

ROTATION versus ACTIVITY IN COROT ERA

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CoRoT Natal : I. de Castro Leão, D. Brito de Freitas, C. Cortés, L. P. de Souza Neto, Y. F. Martinez Osorio, S. C. Maciel, S. Vieira, S. A. do Nascimento, M. L. das Chagas, B. L. Canto Martins and . J.R. de Medeiros.

First CoRoT International Symposium February 2 – 5, 2009, Paris, France

Rotation and Activity (some observational previous claims)

What we know about Stellar Rotation

- Kraft's 67 Obvious drop in rotation at 1 Solar Mass and Activity stars are faster rotators
 - late F dwarfs lose angular momentum during their main sequence life times.
- Skumanich' 72 Quantified a relation $t^{-1/2}$ for rotation, Ca II emission

ROTATION and Activity

Milestones before CoRoT Milestone...

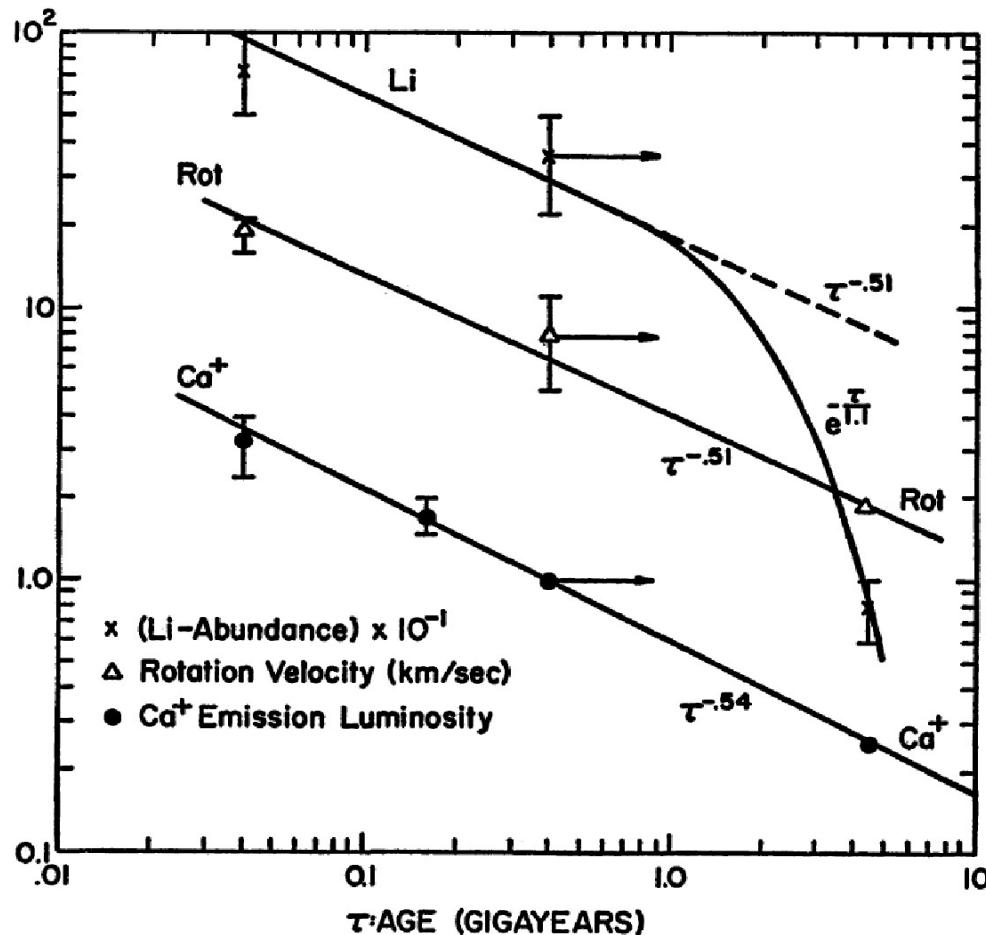
What we know about Stellar Rotation

- Soderbom'83 Rotation of late type stars and the rotational history of the sun. The $t^{-1/2}$ relation cannot hold for stars much younger than the Pleiades. Some open questions...
 - Do 1.25 Solar Mass stars also follow a $t^{-1/2}$ relation?
 - Other classes of stars as massive as the Sun follow this relation?
- Pace and Pasquini 2004 Proposed a new $t^{-\alpha}$ relation on the basis of larger stellar sample than previous studies.

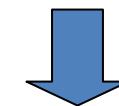
Rotation and Activity

- Several authors have reported a rotation-activity relation for evolved stars based on the linear behavior of the chromospheric flux with stellar rotation (e.g . Rutten 1987; Rutten&Pylyser 1988; Simon & Drake 1989; Strassmeier et al. 1994; Gunn et al. 1998; Pasquini et al. 2000). do Nascimento et al (2003), Pace and Pasquini (2004),
- Pasquini et al. (2004) For a given spectral type, however, a large spread in the rotation-activity relation is observed, which **suggests that rotation might not be the only relevant parameter controlling stellar activity.**
- Pasquini&Brocato (1992) , Pasquini et al. (2000), do Nascimento (2003): chromospheric activity depends on stellar effective temperature (mass of convective zone) and mass.

Decaying Law (Skumanich, 1972)



New-Instruments



Rotation Period for
Field stars and
old and intermediate
age Open Clusters

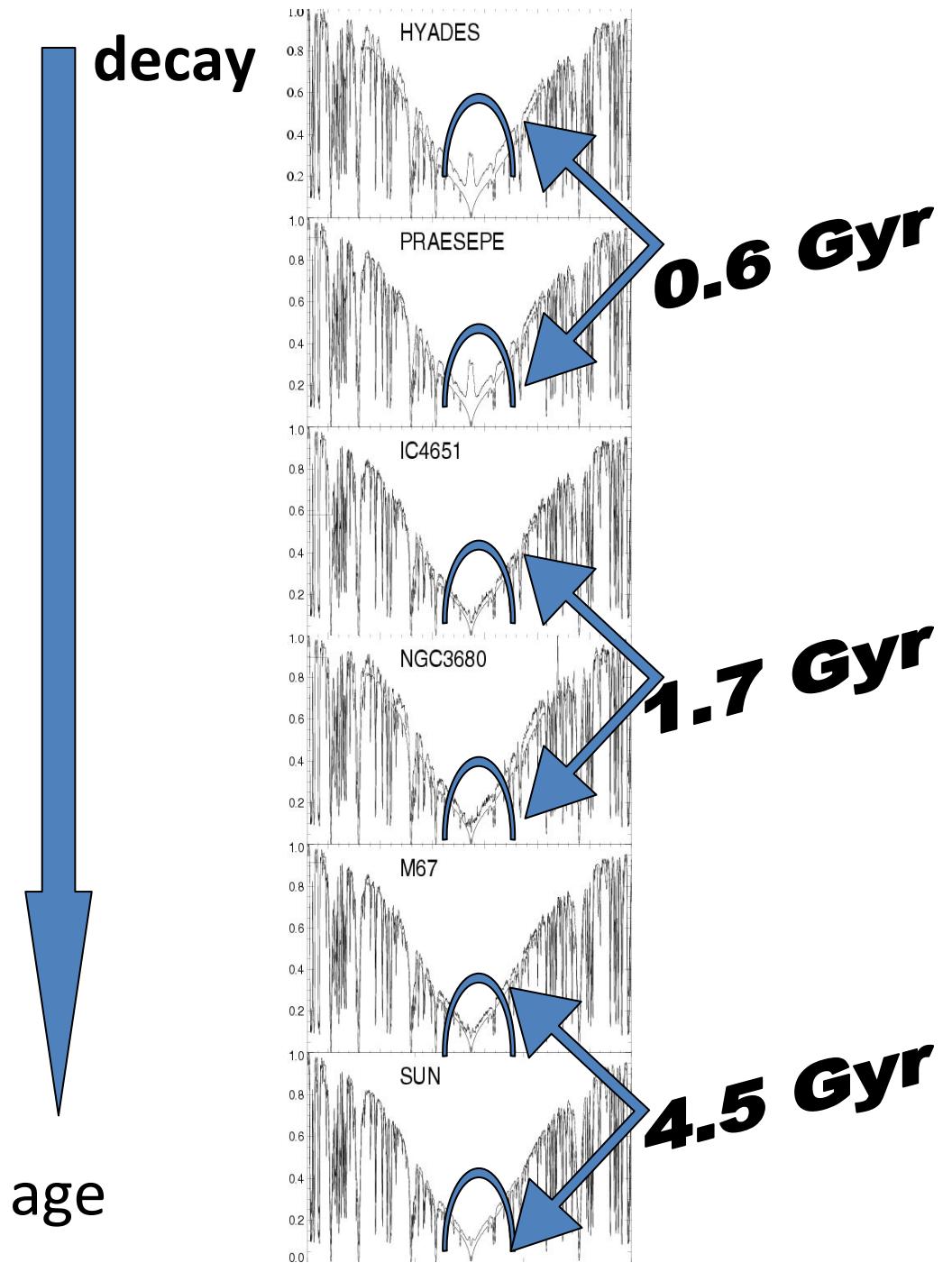
Skumanich (1972) showed that Kraft's Hyades and Pleiades data together with the rotational velocity of the Sun, were consistent with the relation $v \sim t^{-1/2}$

So, Activity \sim Rotation

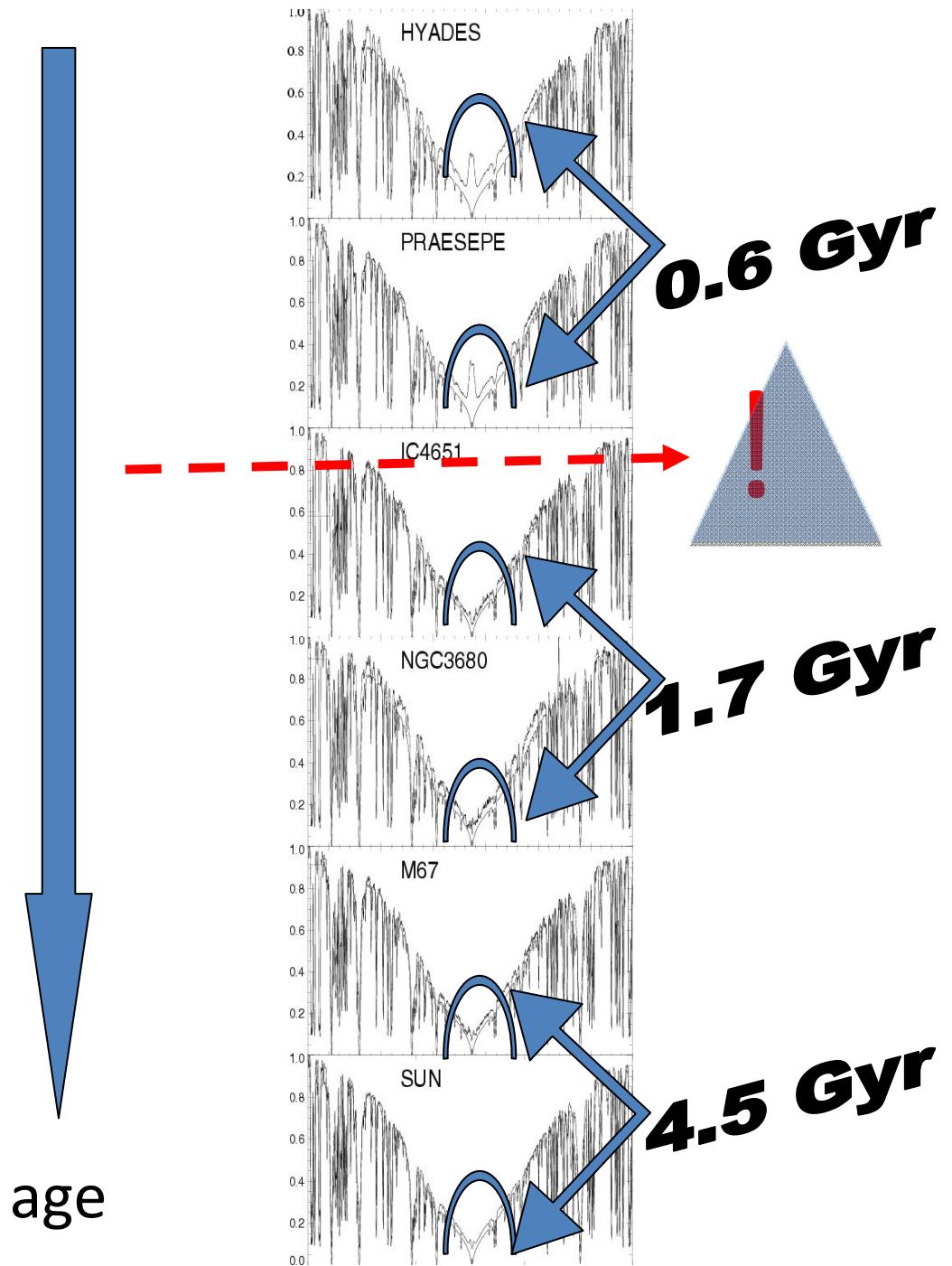
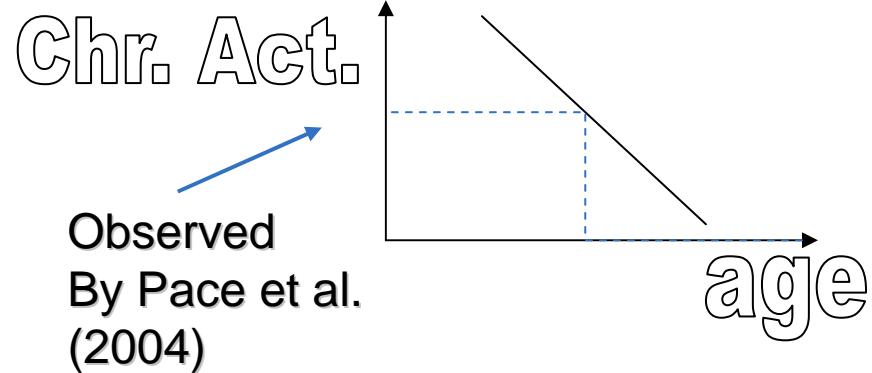
chromospheric activity

Pace et al. (2004)

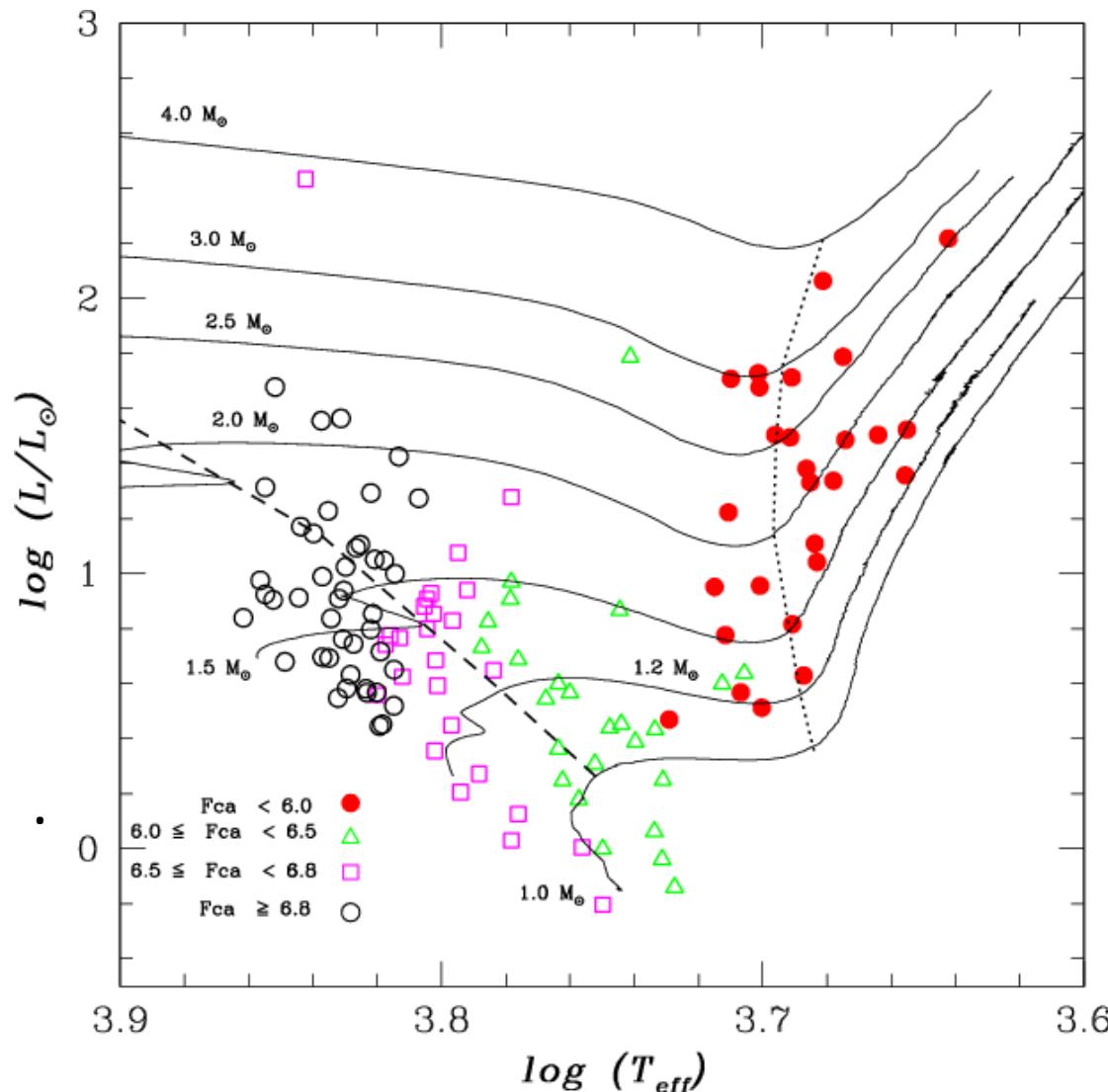
Average clusters Ca II K line spectra. The synthetic photospheric-solar model is super-imposed. In the bottom panel we plot the real solar spectrum, also super-imposed on its model. The effect of the back heating of the chromosphere is also evident outside the core.



chromospheric activity decay



Distribution of FCall in subgiant stars in the HR diagram.



- Luminosities from the HIPPARCOS parallaxes.
- Evolutionary tracks are shown for stellar masses between 1 and 4 compute with Toulouse-Geneva code.
- The dashed line indicates the beginning of the subgiant branch and the dotted line represents the beginning on the red giant branch

do Nascimento et al. A&A 405, 723-731 (2003)

COROT ERA...



DFTE

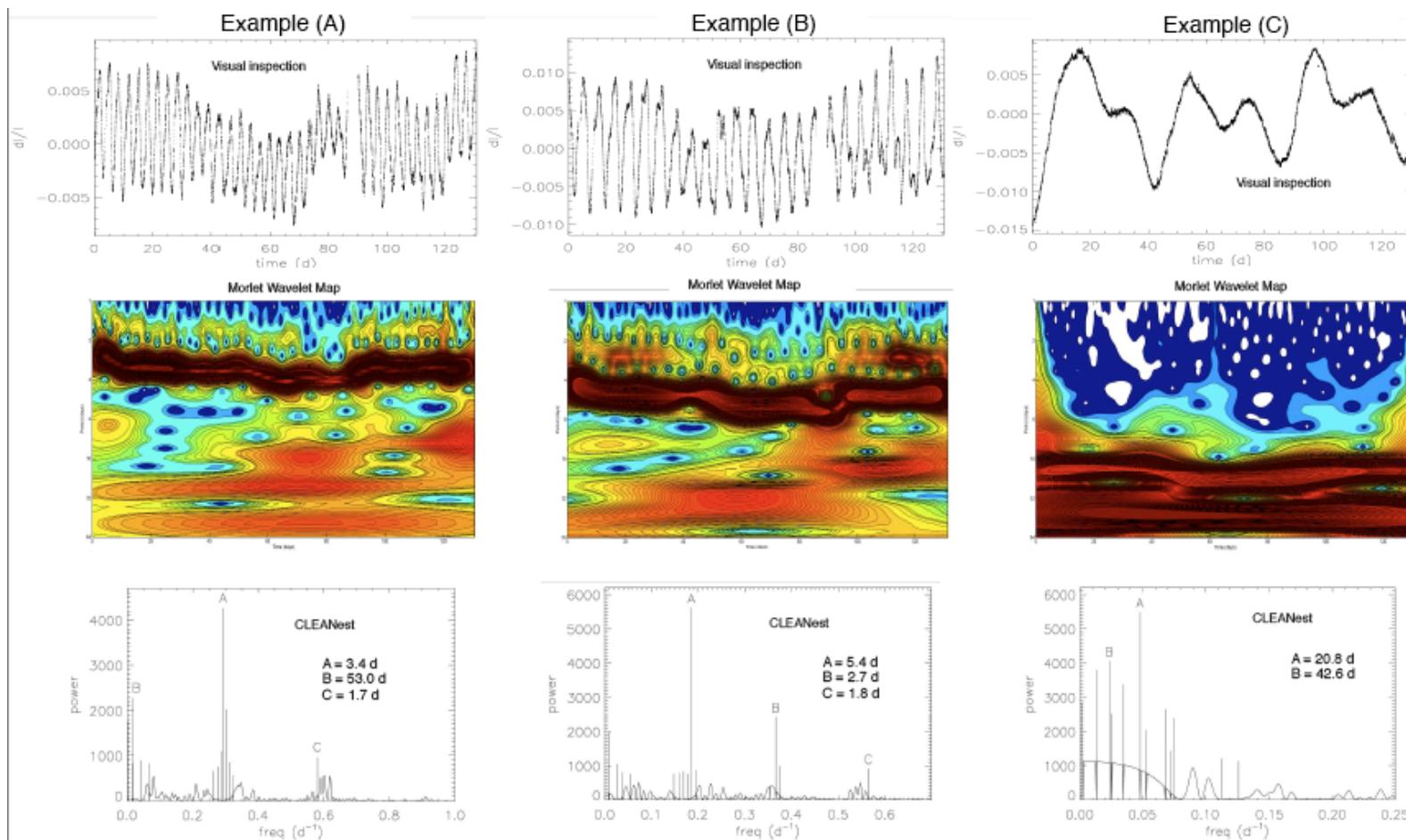
(Light Curves analysis: poster P-XII-114)



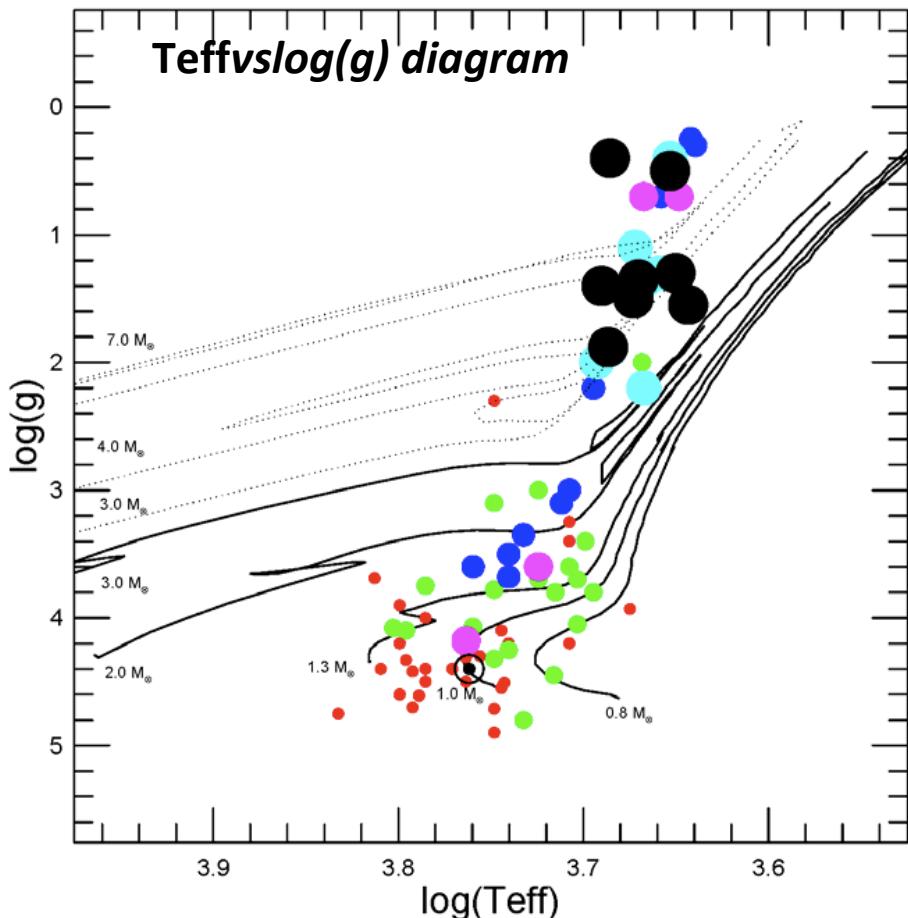
Determination of stellar rotation period from CoRoT data

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The distribution of Rotation Period from CoRoT light curves analysis



Evolutionary tracks with $Z=0.019$ (Solar) and $Z=0.004$ ($[Fe/H] \approx -0.8$) from Girardi et al. (2000)

Colors correspond to different Prot intervals.

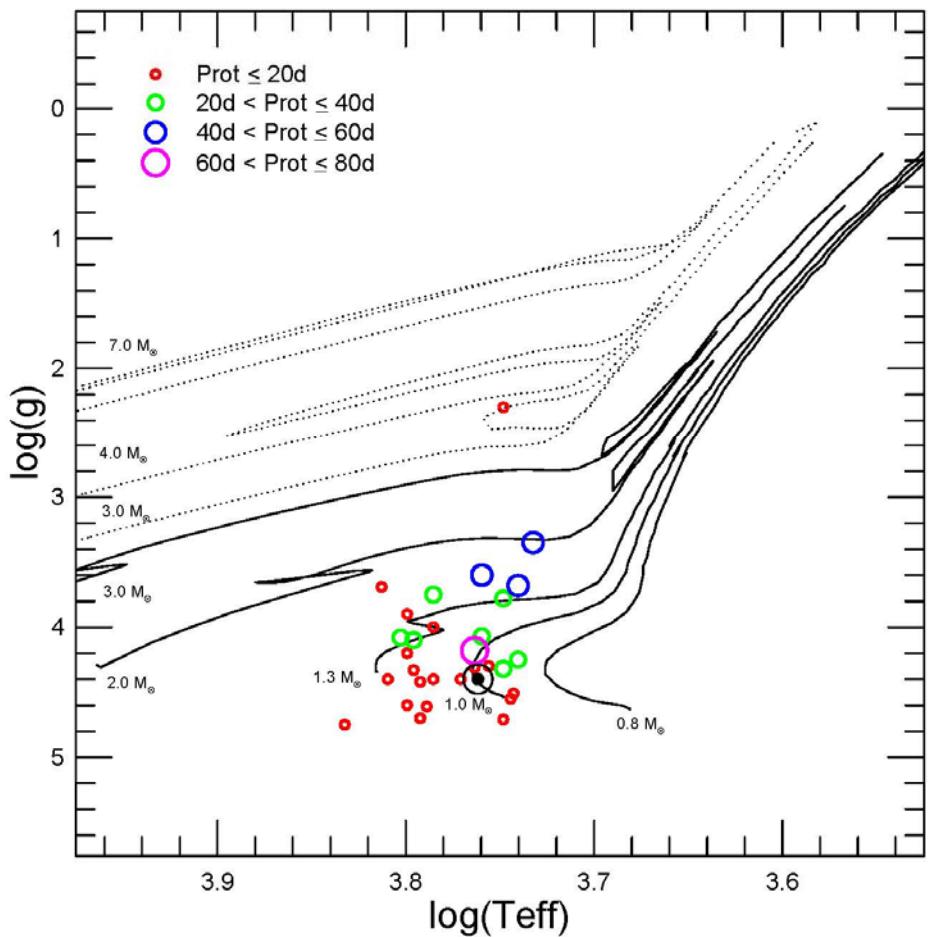
The Prot values were measured independently from Wavelet maps and CLEANest technique (poster P-XII-114).

Spectra for all stars ~ 2000 stars

- UVES/VLT-ESO
- Hydra/Blanco-CTIO

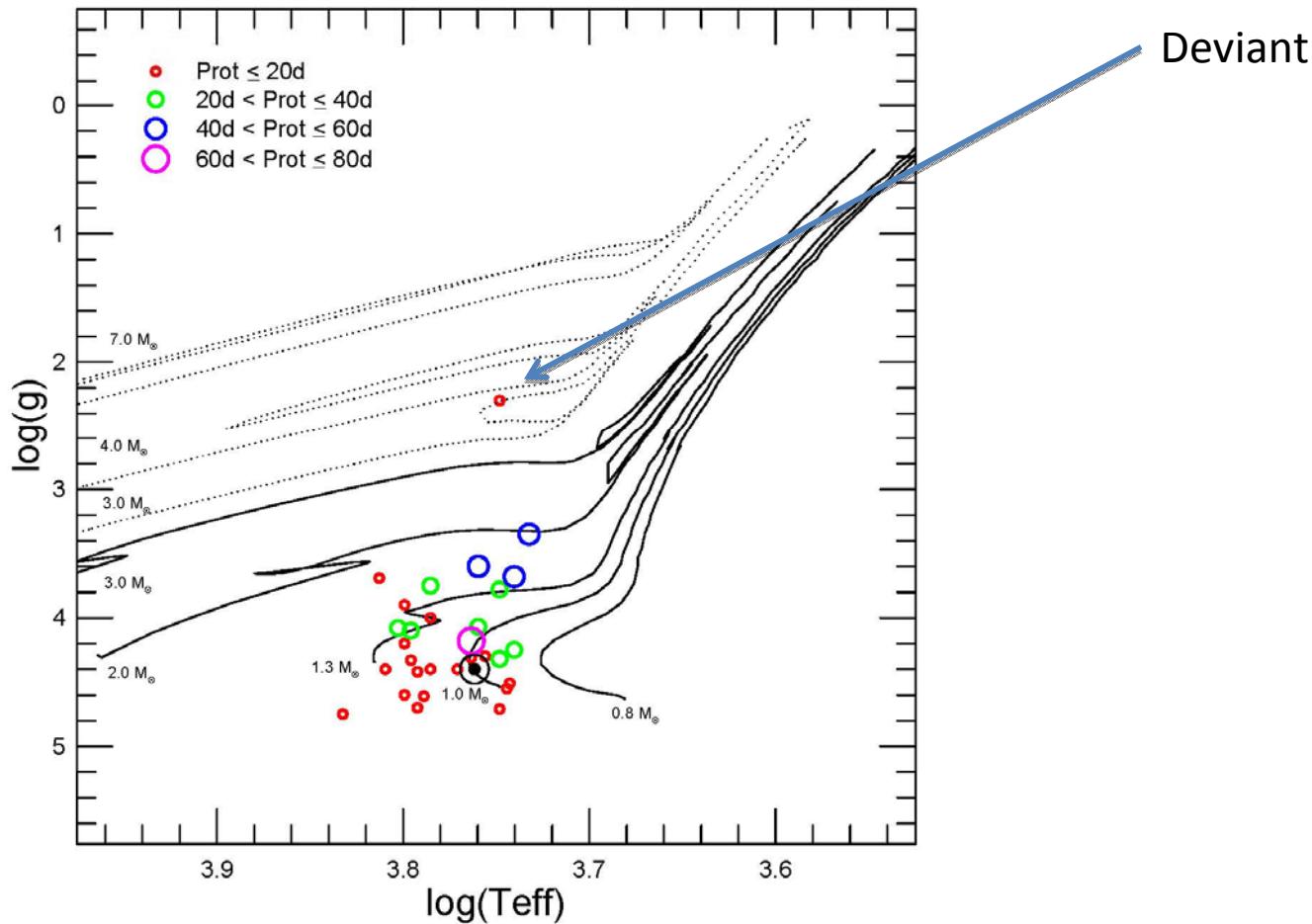
UVES Observations

Teff vs. $\log(g)$ diagram



The distribution of rotation period (Prot), from CoRoT light curves only for UVES OBSERVATIONS.

UVES@VLT



Teff vs. $\log(g)$ diagram

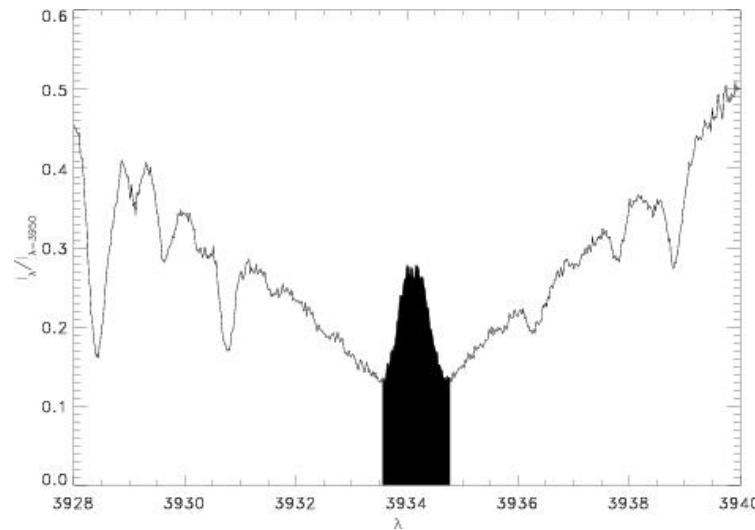
Indicator of Chromospheric Activity

Emission core of the Ca II K and H line

A index  Flux

High resolution and
high S/N spectra

**UVES at Kueyen VLT
Hydra/Blanco-CTIO**



Data Analysis

Observations were obtained with the UVES spectrograph at the VLT Kueyen telescope. The data were reduced using the UVES pipeline (Ballester et al. 2000), radial velocity corrected and finally co-added.

- Spectra normalization and rectification

All the Ca II data have been normalized to the 3950.5 Å pseudocontinuum (Catalano 1978).

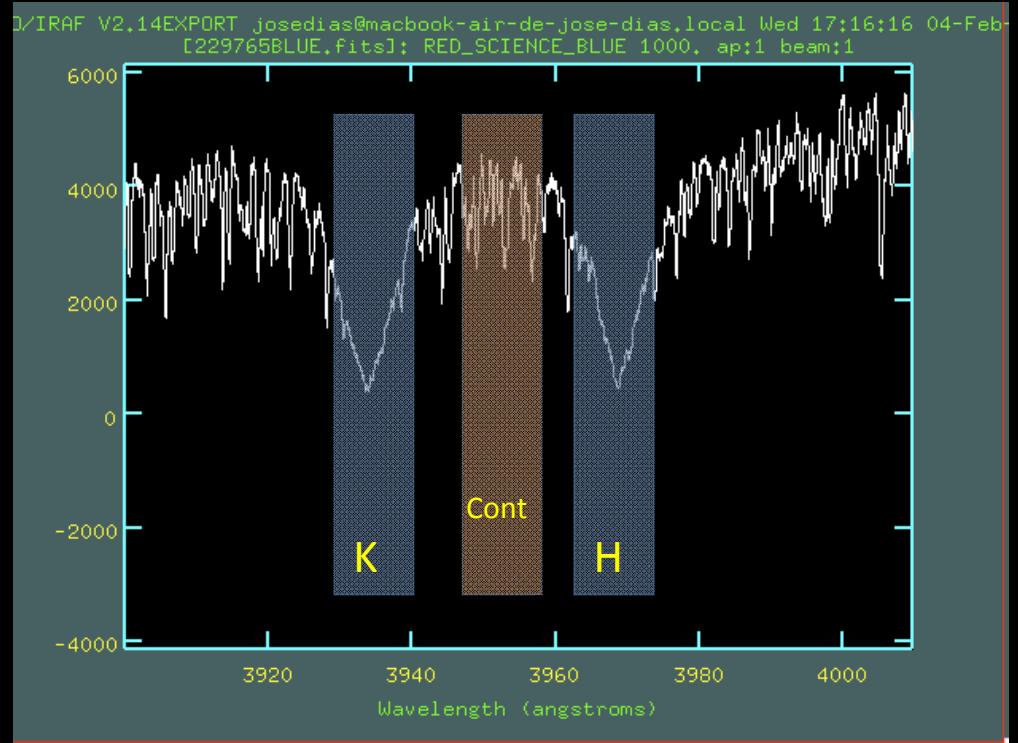
- Subtraction of the IS absorption

- Index measurement

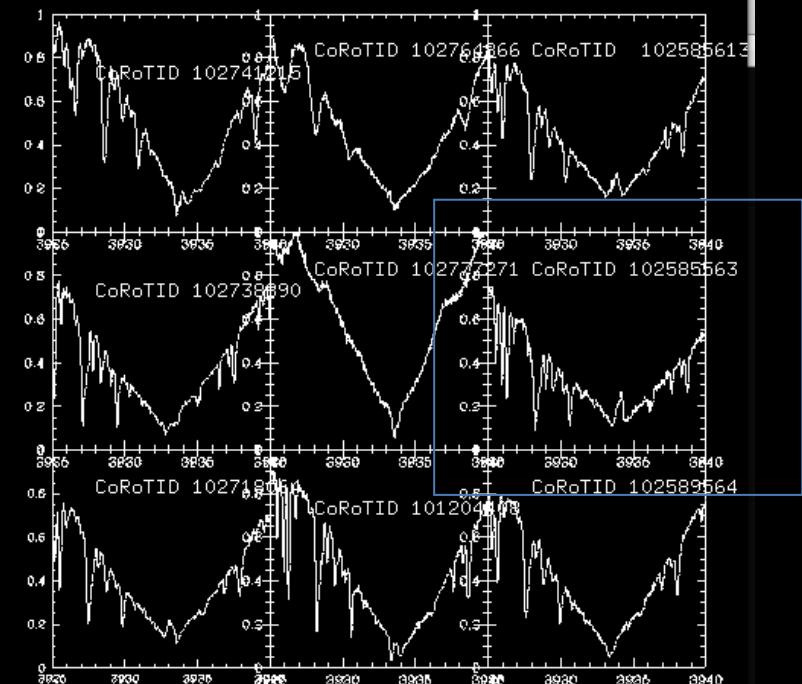
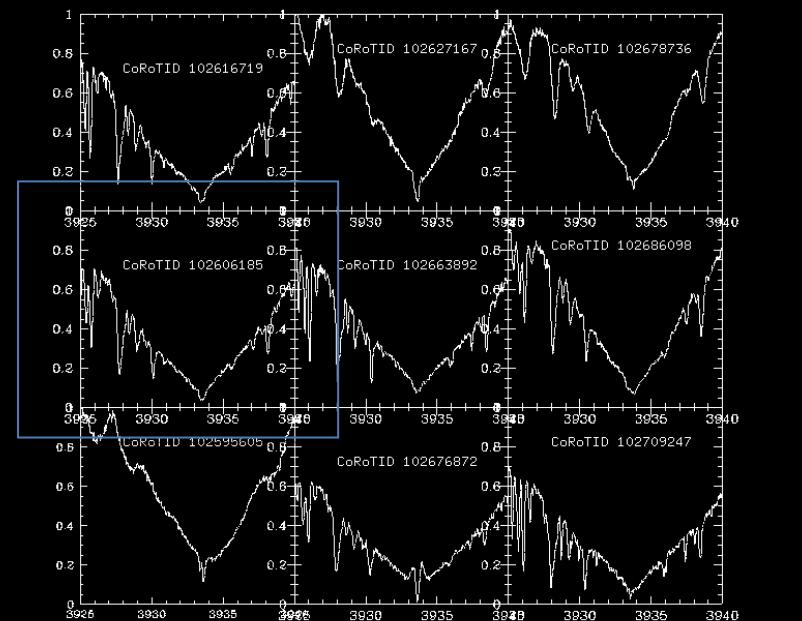
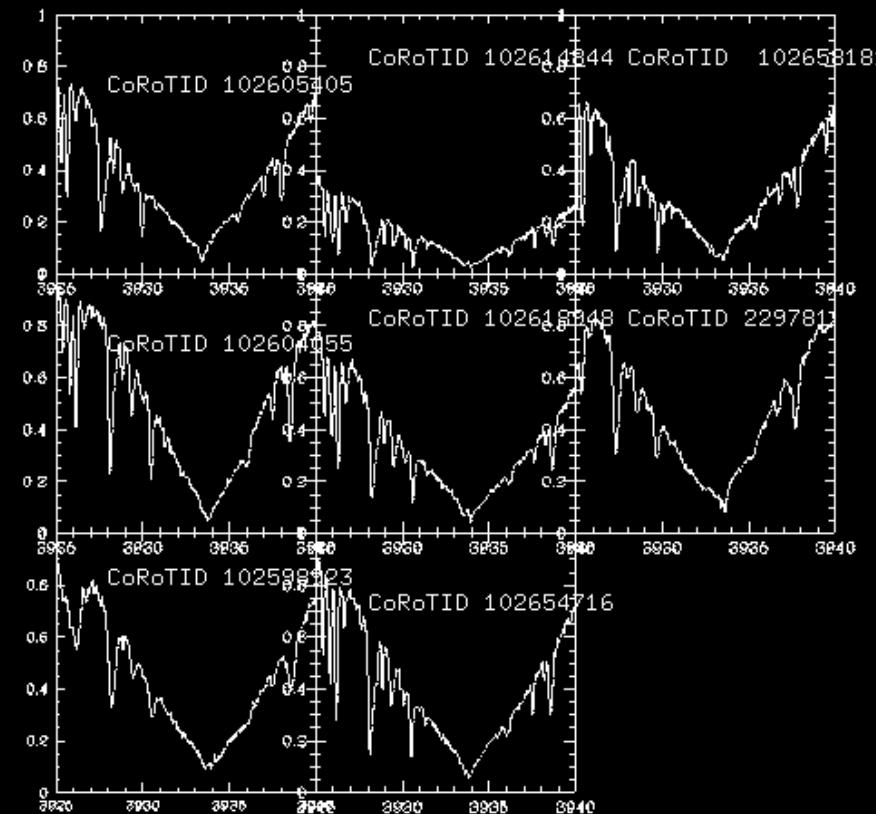
- Subtraction of the photospheric contribution

- Calibration in fluxes

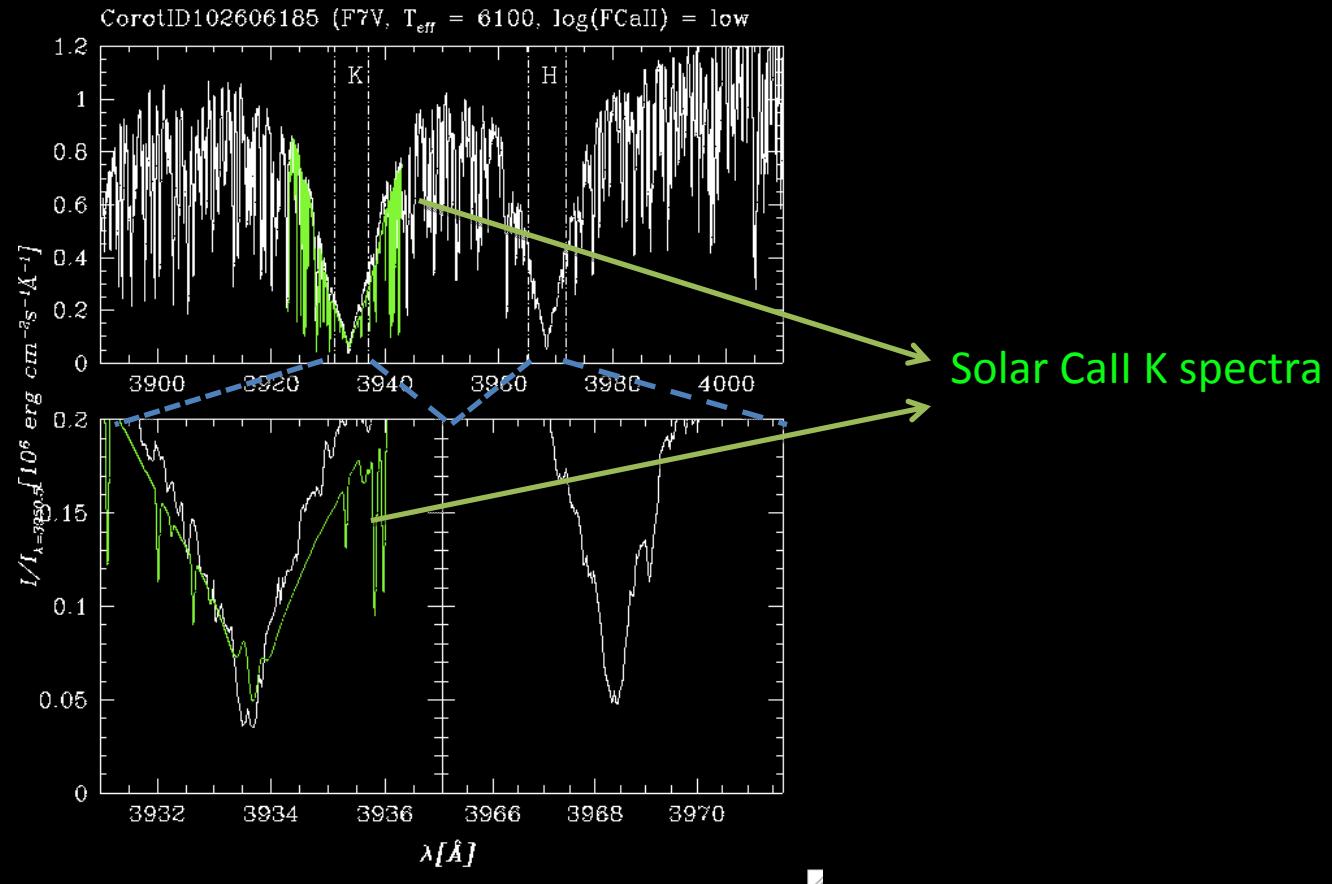
Data Analysis 1

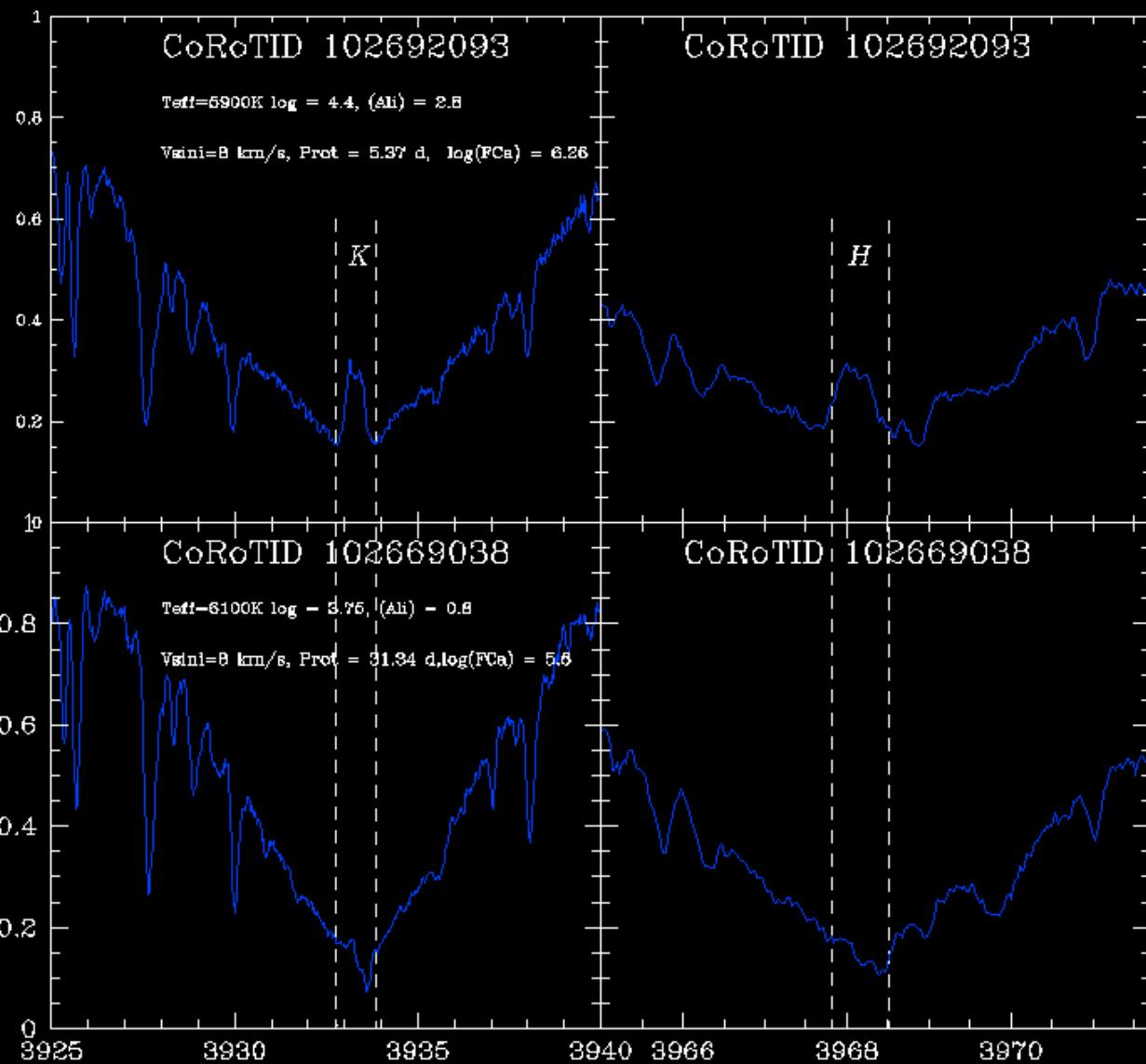


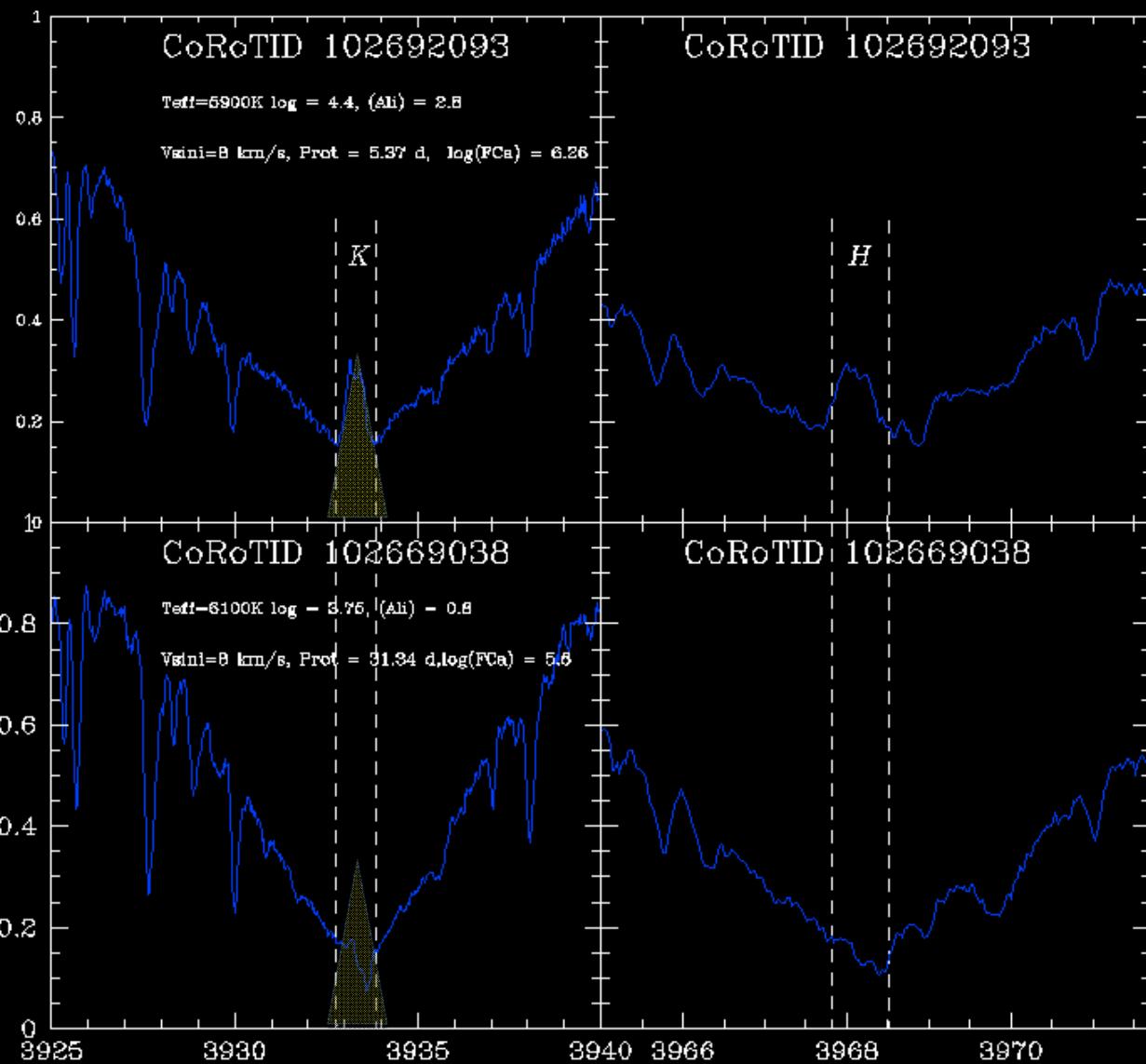
Data Analysis 2



Data Analysis 3



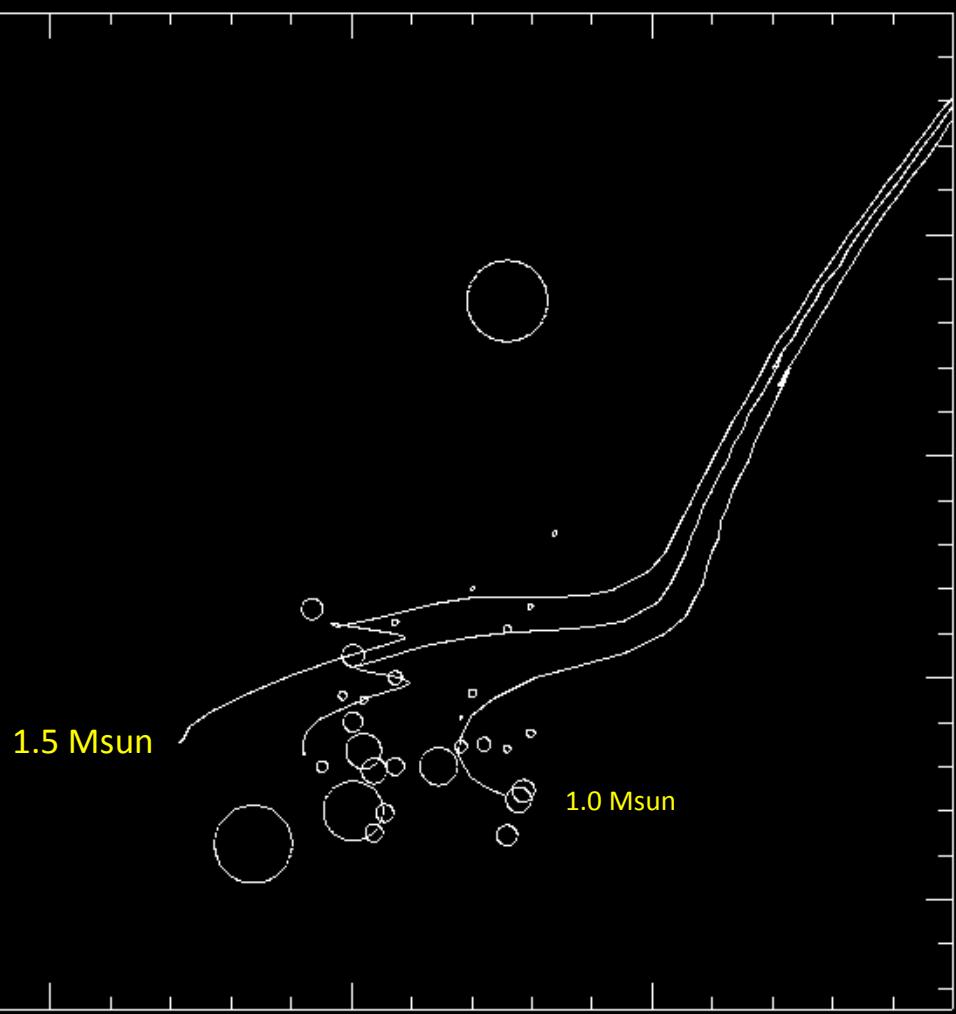




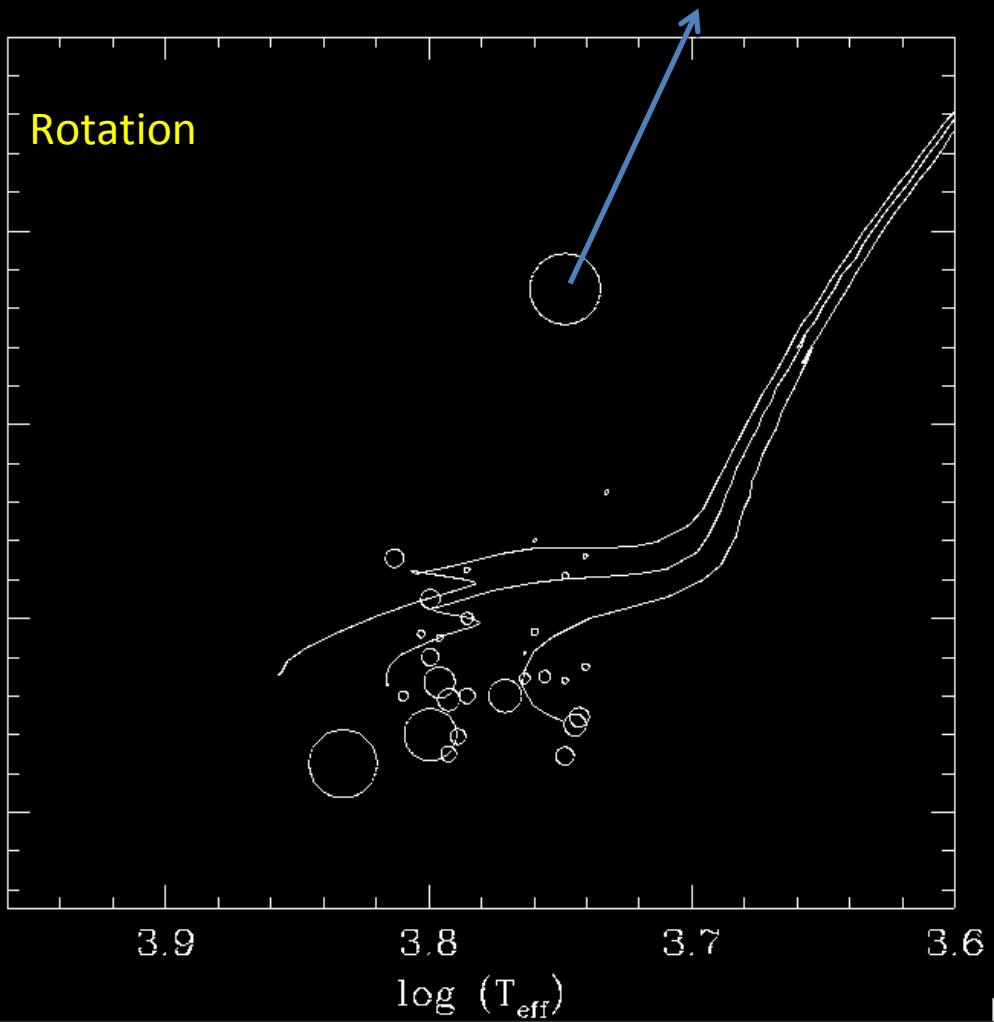
| <i>RUN(spec)</i> | <i>PROT</i> | <i>TEFF</i> | <i>Logg</i> | <i>Call HK</i> | <i>Vmic</i> | <i>A(Fe)</i> | <i>[Fe/H]</i> | <i>A(Li)</i> | <i>Vsini</i> | <i>[Fe/H]</i> |
|-------------------------|--------------------|--------------------|--------------------|-----------------------|--------------------|---------------------|----------------------|---------------------|---------------------|----------------------|
| UVES33NEWS | 4,105 | | NO LINES | ✓ | X | X | X | X | X | X |
| UVES33NEWS | 14,9 | 6100 | 4 | ✓ | 2,1 | 7,65 | 0,16 | ✓ | 9,5 | 0,16 |
| UVES33NEWS | 11,485 | 6200 | 4,7 | ✓ | 1,4 | 7,6 | 0,11 | ✓ | 6,1 | 0,11 |
| UVES33NEWS | 1,075 | High Rot | NoLine | ✓ | X | X | X | X | X | X |
| UVES33NEWS | 11,36 | 6150 | 4,61 | ✓ | 1 | 7,67 | 0,18 | ✓ | 3,2 | 0,18 |
| UVES33NEWS | 43,16 | 5400 | 3,35 | ✓ | 1,7 | 7,33 | -0,16 | ✓ | 11 | -0,16 |
| UVES33NEWS | | 5750 | 3,2 | ✓ | 6 | 6,66 | -0,83 | x | 17 | -0,83 |
| UVES33NEWS | | 6450 | 4,38 | ✓ | 1 | 7,54 | 0,05 | ✓ | 12 | 0,05 |
| UVES33NEWS | 29,3 | 5600 | 4,32 | ✓ | 0,9 | 7,79 | 0,3 | ✓ | 1 | 0,3 |
| UVES33NEWS | | 6330 | 4,72 | ✓ | 0,52 | 7,65 | 0,16 | ✓ | 9,8 | 0,16 |
| UVES33NEWS | 63,33 | 5800 | 4,18 | ✓ | 1,25 | 7,49 | 0 | ✓ | 3,8 | 0 |
| UVES33NEWS | 9,615 | 6500 | 3,69 | ✓ | 2 | 7,36 | -0,13 | ✓ | 17 | -0,13 |
| UVES33NEWS | 10,41 | 6300 | 4,2 | ✓ | 1 | 7,77 | 0,28 | ✓ | 19 | 0,28 |
| UVES33NEWS | | NO LINES | | ✓ | X | X | X | X | X | X |
| UVES33NEWS | 27,735 | 6250 | 4,1 | ✓ | 2,2 | 7,24 | -0,25 | ✓ | 1 | -0,25 |
| UVES33NEWS | 3,375 | 6300 | 4,6 | ✓ | 2 | 7,49 | 0 | ✓ | 10,5 | 0 |
| UVES33NEWS | | 5550 | 4,75 | ✓ | 1,3 | 7,45 | -0,04 | ✓ | 6 | -0,04 |
| UVES33NEWS | 5,72 | 6250 | 4,33 | ✓ | 2 | 7,39 | -0,1 | ✓ | 9 | -0,1 |
| UVES33NEWS | | NO LINES | X | X | X | X | X | X | X | X |

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Rotation



Unexpected Period



Teff : 5600 (3.7481)

Logg: 2.3

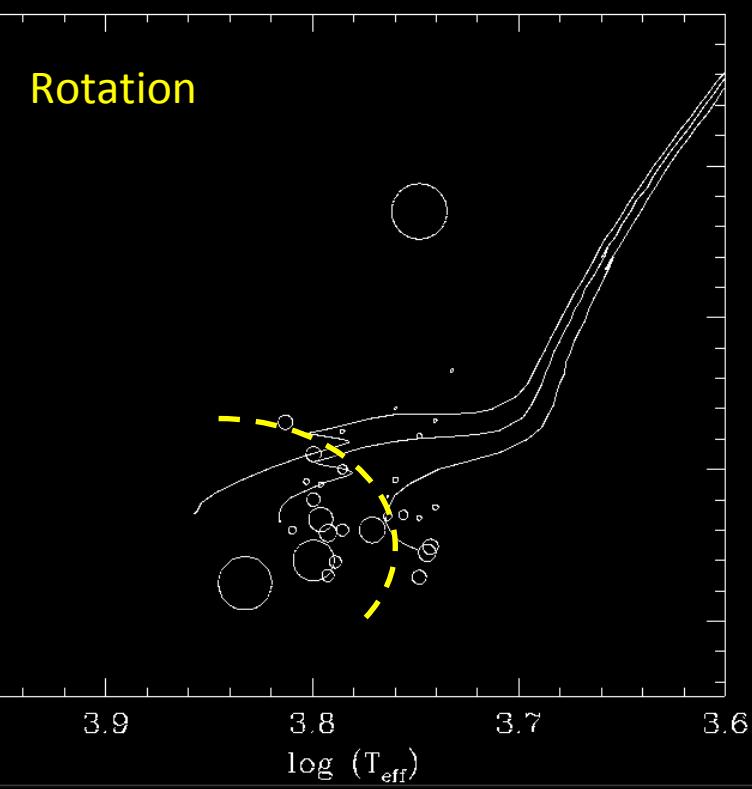
Vsin*i*: 12.5

Prot = 2.5 d

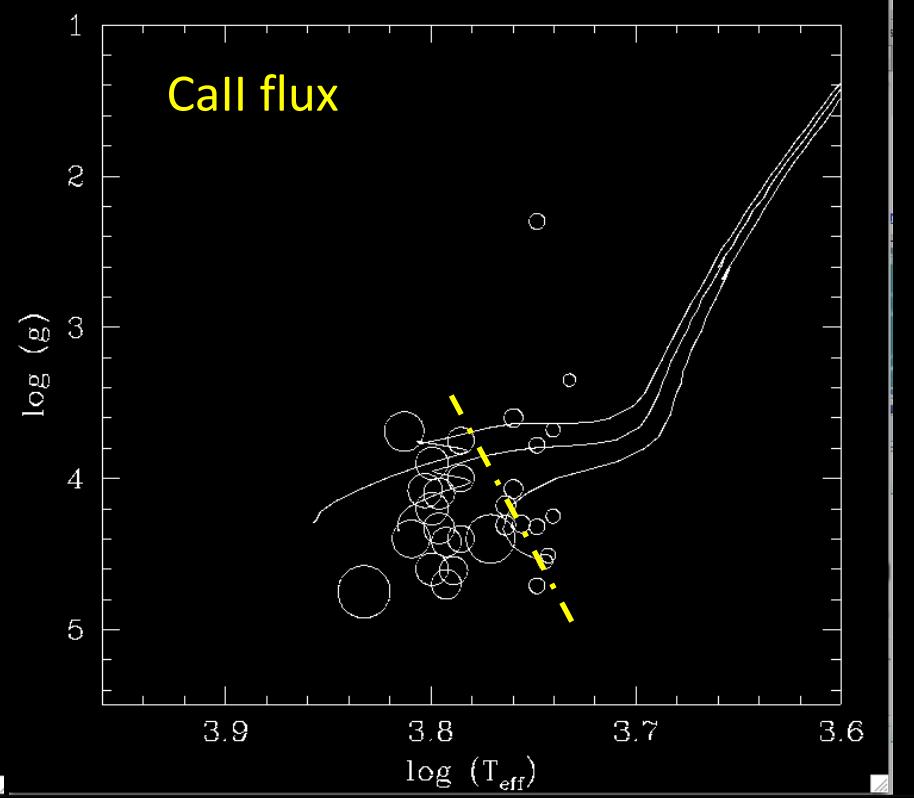
A(Li) < 1.7

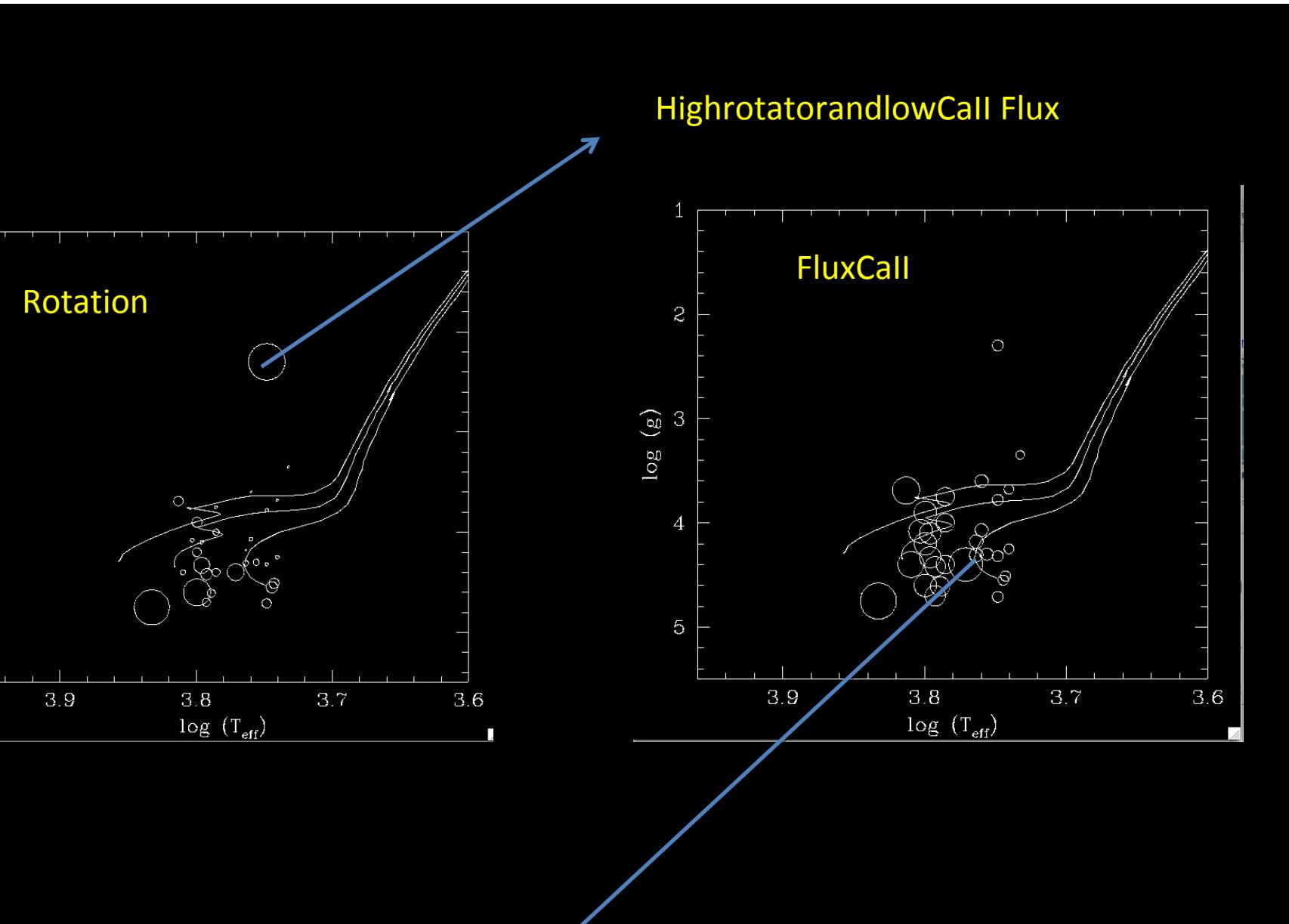
AGB Star ?

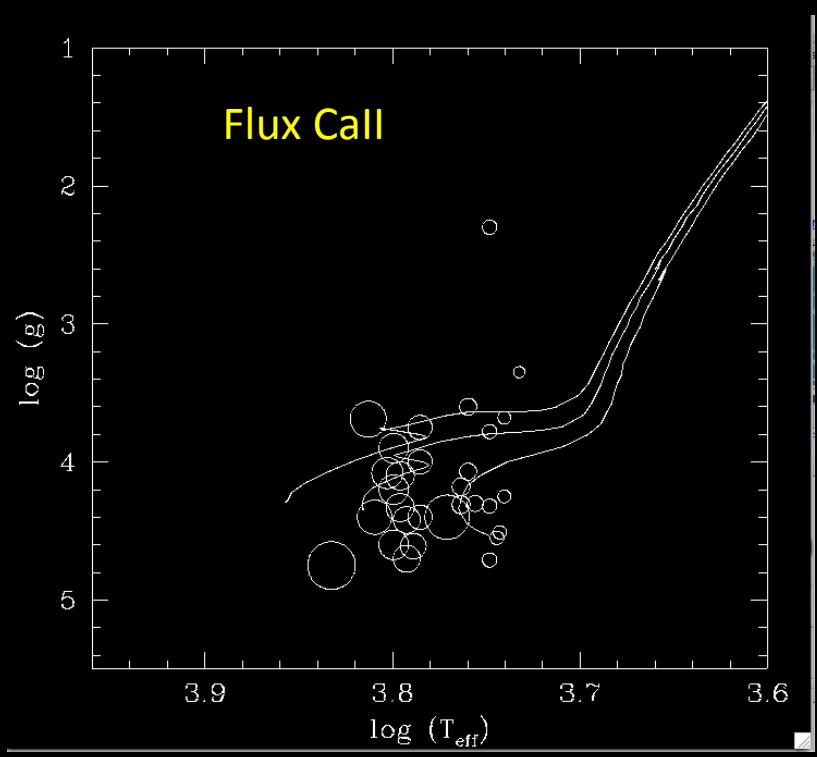
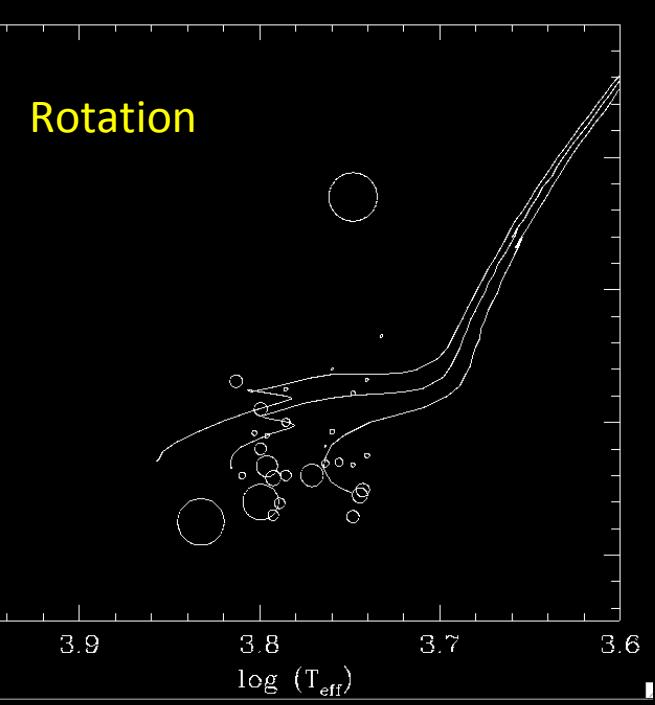
Rotation



Call flux







you!!

