Addressing stellar activity at every step in the RV follow-up of small planets

Raphaëlle D. Haywood

and the HARPS-N GTO Science Team

NASA Sagan Fellow, Harvard College Observatory

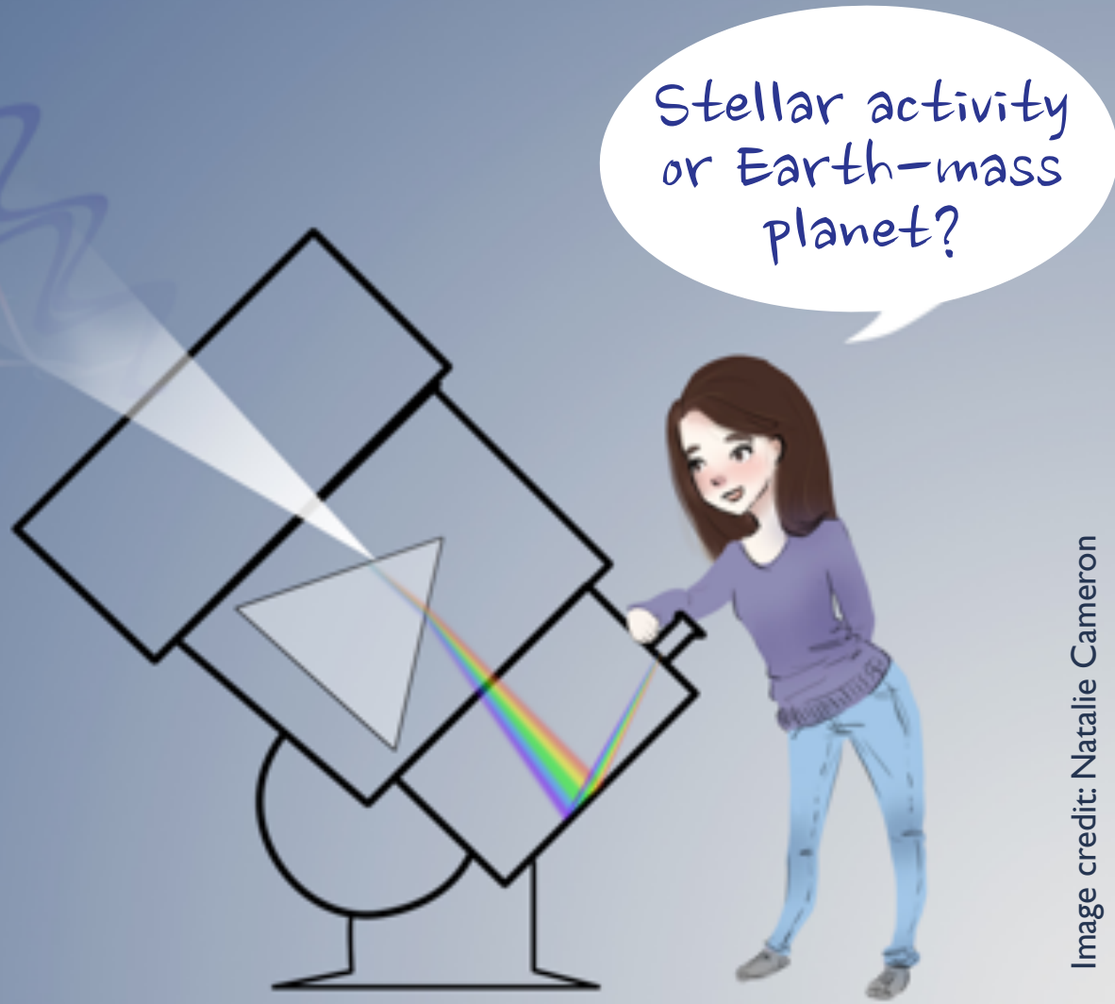
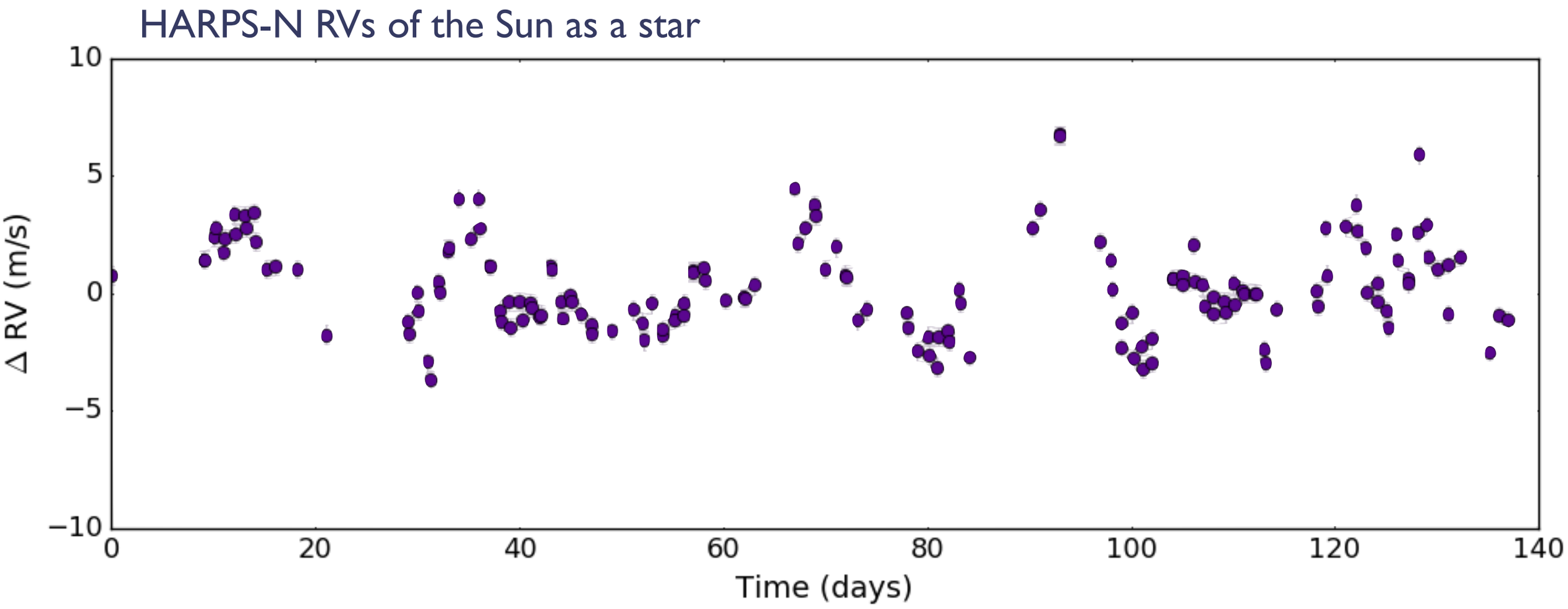


Image credit: Natalie Cameron

Stellar activity-induced RV variations are quasi-periodic



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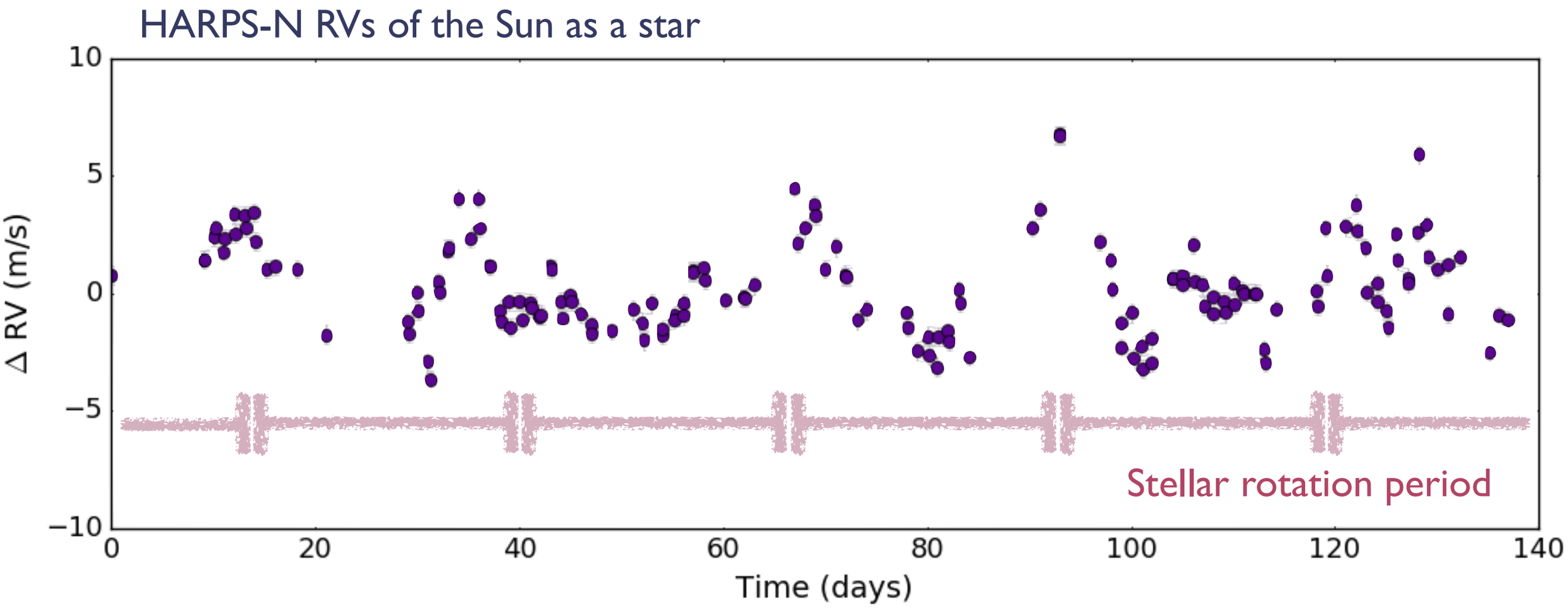

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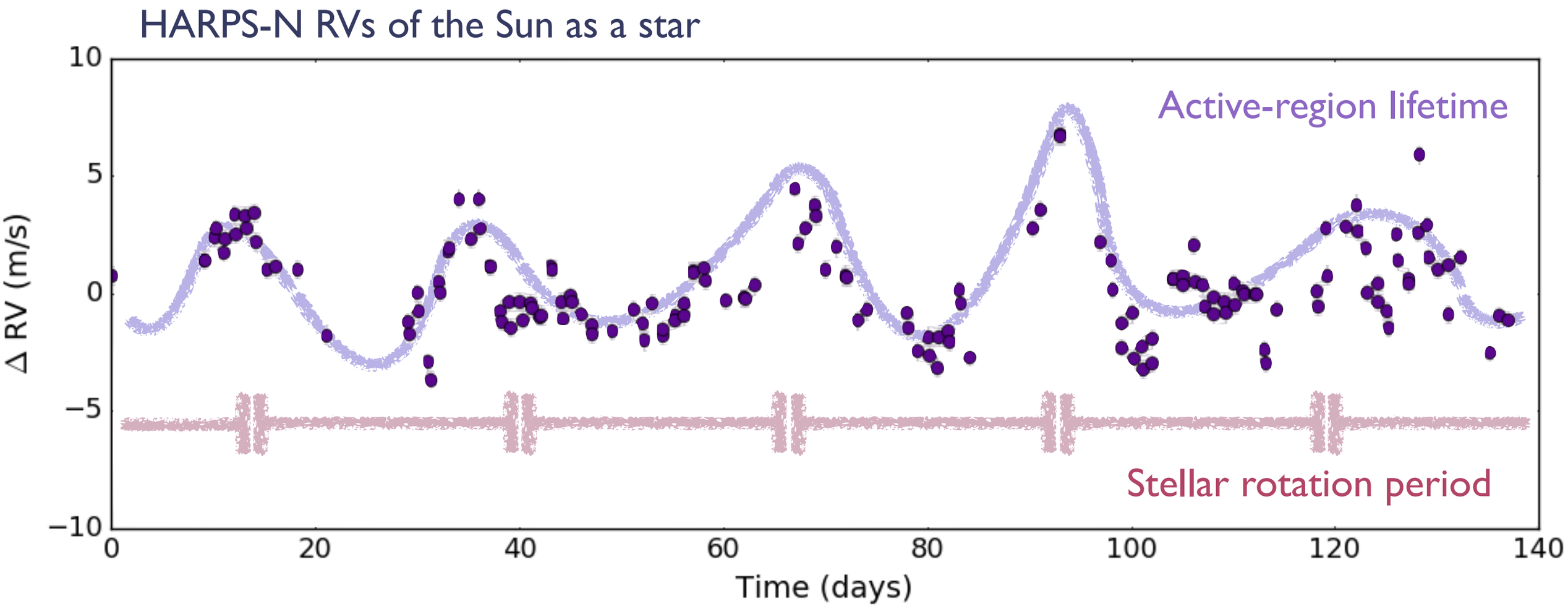

Towards robust mass determinations for small planets

We need to know about the temporal magnetic behaviour of our host stars

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See next talk by Helen Giles!

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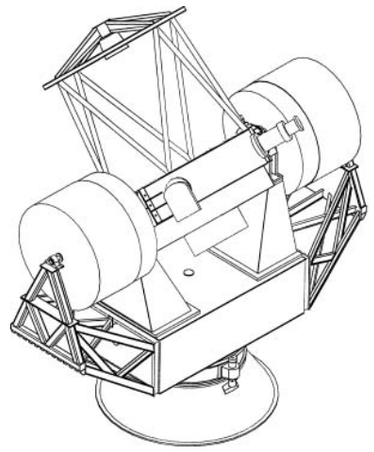

Sample planet orbit and stellar activity strategically

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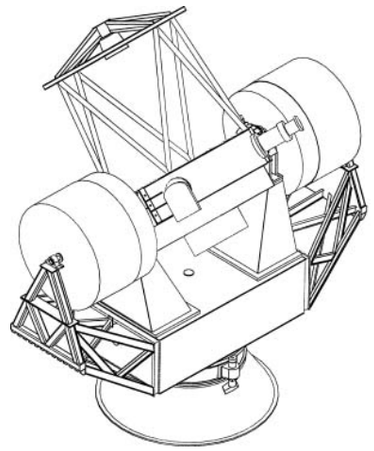

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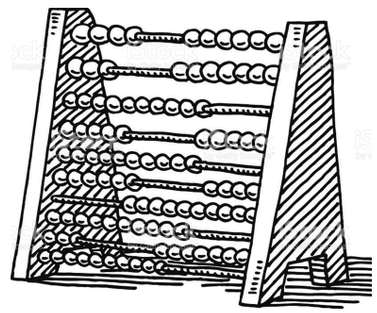

Account for both uncorrelated and correlated noise in RV analysis

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Kepler-21

P_{orb}: 2.7 days

1.6 $R_\oplus$

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Mass estimate from
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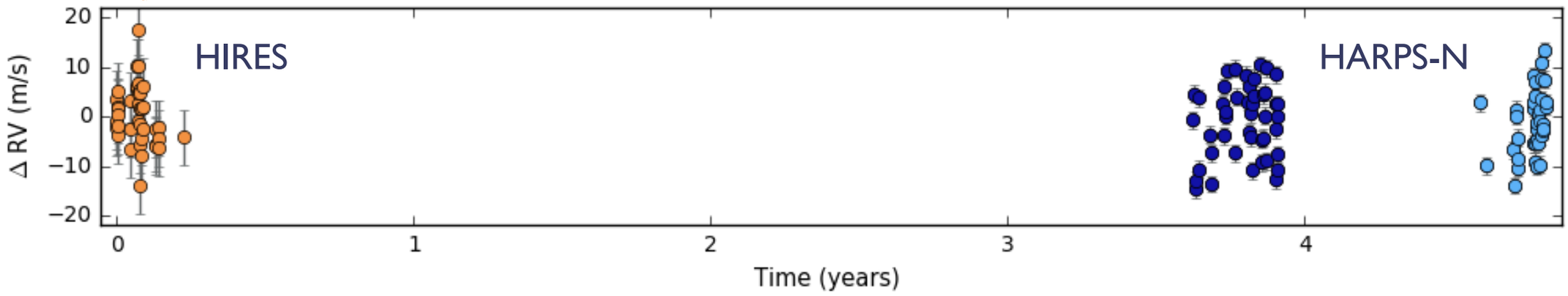
Howell et al. (2012)



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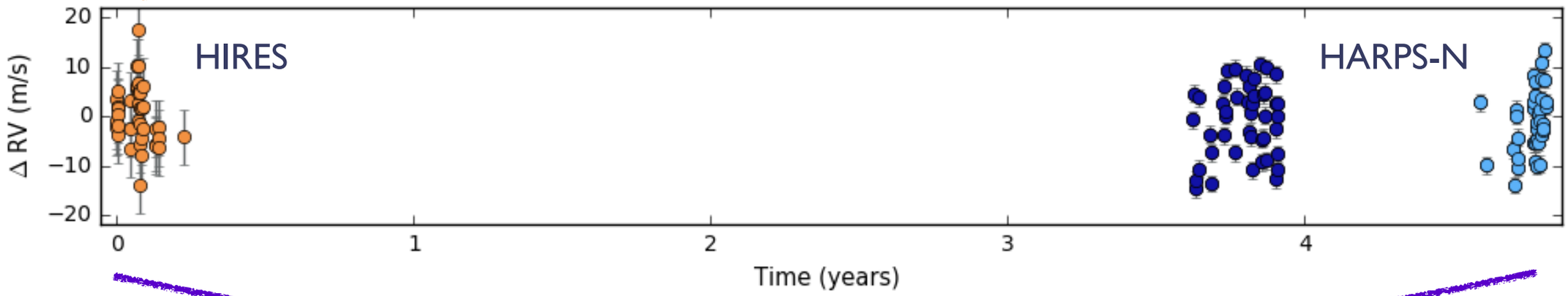
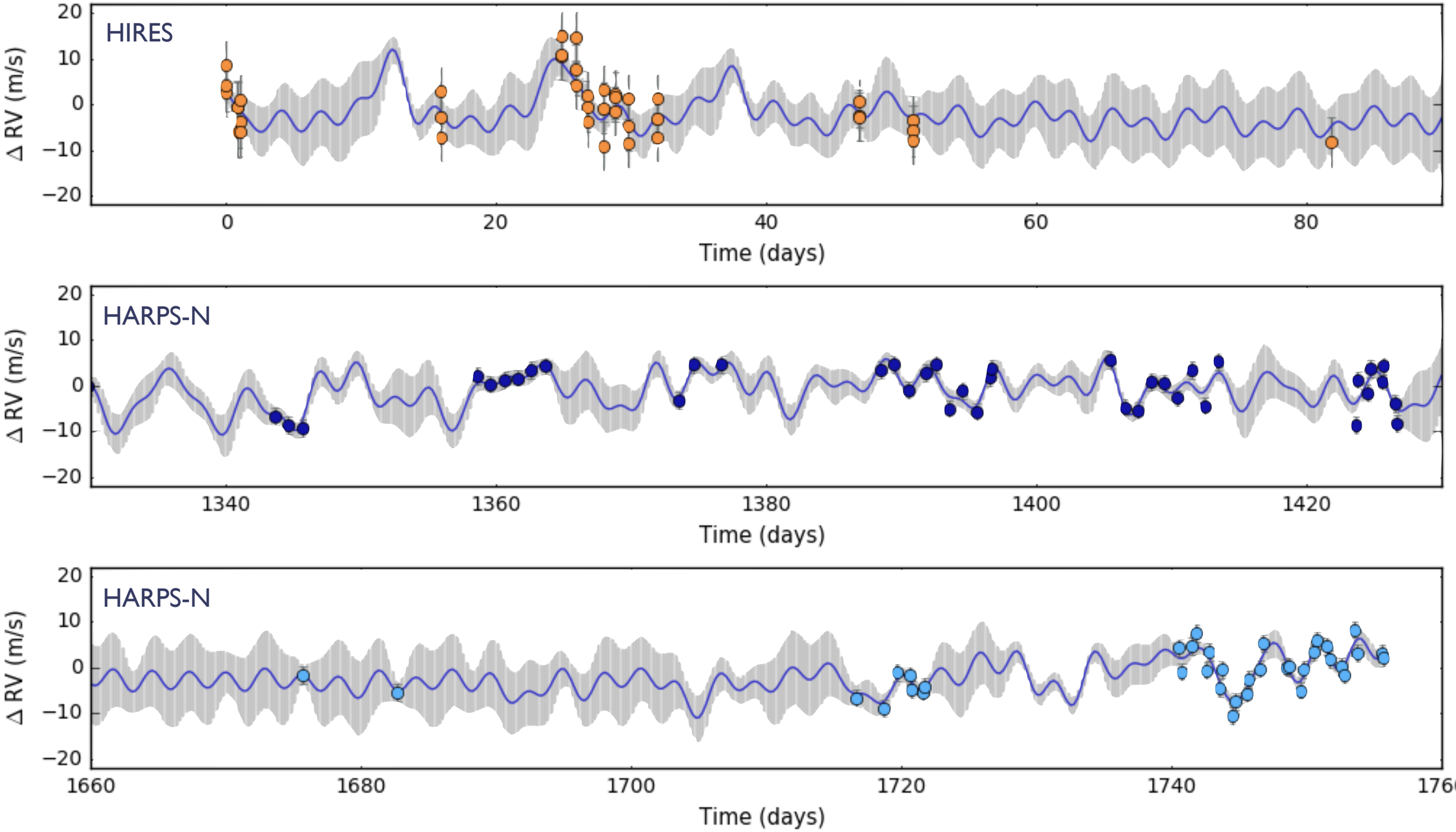


$m_p = 5.1 \pm 1.7\ M_\oplus$ (3-sigma significance)

López-Morales, Haywood, Giles et al. (2016)



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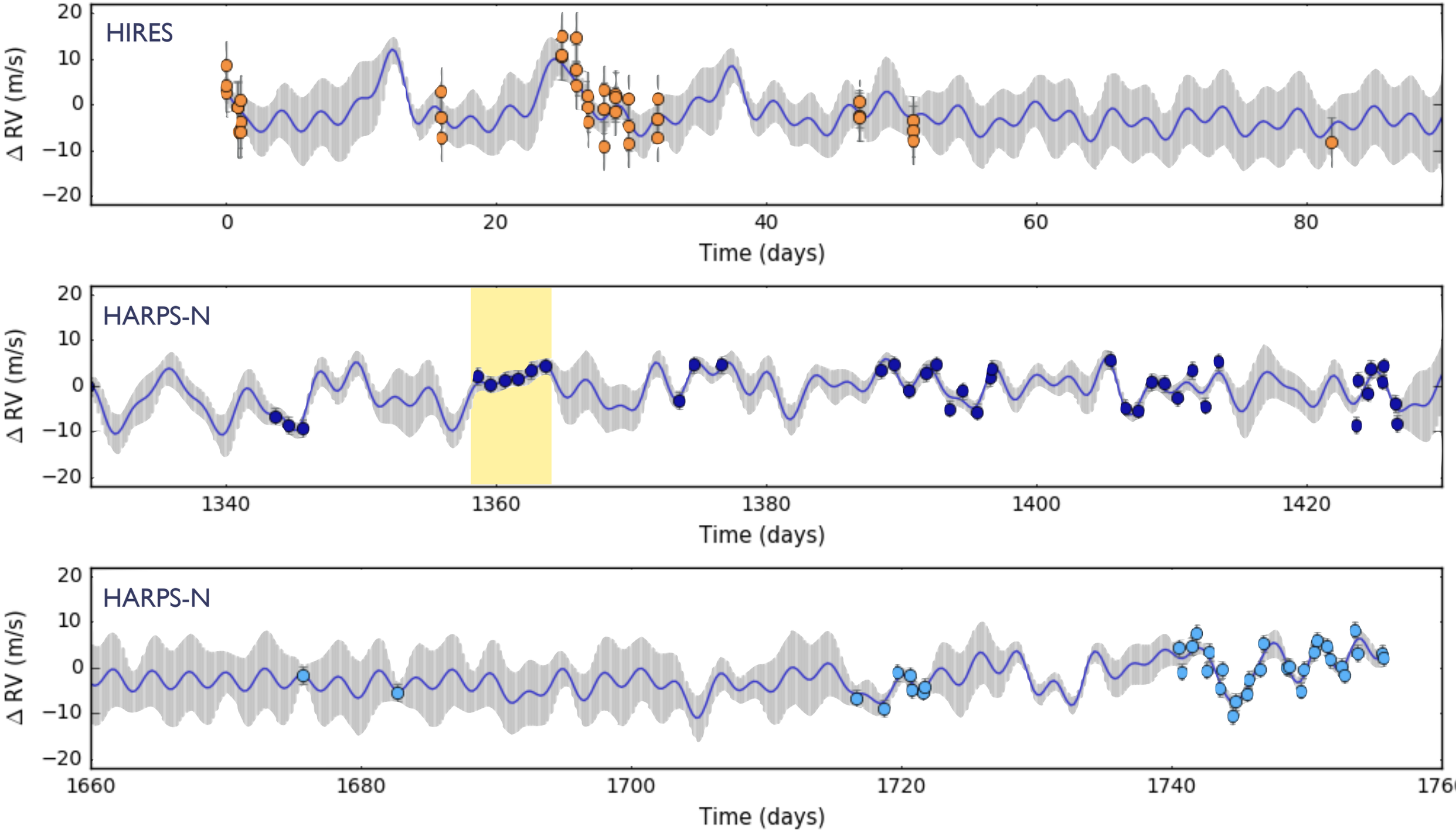

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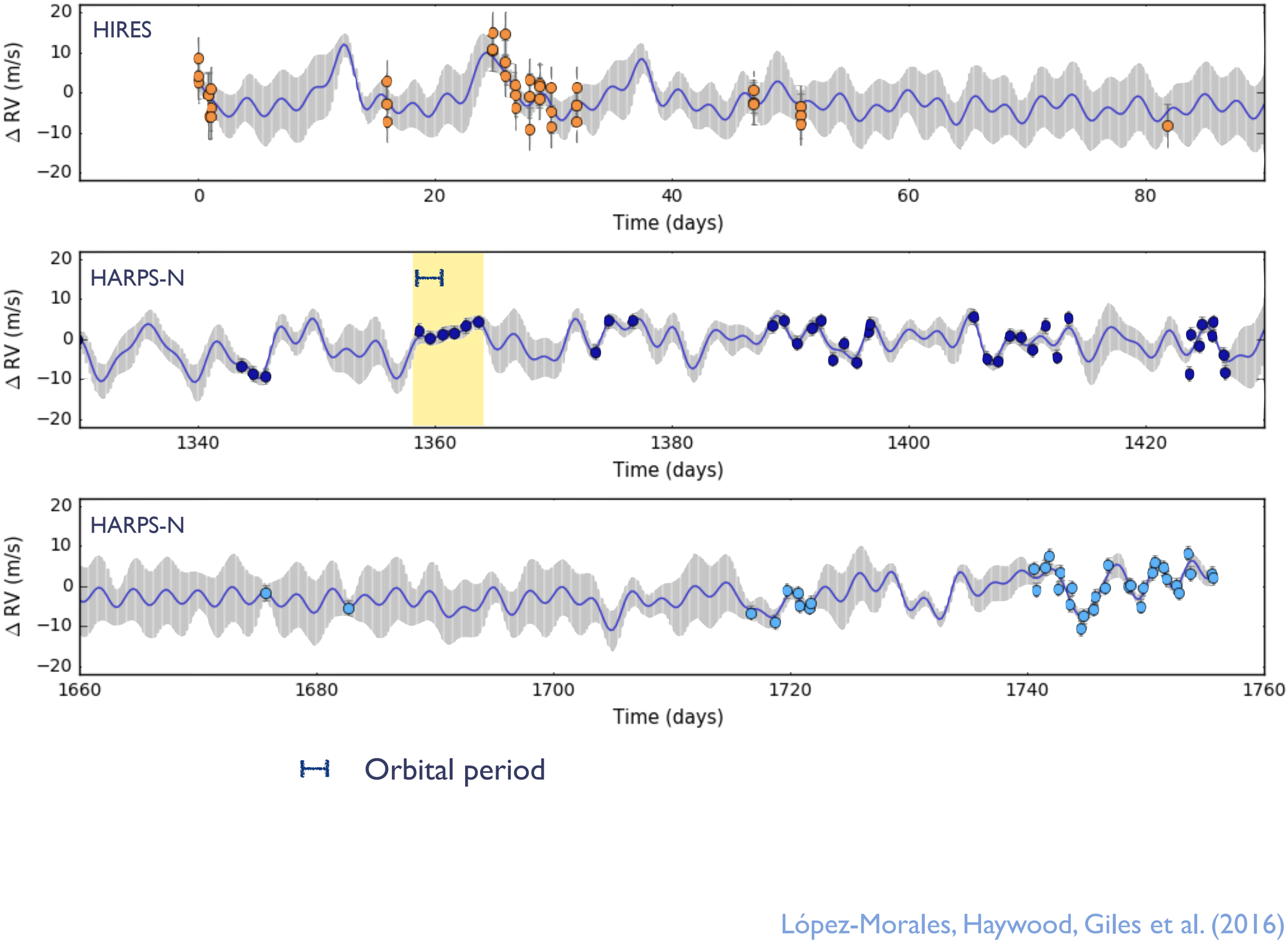

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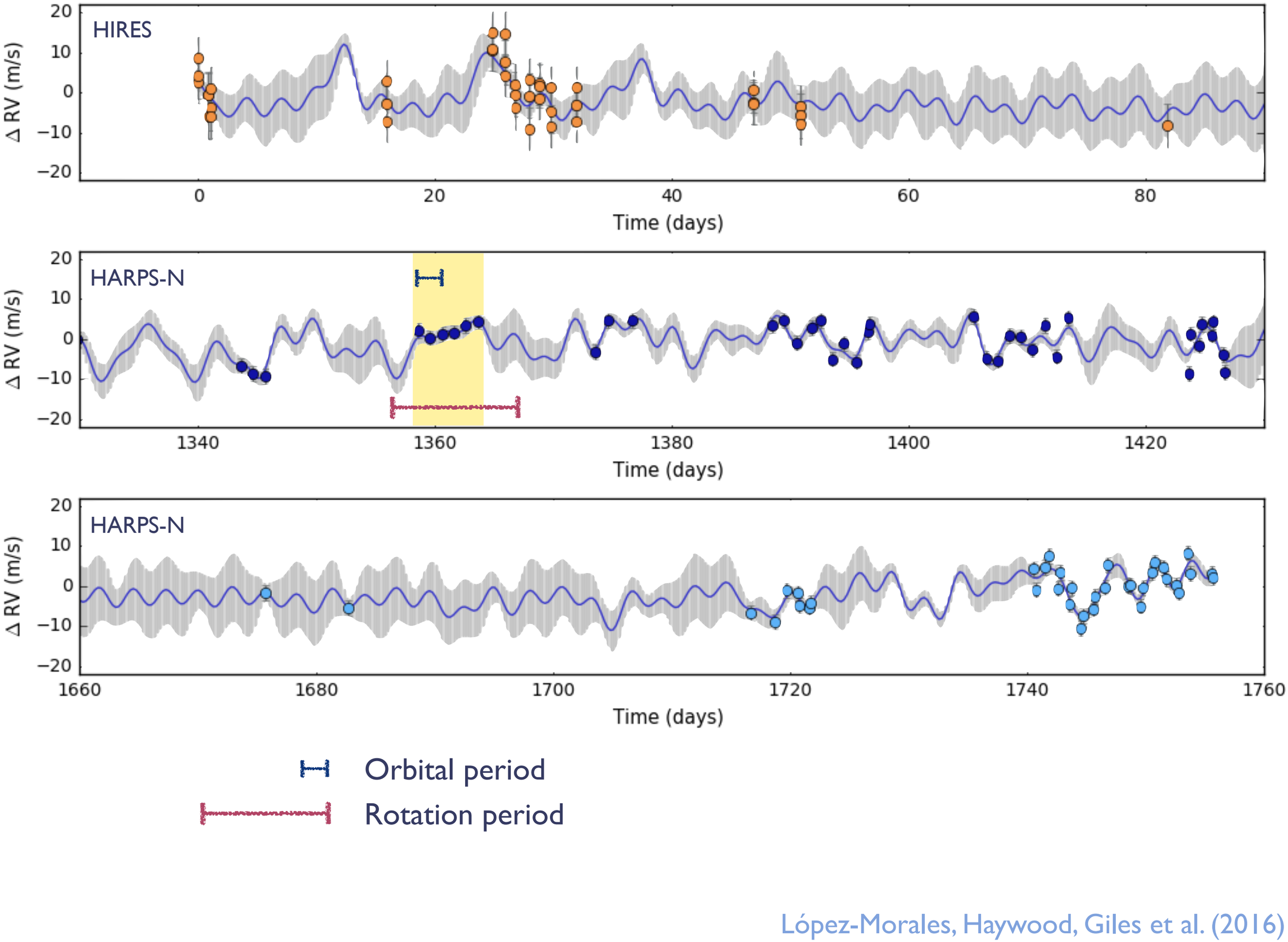

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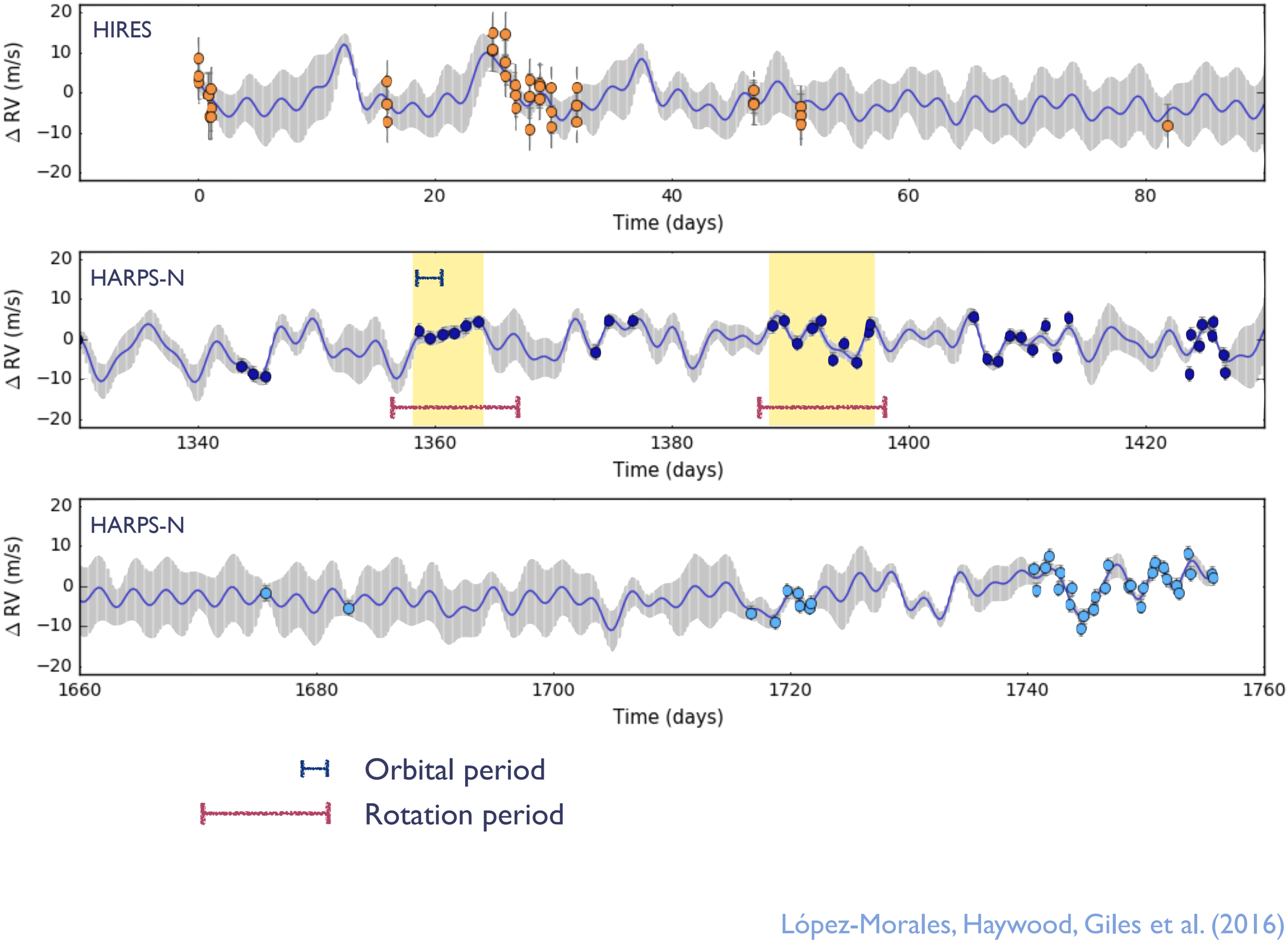

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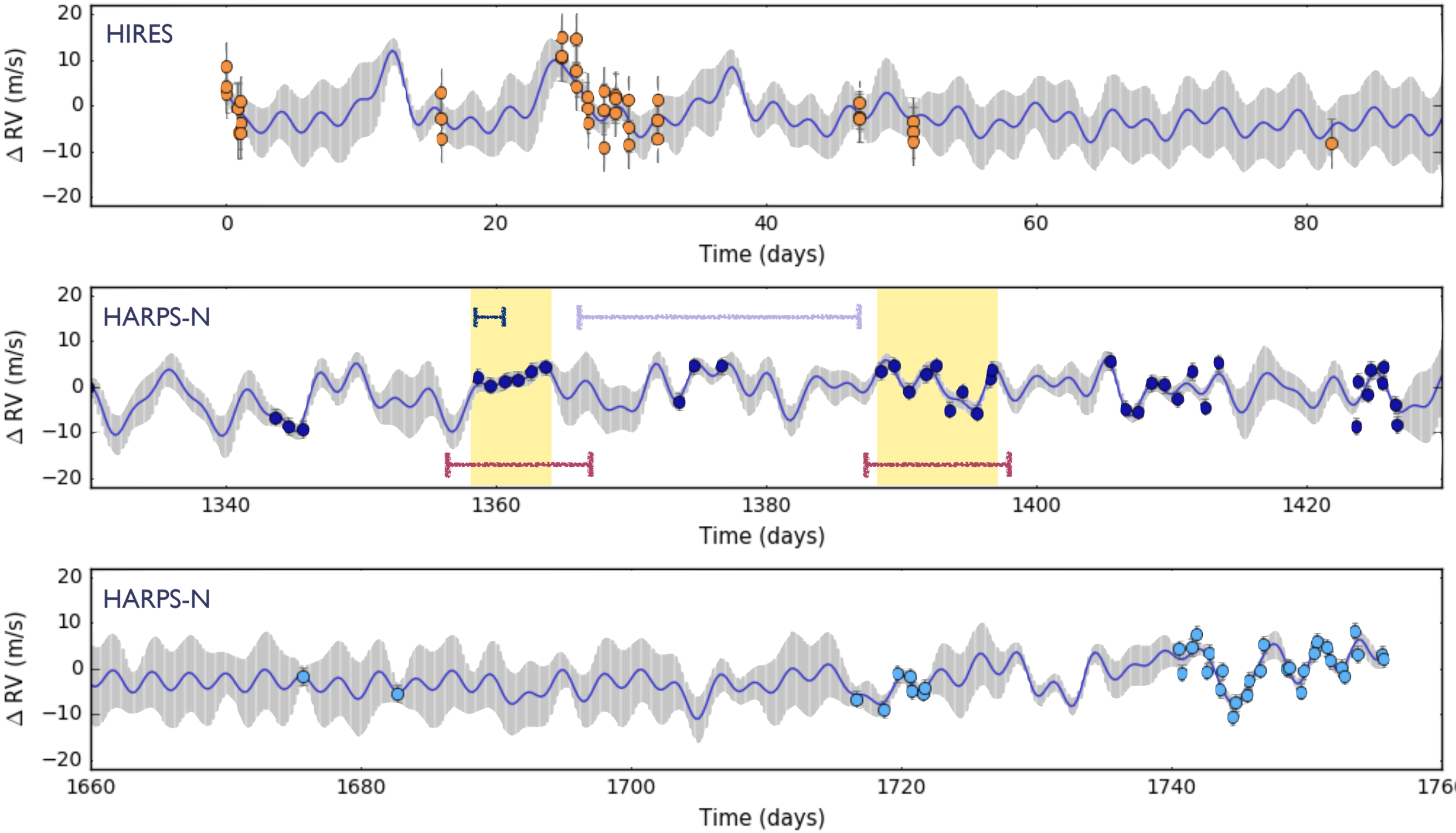

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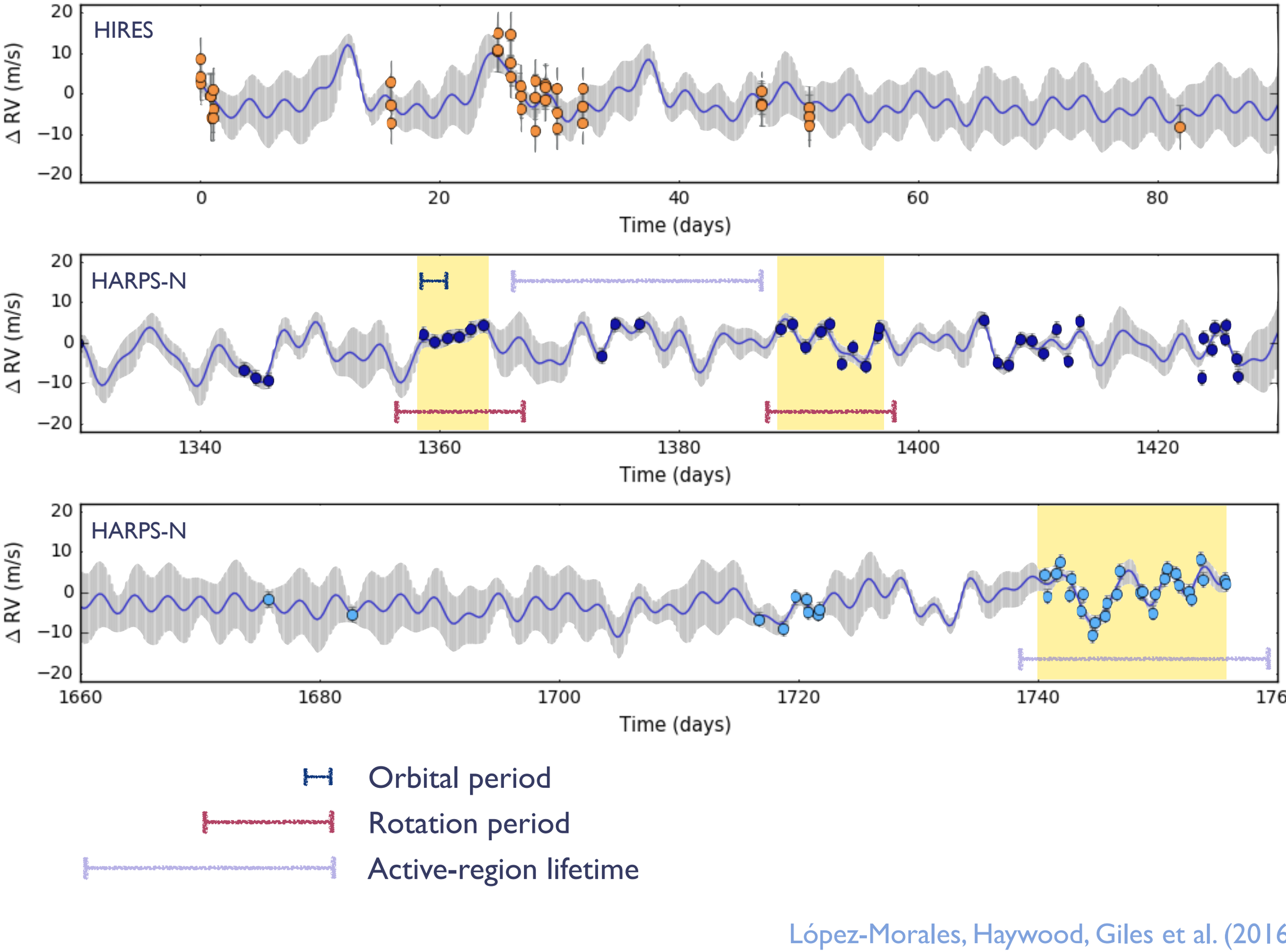

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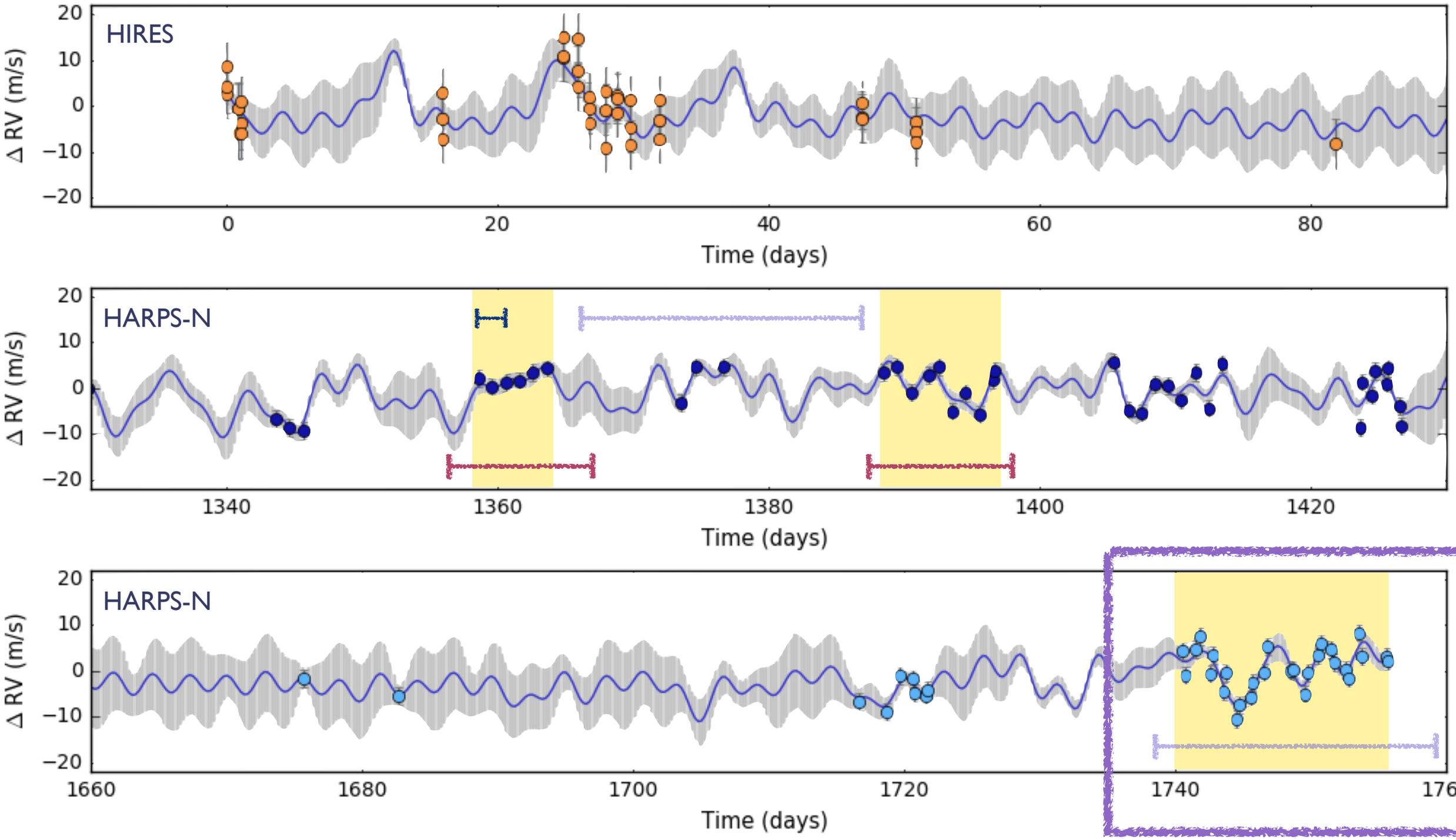


Orbital period

Rotation period

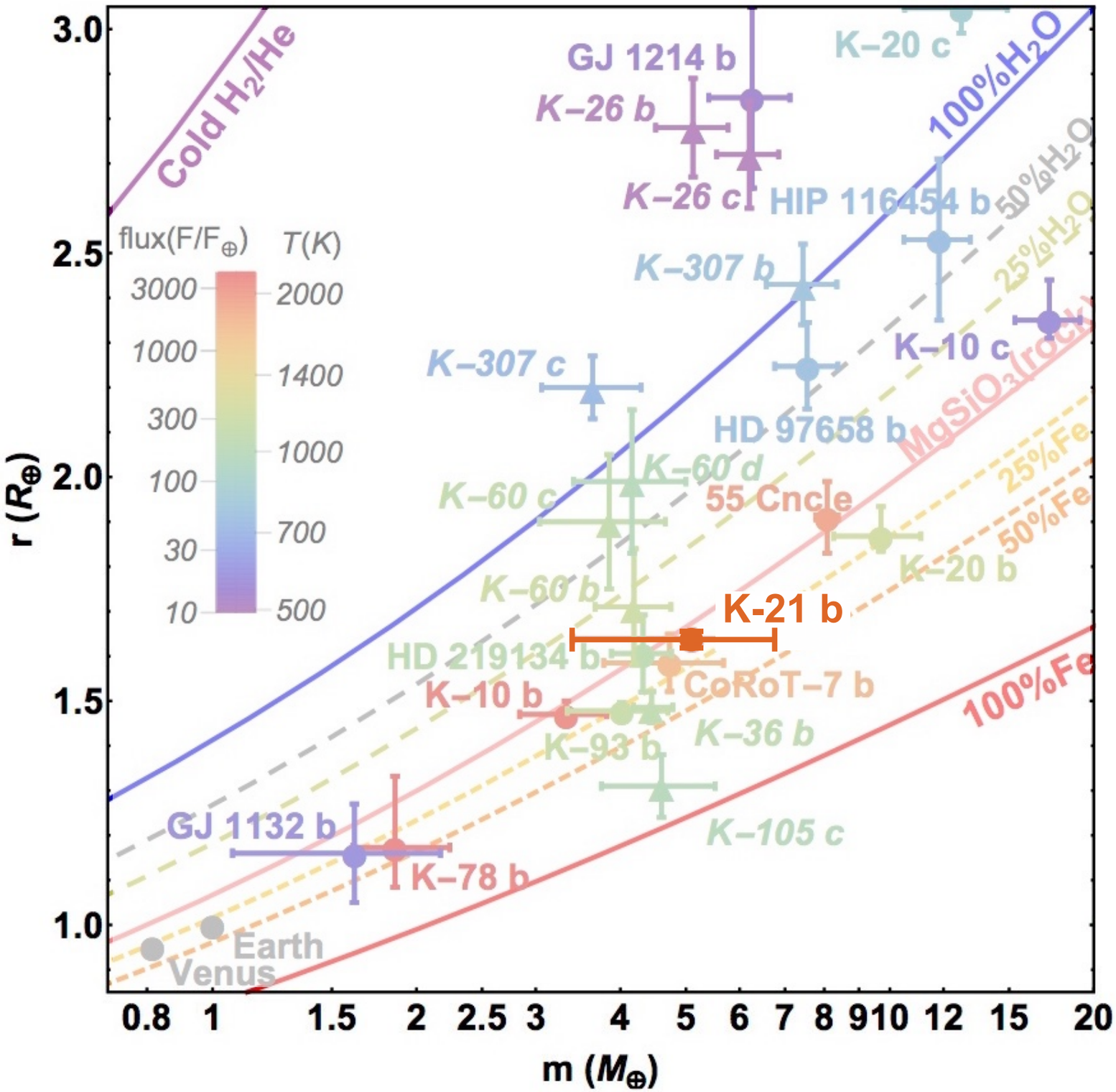
Active-region lifetime

28 obs. over 15 nights

We sampled the rotation period within the active-region lifetime

López-Morales, Haywood, Giles et al. (2016)

Accounting for stellar activity in our mass determination



López-Morales, Haywood, Giles et al. (2016)

Accounting for stellar activity in our mass determination

"jitter" term

For uncorrelated noise:

granulation,

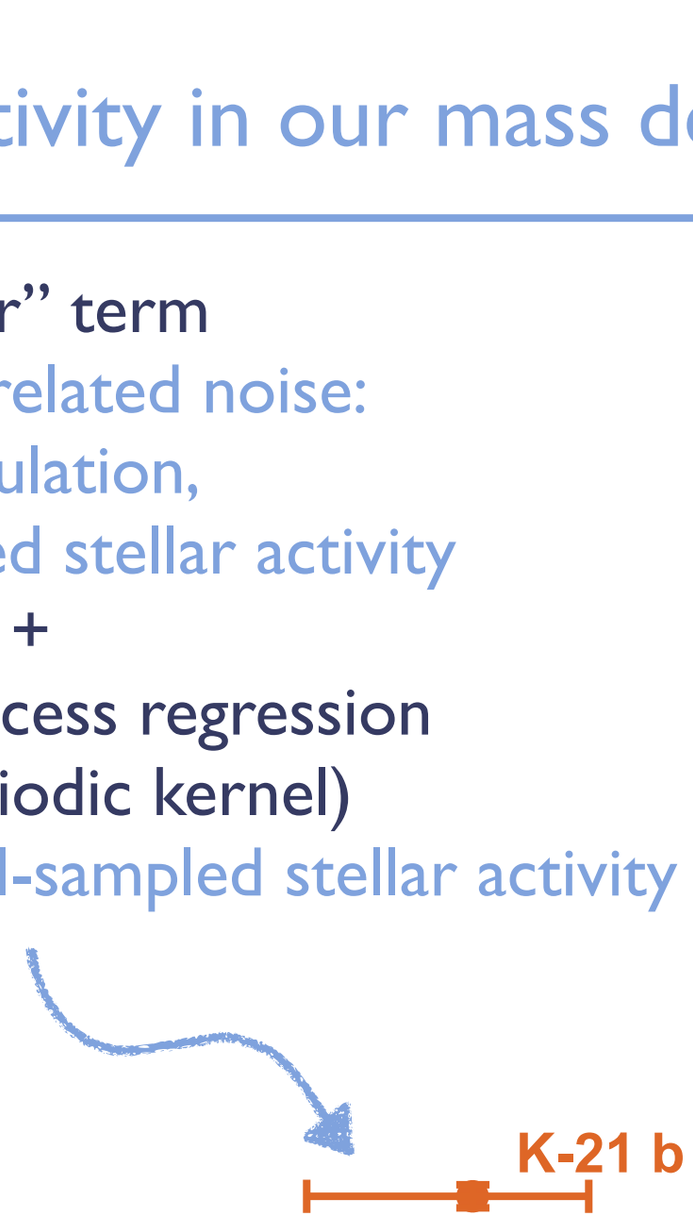
poorly-sampled stellar activity

+

Gaussian process regression

(quasi-periodic kernel)

Correlated noise: well-sampled stellar activity



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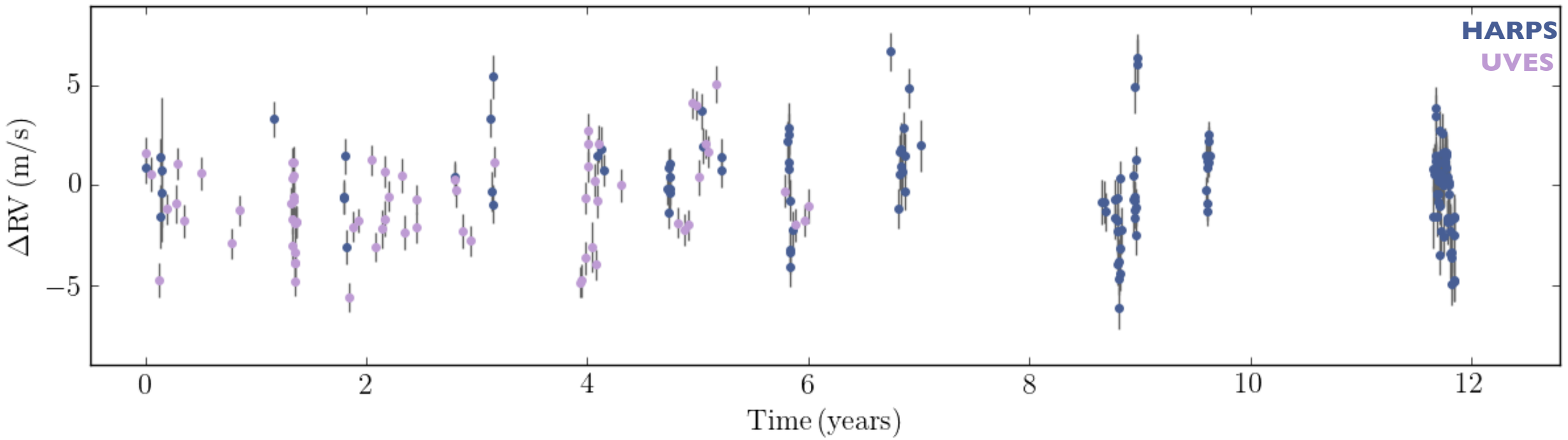
See also Haywood et al. (2014), Grunblatt et al. (2015), Rajpaul et al. (2015), Faria et al. (2016), Barros et al. (2017) and others

Proxima Centauri b

Anglada-Escudé et al. (2016)

Detection of a 1.3 $M_\oplus$ planet in an 11-day orbit around an active M dwarf



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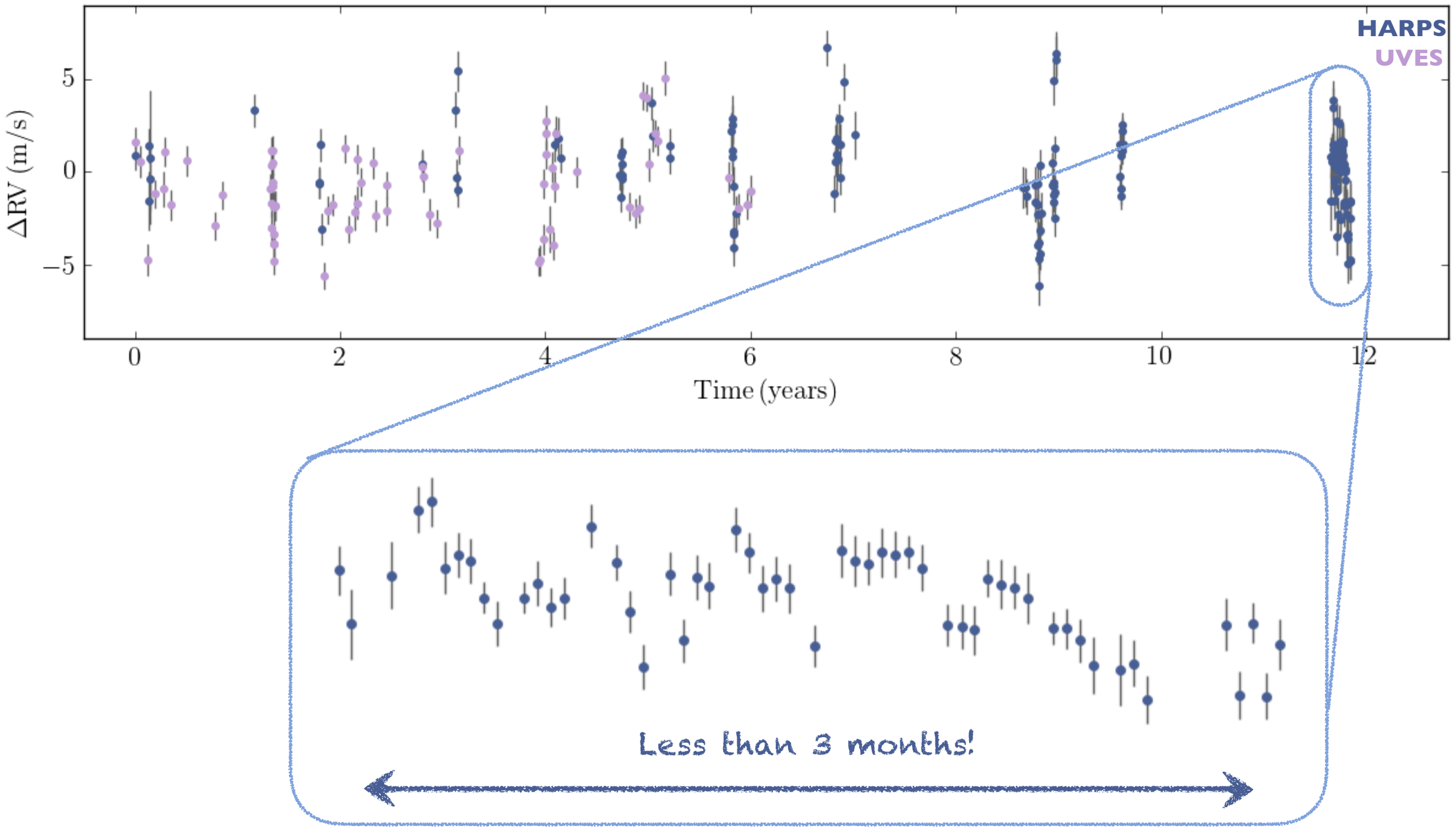

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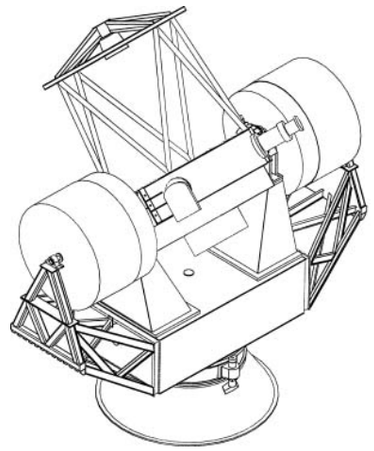

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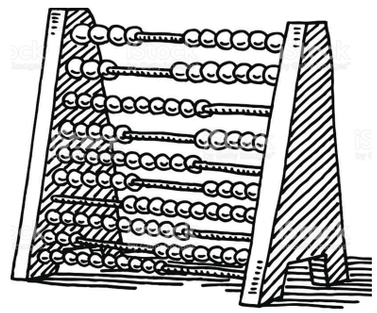

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