PLATOSpec

The first scientific results

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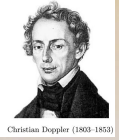
Astronomický ústav AV ČR

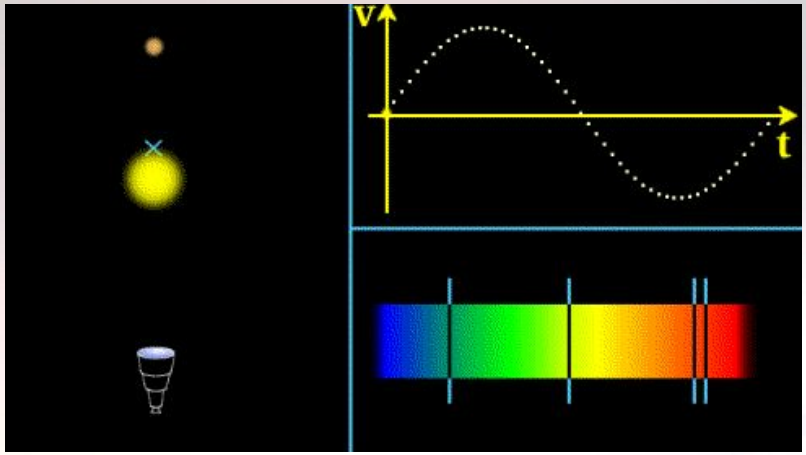
Tatra Astro Meet, Stará Lesná

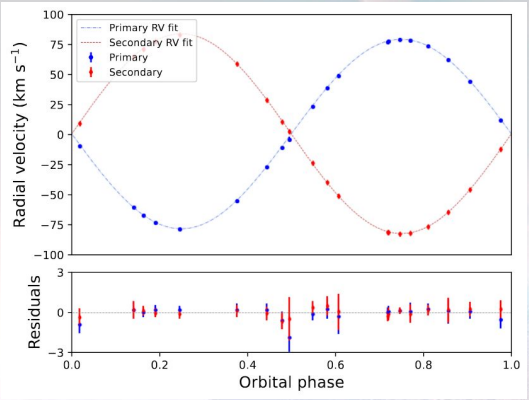
September 24, 2025



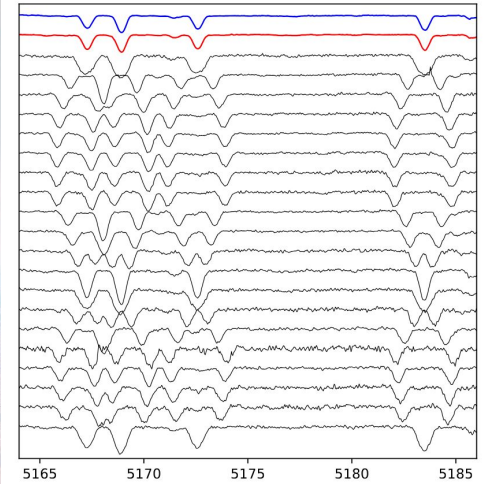
Radial velocities - principles

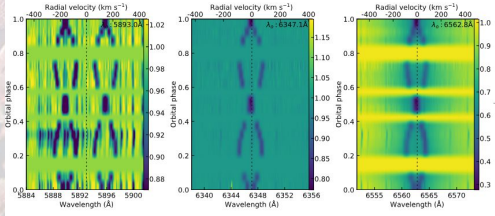
Change of frequency (wavelenght) due to a common movement of the object and observer





Skarka+, 2025A&A...698A..48S





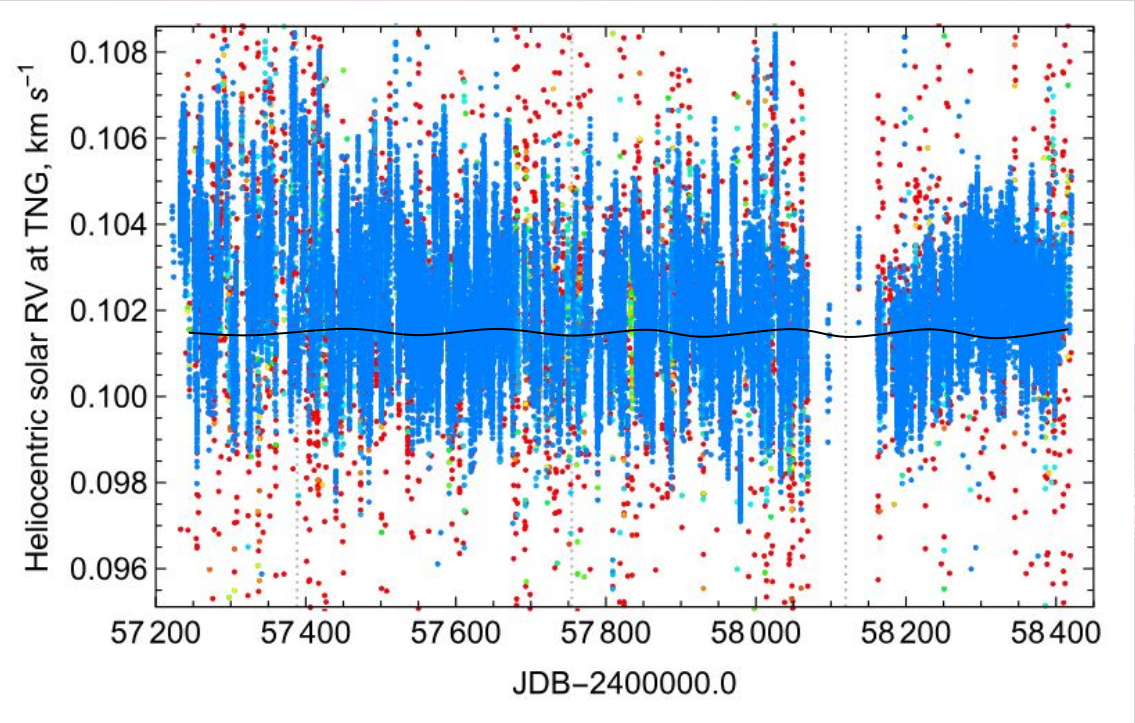
$$\frac{v}{c} = \frac{\lambda_{\mathrm{obs}} - \lambda}{\lambda} = \frac{\Delta\lambda}{\lambda}$$

Measurements of RVs is the best way how to measure masses of stars

Line shifts are very small. For exoplanets, Δλ<~0.002 nm in optical range
Special considerations and techniques are required

Radial velocities

$RV = RV_{stellar} + RV_{orbital} + RV_{instrumental}$



Collier Cameron+, 2019MNRAS.487.1082C

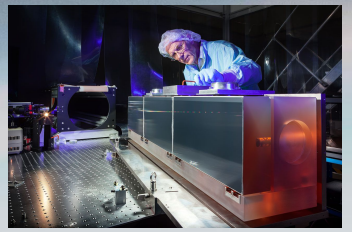
$RV_{stellar}$ - stellar variability (rotation, activity, pulsations) + systemic velocity

$RV_{orbital}$ - reflection motion due to a companion

$RV_{instrumental}$ - stability of the instrument & telescope, weather conditions, movement of the observer, data quality, data reduction & analysis, Earth atmosphere

Radial velocities

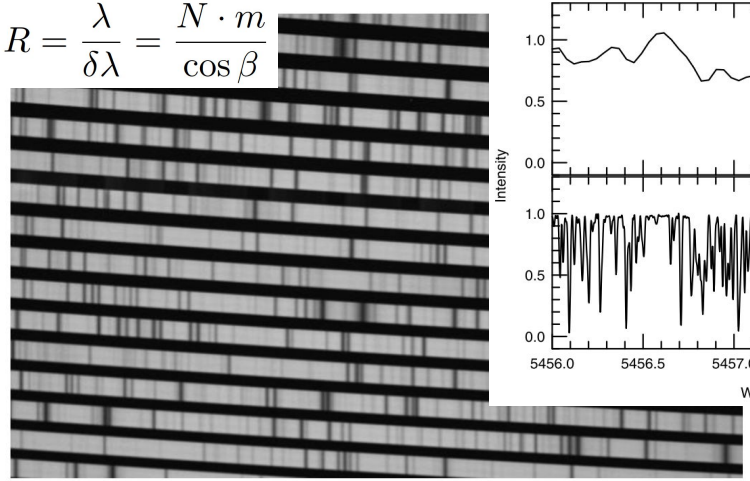
$$\sigma\ [\mathrm{m/s}] \propto \Delta\lambda^{-1/2}(S/N)^{-1}R^{-1.2}f(V)(0.16e^{1.79(T/5000)})$$

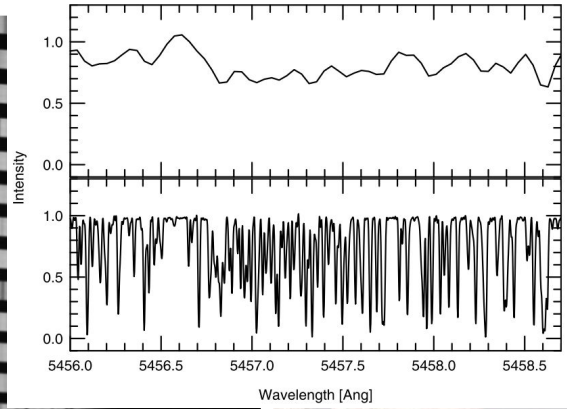


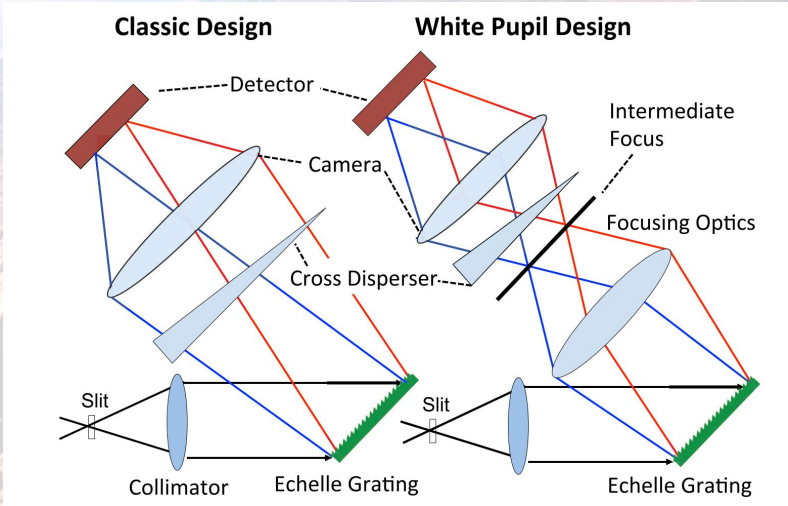
Instrumental characteristics (can be designed)

- **Spectral range** (instrument charactestics) -> Echelle spectrographs
- **Resolving power** (instrument characteristics) -> Echelle spectrographs
- Quality of the data (**efficiency** and **stability** of the instrument and optical system, pointing, observing strategy, observing conditions, data reduction, **data calibration**, analysis)

$$R = \frac{\lambda}{\delta\lambda} = \frac{N \cdot m}{\cos\beta}$$





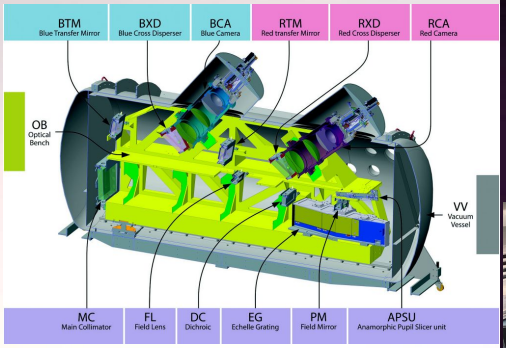


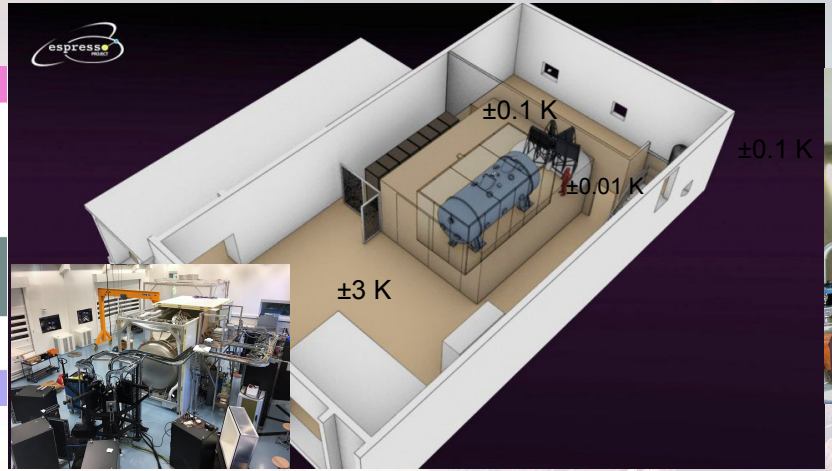
Radial velocities

- Stability and calibrations are crucial (Δp~100 Pa -> ΔRV~80 m/s)

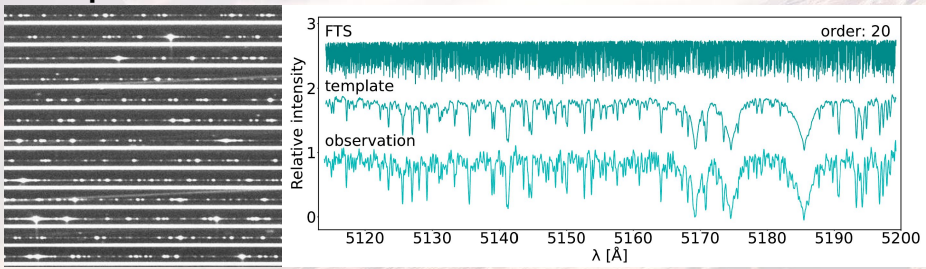
ESPRESSO@VLT: δT~1 mK, Δp~0.1 Pa; ~0.1 m/s

HARPS@3.6mLaSilla: δT~10 mK, Δp~1 Pa; ~1 m/s

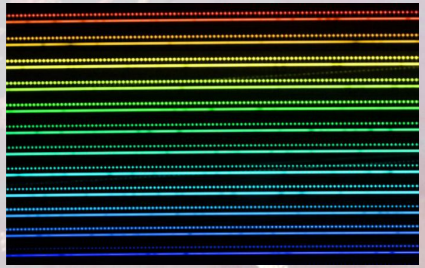




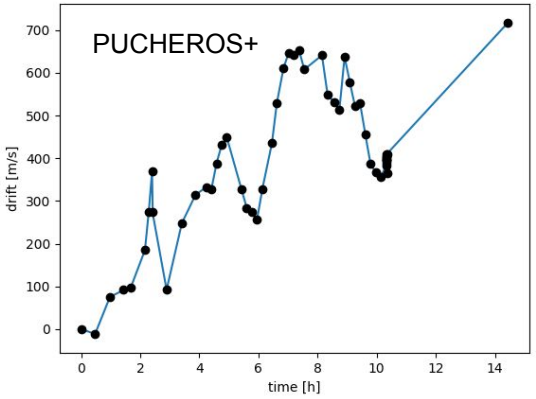
PLATOSpec has simultaneous ThAr and I2 calibrations

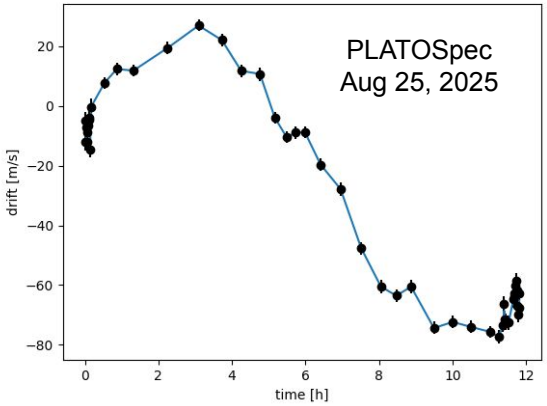


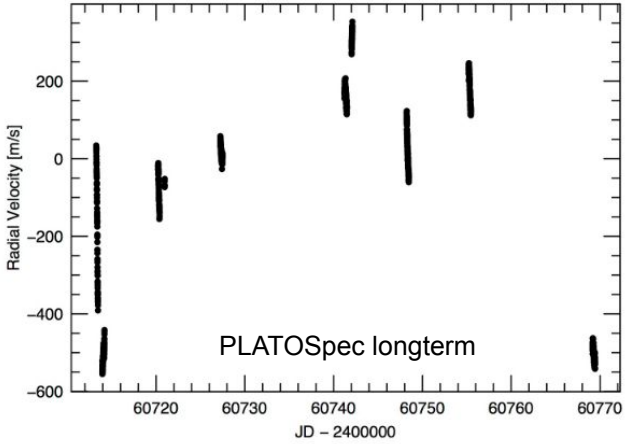
Fabry-Perot and laser combs

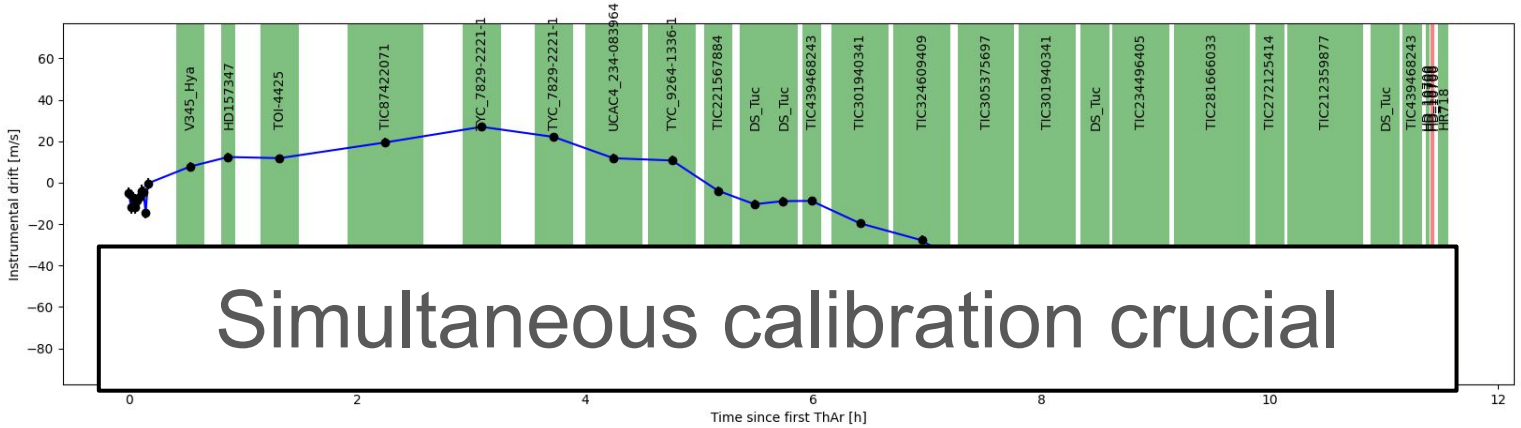


Radial velocities









Simultaneous calibration crucial

Radial velocities

	HARPS@3.6 m	ESPRESSO@8.2 m	ANDES@39 m
Spectral range	380-690 nm	380-790 nm	400-1800 nm
Resolving power	115000	70000, 140000, 190000	100000
Precision	1 m/s	0.1 m/s	0.02 m/s

	Coralie@1.2 m	FEROS@2.2 m	**FIDEOS@1.0 m**	**PLATOSpec@1.5 m**	**OES@2.0 m**
Spectral range	390-680 nm	350-920 nm	**420-800 nm**	**380-700 nm**	**380-9100 nm**
Resolving power	60000	48000	**43000**	**70000**	**50000**
Precision	7 m/s	25 m/s	**5-8 m/s**	**3-5 m/s**	**~10^1 (I2); ~10^2 m/s**

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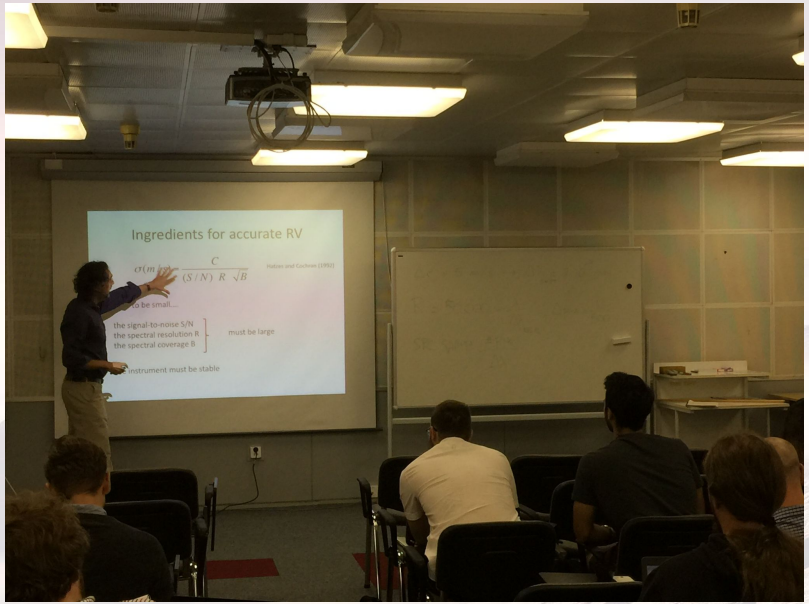
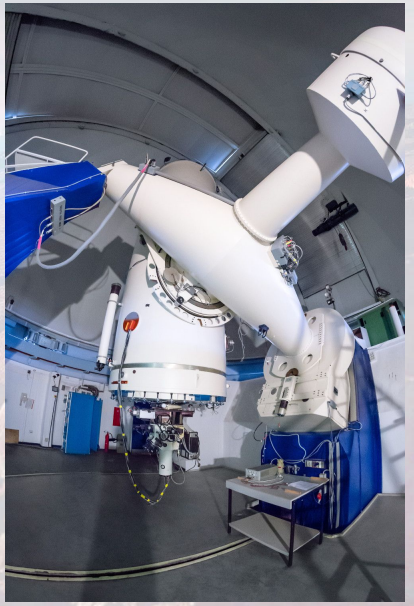
‘Unlimited’ observing time, instrument for exoplanet research

PLATOSpec project

- High-resolution, stable spectrograph as a support for the PLATO (and other) mission(s)
- La Silla, Chile, telescope E152 (E2)
- 2017-2020 negotiations, project planing, funding proposals





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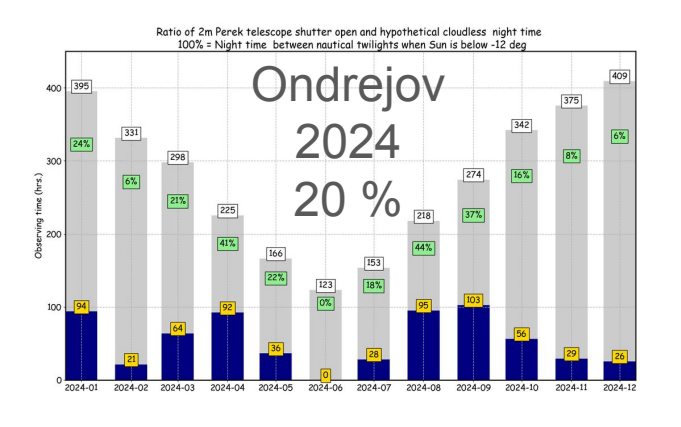


PLATOSpec: 82 %
(since its installation)

https://stel.asu.cas.cz/plato/

CONSORTIUM of PLATOSpec

Major participant

Astronomical Institute
of the Czech Academy of Sciences

Team members

PI Dr. Petr Kabáth - AsU Ondřejov
Dr. Marek Skarka - AsU Ondřejov

Thüringer Landessternwarte Tautenburg

Team members

Prof. Artie Hatzes - Tautenburg
Dr. Eike Guenther - Tautenburg

Universidad Catolica de Chile

Team members

Prof. Leo Vanzi - UC Chile

Minor participant

Masaryk University
Faculty of Sciences

Team members

Dr. Jan Janík - MU Brno

Universidad Adolfo Ibanez

Team members

Rafael Brahm (assistant professor UAI FIC)
Marcelo Tala (postdoc UAI FIC)
Andrés Gajardo (PhD student in data science UAI FIC)

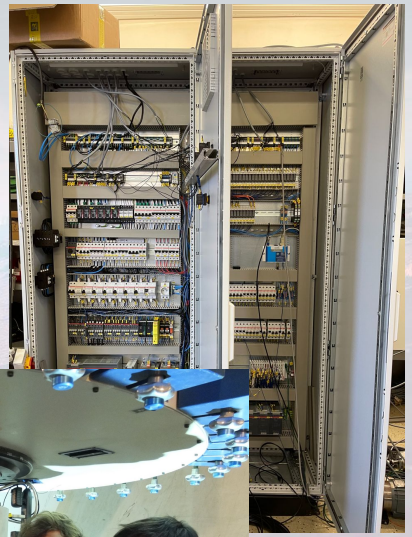
Institute of Plasma Physics
of the Czech Academy of Sciences

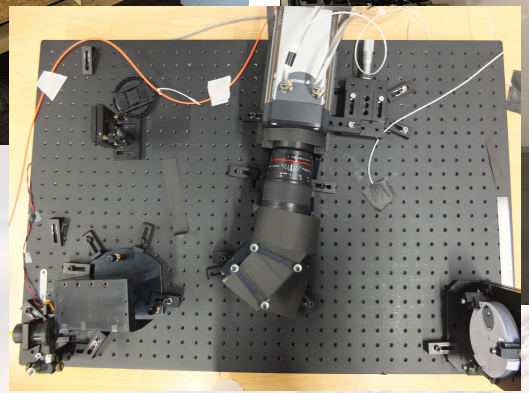
Team members

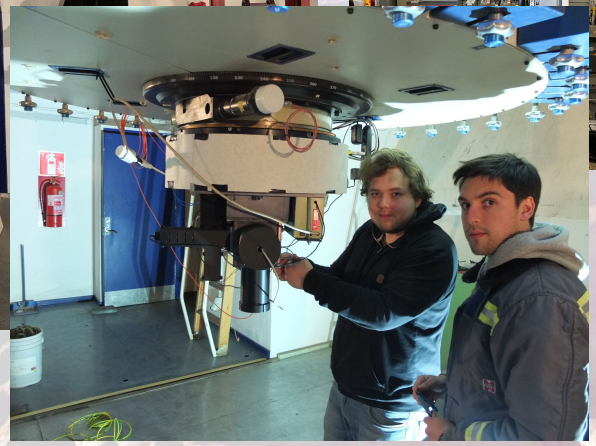
Dr. Pavel Pintr

PLATOSpec project

- 2021-2022 - Telescope refurbishment (Projectsoft), PUCHEROS+ (Antonucci et al. 2025, MNRAS, 542, 1730)

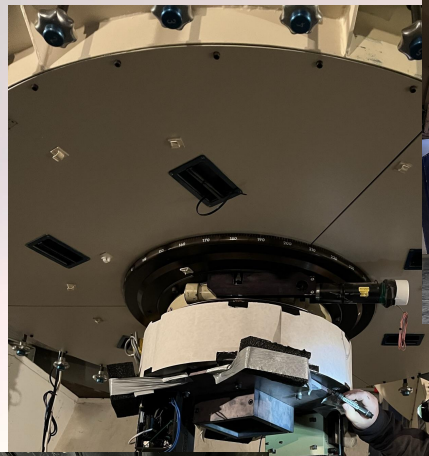




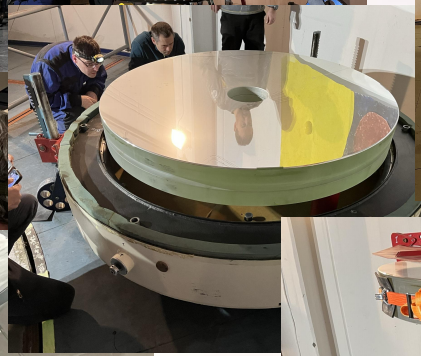


PLATOSpec project

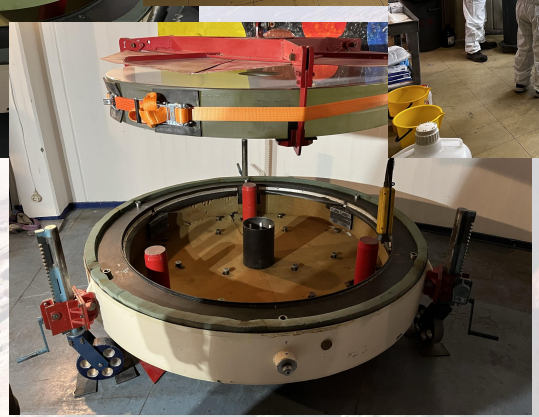
- 2023 - recoating of the mirror, observations with PUCHEROS+









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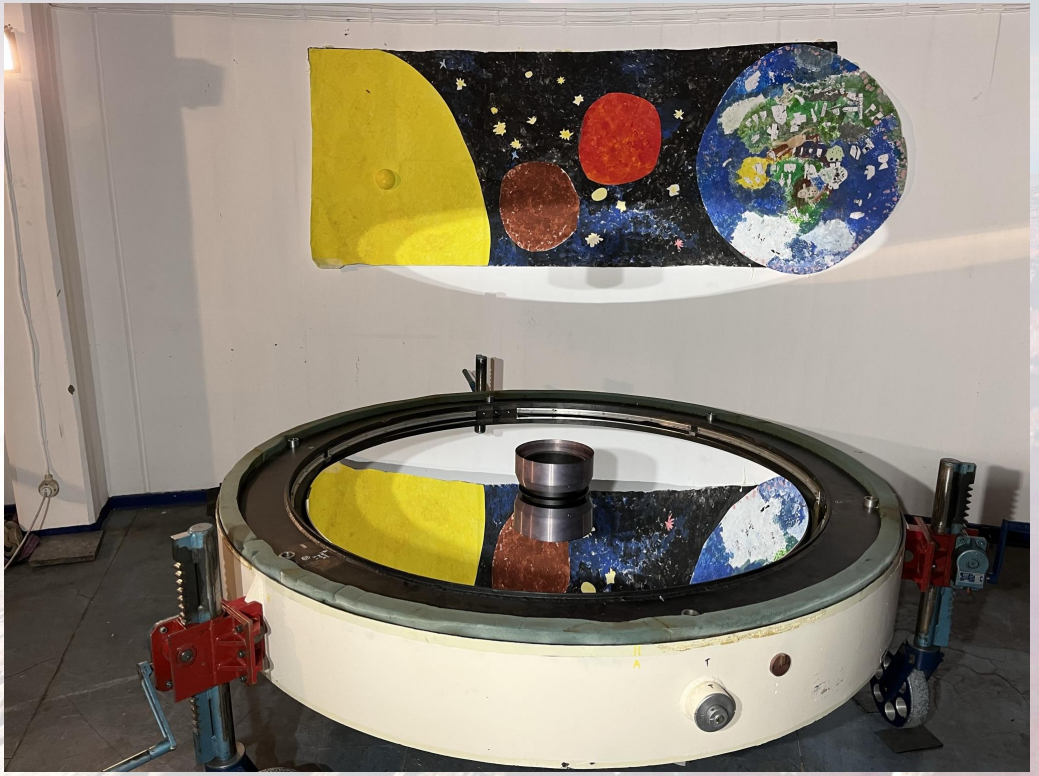
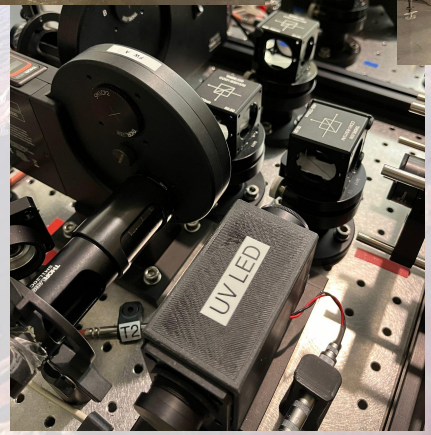


PLATOSpec project

- 2024 - FE, CU, optical fibers, balancing of the telescope, installation of PLATOSpec



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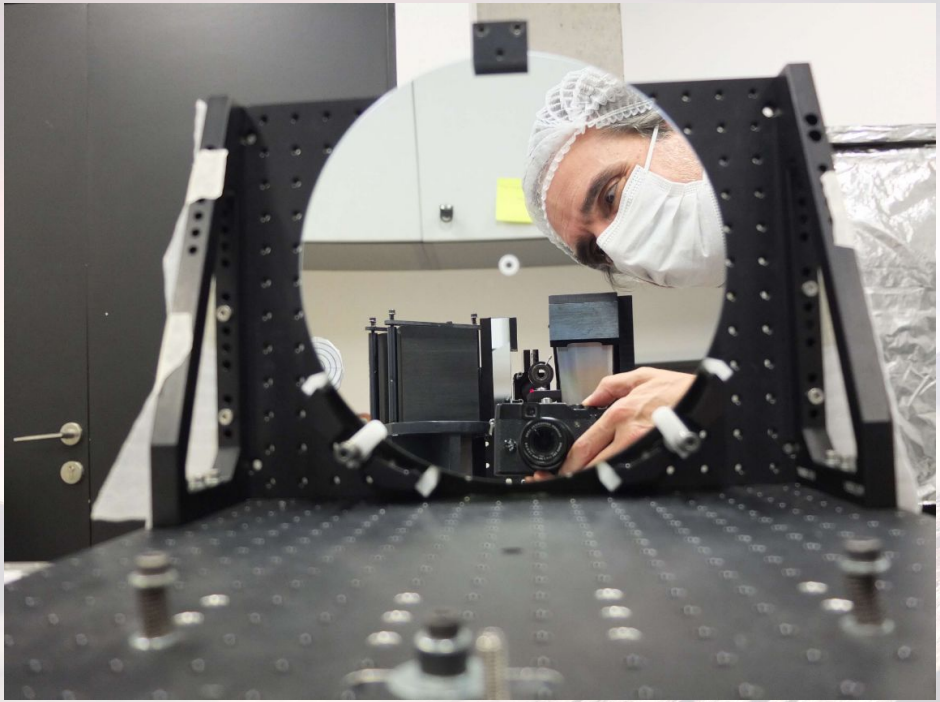

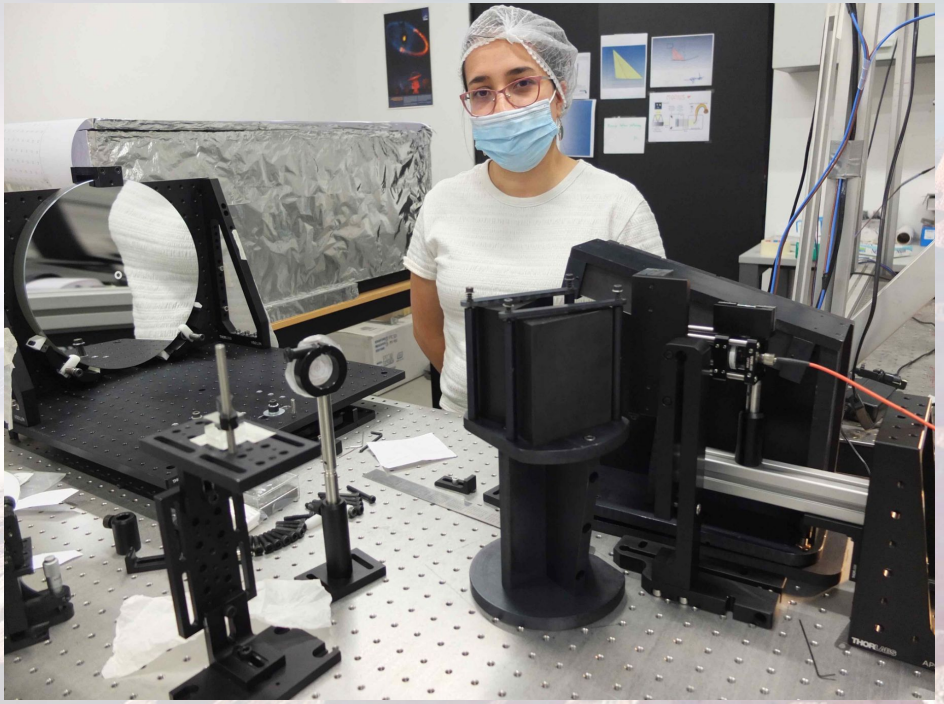

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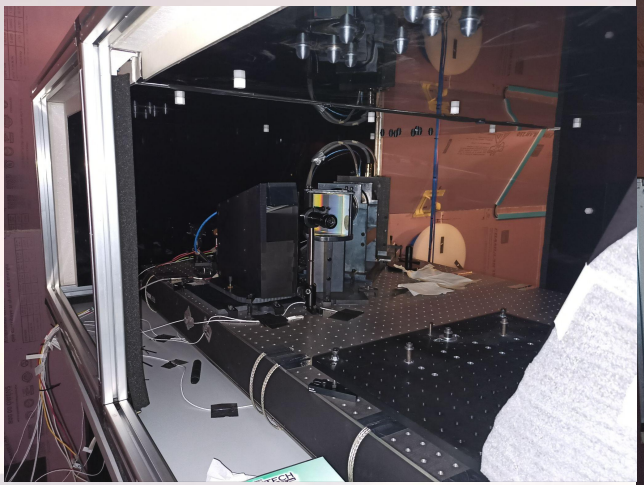
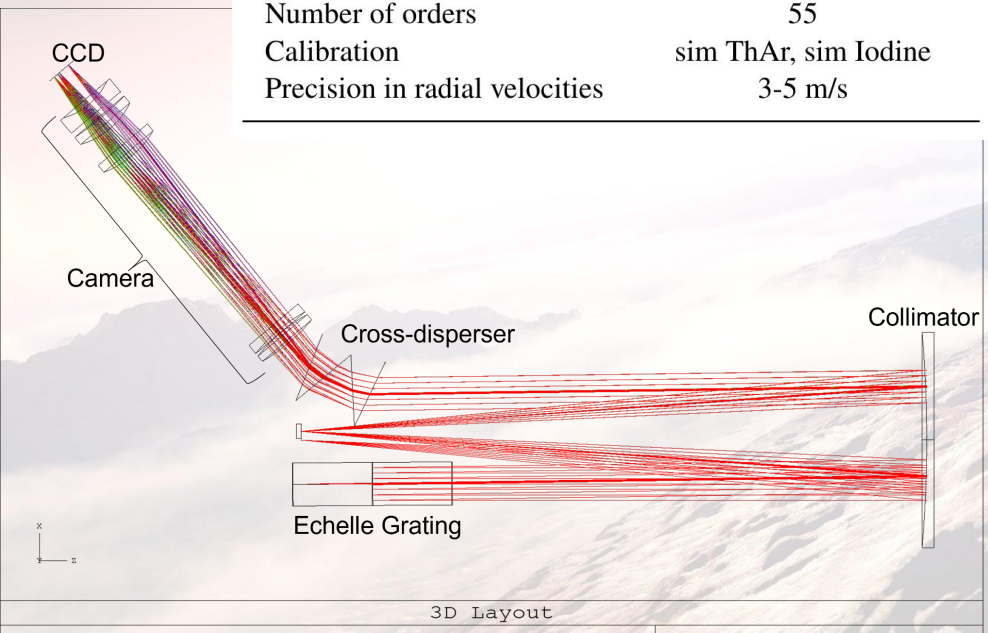
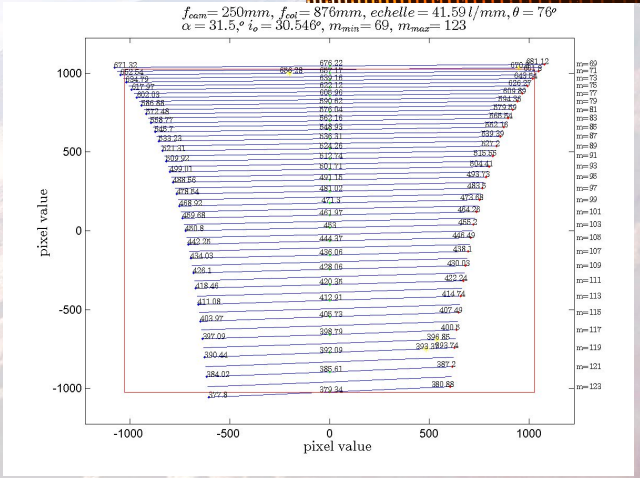


November 25, 2024
- first light and regular observations

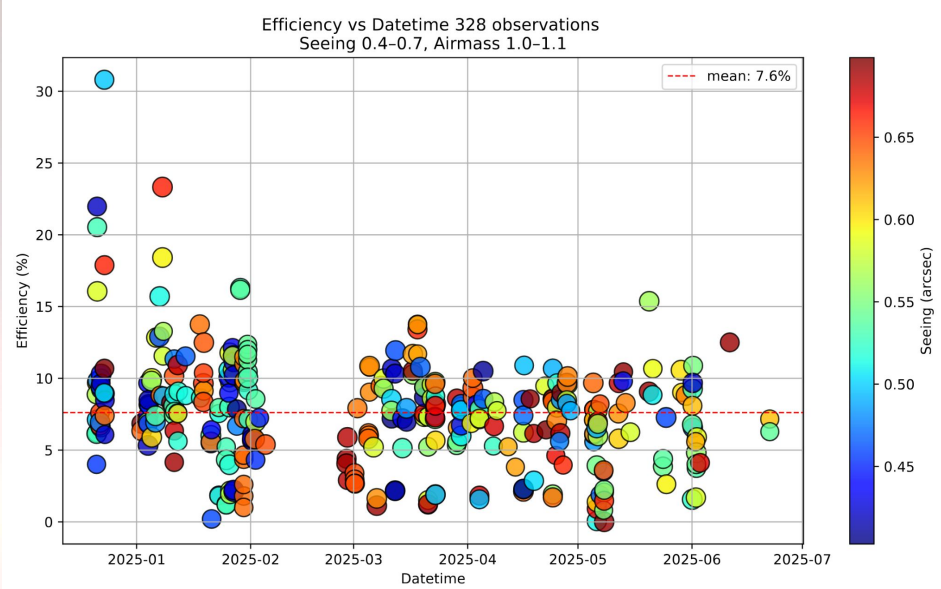
PLATOSpec

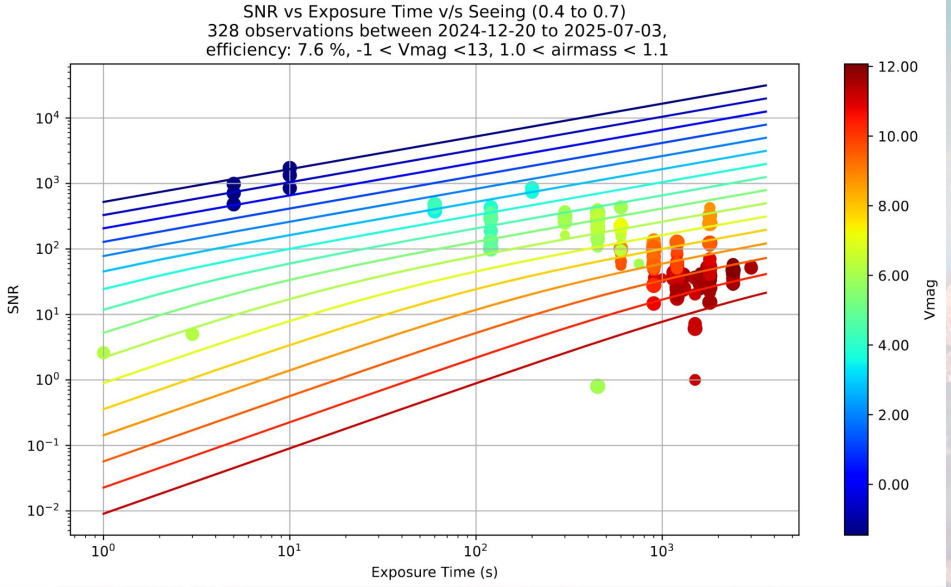
Parameter	Value
Spectrograph feeding	fiber, image slicer
Spectrograph type	echelle, white pupil
Detector	Andor Ikon GLx (2k×2k)
Wavelength range	380-700 (nm)
Resolving power	70,000
Number of orders	55
Calibration	sim ThAr, sim Iodine
Precision in radial velocities	3-5 m/s





PLATOSpec - performance

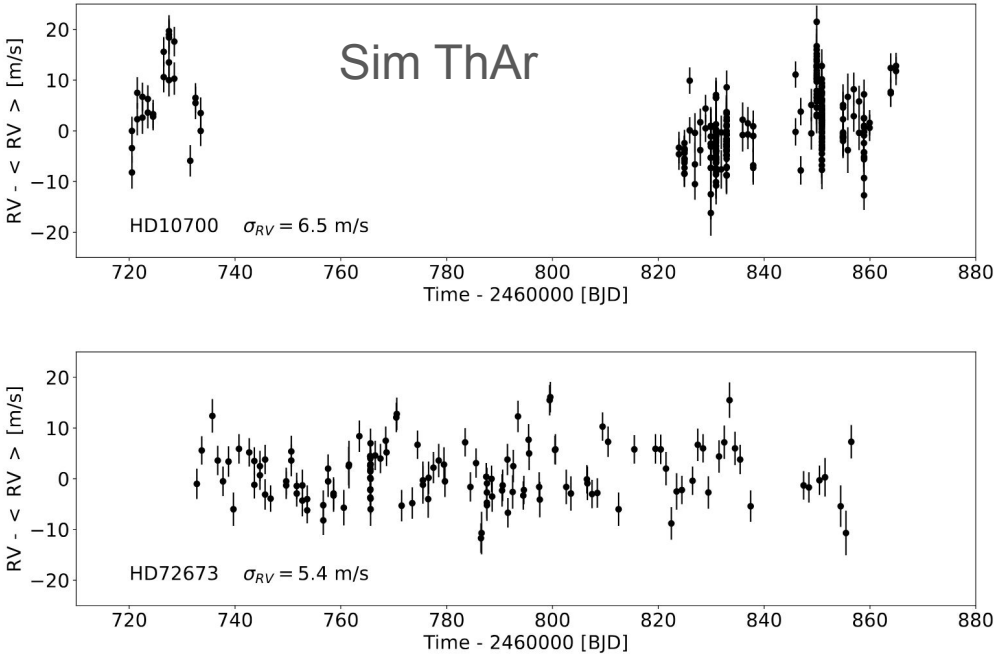


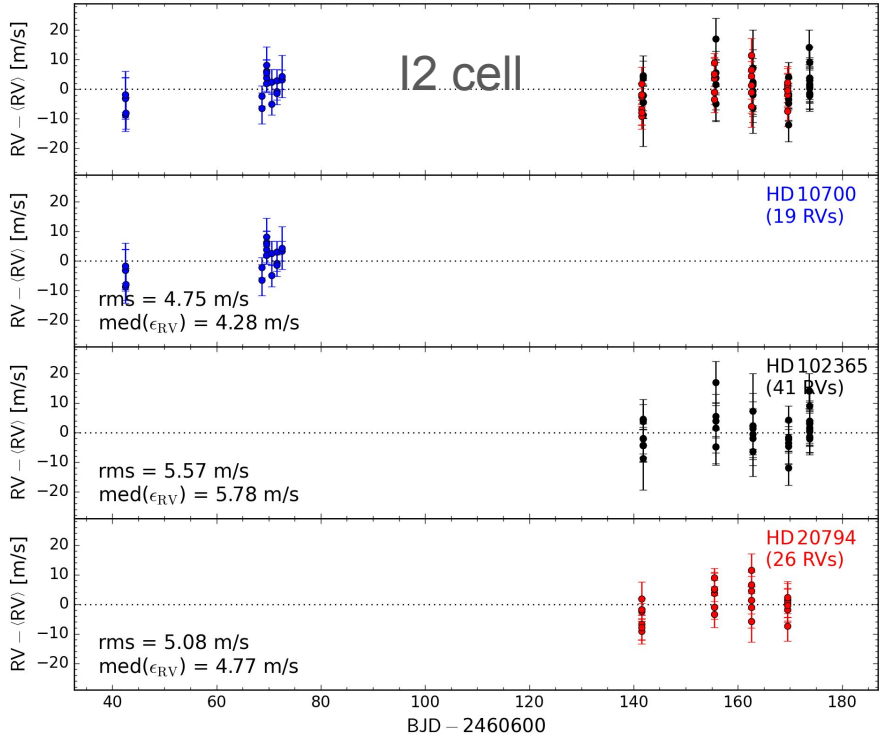


Kabáth et al., under review in MNRAS

- Efficiency of about 7.5 %
- 12-mag star with 1800-seconds exposure time SNR~30-40

PLATOSpec - performance

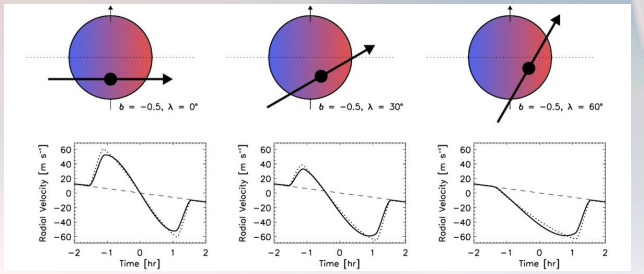


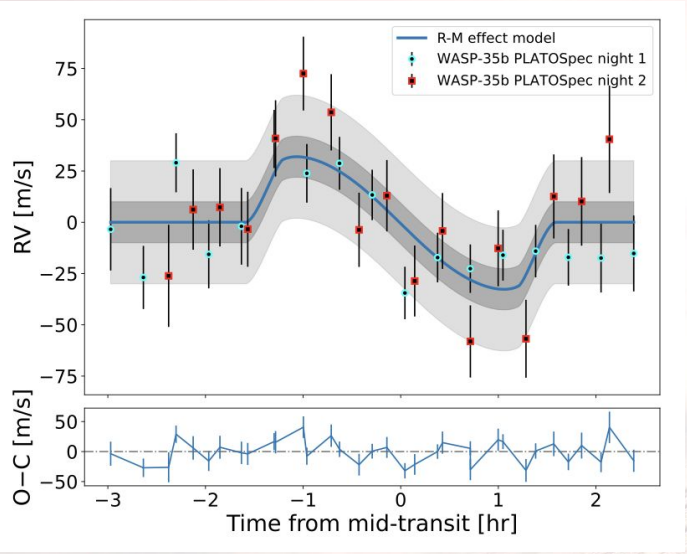


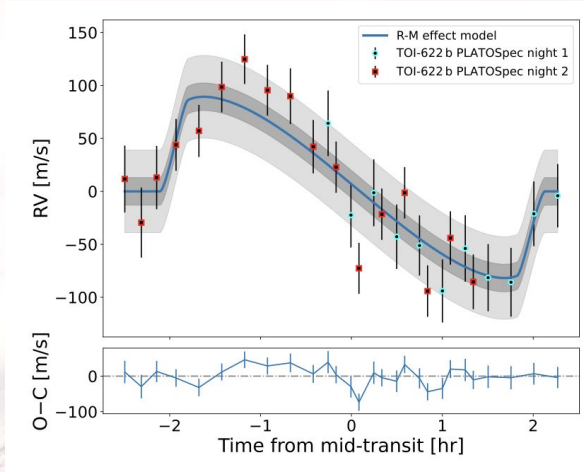
Kabáth et al., under review in MNRAS

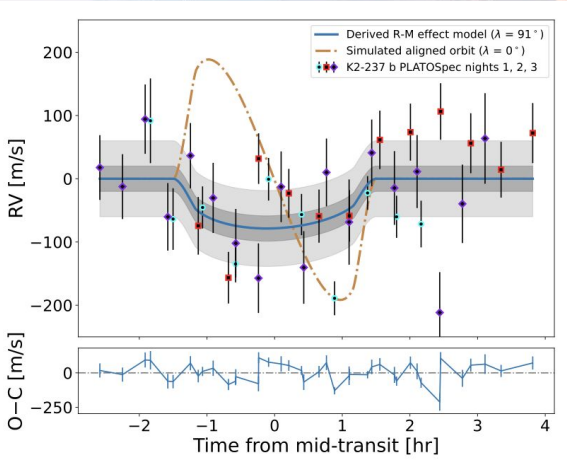
- Single-point uncertainty ~2-3 m/s
- Long-term RMS ~5-6 m/s

PLATOSpec - capabilities



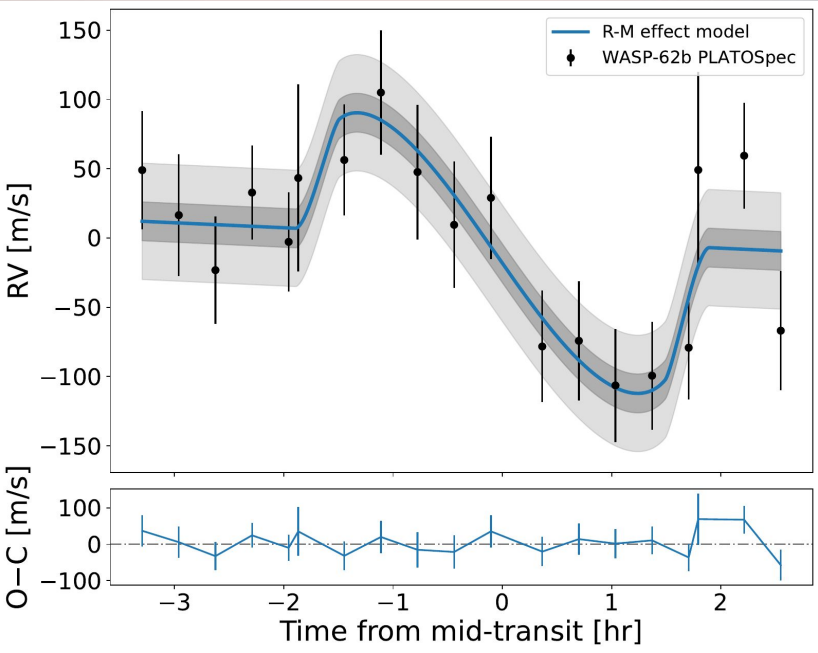


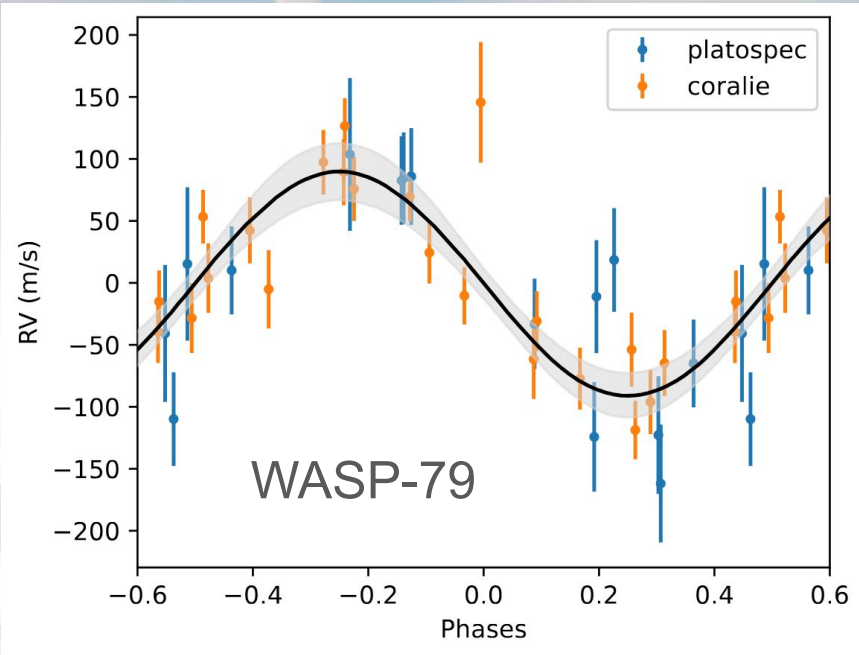




Žák, 2025arXiv250810145Z - Projected spin-angle alignment of three hot jupiters via the RM effect

PLATOSpec - capabilities

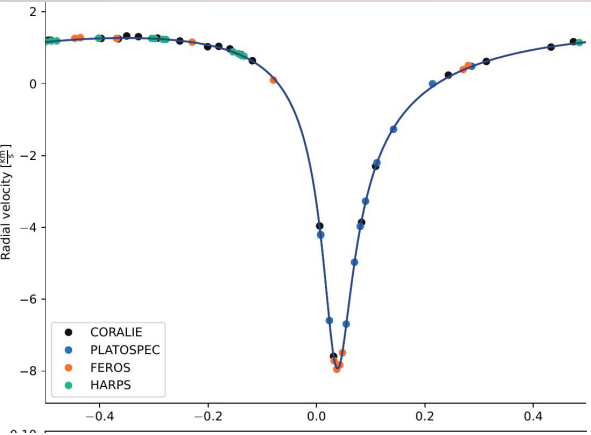


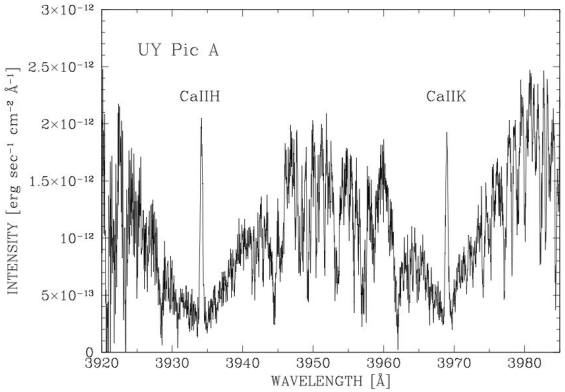


Kabáth et al., under review in MNRAS

- WASP-62 b: projected spin-orbit alignment λ=*23±22* deg (single transit observations, 600-1200 s; SNR 14-30; *σRV*~44 m/s; literature λ=*19±12* deg based on HARPS)
- WASP-79 b: *K=91±17* m/s (literature *K=88±8* m/s); *M=0.93±0.17* M_J (lierature *0.91±0.09* M_J)

PLATOSpec - capabilities





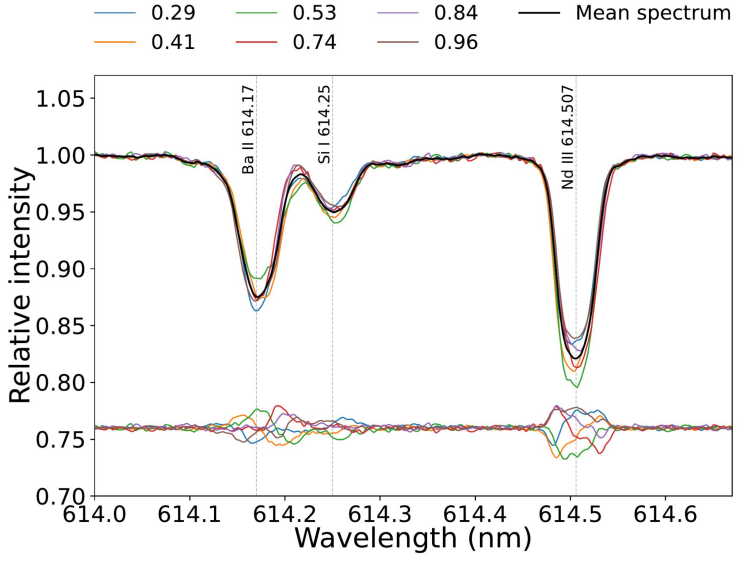


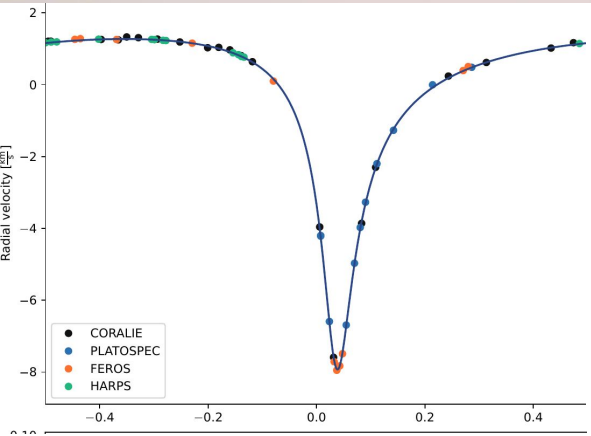
Table 2. Radial velocity parameters of TIC238060327

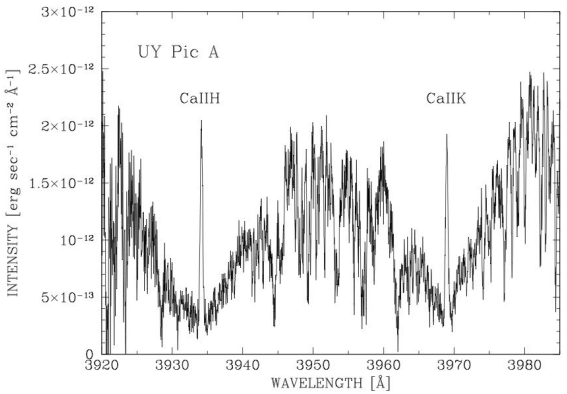
Parameter	combined	Rodel 2025
K [km/s]	4.604±0.010	4.615± 0.010
e	0.7140±0.0006	0.7144± 0.0009
ω [deg]	170.34±0.16	170.54 ± 0.20
$\gamma_{\rm CORALIE}$ [km/s]	78.423±0.008	78.427 ± 0.009
$\gamma_{\rm FEROS}$ [km/s]	78.410±0.013	78.418± 0.010
$\gamma_{\rm HARPS}$ [km/s]	78.317±0.003	78.314± 0.006
$\gamma_{\rm PLATOSpec}$ [km/s]	78.430±0.011	–
$\ln(\sigma_{\rm CORALIE}/\frac{\rm km}{\rm s})$	$-5.1^{+1.3}_{-3.3}$	$-3.99^{+0.4}_{-0.7}$
$\ln(\sigma_{\rm FEROS}/\frac{\rm km}{\rm s})$	-3.3 ± 0.3	-3.5 ± 0.3
$\ln(\sigma_{\rm HARPS}/\frac{\rm km}{\rm s})$	$-7.5^{+1.6}_{-1.8}$	-4.27 ± 0.3
$\ln(\sigma_{\rm PLATOSpec}/\frac{\rm km}{\rm s})$	$-4.3^{+0.7}_{-3.0}$	–

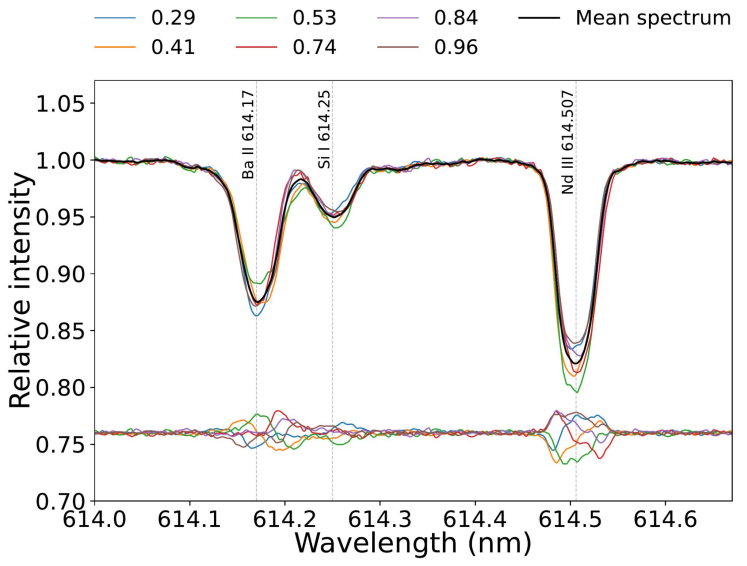
Kabáth et al., under review in MNRAS

- Studies of binary systems, stellar activity, line-profile variations (pulsations, chemical peculiarity)

PLATOSpec - capabilities







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PLATOSpec is a versatile instrument suitable for many areas of stellar astrophysics

PLATOSpec - future

- Study of systematics
- Tip-tilt mirror
- Fabry-Perot etalon
- Contribution to GOP

Thank you for your attention!