



# Stellar Characterisation WG

Activity indexes sub-WG

## Stellar Activity

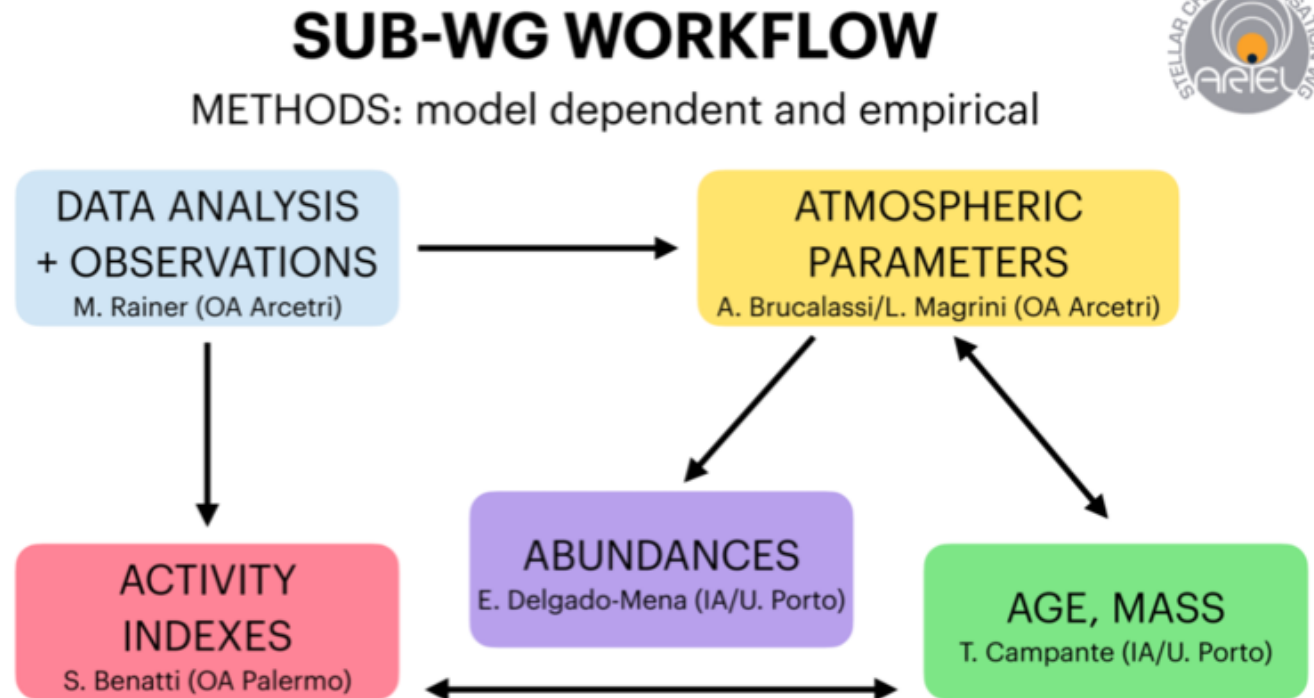
**Serena Benatti**

INAF – Astronomical Observatory of Palermo

On behalf of G. Bruno, C. Danielski, G. Micela, R. Claudi, S. Wedemeyer,  
A. Aret, T. Eenmäe, H. Ramlar (+ M. Rainer)

# Activity indexes sub-WG

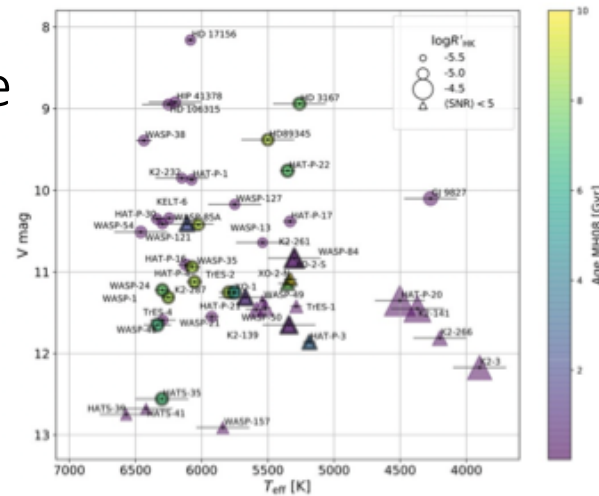
- Characterisation of the stellar activity of the planet hosts through the measurement of the activity indexes (CaII H & K, ....)
- Measurement of the rotation periods
- Synergy with the Stellar Activity WG (more detailed investigations)



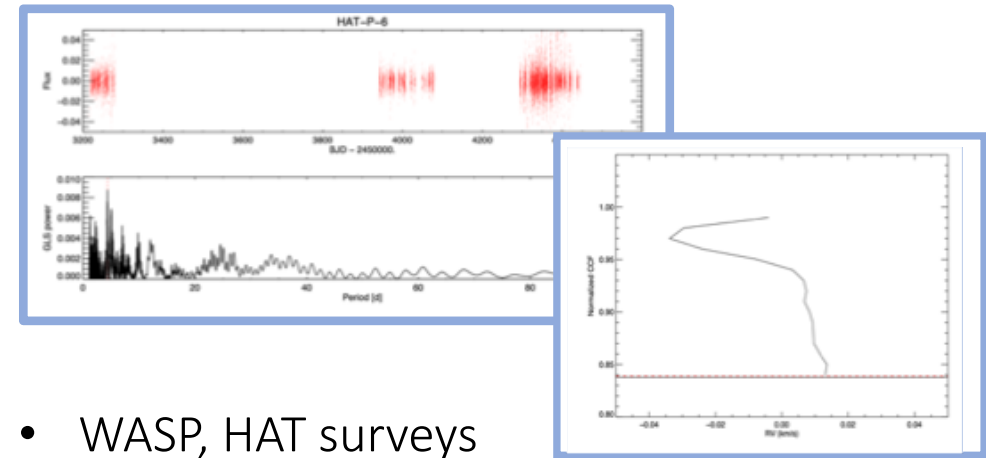
# Previous works (Danielski et al. 2021)

## Measurement of the $\log R'_{HK}$

- 47 targets (matching between SWEET-Cat and ARES)
- No evidence of activity cycle
- Rotation periods and ages from empiric relations
- Analysis of the correlation among activity index and stellar/planet properties



## Evaluation of the rotation periods



- WASP, HAT surveys
- GAPS@HARPS-N survey

**Conclusion:**  
The available data  
are not conclusive

- Need of more spectra to measure  $\log R'_{HK}$  and other activity indexes
- Difficult detection of photometric modulations (few starspots for F/early G stars)
- Spectroscopic timeseries show some agreement with theoretical expectations but few and sparse data produce small significance of the detection

# Analysis of TESS light curves in progress

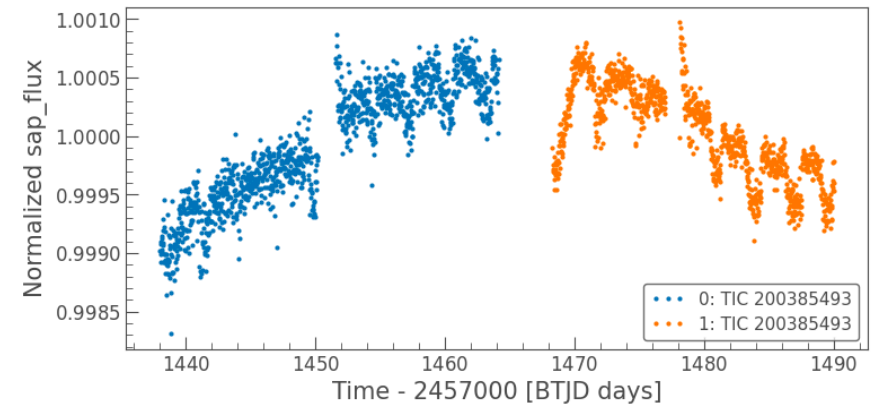
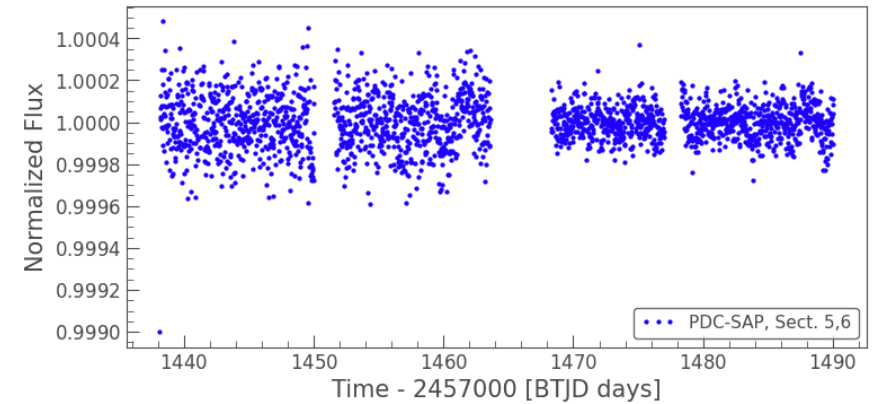
TESS observed several ARES Targets

- ✦ Continuous photometry
- ✦ TESS planets will be included in the ARES
- ⚠ 1 sector = 27 days only
- ⚠ Large pixel scale: potential stellar contamination
- ⚠ Little photometric variability for quiet stars
- ⚠ SAP vs PDC-SAP

# Analysis of TESS light curves in progress

TESS observed several ARES Targets

- 🌟 Continuous photometry
- 🌟 TESS planets will be included in the ARES
- ⚠️ 1 sector = 27 days only
- ⚠️ Large pixel scale: potential stellar contamination
- ⚠️ Little photometric variability for quiet stars
- ⚠️ SAP vs PDC-SAP

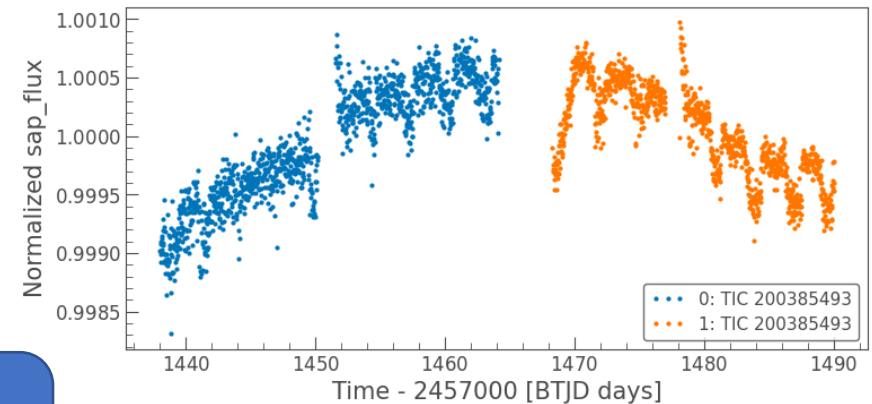
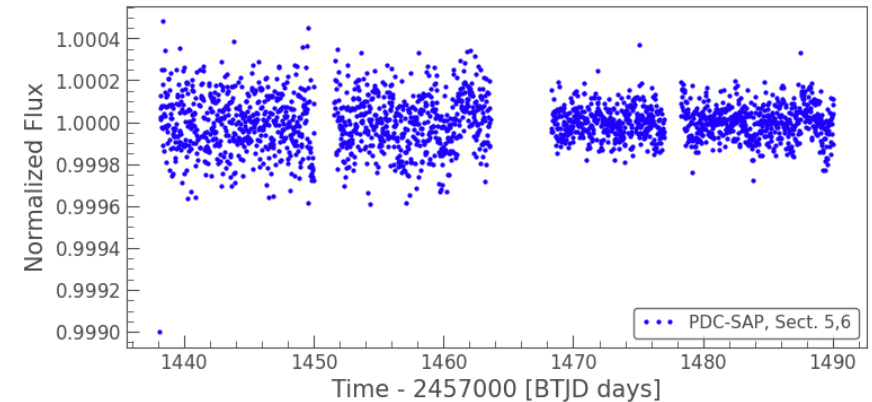


# Analysis of TESS light curves in progress

TESS observed several ARES Targets

- 🌟 Continuous photometry
- 🌟 TESS planets will be included in the ARES
- ⚠️ 1 sector = 27 days only
- ⚠️ Large pixel scale: potential stellar contamination
- ⚠️ Little photometric variability for quiet stars
- ⚠️ SAP vs PDC-SAP

Help from the Ariel-TESS synergy WG



# Observing plan

- **REMIR+ROS2 @ REM (PI: G. Bruno)**  
Combined VIS+NIR photometry:  
Temperature + filling factor for 8 targets from the Reference Sample (July/August)
- **Long term program (2 yrs) with Echelle @ Asiago-Cima Ekar (PI: R. Claudi)**  
H $\alpha$  and Calcium lines timeseries:  
activity and rotation periods for targets from the Reference Sample (Ongoing)
- **Photometric monitoring with ESA at the ASTEP telescope in Antarctic (Stand-by)**
- **Photometric and spectroscopic monitoring for some selected targets** from Tartu Observatory (feasibility study ongoing but good perspectives)
- **Spectroscopic monitoring from Ondrejov (currently discarded: Ca II HK not in the spectrum)**

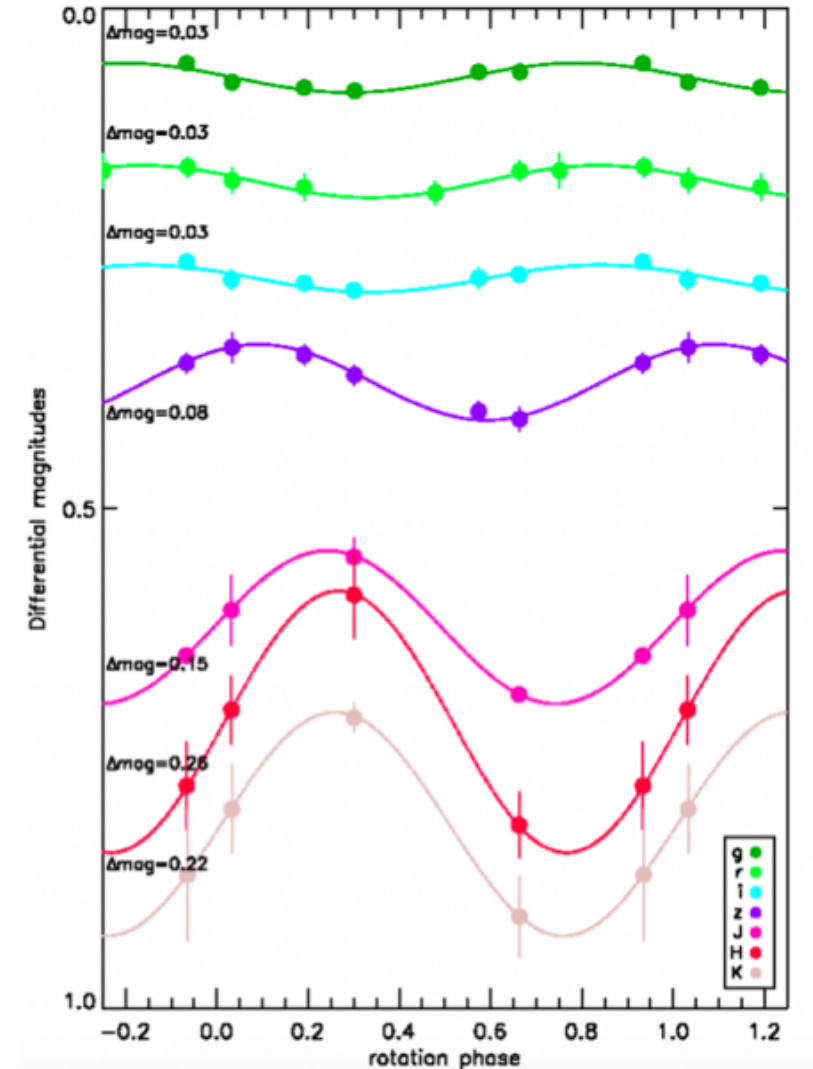
# Measuring activity features temperature/filling factor

(to be combined with other activity indicators)

Proposal for REM visible + IR  
observations: 38.6 hours  
(Bruno, Benatti, Micela, Danielski,  
Rainer, Wedemeyer)

→ 8 moderate rotators from the Ariel  
Reference Sample  
( $P_*$  ~ 3.8-12.6 days,  $V \sim 9.8-12.7$ )

Goal: to break temperature/filling factor  
degeneracy with multi-color photometry





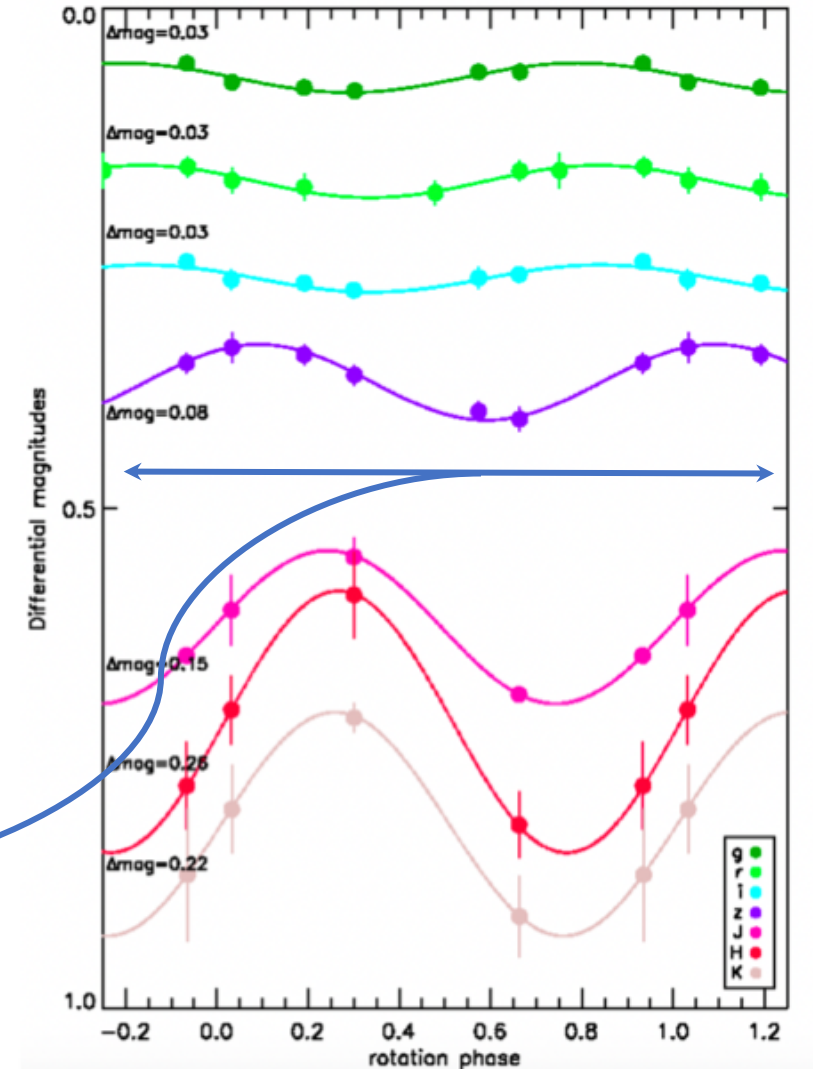
# Measuring activity features temperature/filling factor

(to be combined with other activity indicators)

Proposal for REM visible + IR  
observations: 38.6 hours  
(Bruno, Benatti, Micela, Danielski,  
Rainer, Wedemeyer)

→ 8 moderate rotators from the Ariel  
Reference Sample  
( $P_*$  ~ 3.8-12.6 days,  $V \sim 9.8-12.7$ )

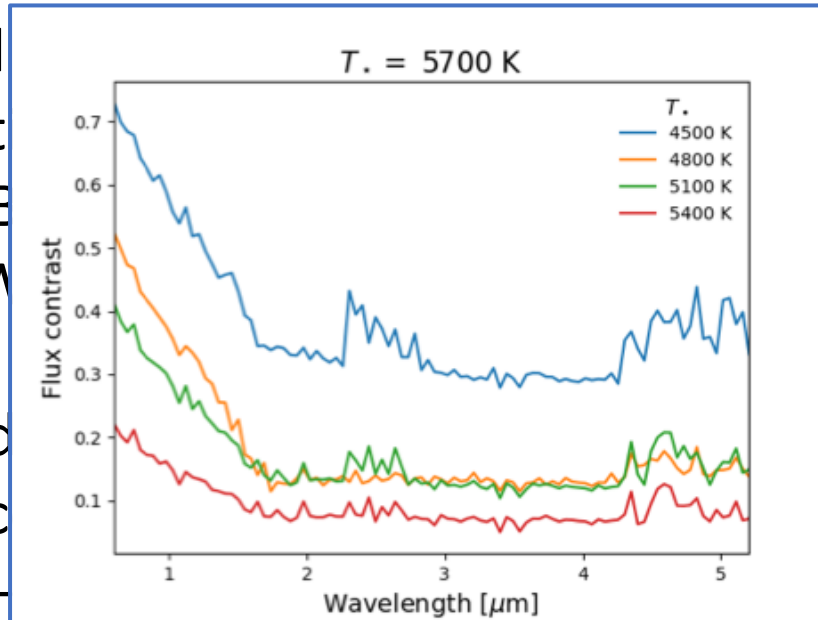
10 measurements x stellar  
rotation period



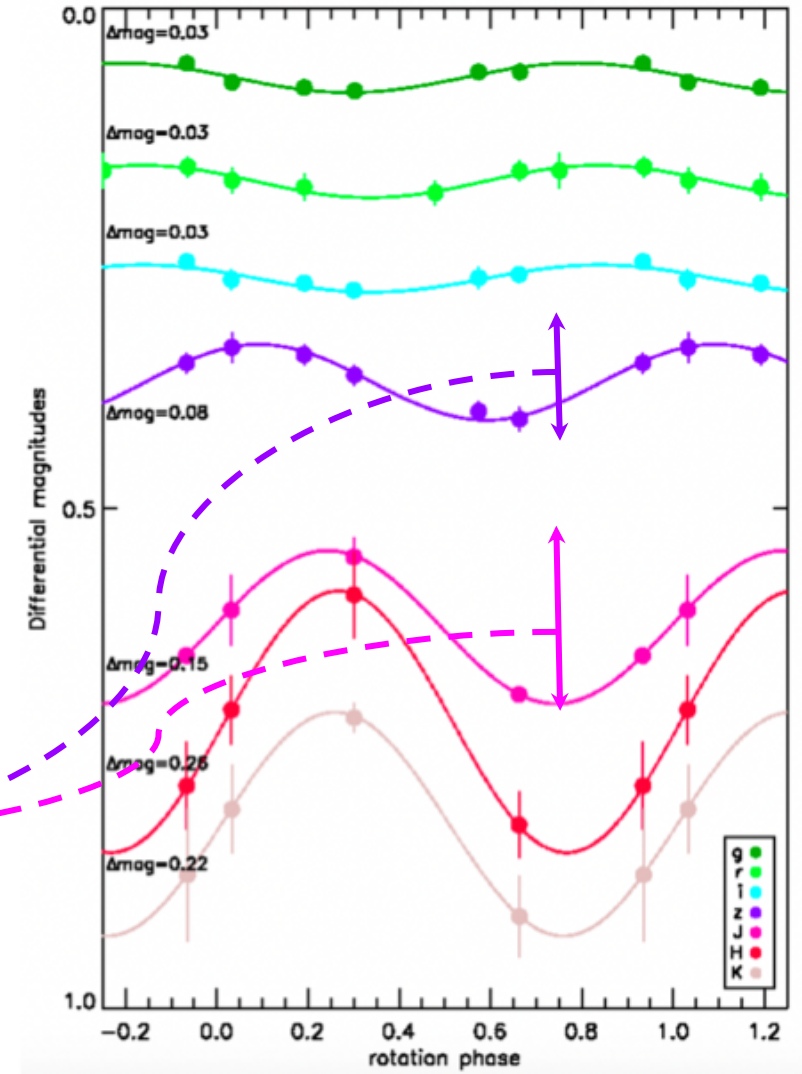
# Measuring activity features temperature/filling factor

(to be combined with other activity indicators)

Proposal  
observat  
(Bruno, E  
Rainer, W  
→ 8 mod  
Referenc  
( $P_* \sim 3.8$ -



Stellar models can be fitted to  
color-dependent mag variations

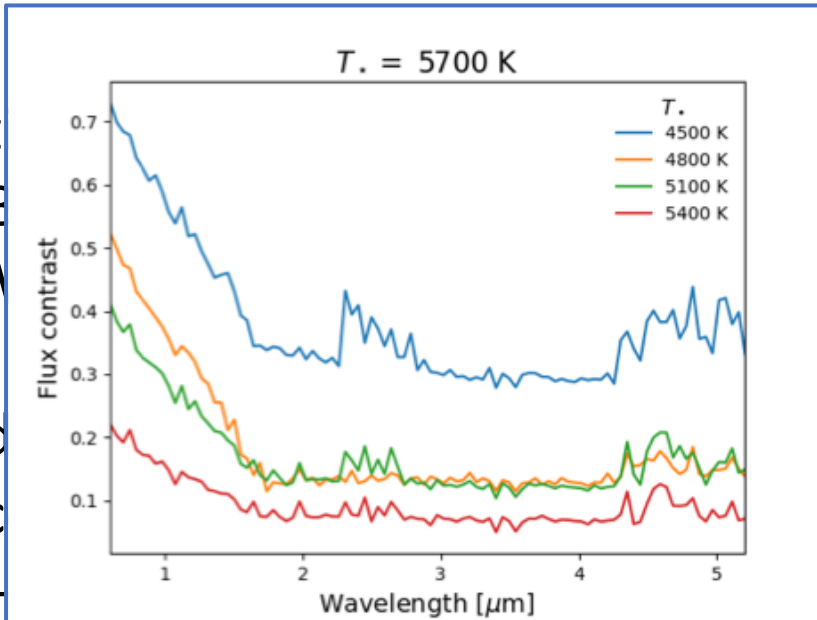


Carleo+2018

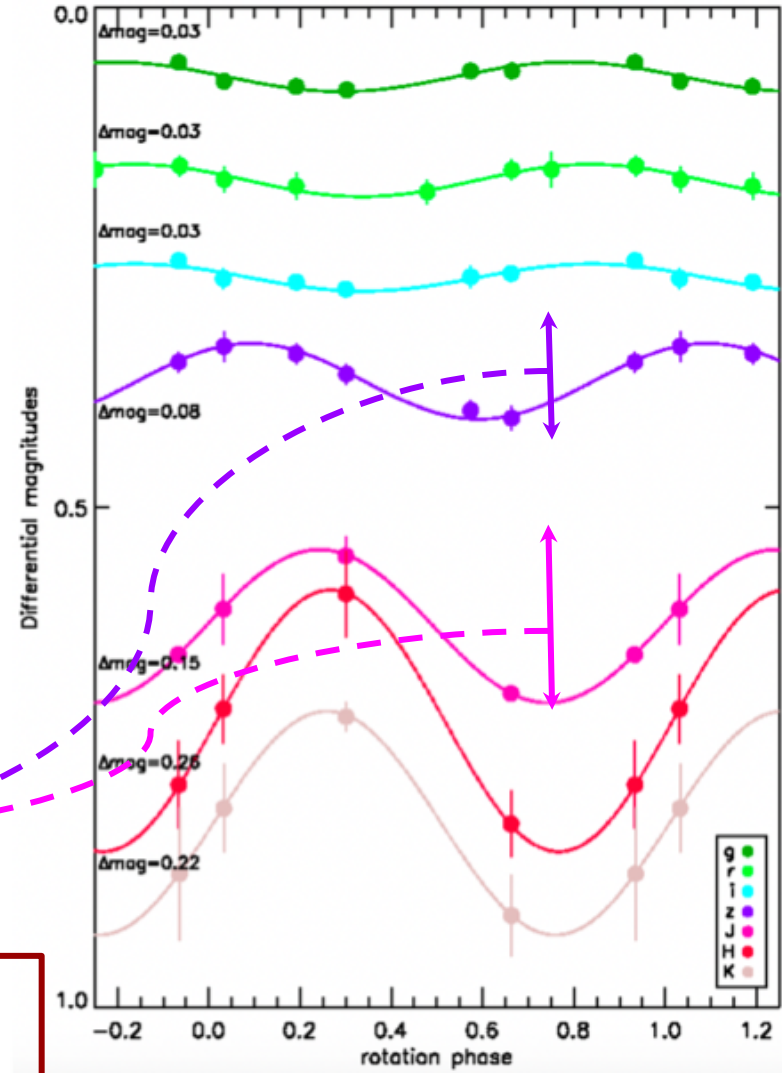
# Measuring activity features temperature/filling factor

(to be combined with other activity indicators)

Proposal  
observat  
(Bruno, E  
Rainer, W  
→ 8 mod  
Referenc  
( $P_* \sim 3.8$



Stellar models can be fitted to color-dependent mag variations

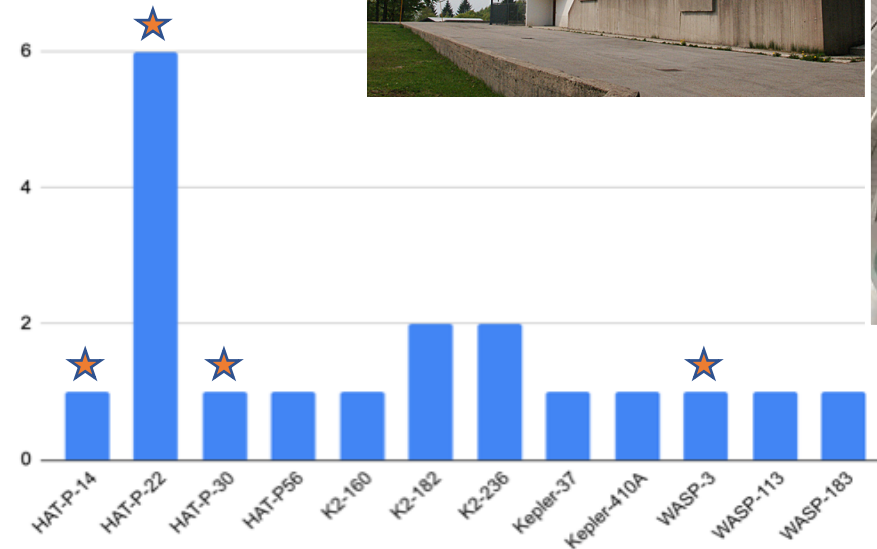


Carleo+2018

If successful, this could be extended to the new ARS

# Large programme (2yrs) @ Asiago

- 1.82 m «Copernico» Telescope at Cima Ekar (Asiago, VI), PI: R. Claudi
- Echelle spectrograph (300l/mm)
- Three runs up to now (2 nights each) with time-sharing agreement with other programs
- First runs to get in touch with the telescope/instrument
- Goal: time series
- Data reduction in progress
- Next observations in August 2022



★ Already investigated in our previous work (useful for confirmation or undetermined periods)

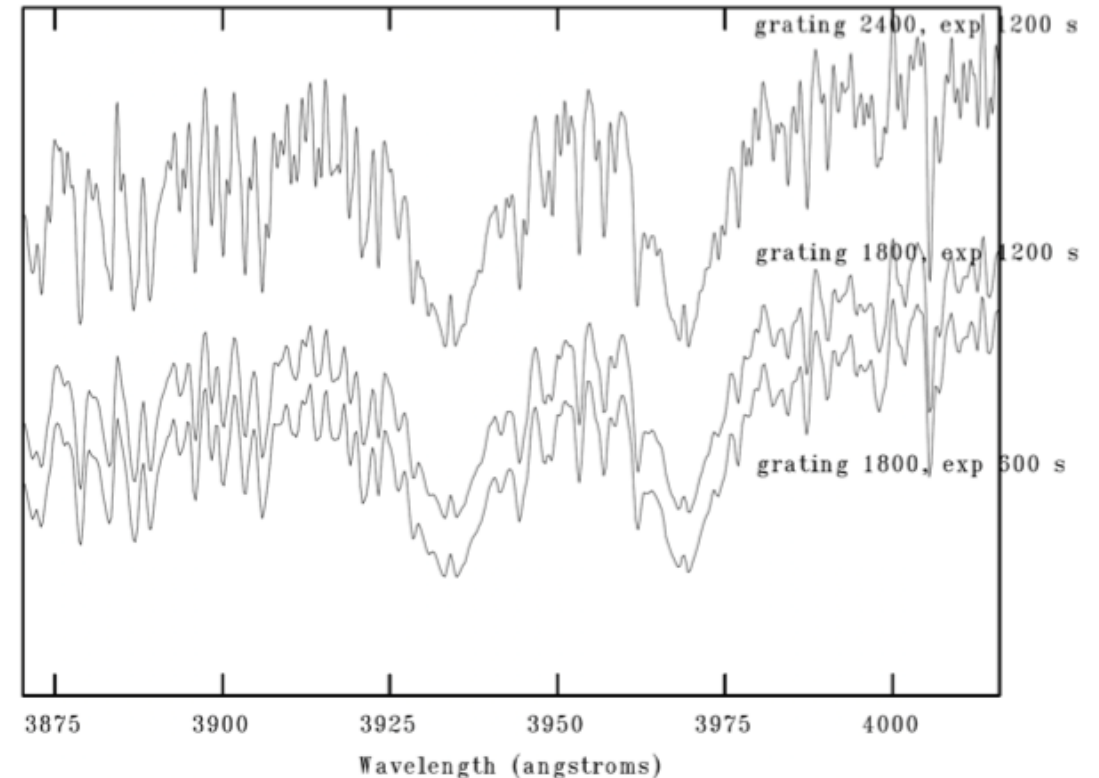
# Updates from Tartu

## Spectroscopic observations

- Tests on Kappa Cet ( $m_v=4.8$ ) and HD37394 ( $m_v=6.2$ ) with different instrumental configurations
- S-index measurements in progress
- Preferably for bright targets ( $m_b < 8$ )

**Photometric monitoring** also available  
(Johnson, RI, H $\alpha$ ;  $m_v < 13$ )

Instrument/telescope refurbishment in 2023





# Setting the target priority

## New Google sheet

- **Matching with the Google sheet *Proposals\_whole\_ARES*:** to check for data (possibly for time series) in public archives
  - Even single spectrum can be useful to evaluate the empirical rotation period and thus the observing strategy
- Search for rotation/ $\log R'_{HK}$  already known (in particular for TOIs) and homogeneous measurement of  $\log R'_{HK}$  (S. Boro Saikia and C. Haswell)
- **Example of entries:**

Planet name	Sp Type	Host v mag	Danielski +2021	Archive Spectroscopy	Archive Photometry	Rotation Period	Prot Reference	$\log R_{HK}$	$\log R_{HK}$ Reference	B-V	B-V Reference	Notes
HAT-P-22b	G5V	9.763	YES	HARPS-N	HAT-Net, TESS	-	-	-5.01±0.06	Danielski+2021	-	-	Asiago sample
DSTucA	G6V	8.17	NO	HARPS	TESS	2.95±0.02	Benatti+2021	-	Benatti+2019	0.693±0.017	Pecaut & Mamajek (2013)	Young star (40 Myr), no atmospheric features from ESPRESSO data bec of the activity (Benatti+2021)

# Conclusions

- Characterization of the stellar activity of the planet hosts:  
     $\text{Log}R'_{\text{HK}}$  (and other activity indexes) + rotation period + spots temperature/ff
- Synergy with the Ariel Stellar Activity WG (& Ariel-TESS WG)
- New photometric and spectroscopic observations planned
- Definition of a priority list to improve the observations' efficiency