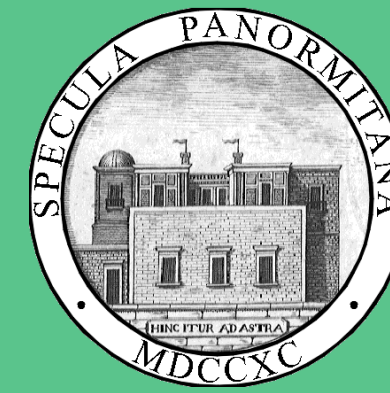
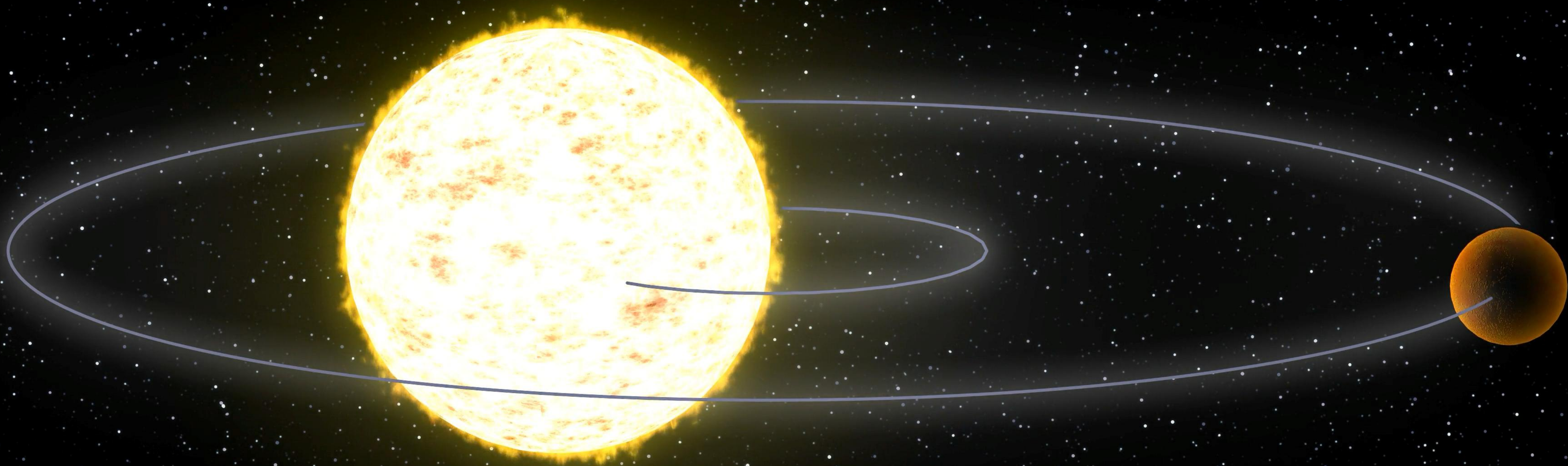


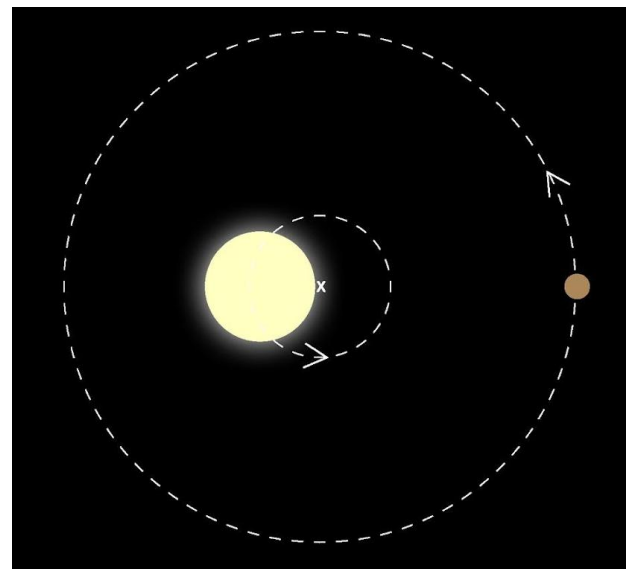
True masses using RV data and Hipparcos-Gaia Astrometry

Piazzì 200: New frontiers in astrometry, small bodies and technologies
Palermo - 30/09/2026

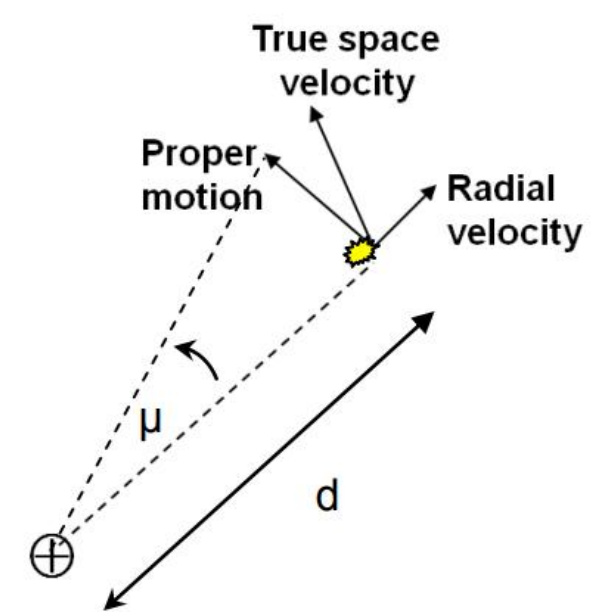
G. Piccinini (INAF-OAPa, UniPa), A. Petralia (INAF-OAPa), A. Sozzetti (INAF-OATo), S. Benatti (INAF-OAPa), D. Gandolfi (UniTo), G. Micela (INAF-OAPa)



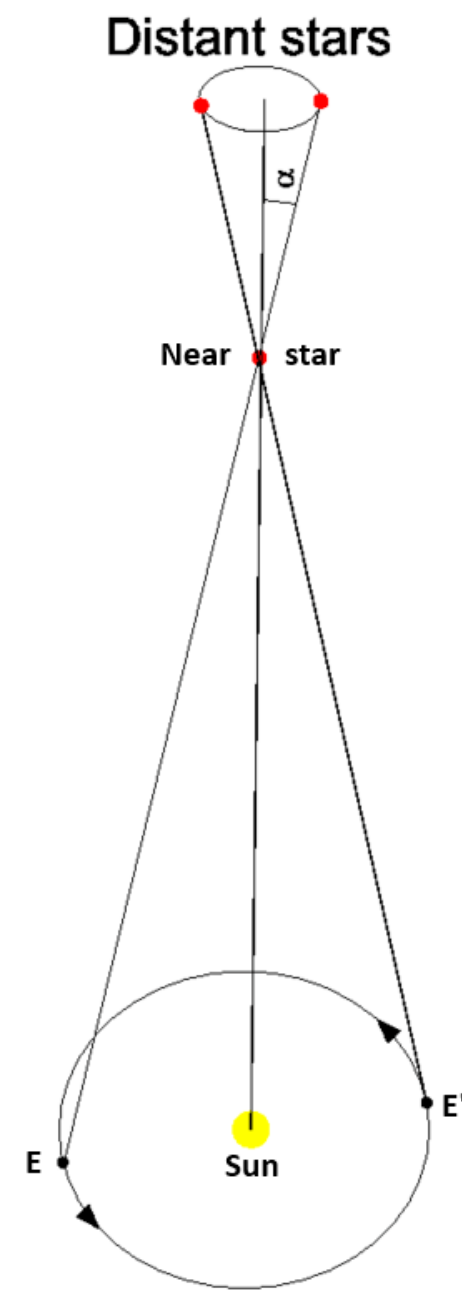
Stellar Motion



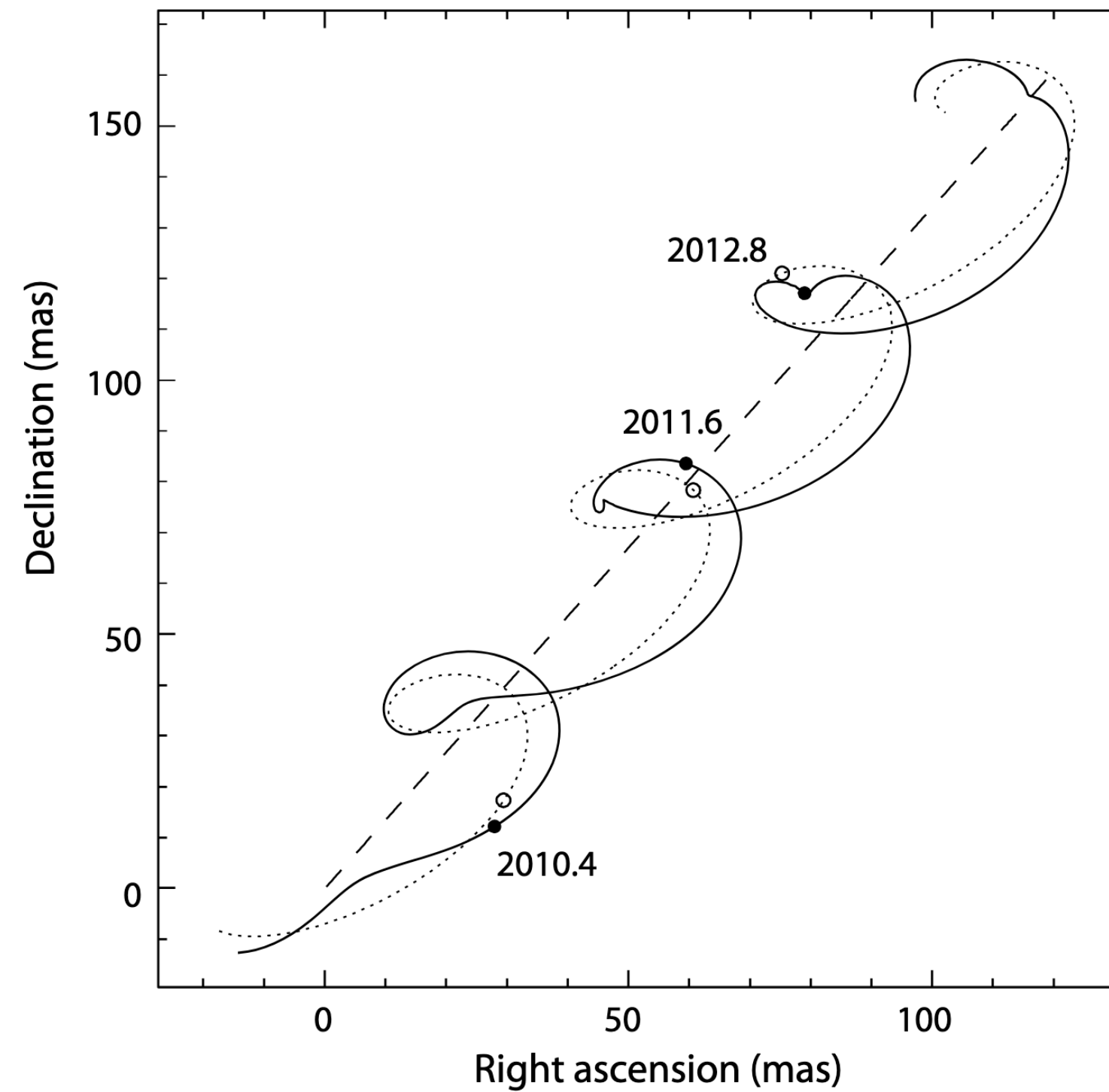
Orbital Motion



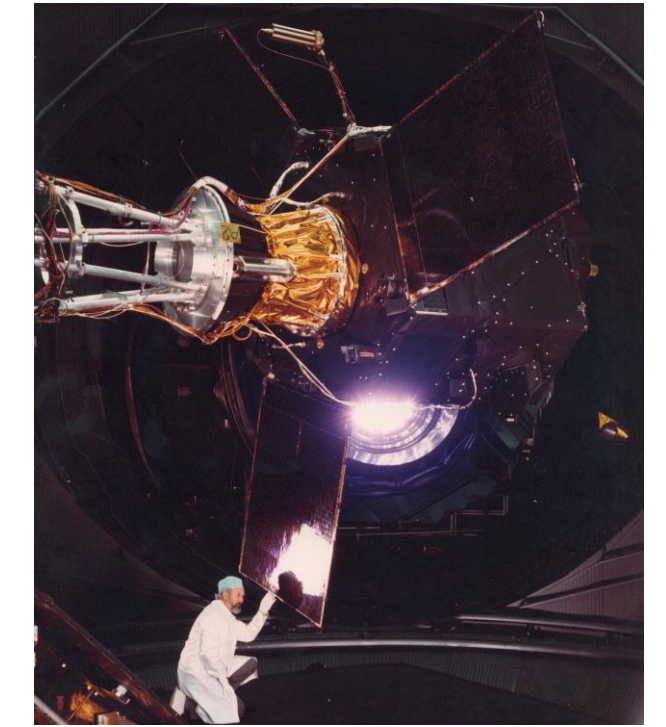
Proper Motion



Parallax



Total Stellar Motion



Hipparcos (1989-1993)

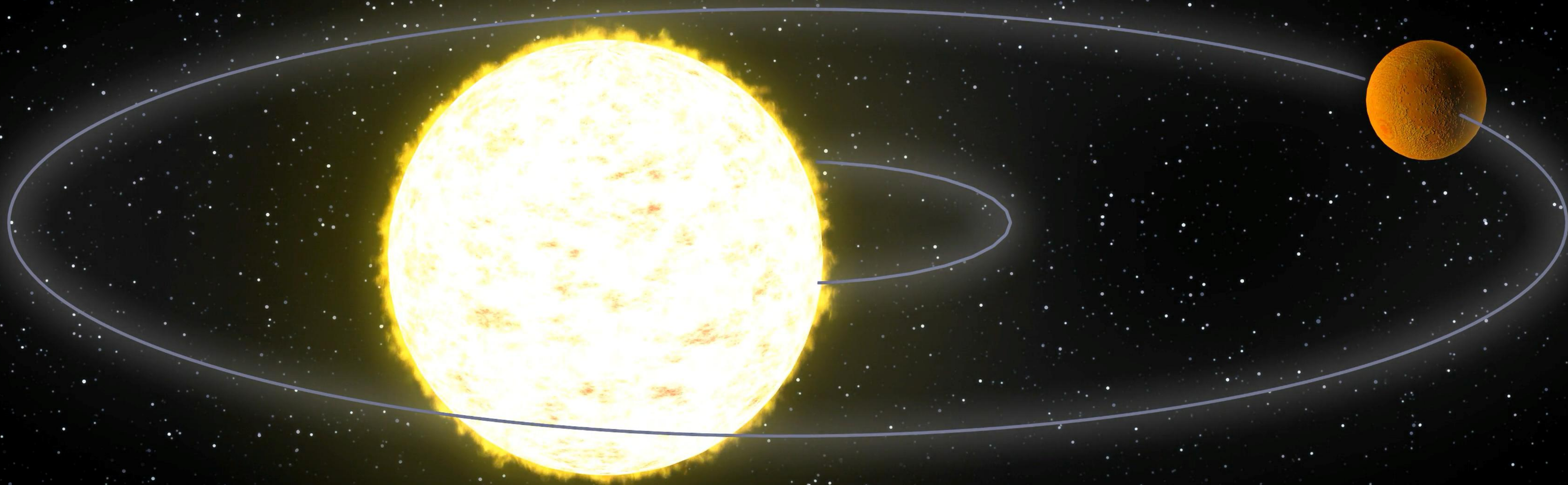


Gaia (2013-2025)



Proper Motion Anomaly

Radial Velocity



RV + PMA simultaneous analysis

RV

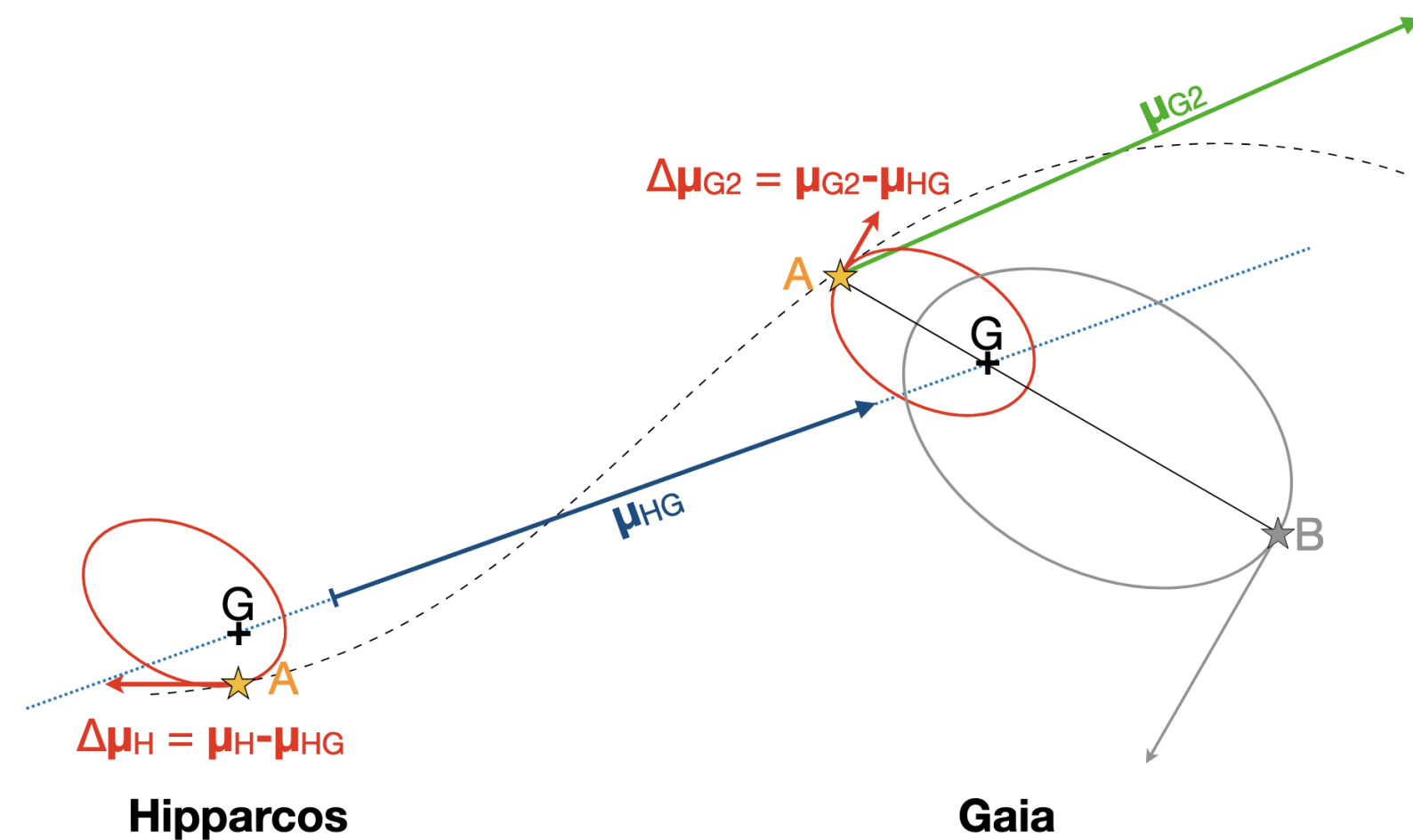
$$K = 28.4 \left(\frac{P}{\text{yr}} \right)^{-1/3} \left(\frac{M_p \sin i}{M_{\text{Jup}}} \right) \left(\frac{M_{\star}}{M_{\odot}} \right)^{-2/3} \frac{1}{\sqrt{1 - e^2}} \text{ms}^{-1}$$

RV + PMA simultaneous analysis

RV

$$K = 28.4 \left(\frac{P}{\text{yr}} \right)^{-1/3} \left(\frac{M_p \sin i}{M_{\text{Jup}}} \right) \left(\frac{M_{\star}}{M_{\odot}} \right)^{-2/3} \frac{1}{\sqrt{1 - e^2}} \text{ms}^{-1}$$

PMA



Adapted from Kervella+2019

$$\Delta\mu_{\text{Dec}}(\text{OrbParam}) = \bar{\mu}_{\text{Dec}} - \frac{\bar{x}_G - \bar{x}_H}{\Delta t}$$

$$\Delta\mu_{\text{RA}}(\text{OrbParam}) = \bar{\mu}_{\text{RA}} - \frac{\bar{y}_G - \bar{y}_H}{\Delta t}$$

Orbital Parameters: $K, P, T_p, e, \omega, \Omega, i, M_p$

$\Delta t = 24.25$ years

The Idea

This method is useful to evaluate orbital inclinations and to derive true mass of stellar companions.

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We applied it to eight systems already characterised.

At that time, only GDR1 was available.

Results

- Use of `GASTON` tool (Kiefer+2019) testing various orbital inclination,
- Each simulated inclination produced a different astrometric excess noise, which was then compared to the actual GDR1 measurement to constrain the inclination.

	GDR1	GDR3
HD 5388 b	Brown Dwarf/Star	Planet
HD 6718 b	Brown Dwarf/Star	Planet
HD 16760 b	Star	Brown Dwarf with a probable second planet
HD 141937 b	Brown Dwarf/Star	Planet
HD 148427 b	Star	Planet
HD 96127 b	Star	Planet
HIP 65891 b	Star	Planet
30 Ari B b	Star	Star

- **GDR3** observational epochs are used to calculate **PMAs + archival RV data**
- Evaluate inclinations and **derive masses**,
- Check results using the **sensitivity curve** (Kervella+2019) and **RUWE**.

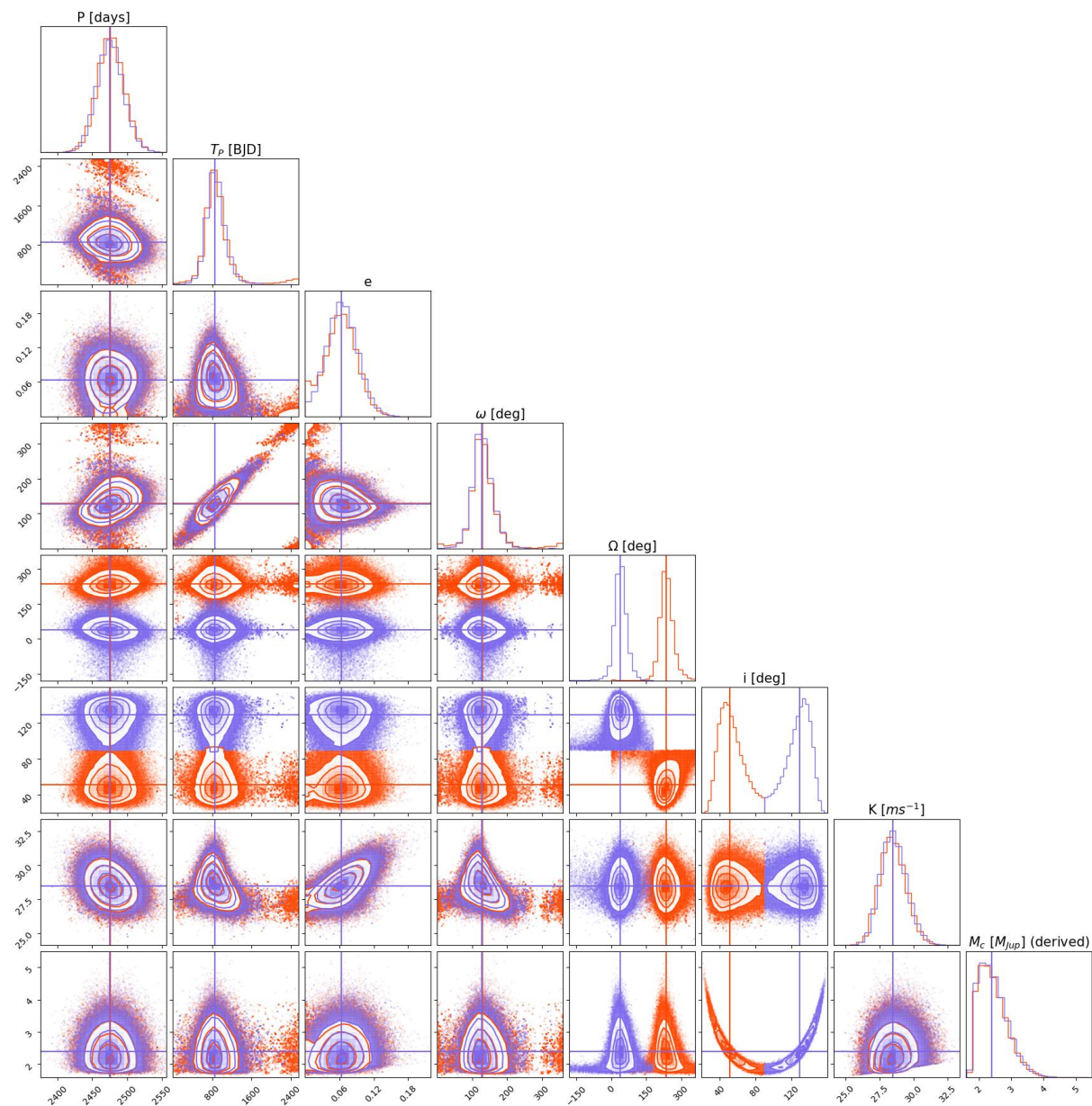
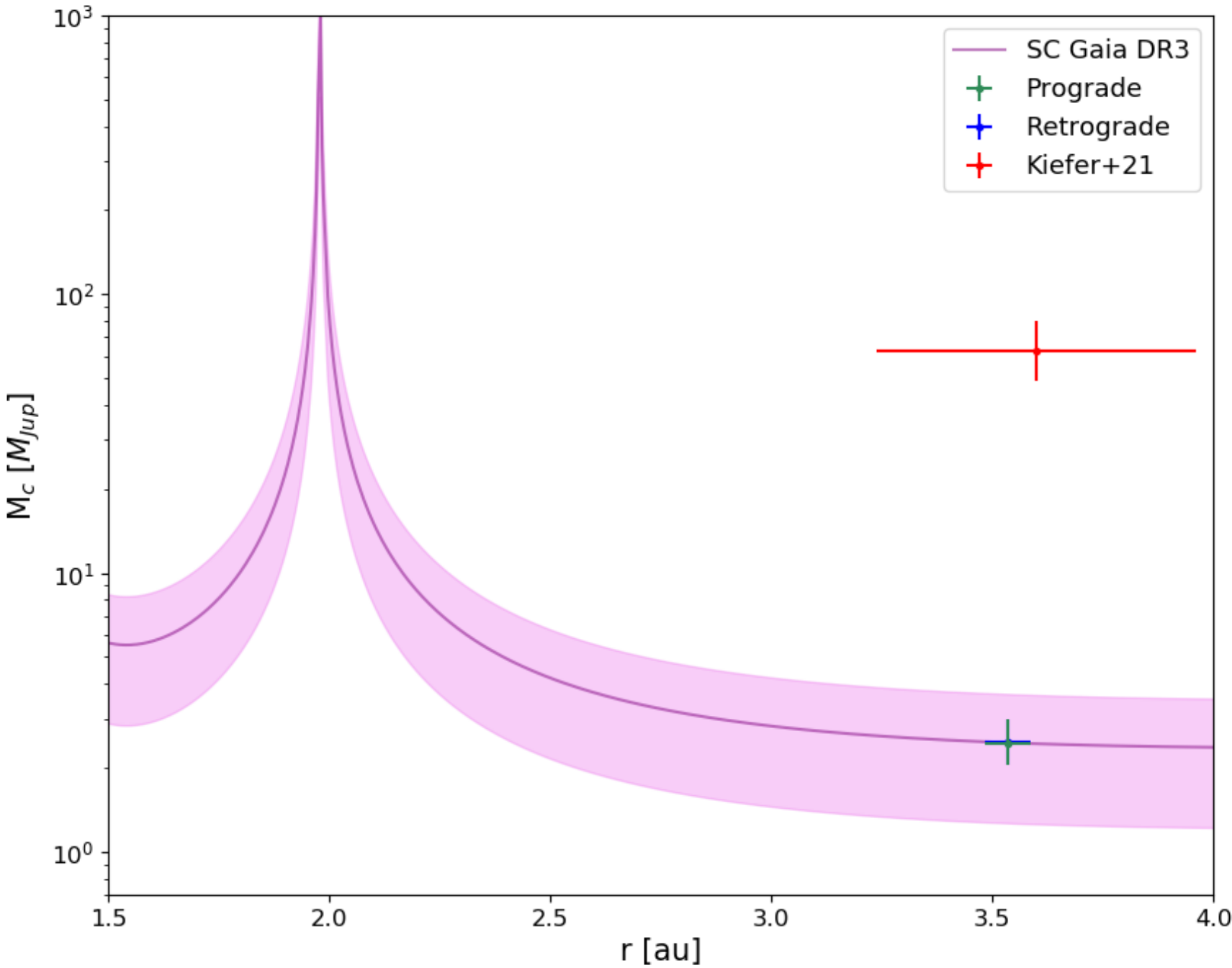
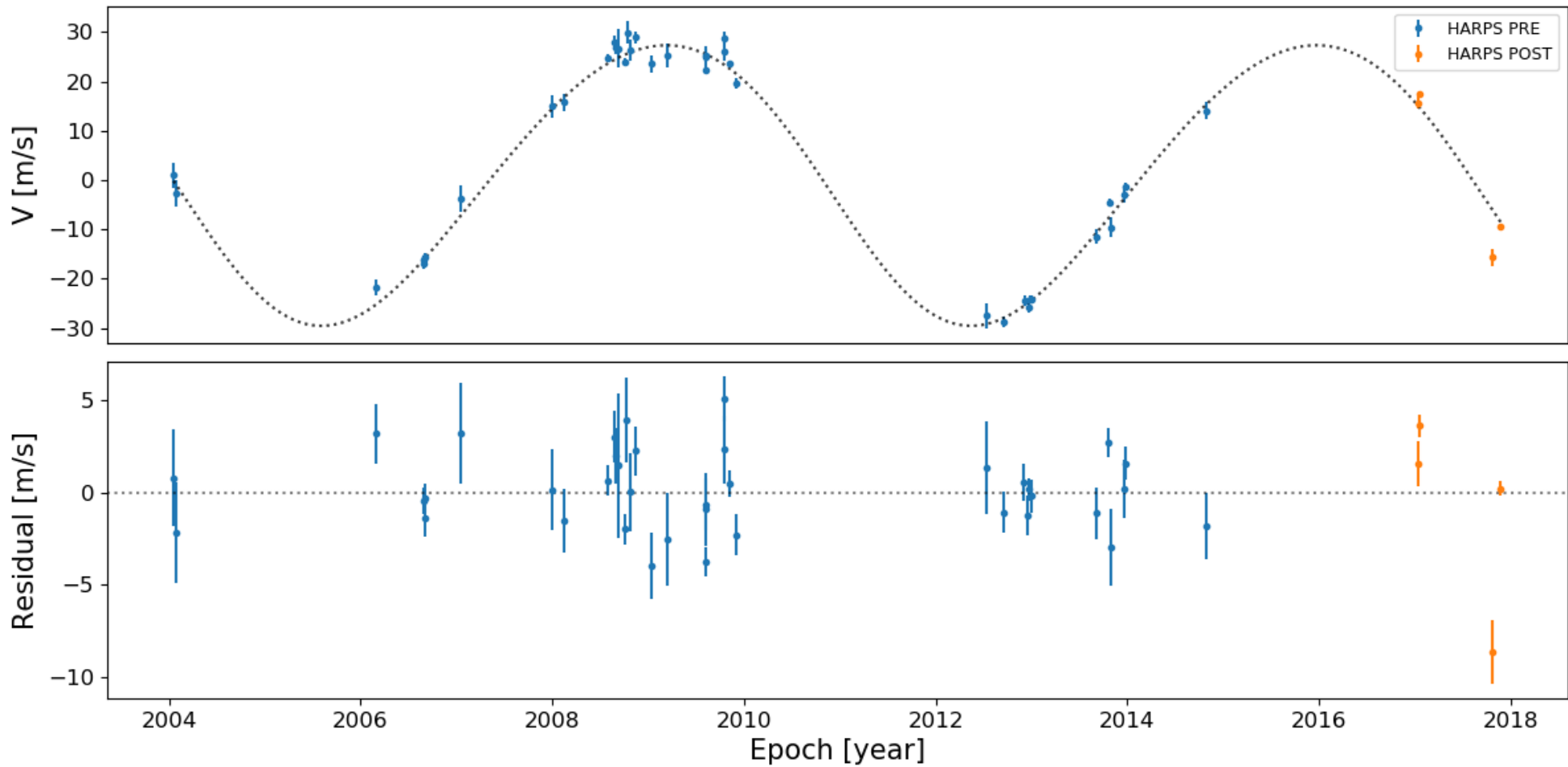


We determined a range for the orbital inclinations

HD 6718 b

Planet Parameter	(a) Naef+10 (b) Kiefer+21	Piccinini+26
P [d] (a)	2496 ± 176	2476 ± 19
e (a)	0.10 _{-0.04} ^{+0.11}	0.06 ± 0.03
a [au] (a)	3.56 _{-0.15} ^{+0.24}	3.53 ± 0.05
K [m/s] (a)	24.1 ± 1.5	28.4 ± 0.9
i [deg] (b) (*)	1.5 _{-0.3} ^{+0.4}	51.4 _{-11.5} ^{+16.4}
		129.0 _{-16.2} ^{+11.2}
Mp [M _{Jup}] (b) (*)	62.79 _{-13.80} ^{+16.98}	2.4 _{-0.2} ^{+0.3}
		2.4 _{-0.2} ^{+0.3}

Parameter	Value
RUWE	0.957

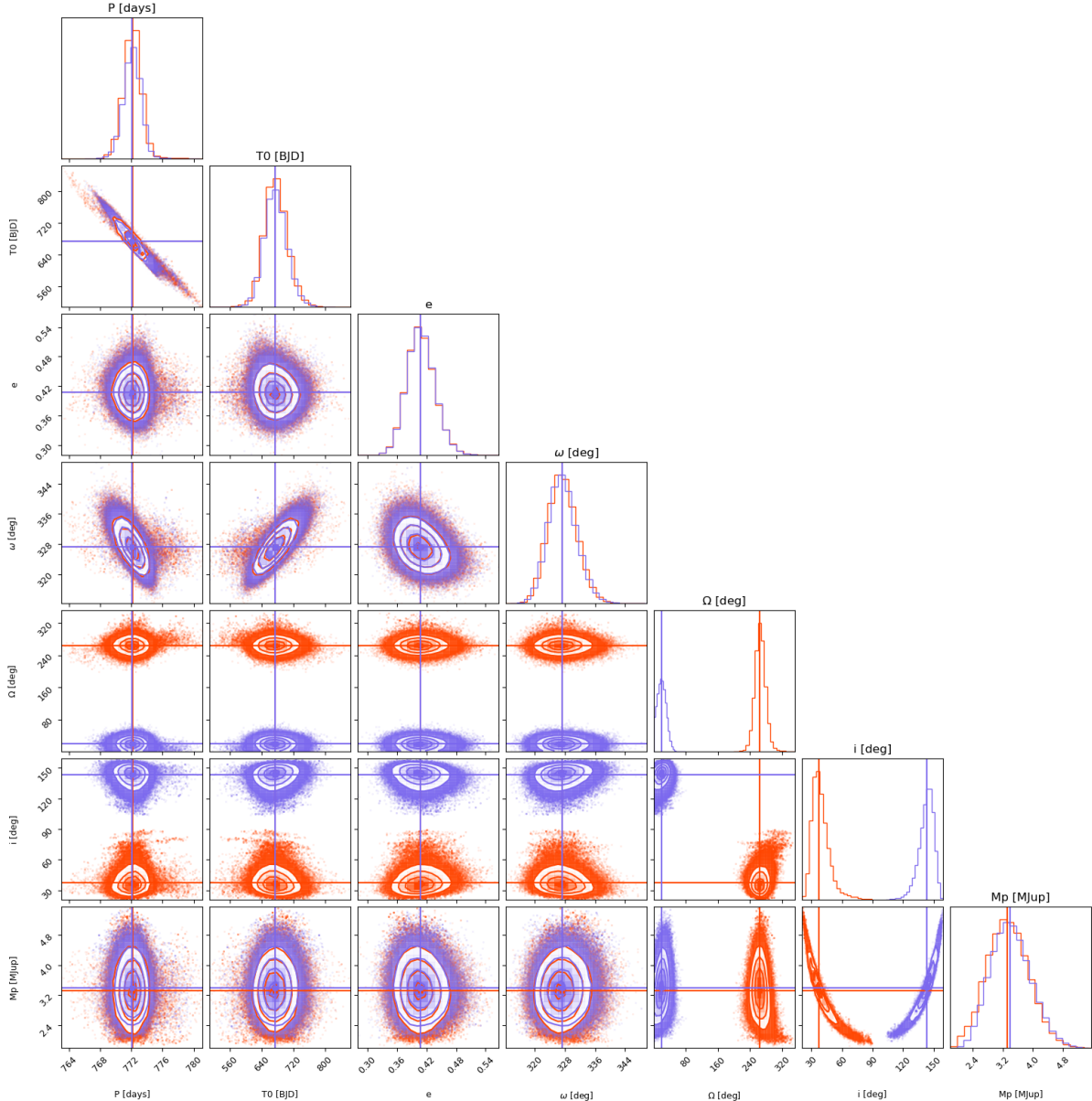
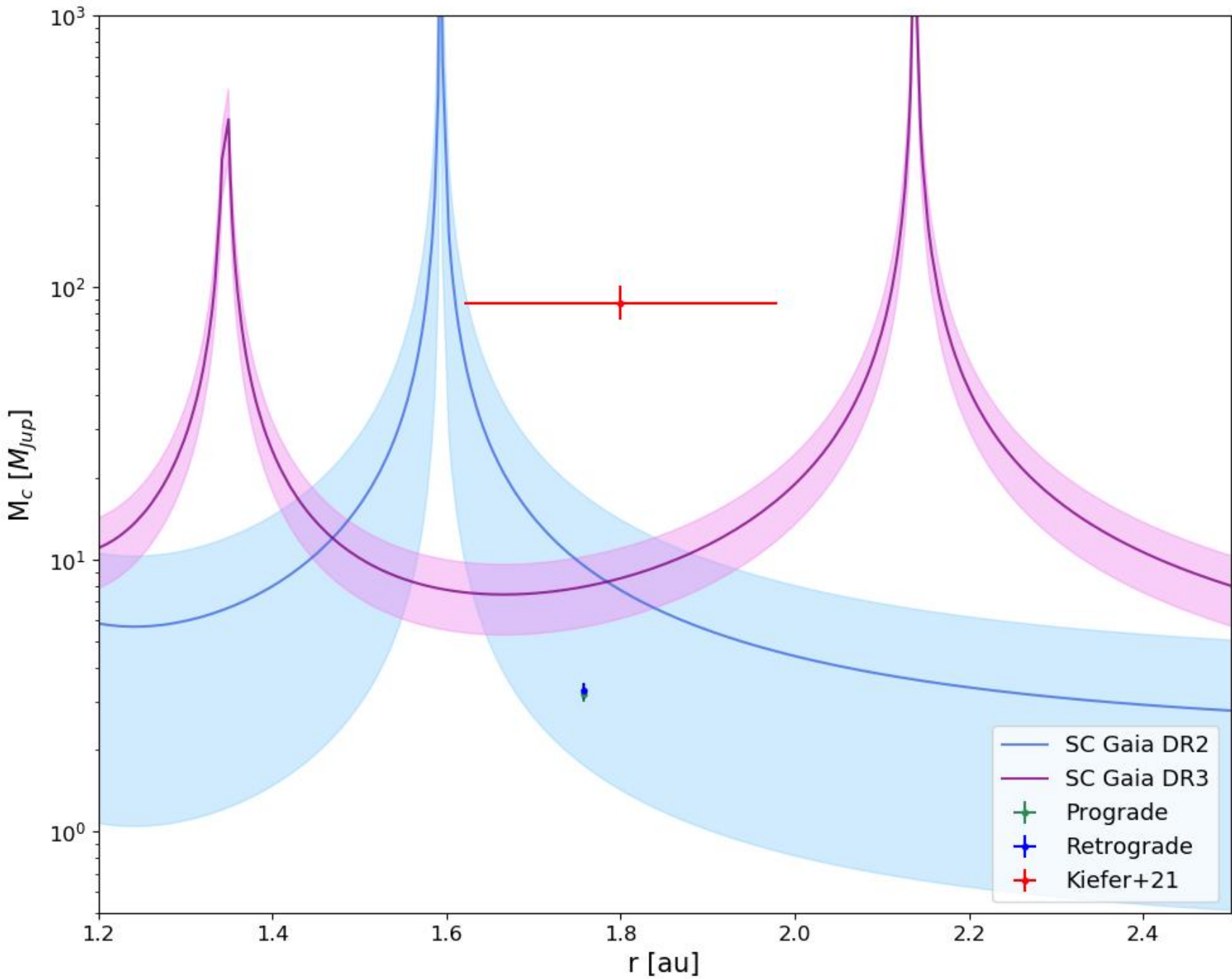
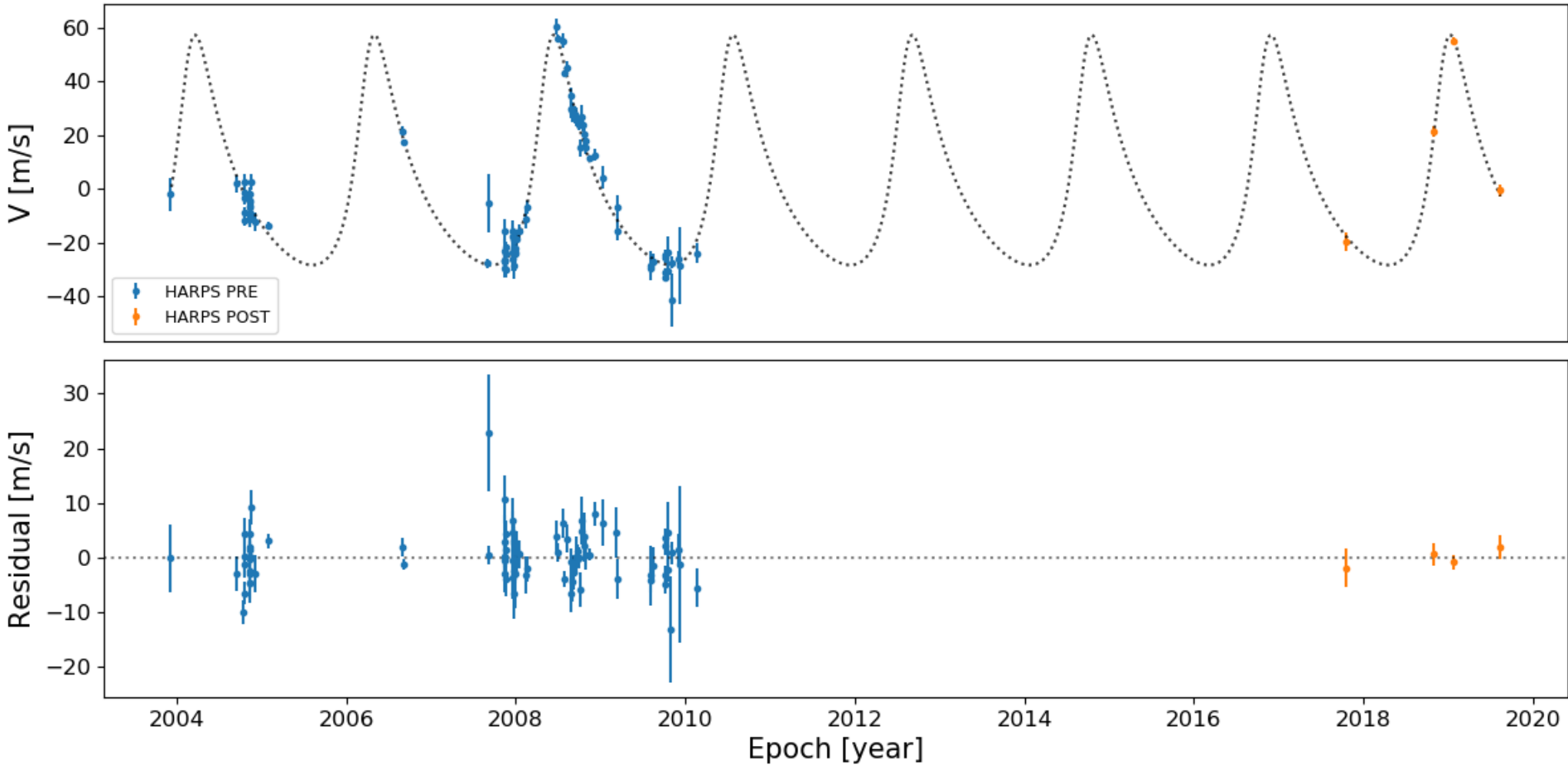


(*) Prograde and retrograde solutions

HD 5388 b

Planet Parameter	(a) Santos+10 (b) Kiefer+21 (c) Sahlmann+11a	Piccinini+26
P [d] (a)	777 ± 4	773 ± 1
e (a)	0.40 ± 0.02	0.41 ± 0.02
a [au] (a)	1.76 ± 0.09	1.757± 0.001
K [m/s] (a)	41.7 ± 1.6	42.7 _{-1.3} ^{+1.4}
i [deg] (b) (c) (*)	1.4 ± 0.2	38.7 _{-6.8} ^{+10.2}
	178.3 _{-0.7} ^{+0.4}	142.4 _{-8.5} ^{+6.2}
M _p [M _{Jup}] (b)(c) (*)	87 ₋₁₁ ⁺¹⁴	3.2 _{-0.2} ^{+0.3}
	69.2 ± 19.9	3.3 ± 0.2

Parameter	Value
RUWE	1.130

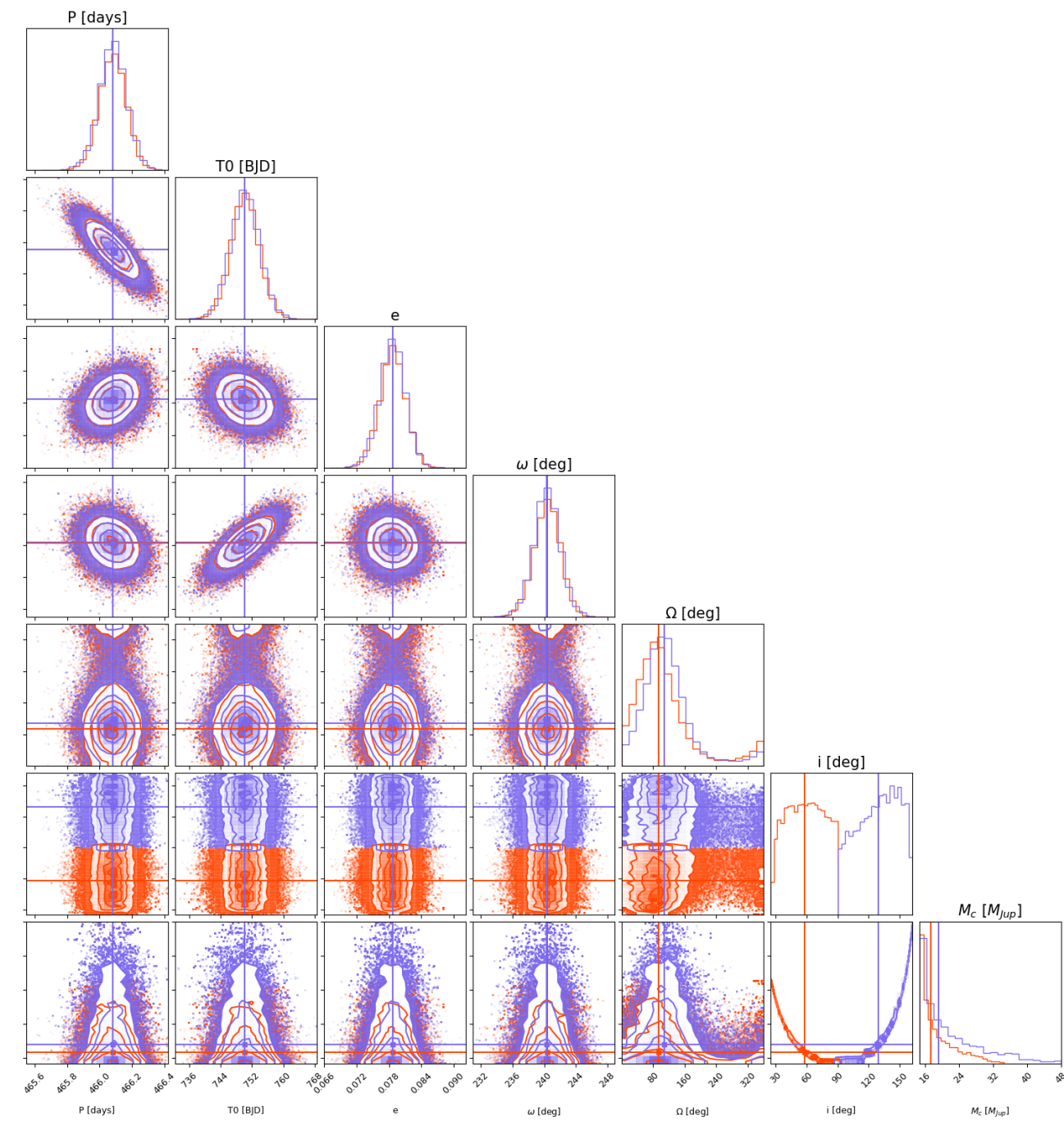
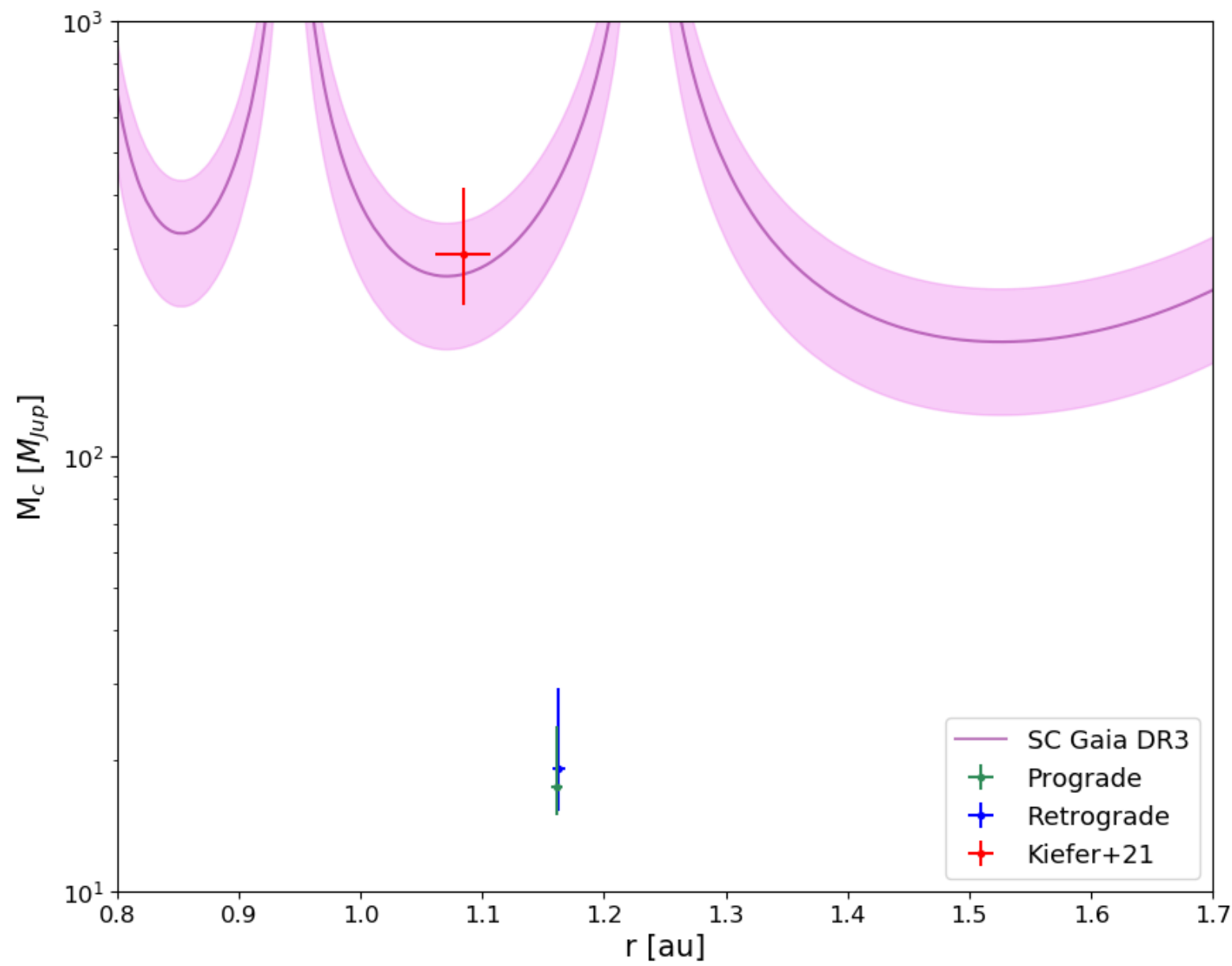
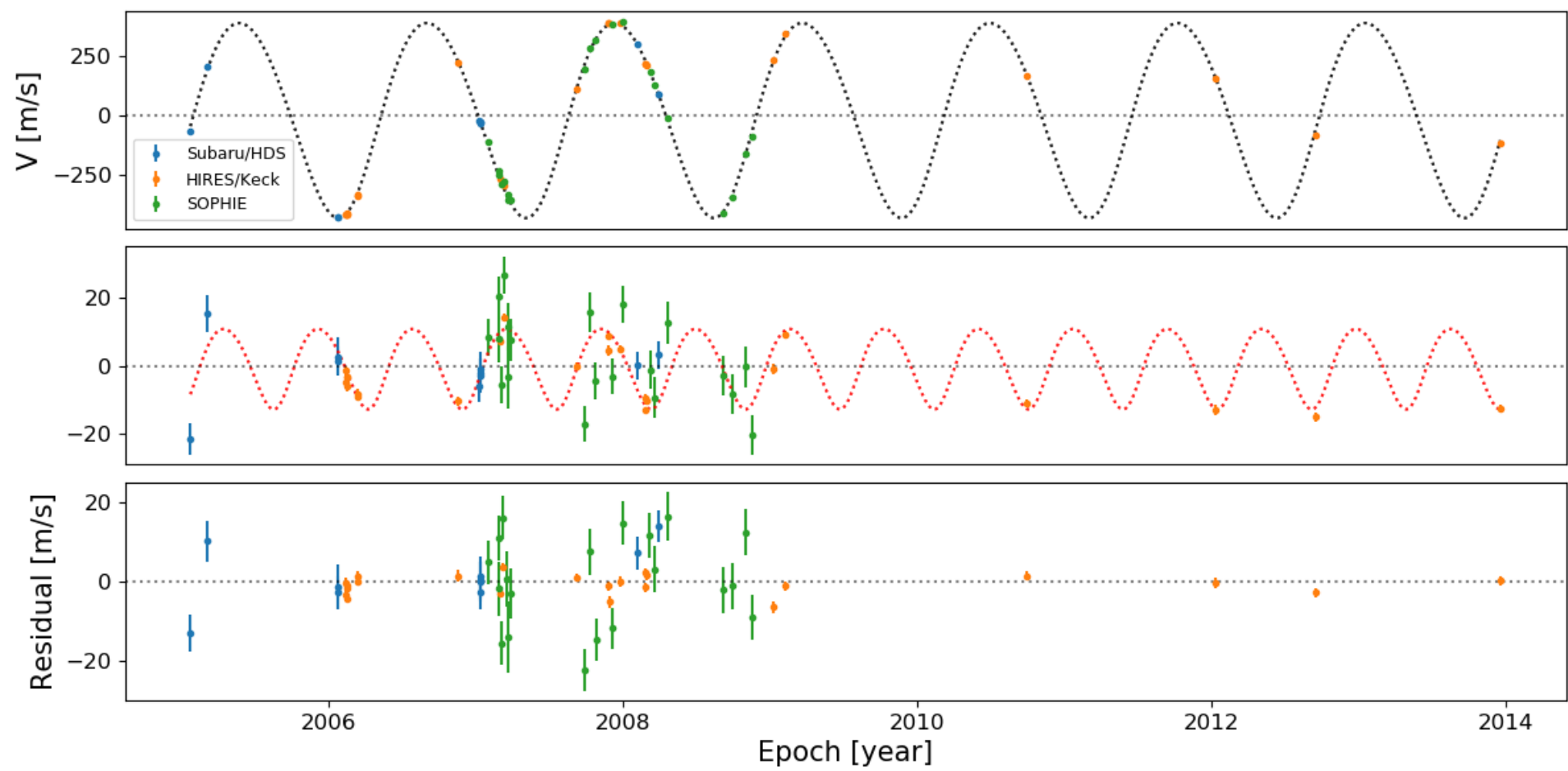


(*) Prograde and retrograde solutions

HD 16760 b

Planet Parameter	(a) Sato+09 (b) Kiefer+21	Piccinini+26
P [d] (a)	466.5 ± 0.4	466.08 ± 0.08
e (a)	0.084 ± 0.003	0.079 ± 0.002
ω [deg] (a)	242.9 ± 1.9	240.4 ± 1.7
K [m/s] (a)	407.7 ± 0.8	407.0 ± 0.9
i [deg] (b) (*)	3.2 ± 0.8	43.3 _{-28.8} ^{+32.2}
		132.6 _{-29.6} ^{+30.3}
M _p [M _{Jup}] (b) (*)	219.9 _{-69.4} ^{+120.7}	21.5 _{-4.5} ^{+5.0}
		20.0 _{-4.0} ^{+4.1}

Parameter	Value
RUWE	26.546



(*) Prograde and retrograde solutions

Conclusions



RV + PMA technique helps us to evaluate the mass of a stellar companion.



We found new insights about eight systems and we re-classify at least four objects.



While awaiting the GDR4 astrometric time series, we will apply this technique to assess the nature of multiple-object systems.