Stellar Science Calibration and Validation in PLATO

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PLATO Science Calibration and Validation Targets



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The challenge of long-term space photometry

Several types of PLATO core targets benefit from long-term (months-years) photometric precision of $\sim 0.1\%$

- Activity cycles of FGK stars, stellar differential rotation
- Rotational variability of slowly rotating stars



Solar irradiance (Nandy+ 2021)



M dwarf rotation (Newton+ 2018)

The challenge of long-term space photometry

PLATO will acquire data in quarters, similar to Kepler. FoV will rotate between quarters

- Intra-quarter systematics
- Jumps between data from different quarters





Need constant-star photometric calibrators to characterize long-term instrumental effects and calibrate methods of their removal

Possible calibrators

- Stars with quiet, stable atmospheres, exhibiting no intrinsic variability on time scales from months to years
 - FGKM stars: **no** (convection, dynamo field, activity cycles)
 - O-B5 stars: **no** (rare, variability due to winds, pulsations, binarity)
 - B5-A stars: yes (no convection, no winds, stabilized by mag. field)
- Types of intermediate-mass star photometric calibrators
 - 1. Non-variable AB stars: very rare, hard to establish
 - 2. Magnetic Ap/Bp stars with very long rotation periods: rare
 - 3. Magnetic Ap/Bp stars with short rotation periods: common, regular mono-periodic variability can be removed by averaging or modelling

More details in PLATO technical notes: PLATO-UU-PSM-TN-001, PLATO-UU-PSM-TN-002

Variability of short-period Ap stars



Variability of long-period Ap stars

- Typical periods of several days, long tail with periods up to decades
- ~200 long-period candidates from TESS light curves (Mathys+ 2020, 2022, 2024)
- 8 stars with accurately measured rotation periods >1000 d





Example: Short-period Ap star in TESS CVZ

- $\,\circ\,\,$ 1 year of TESS photometry of the bright Ap star EE Dra
- Double-wave rotational modulation with P_{rot} =1.123 d, no evidence of any other variability





PLATO Sweden, 2025-05-26

Example: Short-period Ap star in TESS CVZ



PLATO Sweden, 2025-05-26

Current status of scvPIC work

- $\circ~$ Software for PLATO field visibility
- $\circ~$ Input catalogue of ${\sim}500$ Ap stars in LOPS2
 - Binarity (Gaia)
 - Blending (PSF modelling)
 - Variability (TESS)
- Final sample of Ap stars for scvPIC 3a,b
 - 54 slow rotators
 - 173 fast rotators

Input catalogue of Ap stars in LOPS2



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Current scvPIC 3a,b catalogue