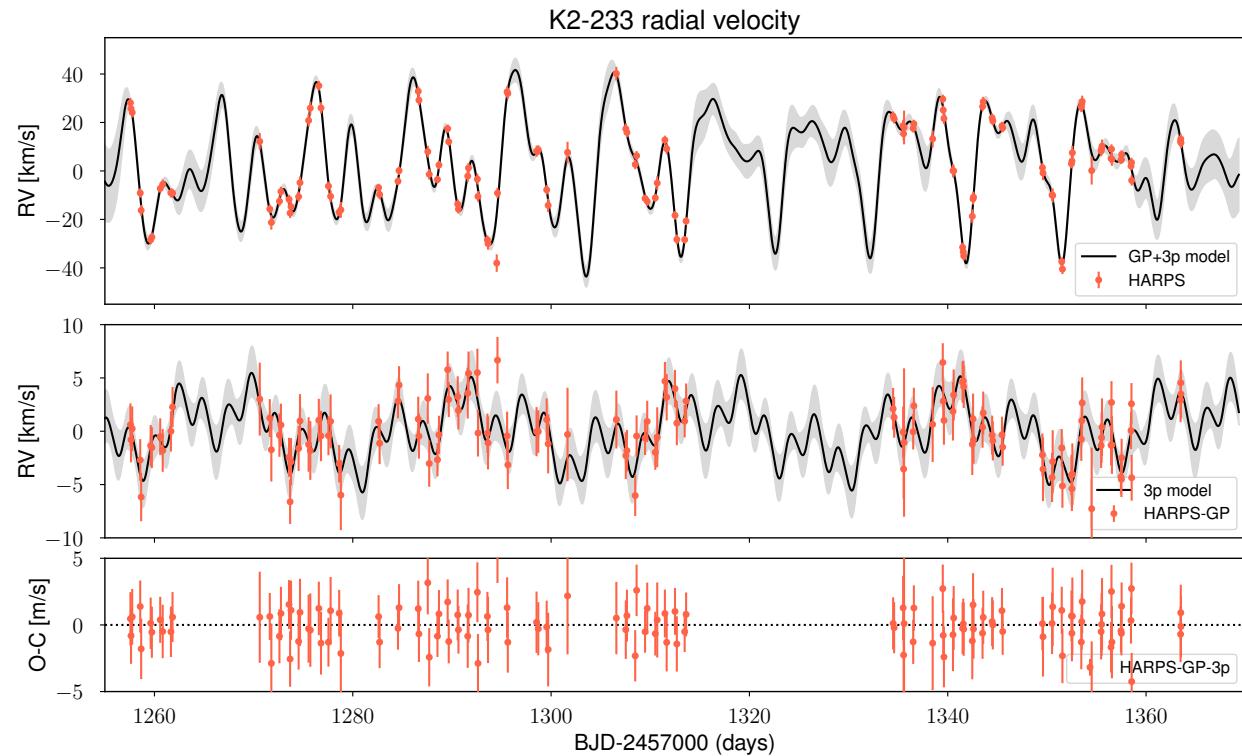
The K2 mission detected **4** transiting planets
around the K2-32 star...





The intensive campaign was key to monitor the variations induced by **stellar activity** in the case of the young (400 Myr) star K2-33.

We performed an **intensive radial velocity follow-up** with the HARPS instrument at La Silla observatory (199 new measurements for K2-32 and 124 for K2-33) to **measure the masses** of the 7 planets.





K2-32 e



$M_p \sim 2.1 M_{\text{Earth}}$
 $R_p \sim 1.2 R_{\text{Earth}}$
Period ~ 4.34 days

K2-32 b



$M_p \sim 15 M_{\text{Earth}}$
 $R_p \sim 5.3 R_{\text{Earth}}$
Period ~ 8.99 days

K2-32 c



$M_p \sim 8.1 M_{\text{Earth}}$
 $R_p \sim 3.1 R_{\text{Earth}}$
Period ~ 20.7 days

K2-32 d



$M_p \sim 6.7 M_{\text{Earth}}$
 $R_p \sim 3.5 R_{\text{Earth}}$
Period ~ 31.7 days

2 days

5 days

10 days

40 days

K2-233 b



$M_p \sim 3.3 M_{\text{Earth}}$
 $R_p \sim 1.3 R_{\text{Earth}}$
Period ~ 2.47 days

K2-233 c



$M_p \sim 5.1 M_{\text{Earth}}$
 $R_p \sim 1.2 R_{\text{Earth}}$
Period ~ 7.06 days

K2-233 d

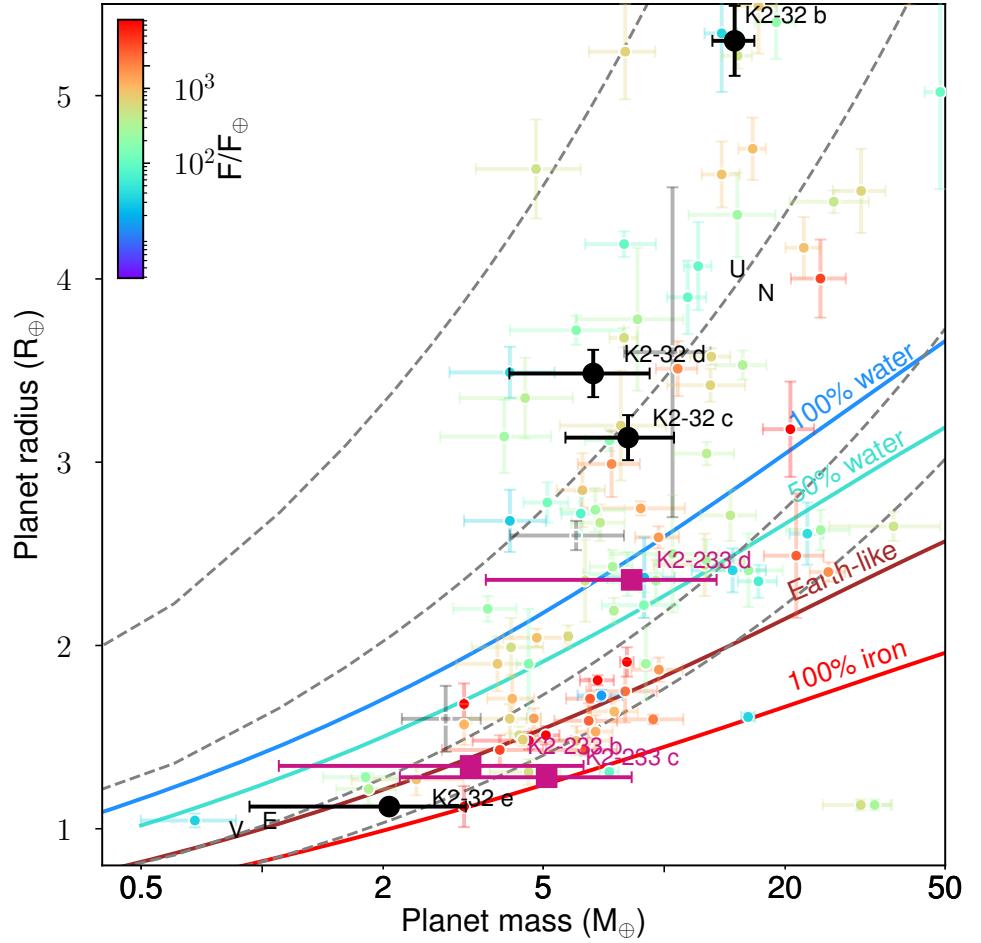


$M_p \sim 8.3 M_{\text{Earth}}$
 $R_p \sim 2.4 R_{\text{Earth}}$
Period ~ 24.4 days

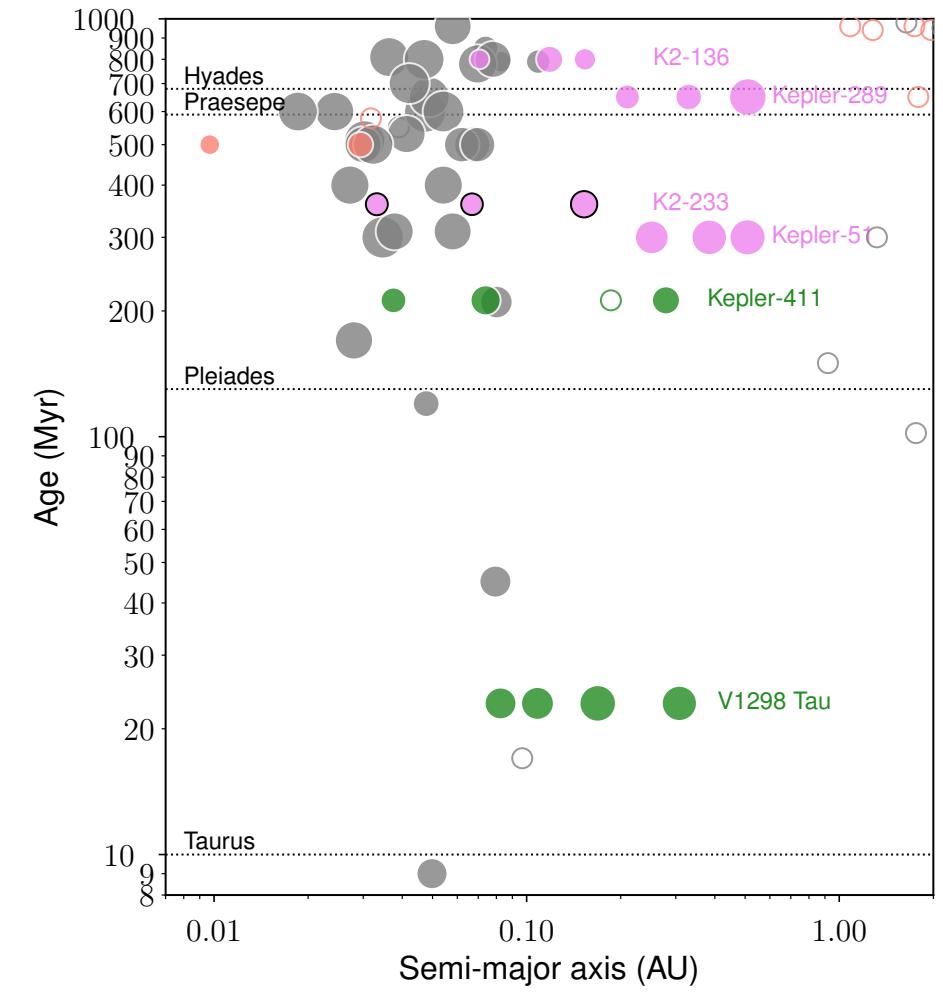
The derived masses and radii unveil K2-32 as a **miniature Solar System**, with a rocky world in the inner regions, followed by a gas giant and two Neptune-like planets in the outer parts.

In K2-233 we could confirm the first rocky planets around a young star (400 Myr).

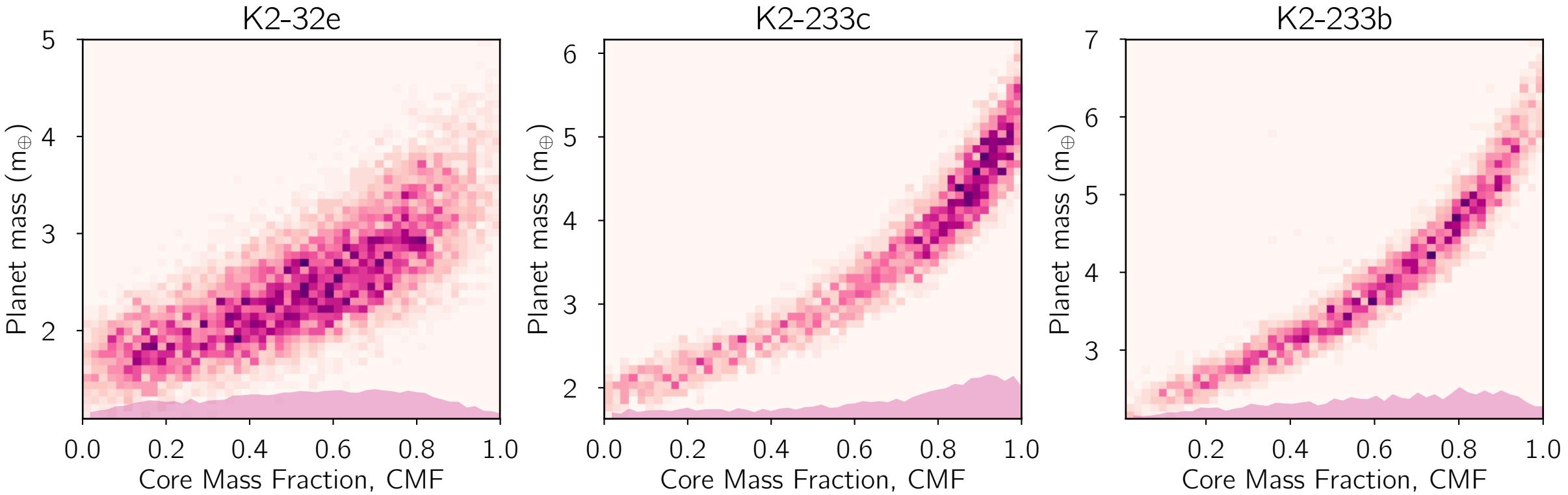




The mass-radius diagram shows that both systems have planets at both sides of the radius gap with K2-32e, K2-233b and K2-233c in the rocky regime



K2-233b and K2-233c are the first rocky worlds around a young star, and K2-233 is one of the few multi-planetary system in a star younger than 1Gyr.



The derived masses allowed us to perform and **internal structure** analysis of the rocky planets. We concluded that K2-233b and K2-32e have iron compositions compatible to Earth values, while K2-233c is a denser body with an internal structure more compatible with Mercury.

These newly characterised transiting planets are now key targets for atmospheric characterization with JWST.