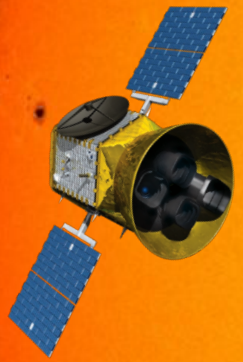
Photometric variability and magnetic activity in young suns



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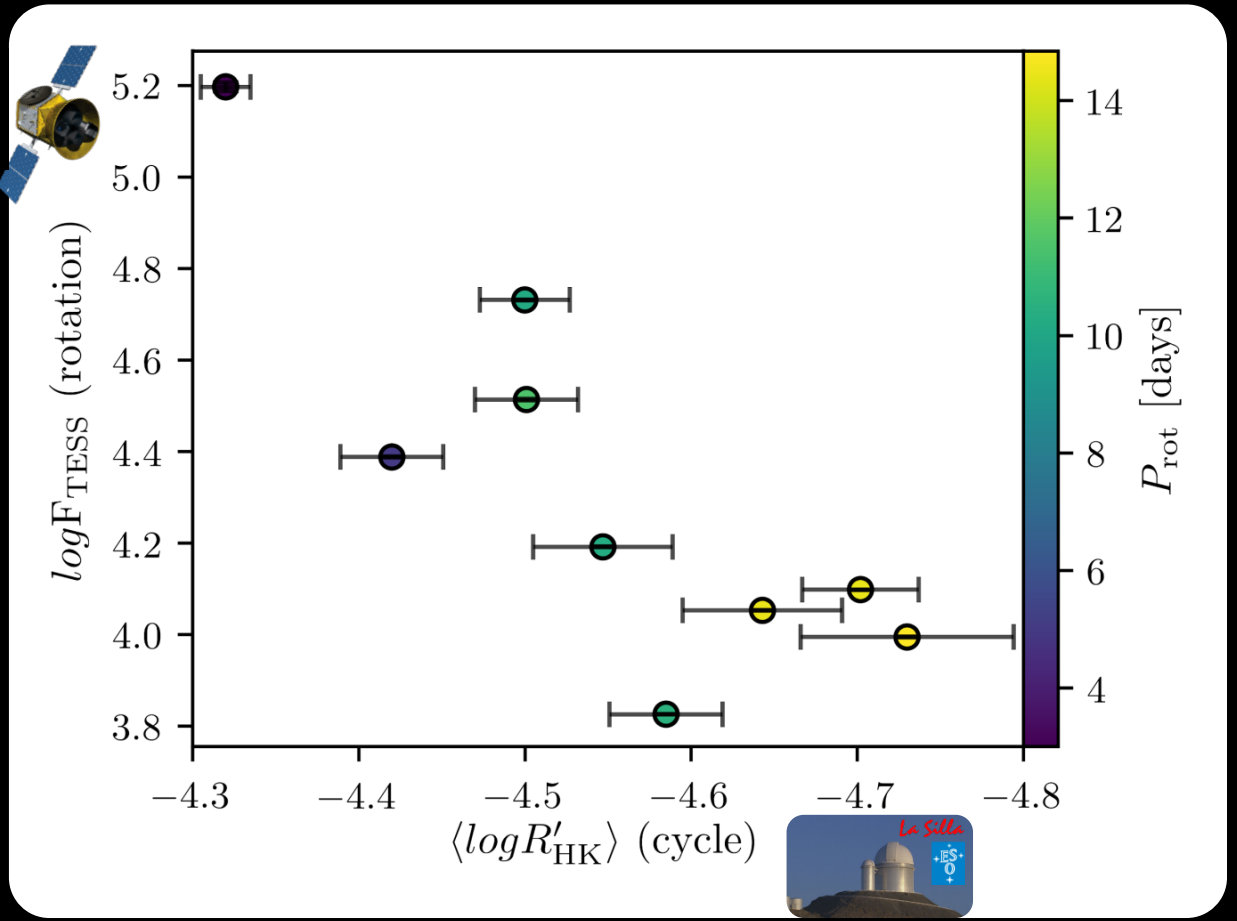
In collaboration with:

Adriana Valio, Diego Lorenzo-Oliveira, Jhon Yana Galarza, and Jorge Meléndez

while you are still focused



SPOILER ALERT!

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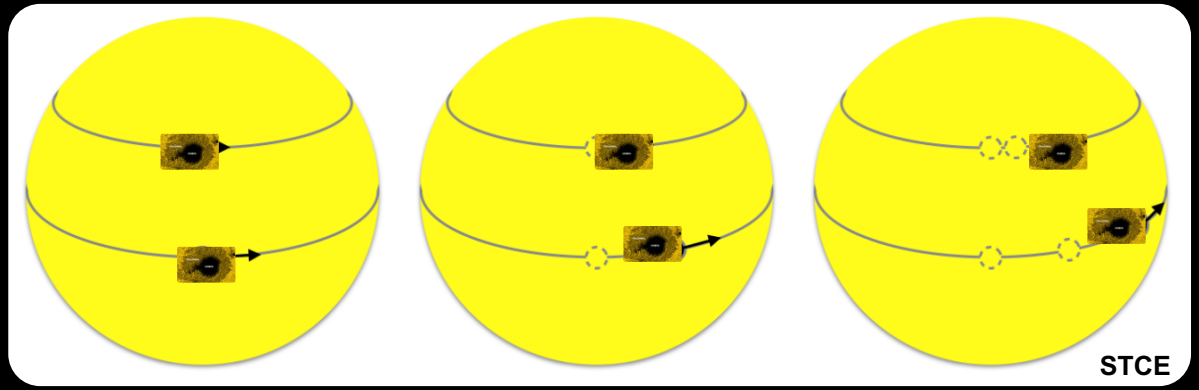
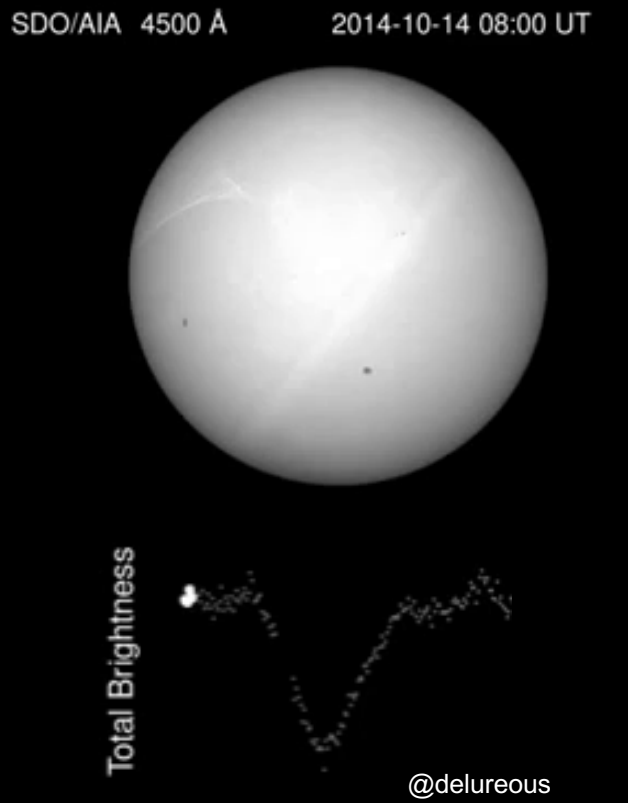
Introduction

The magnetic cycle of the solar-type stars is accompanied by **brightness variations**



Cyclic activity has also been observed through **brightness changes caused by occurrence of active regions** on the rotating surface



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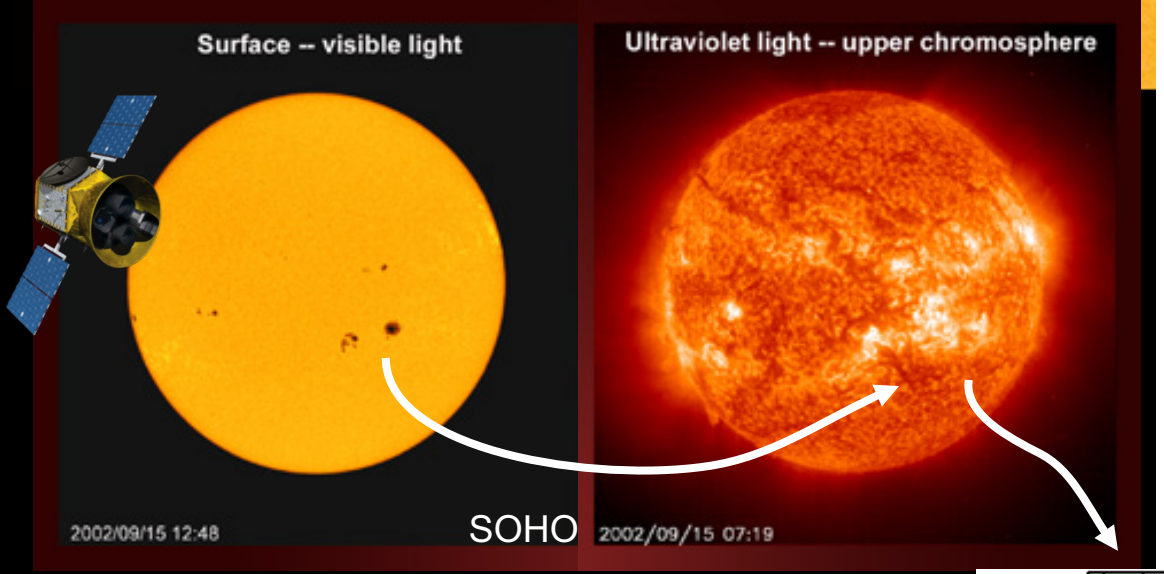
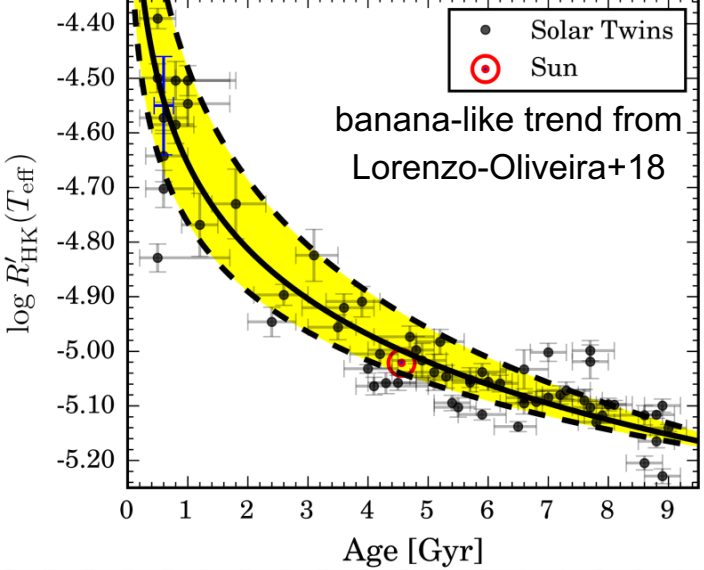
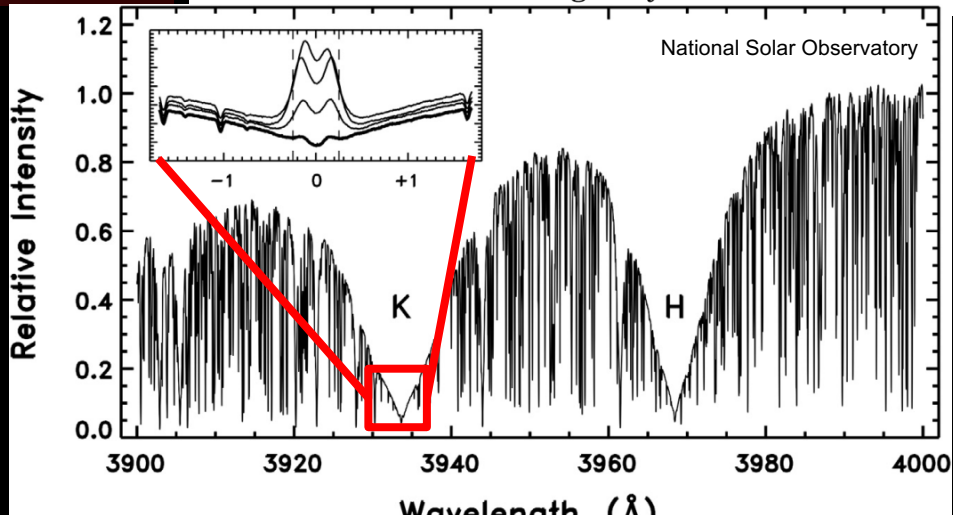


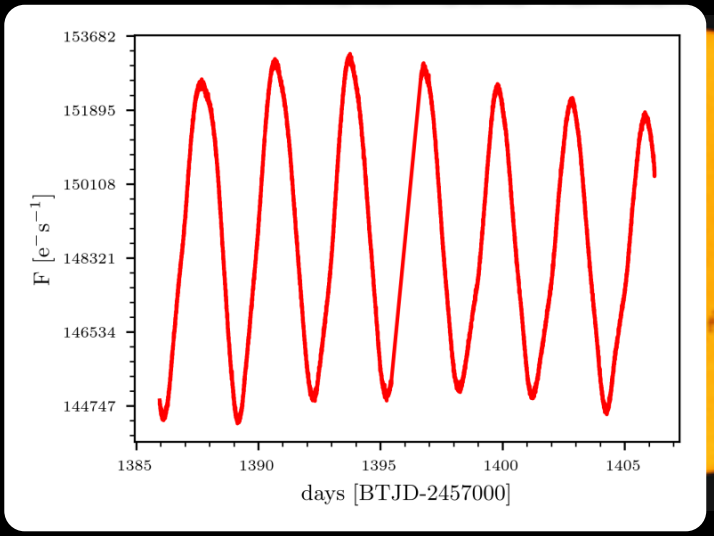


The magnetic field of the **active regions transports energy into the chromosphere**, which leads to increased chromospheric emission, most evident in the cores of the **Ca II H&K lines** **(Lockwood 1994)**.



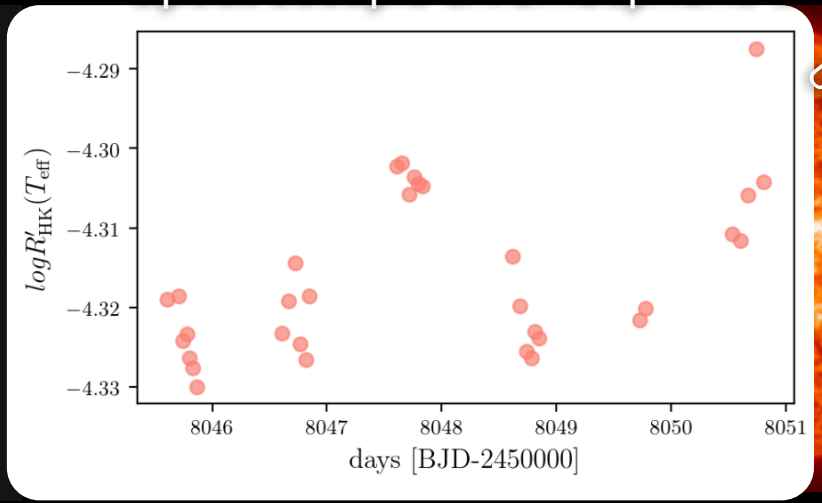
How do we compare the data?

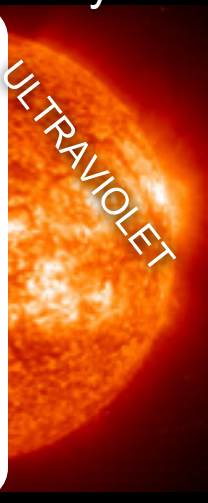
Photometric variability



Rotational modulation from TESS lightcurves

Spectroscopic chromospheric activity





Spectroscopic activity levels determined using Ca II H&K lines from HARPS/ESO

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Data sample

In this preliminary analysis, we selected **9 young solar twins** with:

full rotational period phase variations **covered by TESS** observational window of ~27 days

high-cadence HARPS time series (> 6 years)

determined rotational periods **P_{rot}**
Lorenzo-Oliveira+19a

precise spectroscopic, evolutionary parameters, e.g. **masses, ages, spectroscopic T_{eff} and [Fe/H]**

average activity levels (**Ca II R'HK indicator**) previously determined by our group
Lorenzo-Oliveira+18; Yana-Galarza+19, submitted

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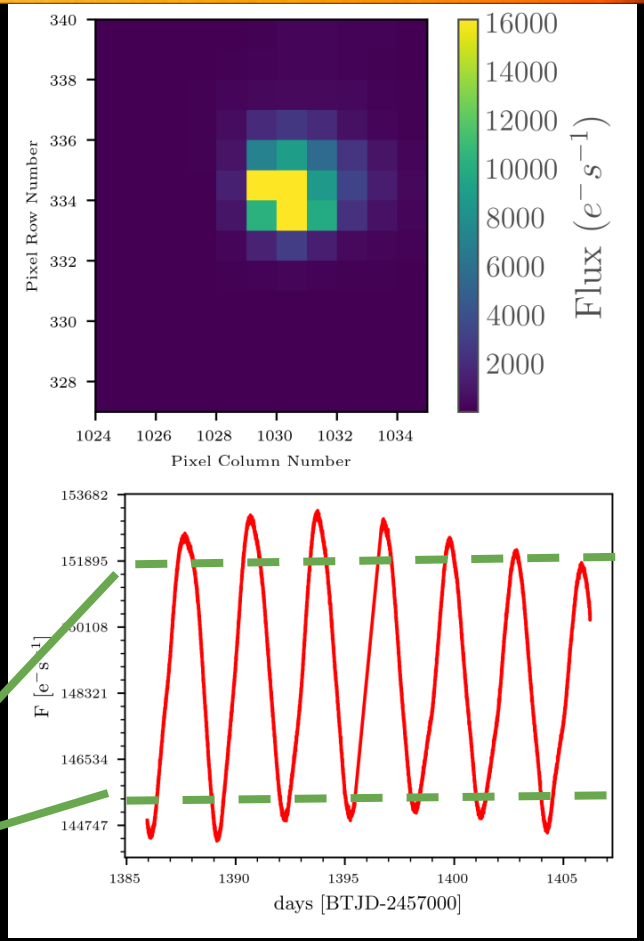
Exploring TESS lightcurves

TESS lightcurves were extracted using *Lightkurve* (Lightkurve Collaboration, 2018) package.

Through photometric flux (**F**) time series, we measured P_{rot} and computed the differential variability of flux amplitudes (A_{TESS}) defined by the following equation:

$$A_{TESS} = (F_{97.5\%} - F_{2.5\%}) / 2\, F_{50\%}$$

2σ



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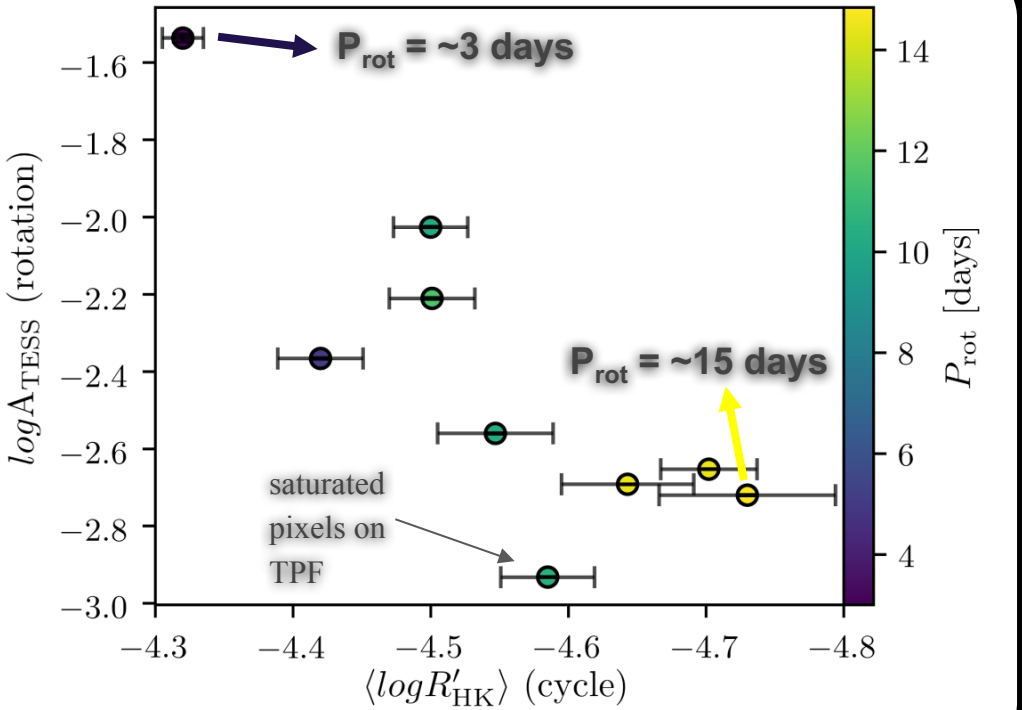
TESS photometric amplitudes



We show that TESS photometric amplitudes A_{TESS} are strongly correlated (~80%) with mean chromospheric activity levels of our sample stars.

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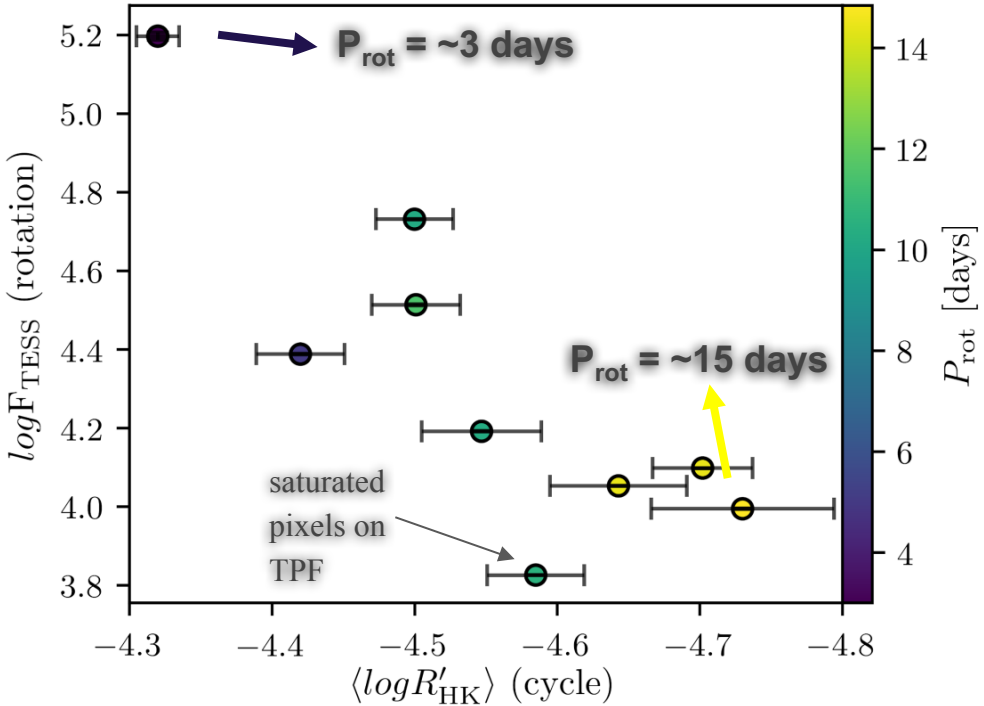
TESS surface fux amplitudes: F_{TESS} [erg/cm²/s/Å]



A_{TESS} is an instrumental index that depends on stellar atmospheric parameters.

We converted **A_{TESS}** into absolute surface fluxes using the model of atmospheres:

A_{TESS} flux(T_{eff}) = **F_{TESS}**

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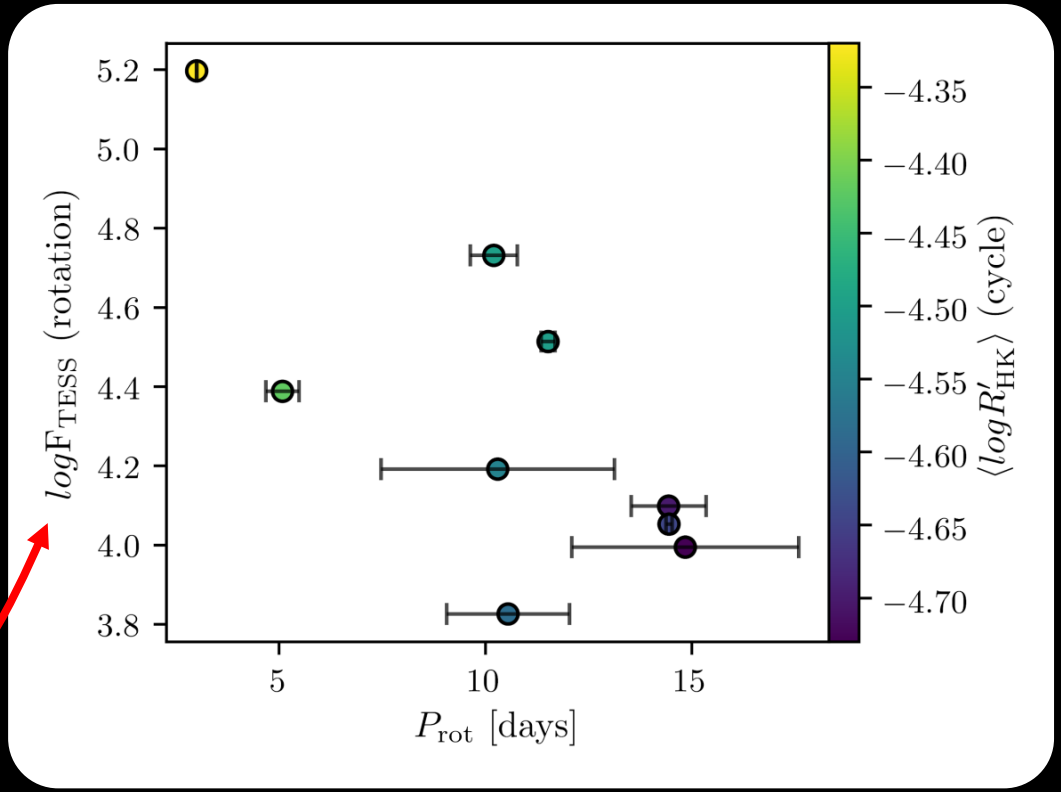
TESS surface fux amplitudes

When we look directly at rotational period

This is our index F_{TESS}



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TESS surface fux amplitudes

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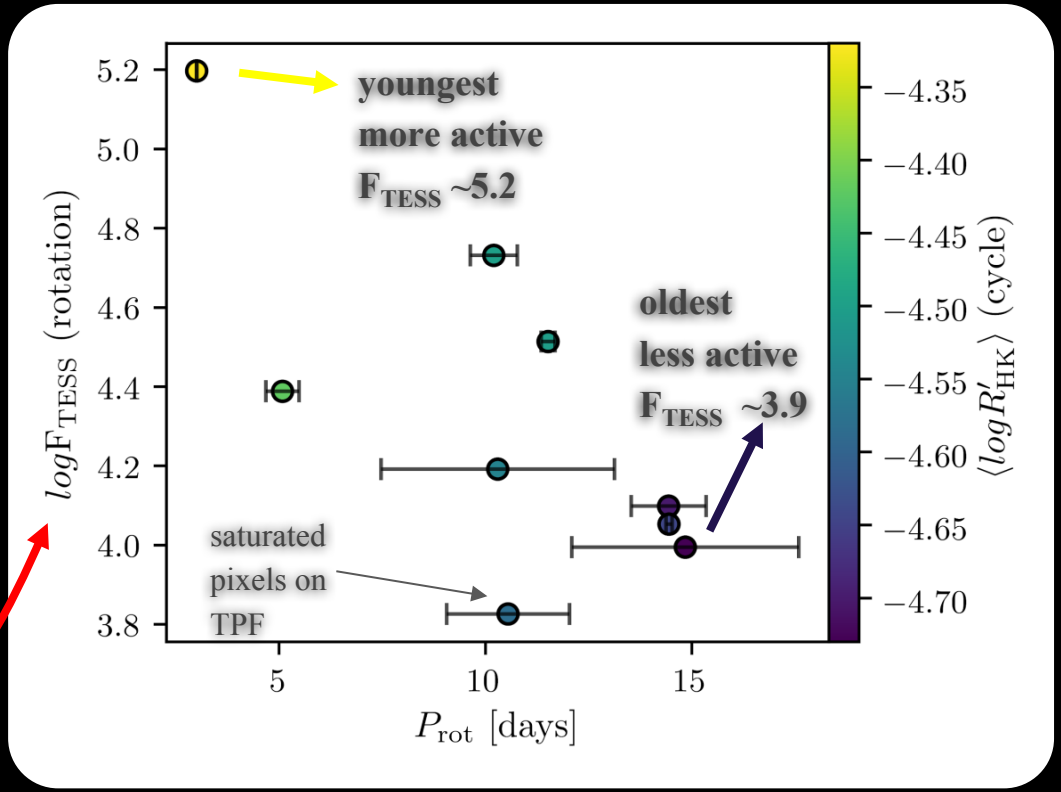
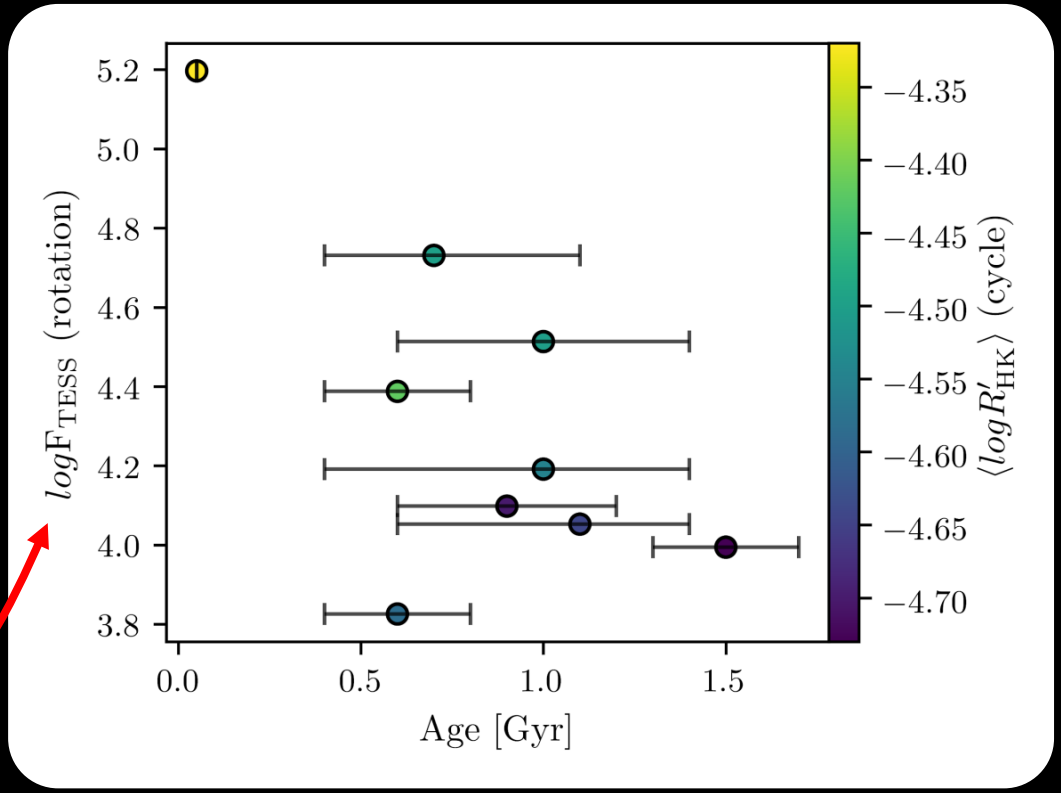


TESS surface fux amplitudes: F_{TESS}

When we look directly at ages (from Lorenzo-Oliveira+18)

This is our index F_{TESS}



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TESS surface fux amplitudes: F_{TESS}

When we look directly at ages (from Lorenzo-Oliveira+18)

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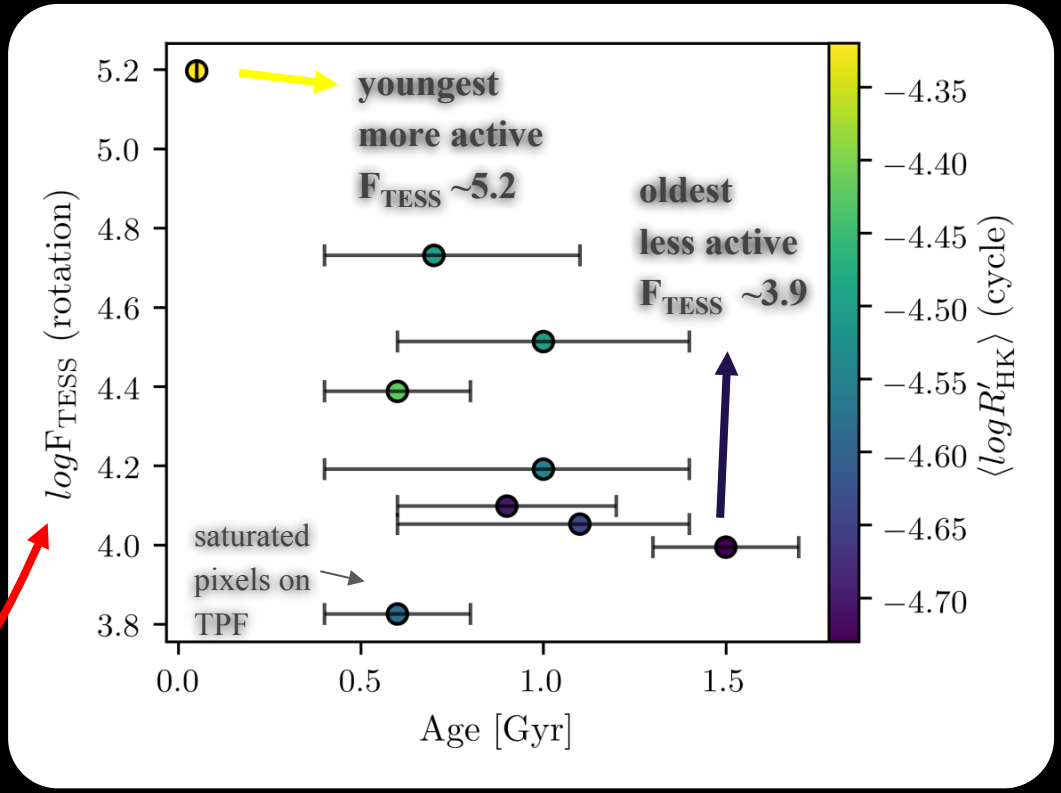
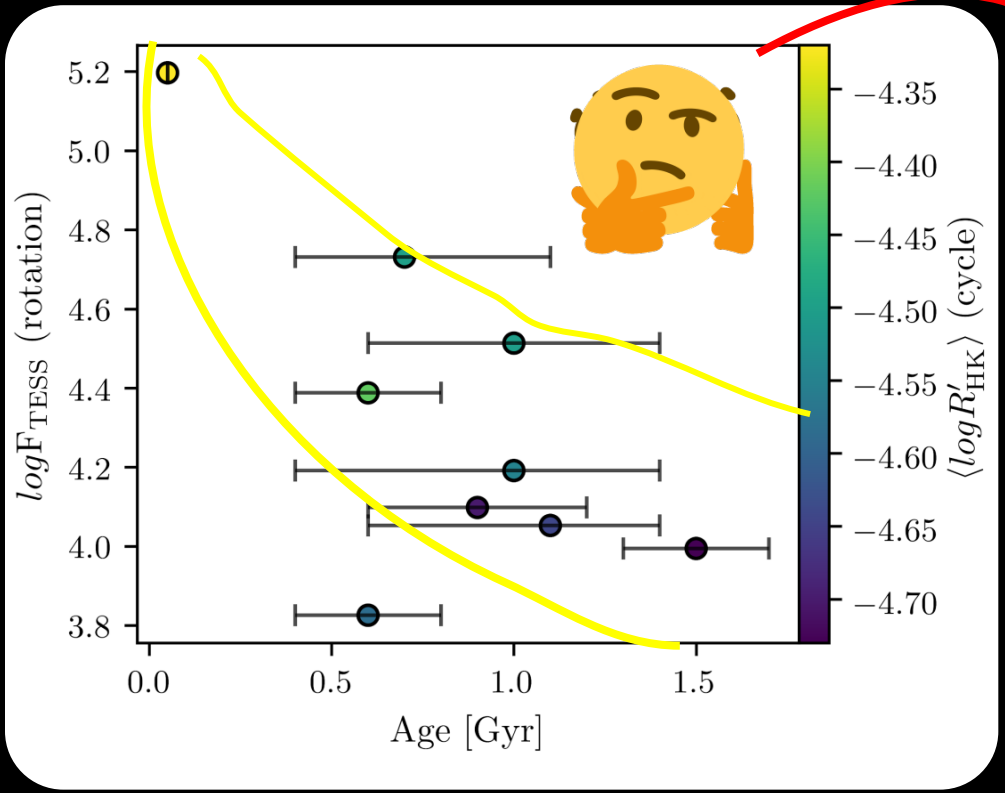
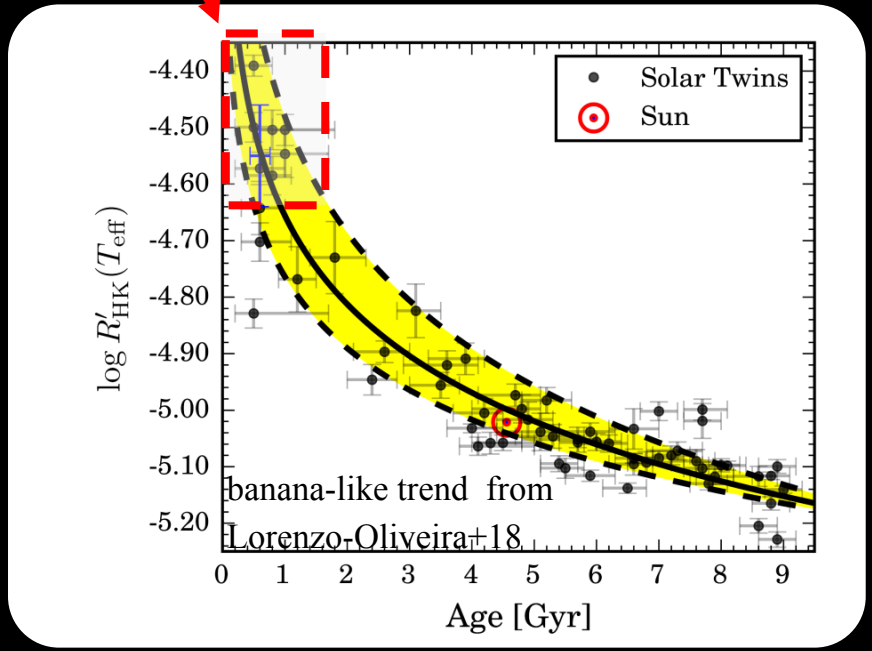


A little banana cousin?

When we look directly at ages (Lorenzo-Oliveira+18)



a hypothesis



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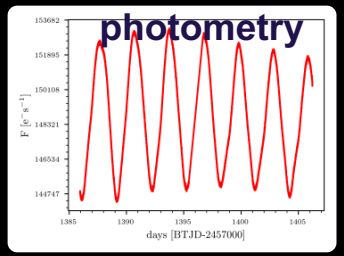
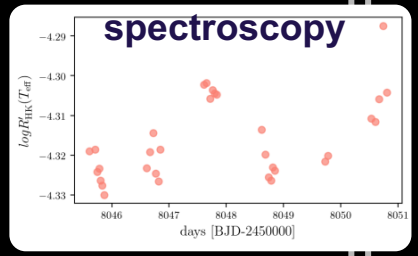
SUMMARY

We estimate the **photometric variability of TESS** lightcurves due to rotational modulations and explore its correlations with chromospheric spectroscopic indicators, ages and rotational periods.

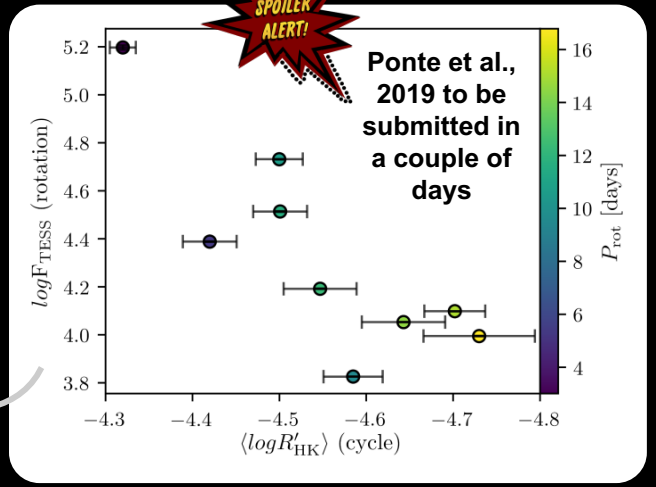




Focus on young solar twin stars with rotational periods covered by TESS observations.

We are testing the consistency of photometric amplitude variations due to the passage of active regions. The idea is **to create a new indicator of magnetic activity**, as empirical as possible, and compare it with the classic indicator R'_{HK}.

F_{TESS}



Our results show that stellar photometric flux amplitudes are strongly correlated (~80%) with the mean chromospheric activity levels of our sample stars.

This analysis provides prior information about the rotational signal of TESS lightcurves as a function of activity levels, and we'll explore **F_{TESS} as a chronometer**.

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