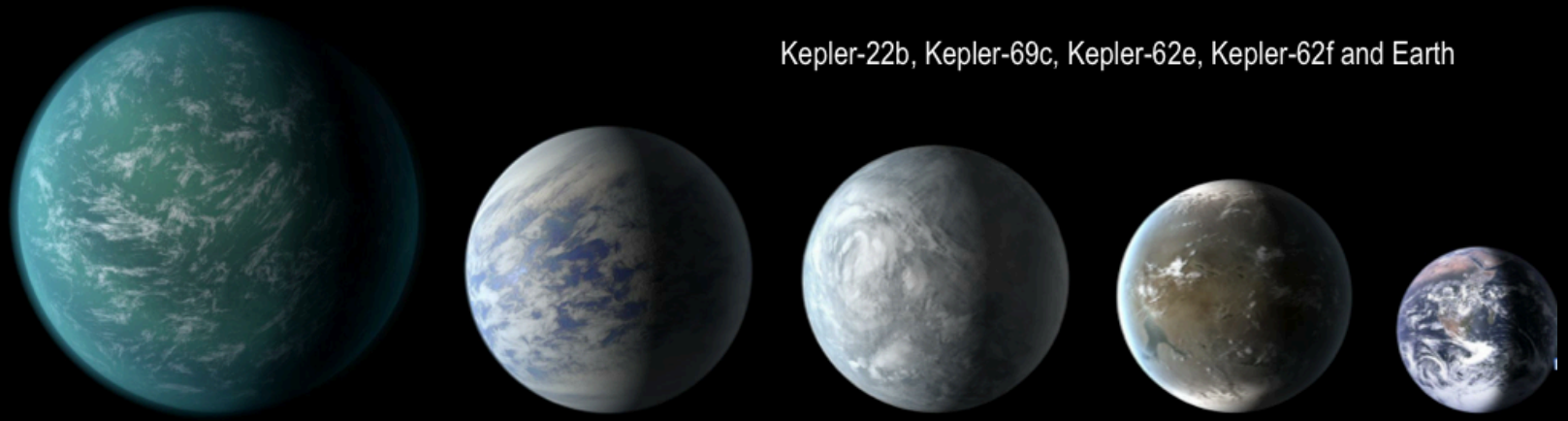

Possibilities of small-size telescopes in complementing results of space missions

Gražina Tautvaišienė

Institute of Theoretical Physics and Astronomy
Vilnius University

Co-authors:

Mikolaitis Š.
Drazdauskas A.
Minkevičiūtė R.
Chorniy Y.
Pakštienė E.
Stonkutė E.
Bagdonas V.
Viscasillas Vazquez C.

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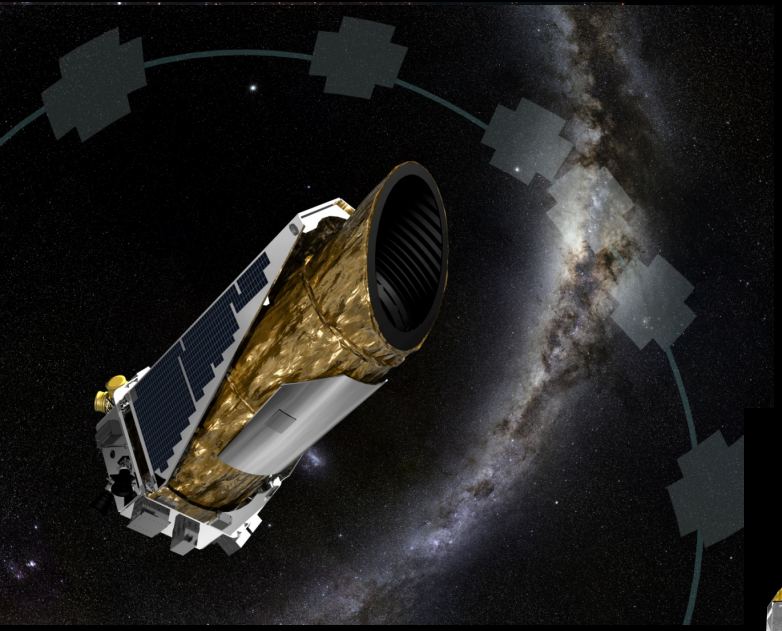
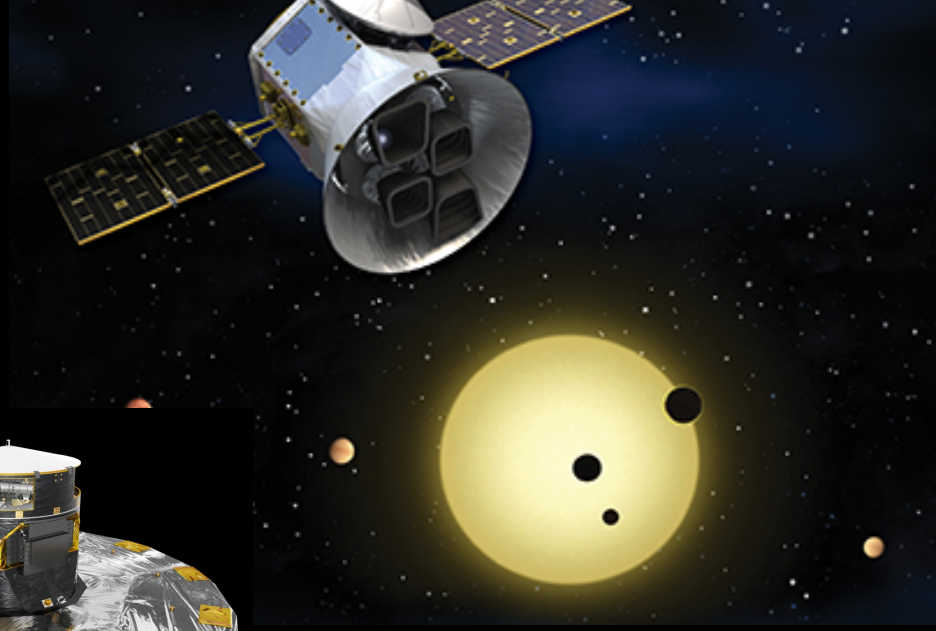
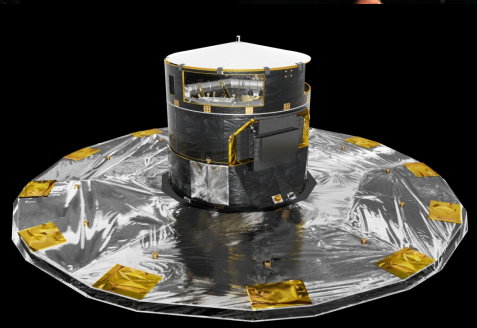




Kepler

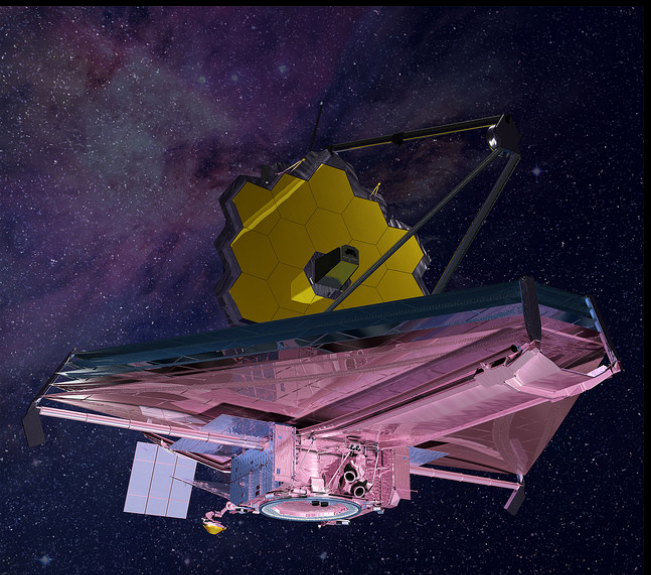
JWST



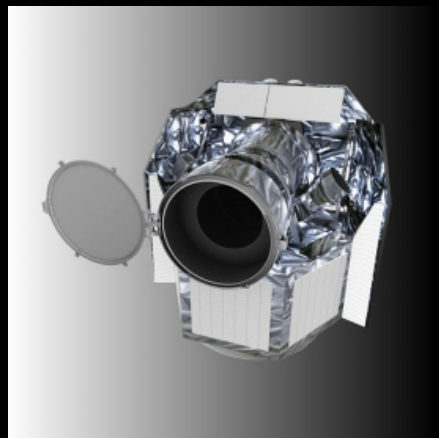
Gaia

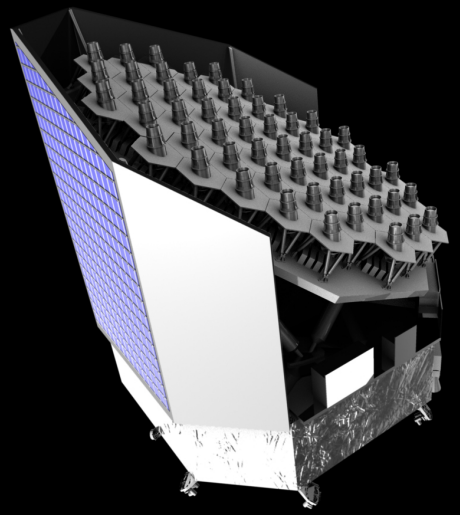
TESS

PLATO



CHEOPS





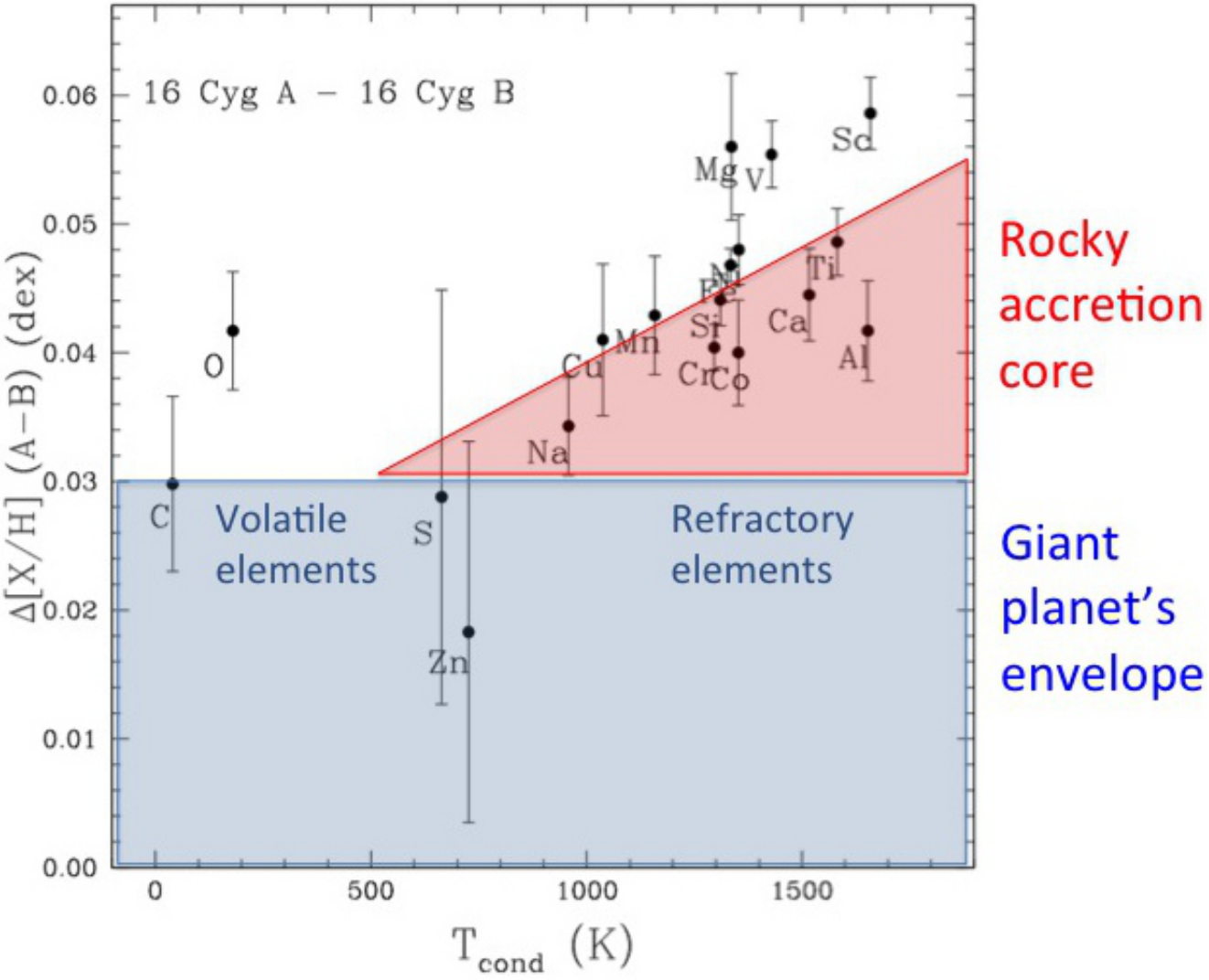
Know the star – know the planet

- Stellar chemical composition study is very important in characterizing exoplanets.
- Recent spectroscopic studies showed that stars hosting planets are relatively more metal-rich than those without planets detected.
- One of the possible interpretation of this fact is the so-called "self-enrichment" scenario.
- It is believed that the origin of overabundance of metals is related to the accretion of rocky planetesimal materials onto the star.

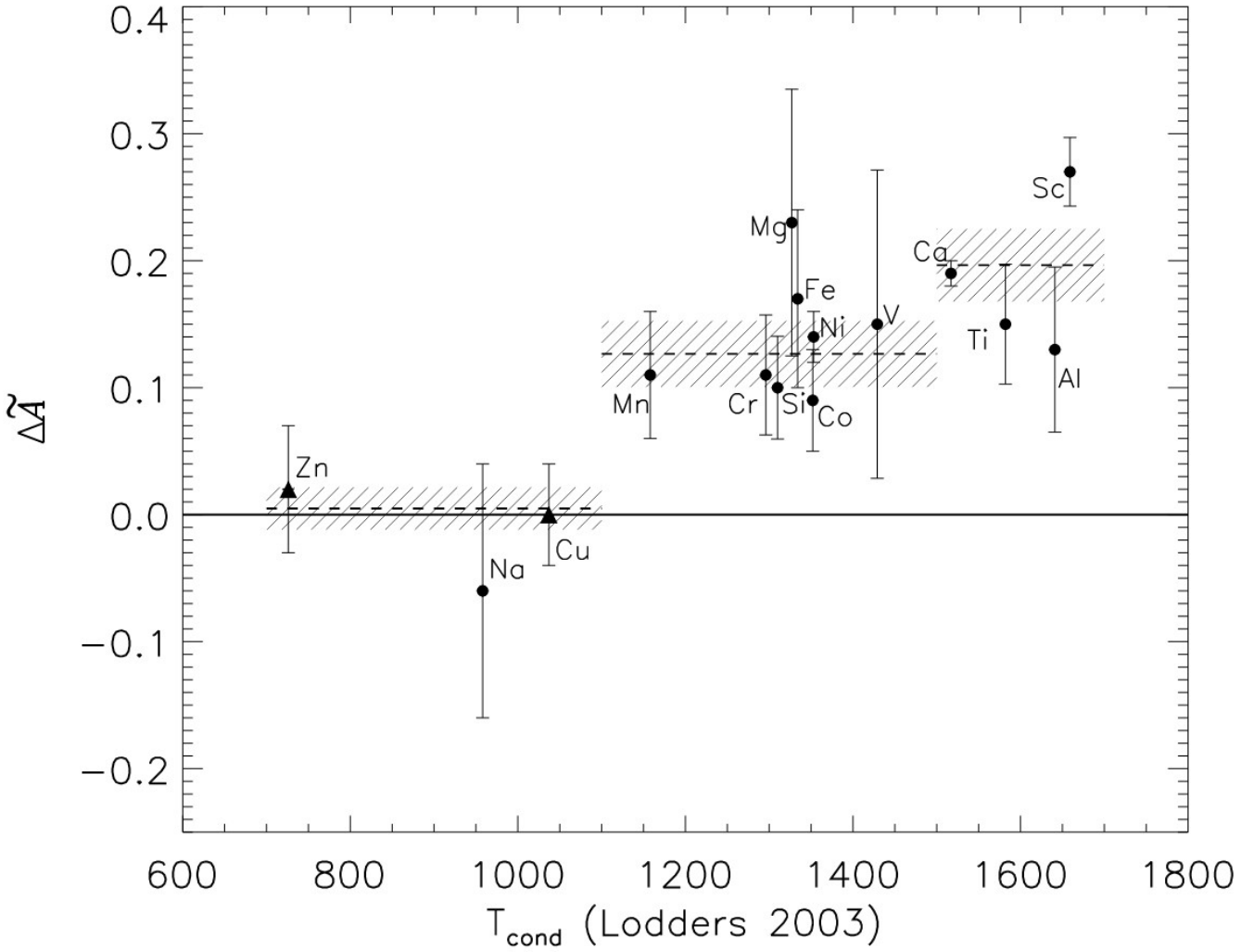
Self-enrichment scenario

- Could be triggered by the action of hot jupiters migrating from outside the protoplanetary disc (Chavero et al. 2010).
- Could lead to a relative overabundance of refractories, such as Si, Mg, Ca, Ti, and the iron-group elements, compared to volatiles, such as C, N, O, S, and Zn.

16 Cyg A and 16 Cyg B (Tucci Maia et al. 2014)

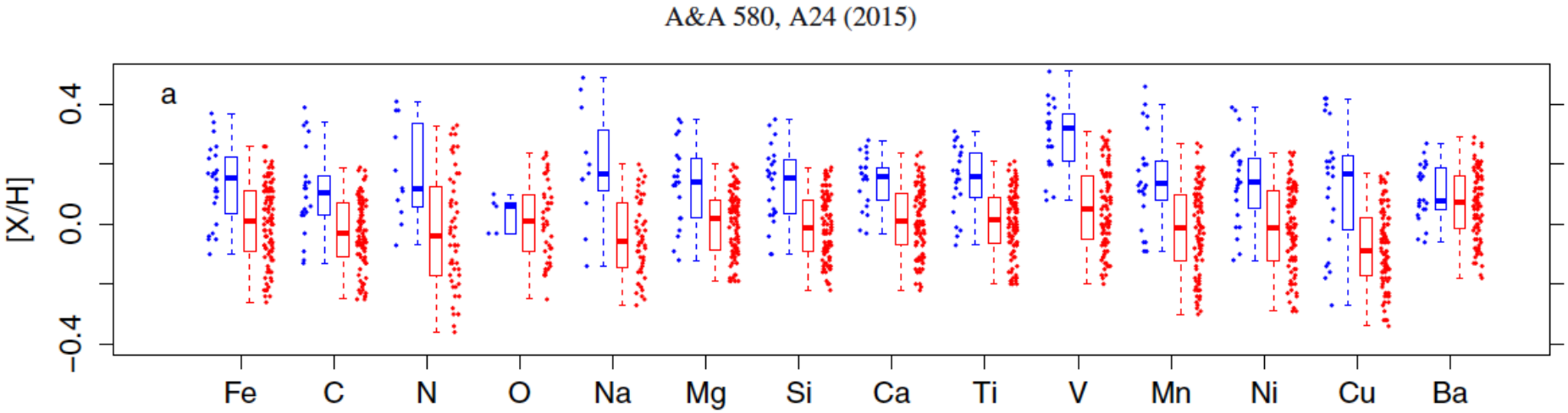


Chemical composition differences in Gamma Velorum 10-20 Myr old open cluster stars #52 and #45 (Gaia-ESO Survey, Spina et al. 2015)



93 F-G-K dwars without and 47 with planets detected
da Silva et al. 2015

- The slopes in the Δ[X/Fe] vs. Tc diagrams show a correlation with age and an anticorrelation with the surface gravity, even after accounting for the effects of the Galactic chemical evolution.
- Good indicators: C, N, Na, Mg, Si, Ca, Ti, V, Mn, Fe, Ni, and Cu
- Less sensitive: oxygen and barium
- Most sensitive: vanadium



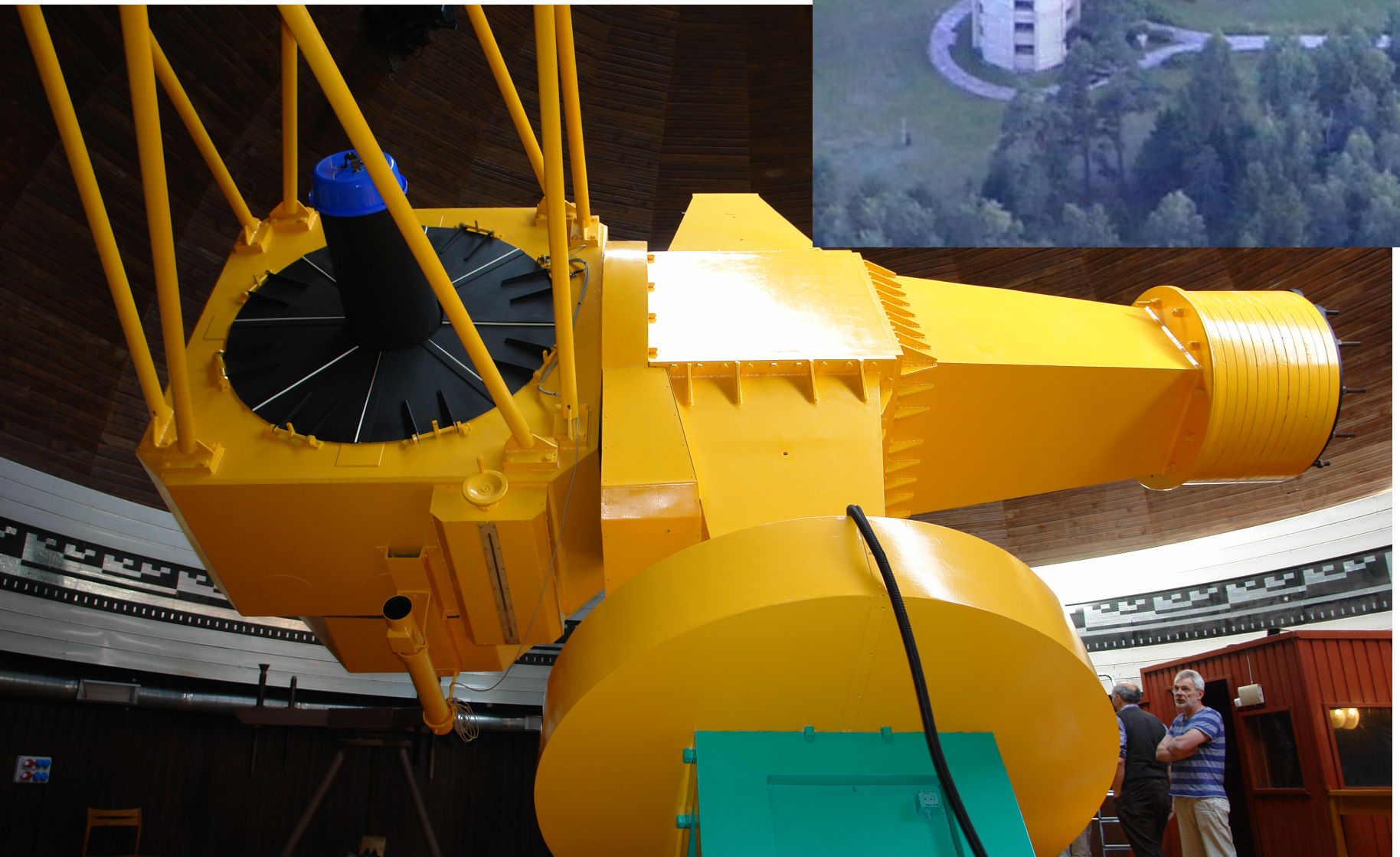
F spectral type dwarf J37 in NGC 6633

- Enhancement of highly refractory elements like Be, Ca and Fe, together with much lower abundances of C and O, can be explained by the accretion of about 0.01 $M_{\oplus}$ of volatile-depleted material such as chondritic meteorites (Ashwell et al. 2005)

Investigations of stars with planets

- What is relation between stellar atmospheric parameters and exoplanet types
- What is relation between the detailed stellar chemical composition and presence of various types of exoplanets
- Changes in the stellar atmospheric chemical composition caused by accretion of exoplanets
- Many more interesting phenomena…

1.65 m telescope Moletai Astronomical Observatory, ITPA VU

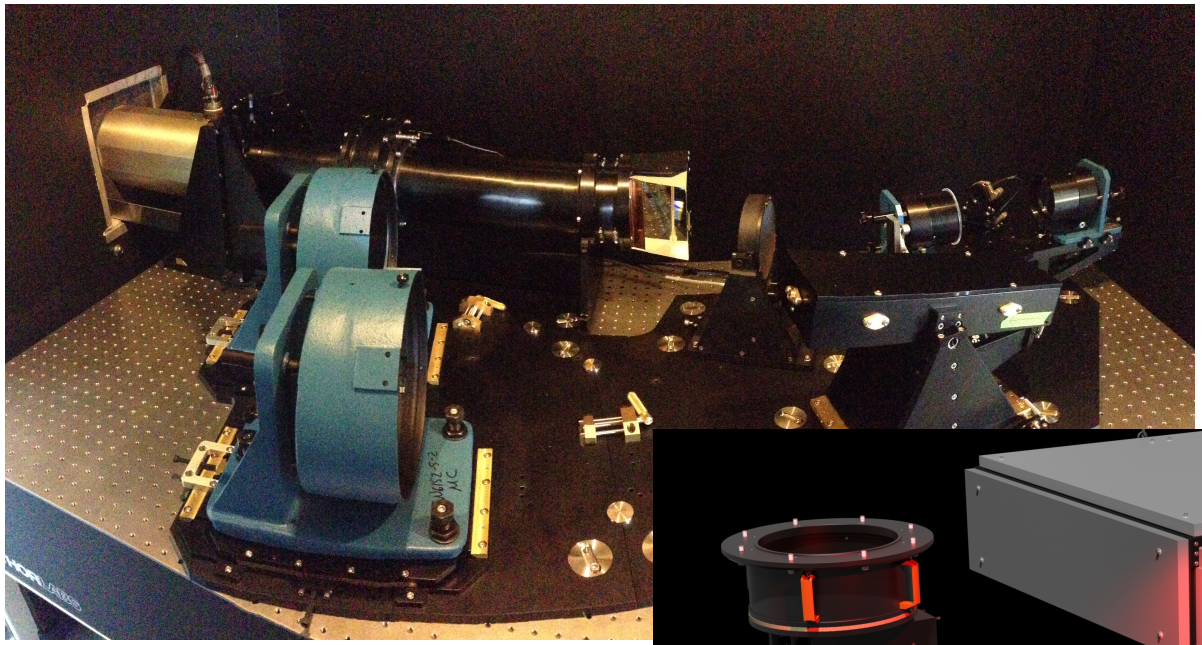


SPFOT survey

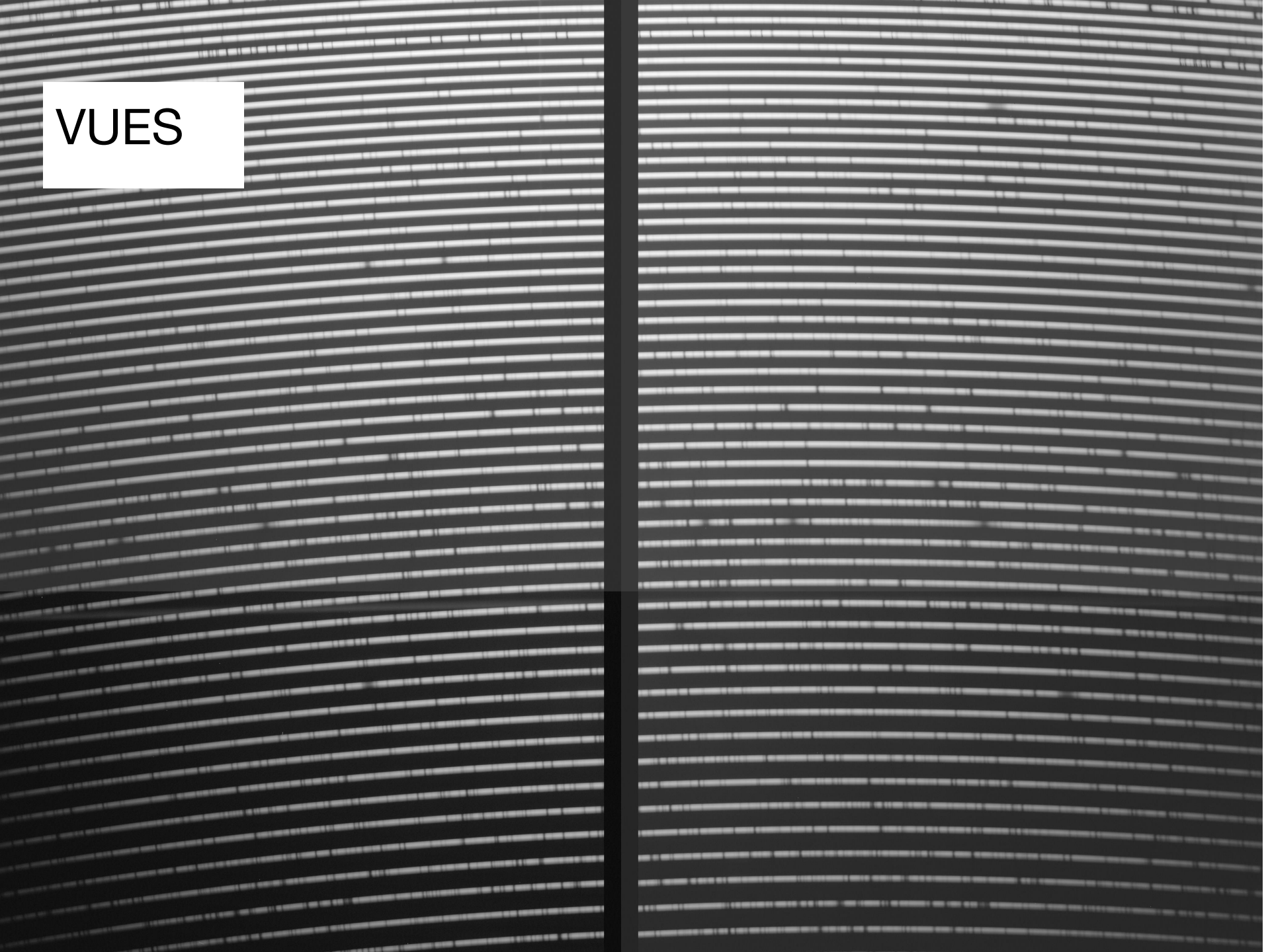
Vilnius University Echelle Spectrograph (since 2016)

Resolutions R = 30 000, 45 000, and 60 000

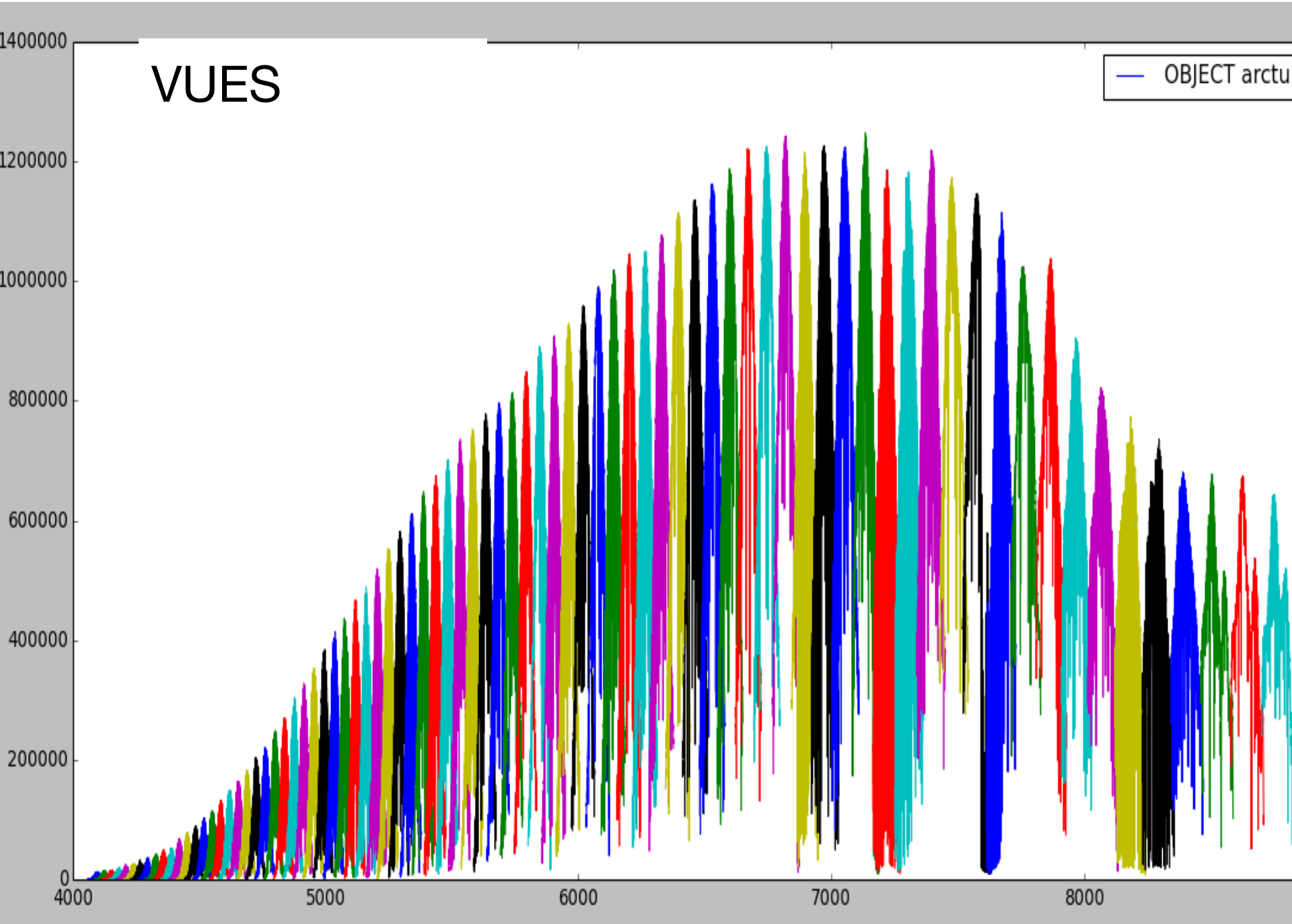
Wavelenght coverage 4000 – 8800 A



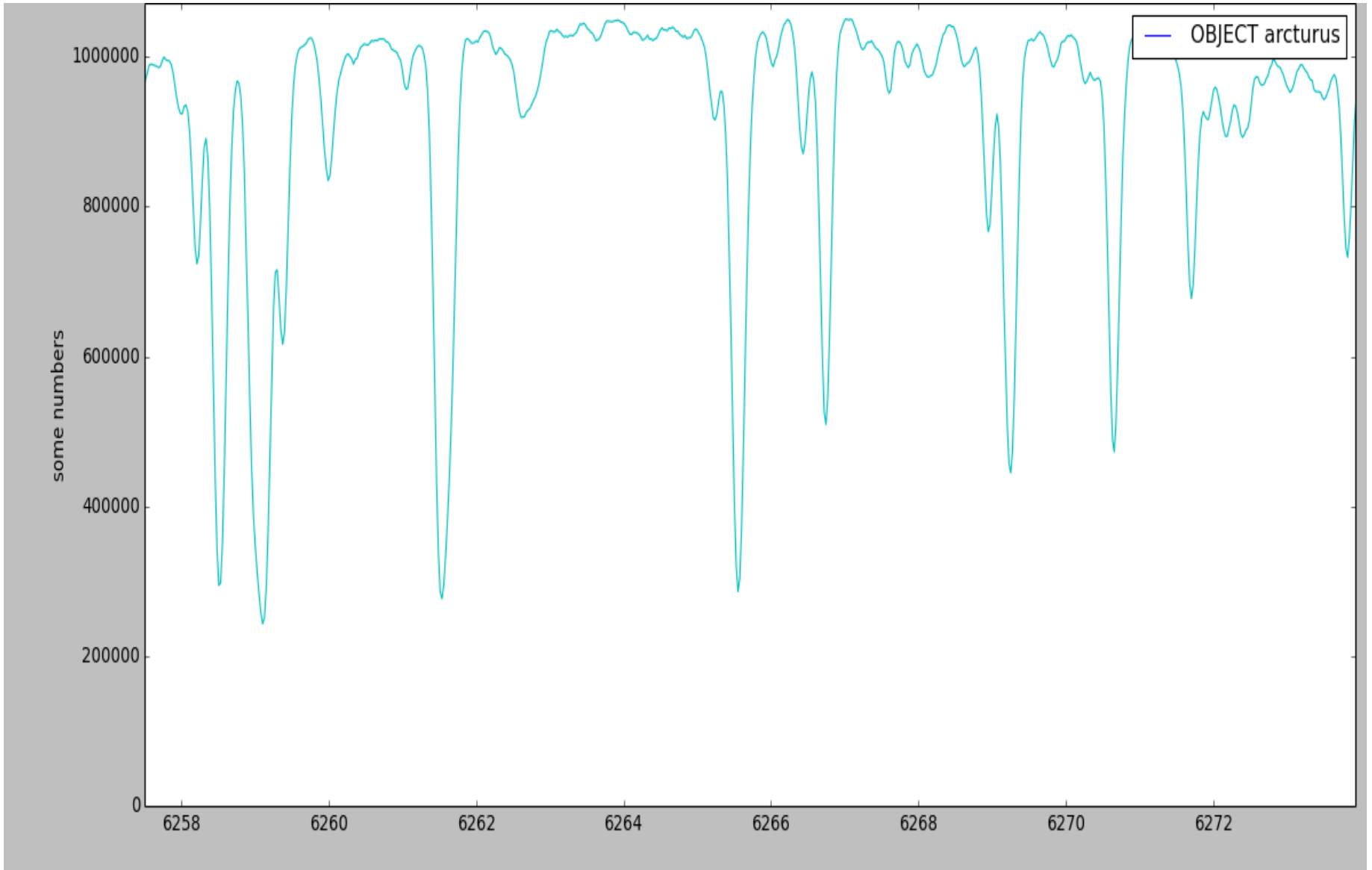
VUES

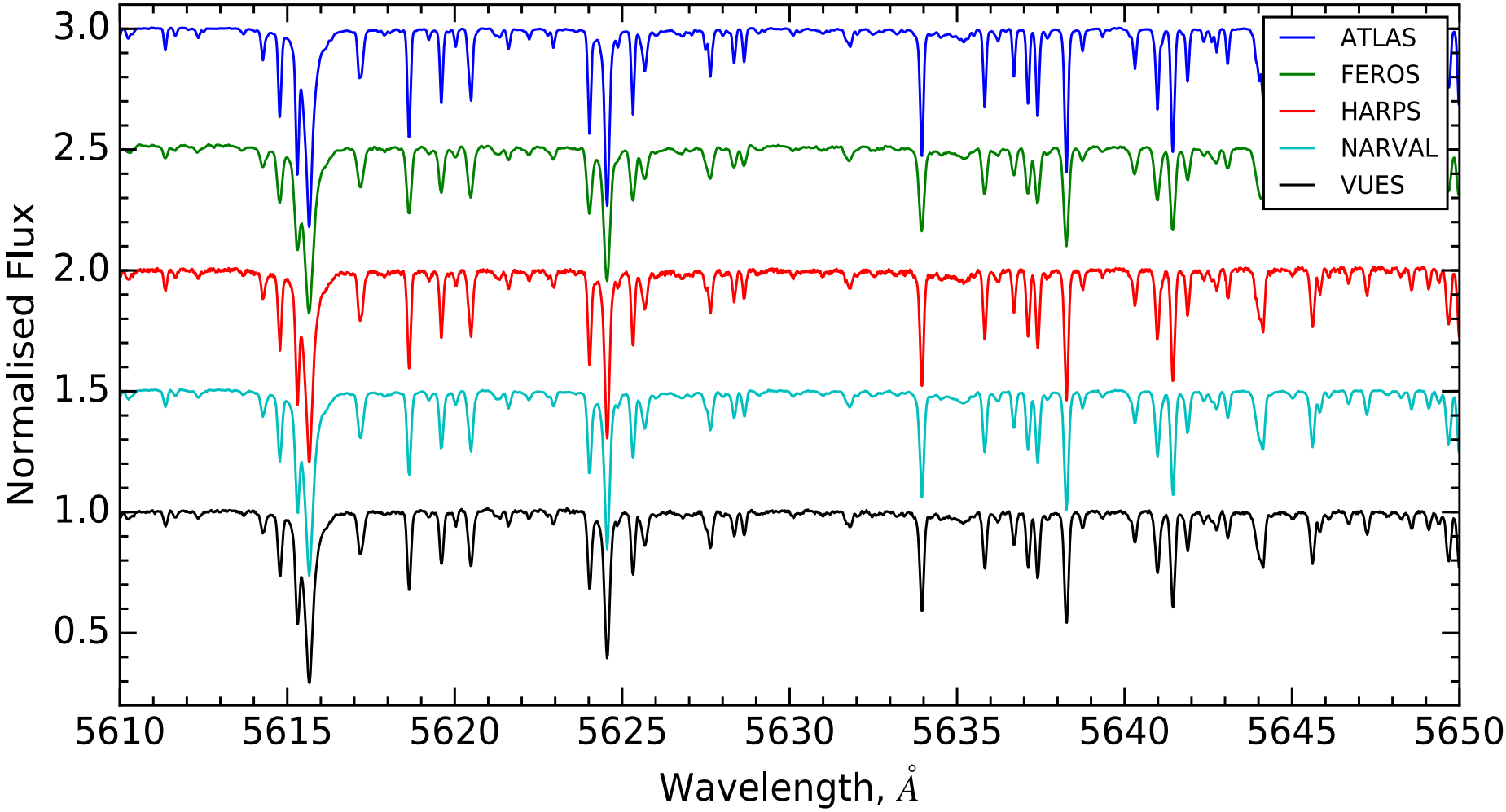

VUES

VUES


OBJECT arctu
1400000
1200000
1000000
800000
600000
400000
200000
0
4000
5000
6000
7000
8000

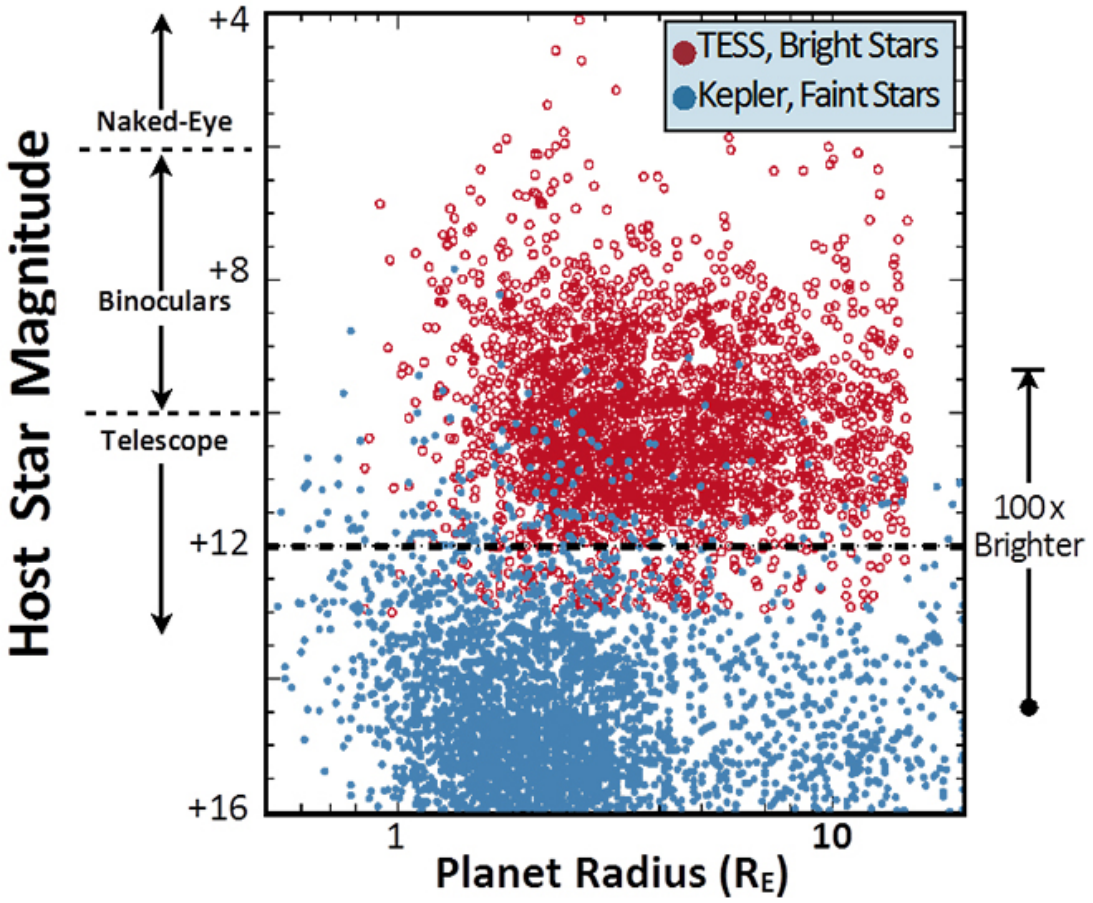
VUES


OBJECT arcturus
some numbers
1000000
800000
600000
400000
200000
0
6258
6260
6262
6264
6266
6268
6270
6272

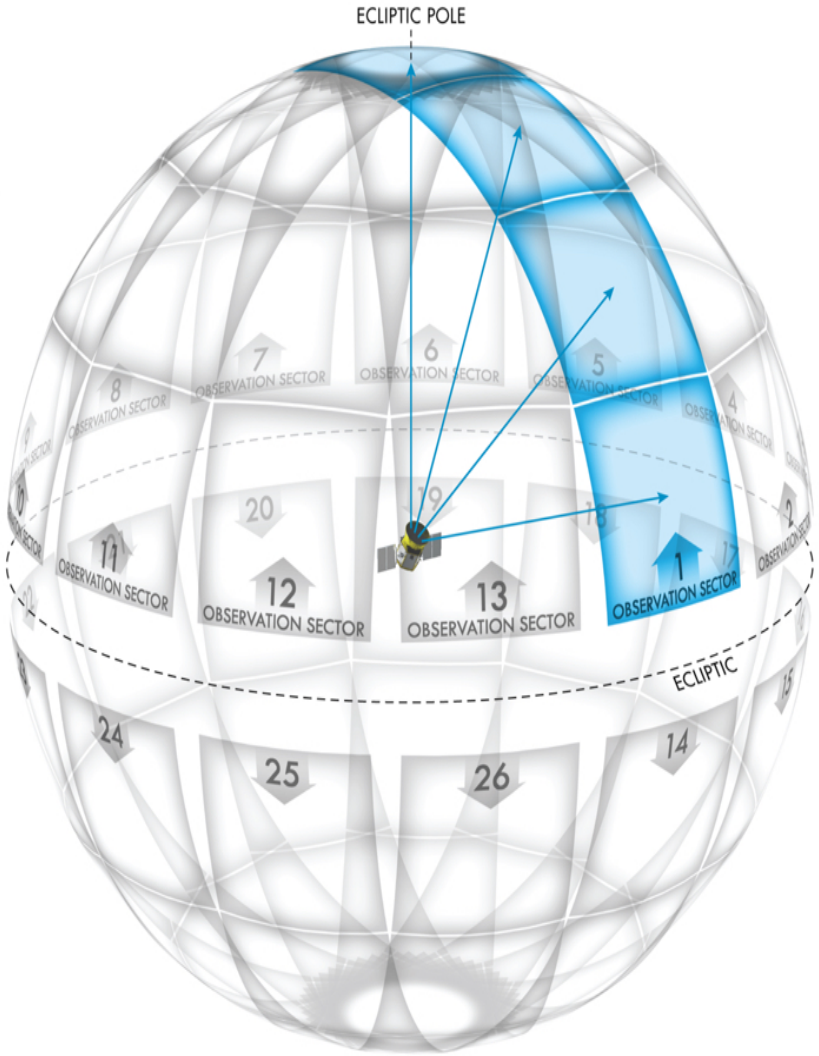

ATLAS
FEROS
HARPS
NARVAL
VUES
Normalised Flux
3.0
2.5
2.0
1.5
1.0
0.5
5610
5615
5620
5625
5630
5635
5640
5645
5650
Wavelength, Å

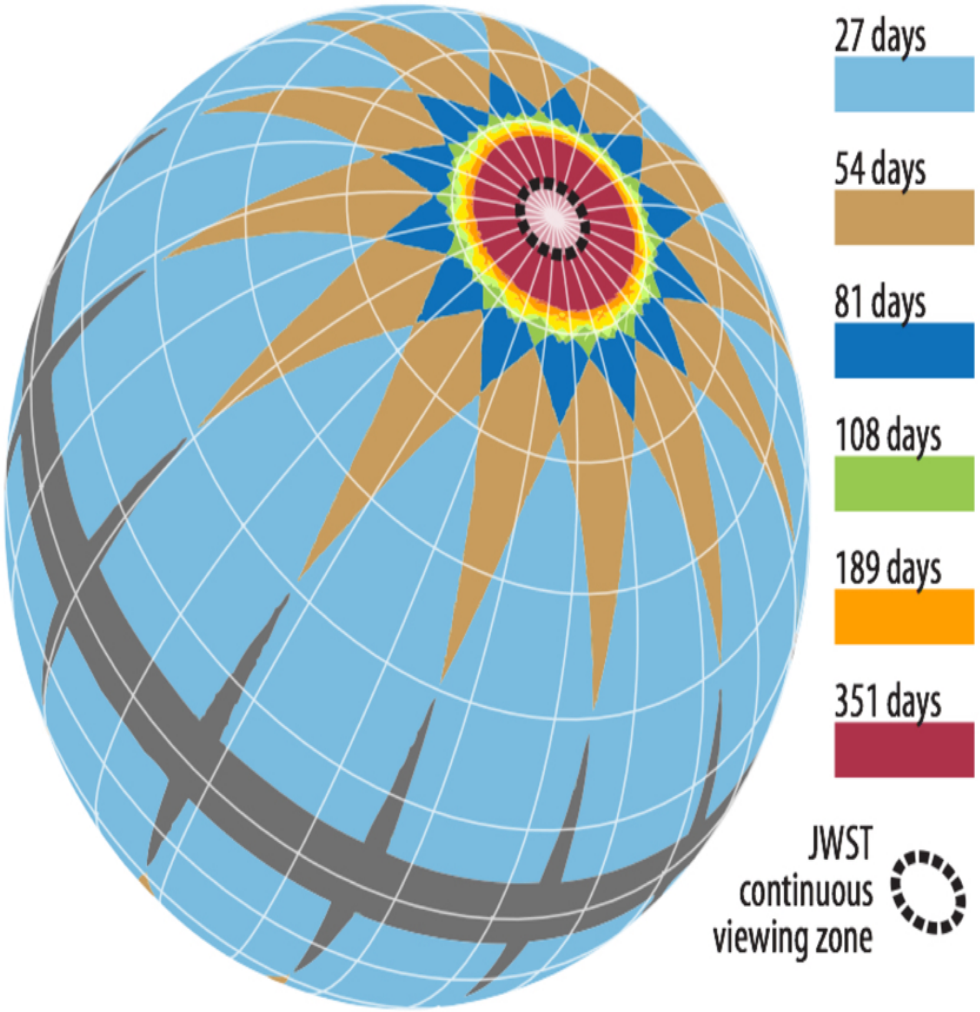
NASA TESS

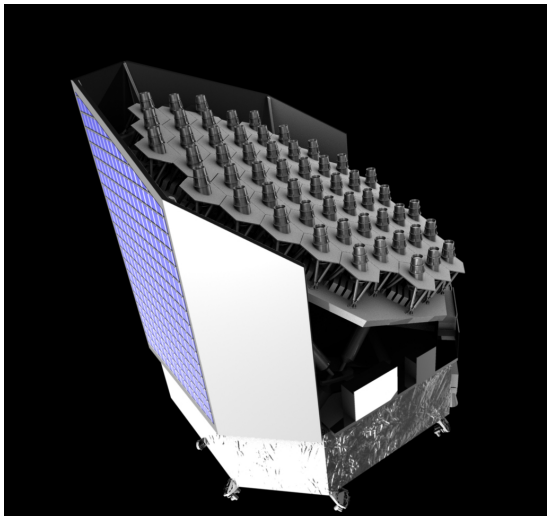
TESS will create a catalog of thousands of exoplanet candidates using this transit photometry method. After this list has been compiled, the TESS mission will conduct ground-based follow-up observations to confirm that the exoplanets candidates are true exoplanets and not false positives.



TESS northern sky



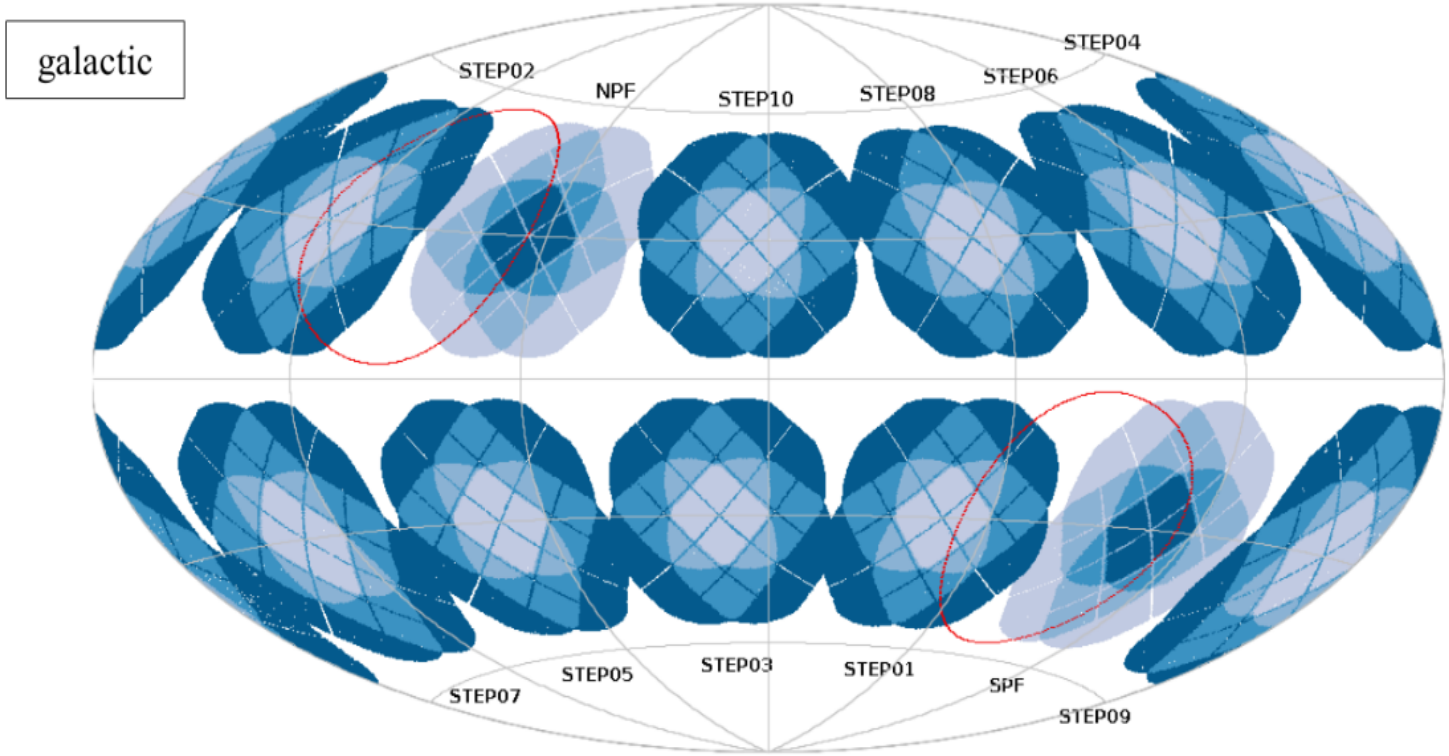




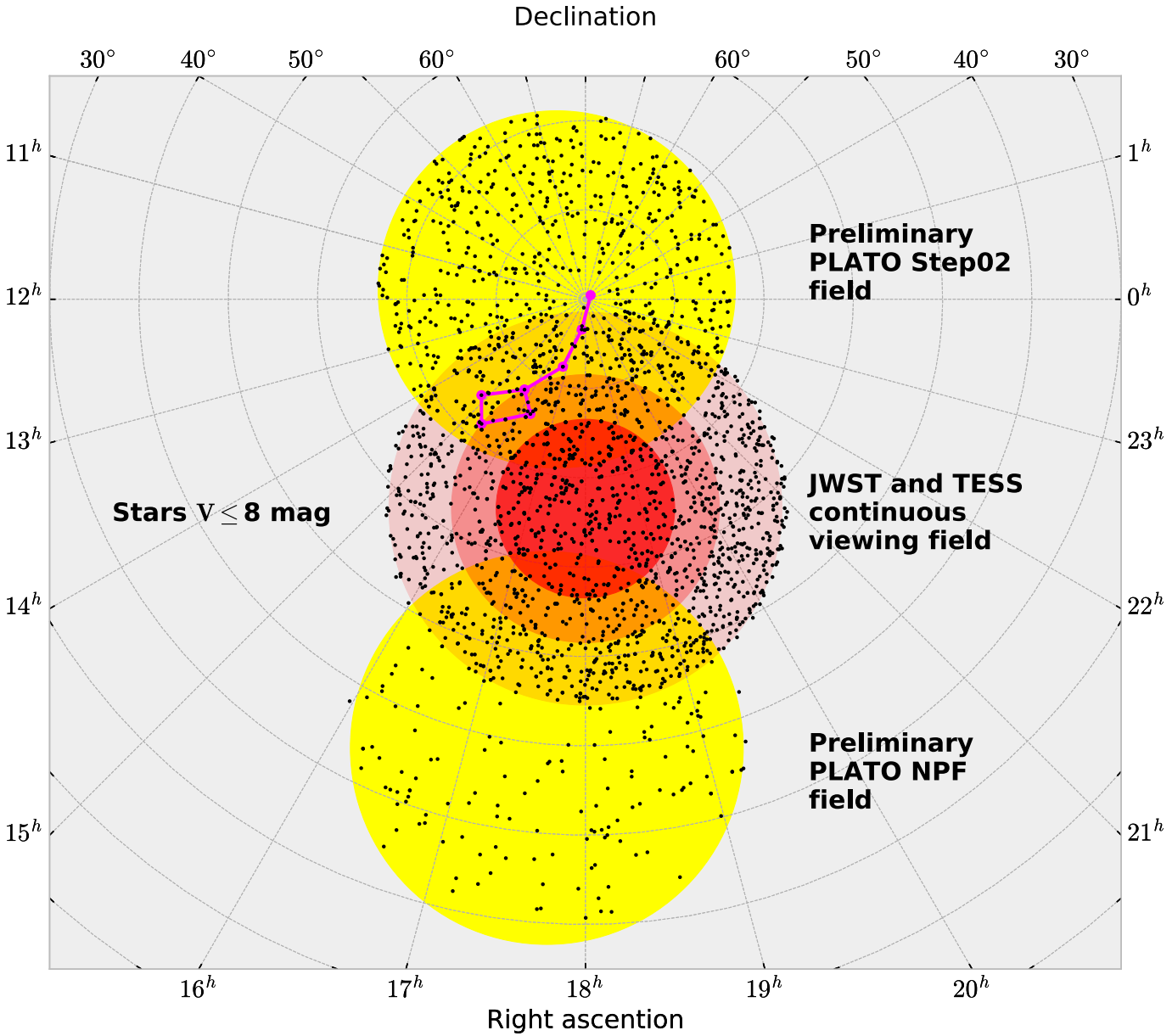
ESA PLATO

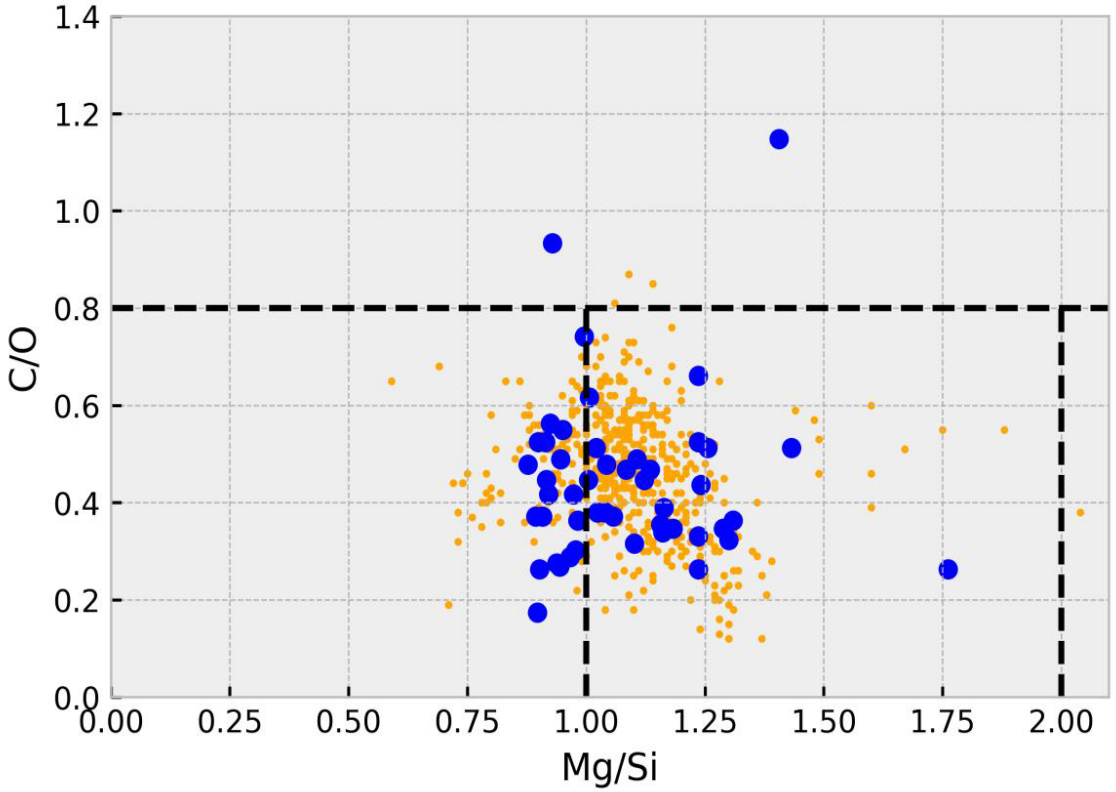
Targeted launch date: 2026

Lifetime: 4 years of nominal science operations; satellite built and verified for an in-orbit lifetime of 6.5 years



SPFOT Survey



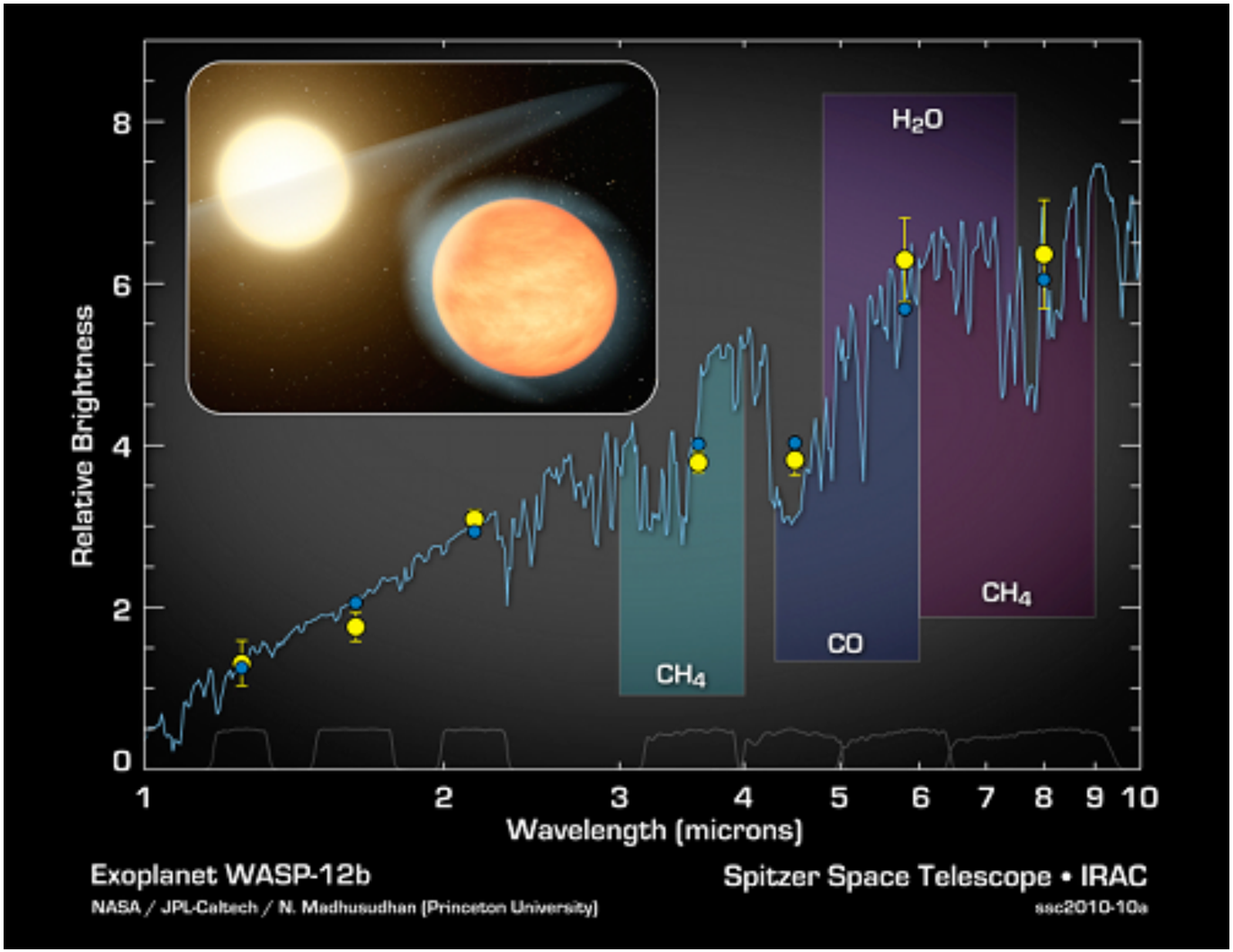


Blue dots – Our study
Yellow dots - Suarez-Andres et al. 2018, A&A, 614, A84 (499 stars)

- For the solar system, C/O = 0.55
- Amount of water increases with decreasing C/O

- Mg/Si > 1.0 – 1.1 – low-mass rocky planets
- Mg/Si < 1.0 – 1.1 – high mass gaseous planets

The gas giant exoplanet named WASP-12b, is the first carbon-rich world ever observed. The discovery was made by Nikku et al. (Nature, 2010) using NASA's Spitzer Space Telescope, along with previously published ground-based observations.

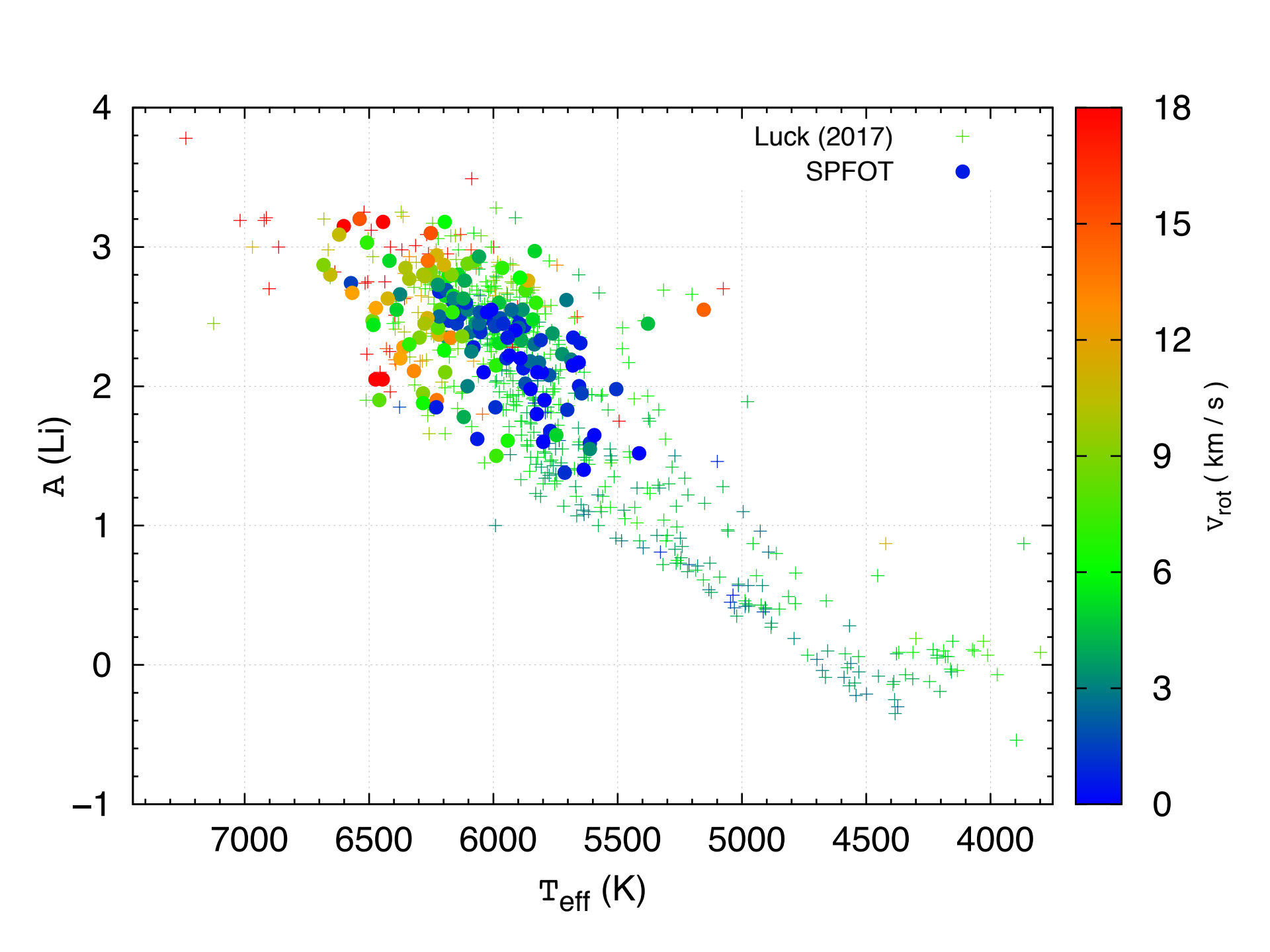


Carbon, nitrogen, and oxygen (CNO)

- comprise in stars most of the mass of elements heavier than helium
- are among the first elements to form in the nucleosynthesis chain
- play important roles in stellar interiors as sources of opacity and energy production through the CNO cycle
- Nitrogen distributions for stars with and without planets show that planet hosts are nitrogen-rich when compared to single stars (Suarez-Andres et al. 2016).

Lithium abundances

- In 16 Cyg, the Li abundance is 4.5 times lower in the planet hosting star (King et al. (1997)
- Amount of depletion of Li in planet-host solar-type stars is higher when the planets are more massive than Jupiter (Delgado Mena et al. 2014)


Luck (2017)
SPFOT
A (Li)
T_eff (K)
v_rot (km / s)
4
3
2
1
0
−1
7000
6500
6000
5500
5000
4500
4000
18
15
12
9
6
3
0

- There are alterations of mixing sensitive elements in evolved stars, e. g., ^{3}He, ^{7}Li, ^{12}C, ^{13}C, ^{14}N, ^{23}Na.
- Abundance ratios depend on stellar age and on the Galactocentric distance.
- There is a hint that the Tc trend depends on the Galactocentric distance (Adibekian et al. 2016).

We plan to use the **SONG telescope** as well in collaboration with a group of astronomers lead by Hans Kjeldsen at the Aarhus University and Carlos Allende Prieto from the Canary Islands Institute of Astrophysics


Thank you for your attention
Picture by Ron Miller