# Characterising planets around iron-poor stars

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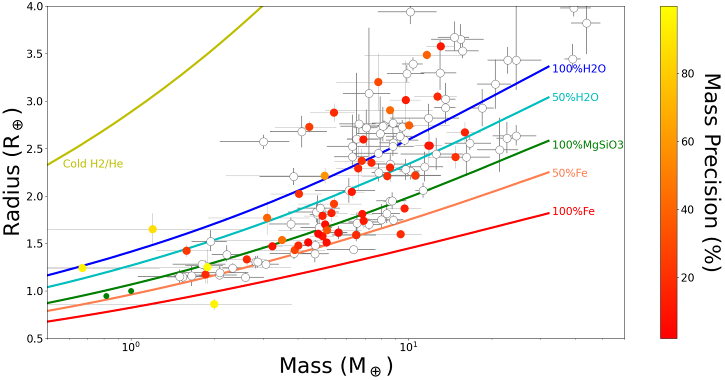
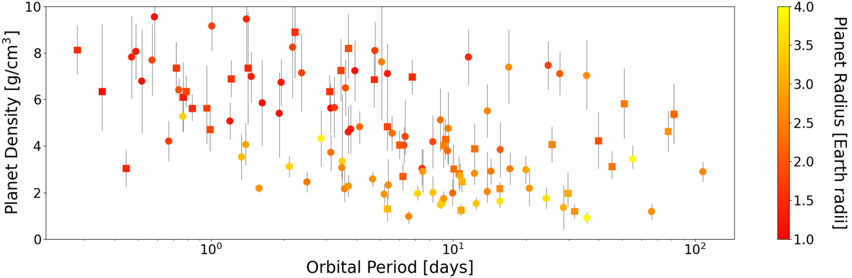
# HARPS-N fills the mass-radius diagram for small planets




(HARPS-N Collaboration data: Bonomo et al. 2014, 2019; Buchhave et al. 2016; Christiansen et al. 2017; Cloutier et al. 2020a,b,2021; Damasso et al. 2018, 2019; Dressing et al. 2015; Dubber et al. 2019; Frustagli et al. 2020; Gettel et al. 2016; Gillon et al. 2017; Haywood et al. 2018; Kosiarek et al. 2019; **Lacedelli et al. 2021**; Lopez-Morales et al. 2016; Malavolta et al. 2017, 2018; Mayo et al. 2019; **Mortier et al. 2018, 2020**; Pepe et al. 2013; Polanski et al. 2021; **Rajpaul et al. 2017, 2021**; Rice et al. 2019; Santerne et al. 2021; Vanderburg et al. 2015, 2017. Non-HARPS-N Collaboration data: exoplanet.eu)

# Ultra-short period planets get characterised ...

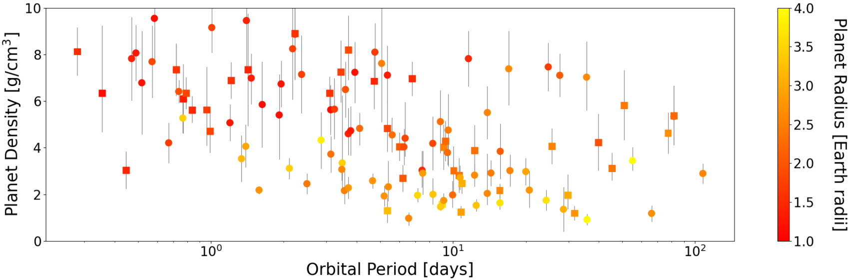



K2-141b - 0.2803244 d - 1.51 $R_\oplus$ - 5.08 $M_\oplus$ (Malavolta et al. 2018)

Kepler-78b - 0.3550 d - 1.173 $R_\oplus$ - 1.86 $M_\oplus$ (Pepe et al. 2013)

TOI-561b - 0.446578 d - 1.423 $R_\oplus$ - 1.59 $M_\oplus$ (Lacedelli et al. 2021)

# as well as the longest period planets.

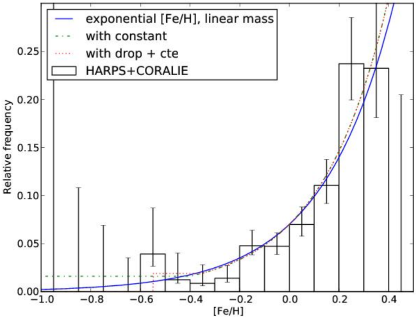



K2-263b - 50.8 d - 2.41 $R_\oplus$ - 14.8 $M_\oplus$ (Mortier et al. 2018)

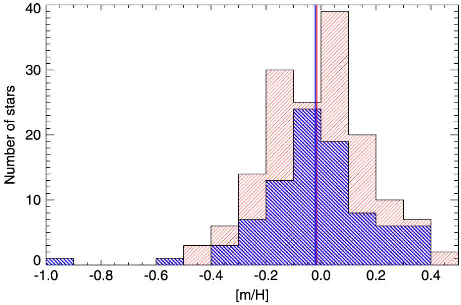
TOI-561e - 77.2 d - 2.67 $R_\oplus$ - 16.0 $M_\oplus$ (Lacedelli et al. 2021)

Kepler-538b - 81.73778 d - 2.215 $R_\oplus$ - 10.6 $M_\oplus$ (Mayo et al. 2019)

# Planets and metallicity



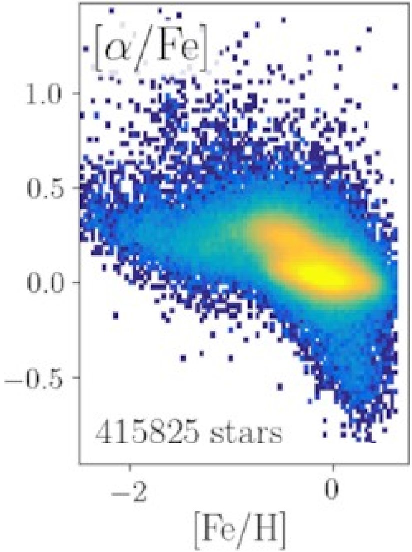

(Mortier et al. 2013a)




(Buchhave et al. 2015)

Large planets prefer high metallicity (not clear what happens at lower end). Small planets seem to have no metallicity preference

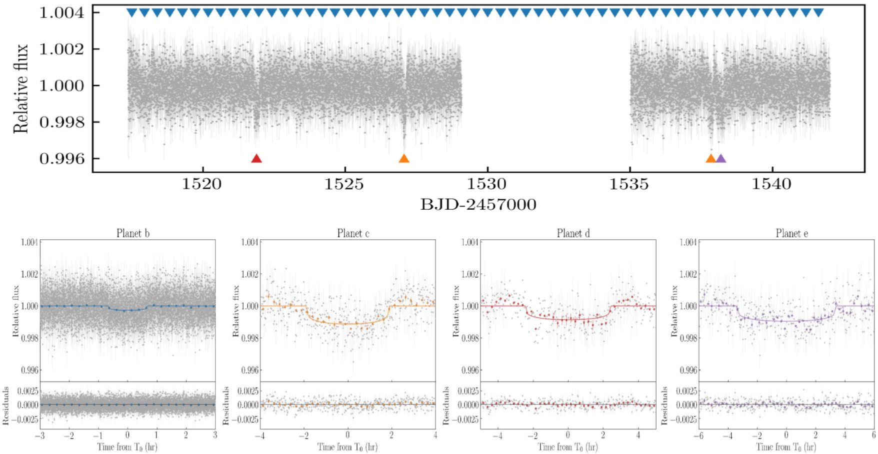
# Metallicity is complicated




"Iron"-poor stars are enhanced in alpha-elements (Mg, Si, C, ...).
How does this influence their orbiting planets?
See also Adibekyan et al. 2012, 2021; Dorn et al. 2015, 2017; and Bonsor et al. 2021.

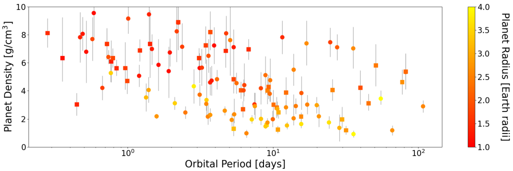
(reproduced from Buder et al. 2021 - GALAH+ survey results)

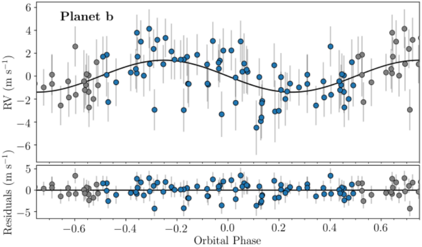
# TOI-561 - system with many secrets

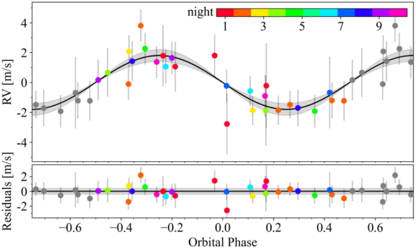



Are there 3 or 4 transiting planets? (Lacedelli et al. 2021)

# TOI-561 b has an unusually low density

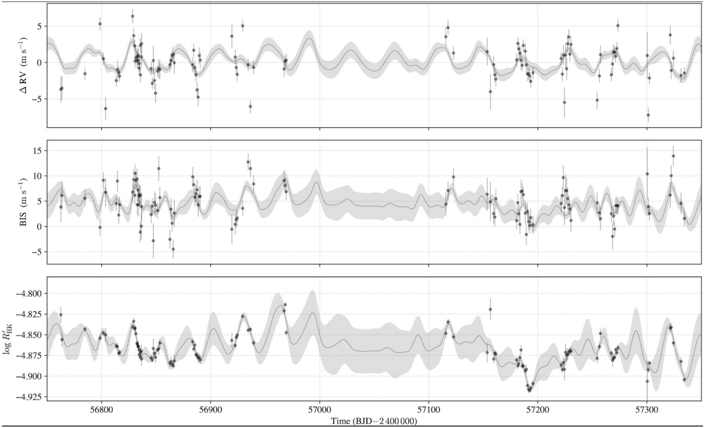



Small ultra-sort period planets should not retain a large atmosphere. Does TOI-561 b have a large water envelope or a much smaller iron core? (Lacedelli et al. 2021)

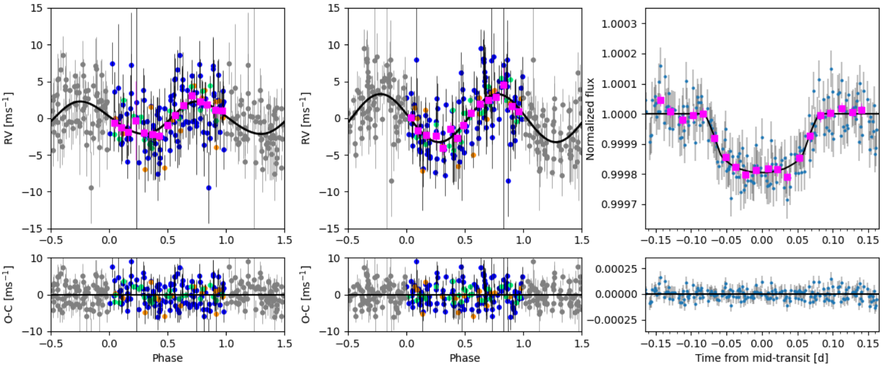
# Kepler-37d - an advert for Cambridge expertise




(Rajpaul et al. 2021)

Independent RV extraction (Rajpaul et al. 2020) and in-depth stellar activity modeling (Rajpaul et al. 2015) using Polychord (Handley, Hobson & Lasenby 2015) led to the extraction of the smallest significant RV semi-amplitude ($1.22 \pm 0.31\,\mathrm{m/s}$) with HARPS(-N) data.

# K2-111b - iron-poor planet around iron-poor star




$\mathrm{R}_{p,b} = 1.82 \pm 0.1\,\mathrm{R}_\oplus$ and $\mathrm{M}_{p,b} = 5.29 \pm 0.77\,\mathrm{M}_\oplus$

Iron core with a mass fraction of around 10% in a two-layer model;

Consistent with its iron-poor, alpha-enhanced host star.

Non-transiting planet in near-resonance: $\mathrm{M}_{p,c} = 11.3 \pm 1.1\,\mathrm{M}_\oplus$

(Mortier et al. 2020)

# Conclusions - small planets are fun! (but hard)