GLOBAL HELIOSEISMOLOGY
SOLAR & STELLAR MAGNETISM

SpaceInn.eu

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WP4.1 GLOBAL HELIOSEISMOLOGY:

- To generate two novel solar magnetic activity proxies based on GOLF and VIRGO measurements using the luminosity variations and velocity perturbations induced by the active regions crossing the visible surface of the Sun.

- Compare the rising phases of solar Schwabe cycles 22, 23 and the current cycle 24, to uncover possible differences during this phase after the unusual behaviour of the Sun during the last magnetic-activity minimum.

DELIVERABLES

- Magnetic activity proxy for GOLF & VIRGO/SPM

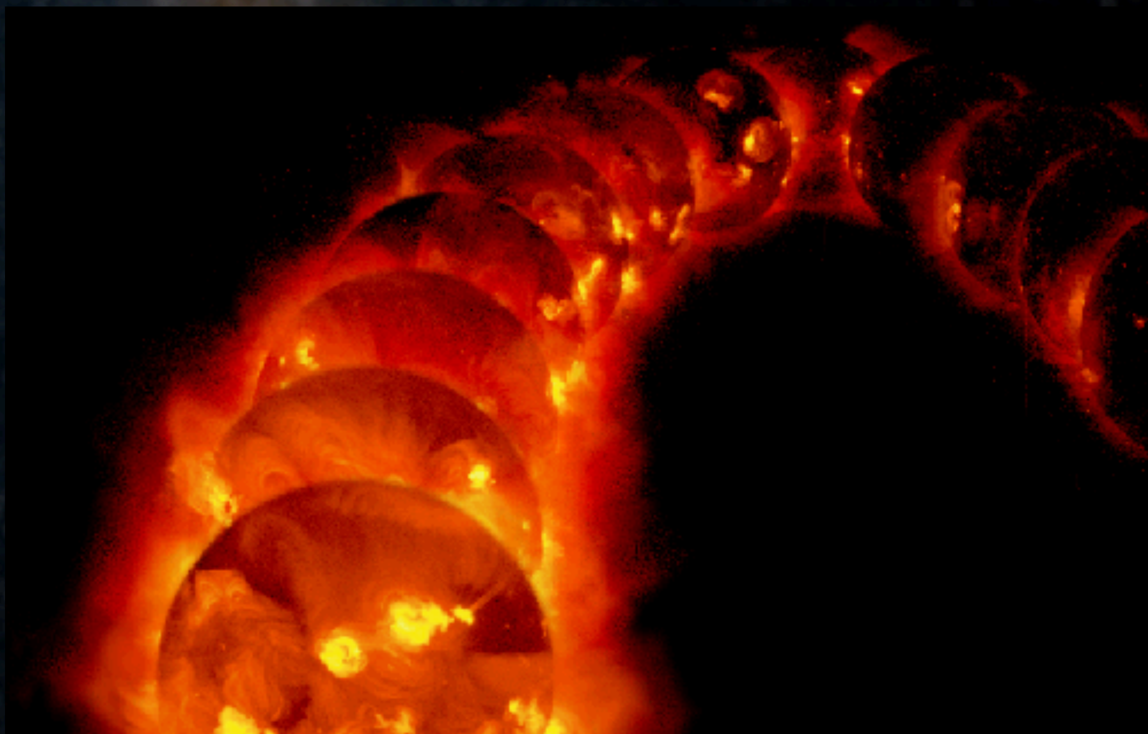
  [Garcia, Salabert, Mathur et al., 2013]

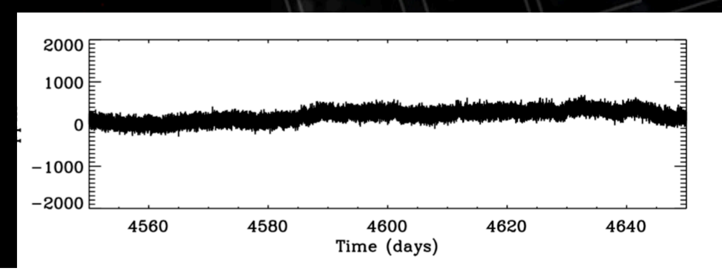
- Comparison of cycle 24 with previous ones

  [Basu, Broomhall, Chaplin & Elsworth, ApJ 758, 43]

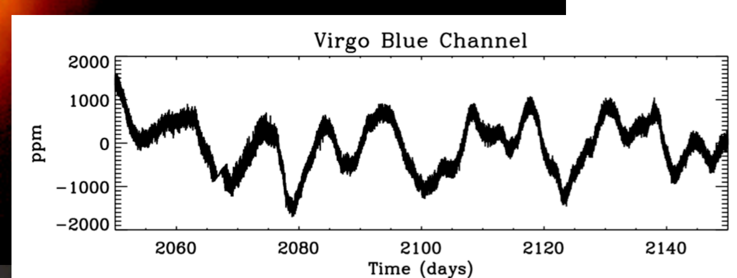
III SURFACE ROTATION

- When a star is magnetically active
    - Starspots crossing the visible disk of stars induce a modulation in the light curve





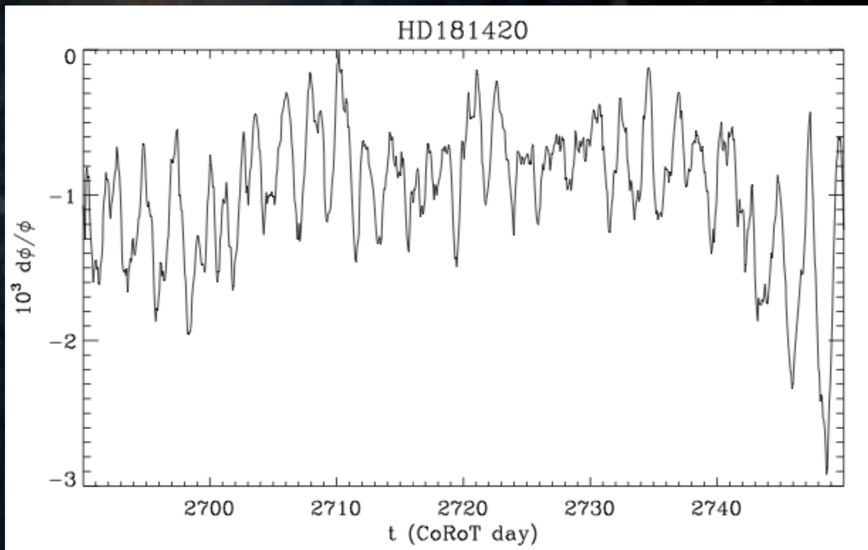
Solar Activity Minimum

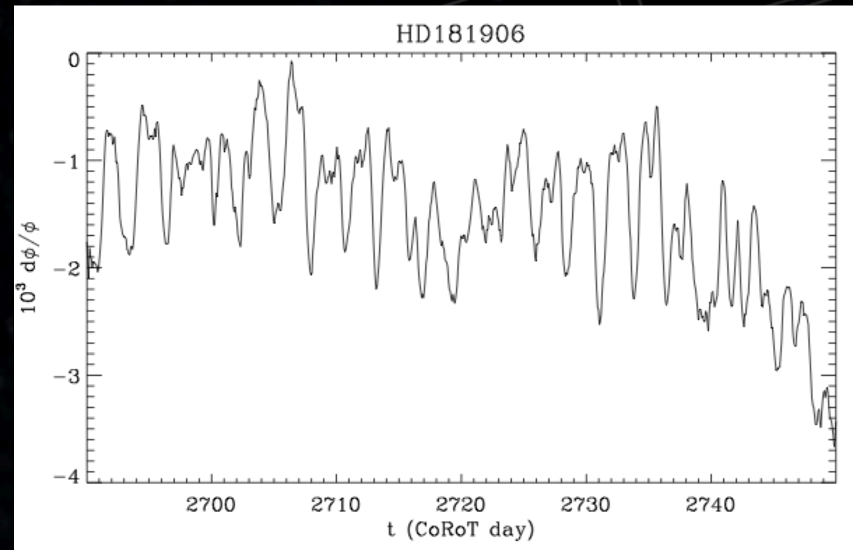


Solar Activity Maximum

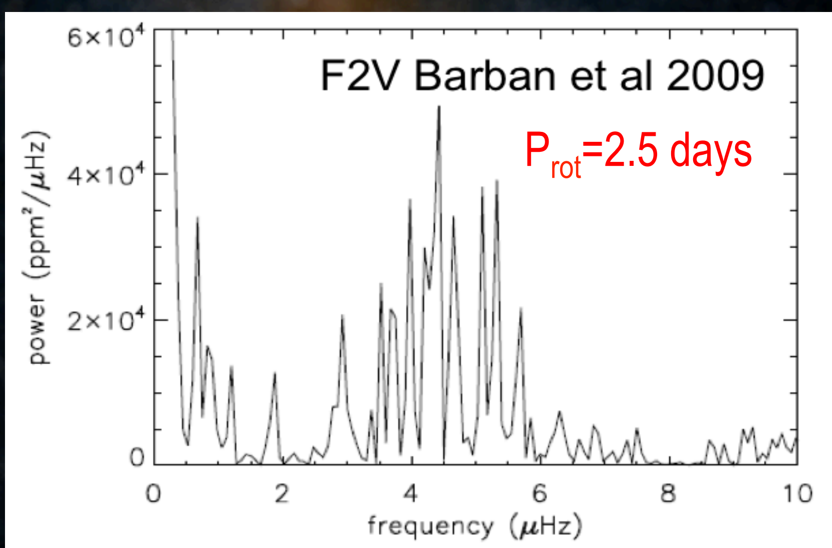
II-ROTATION (SURFACE)

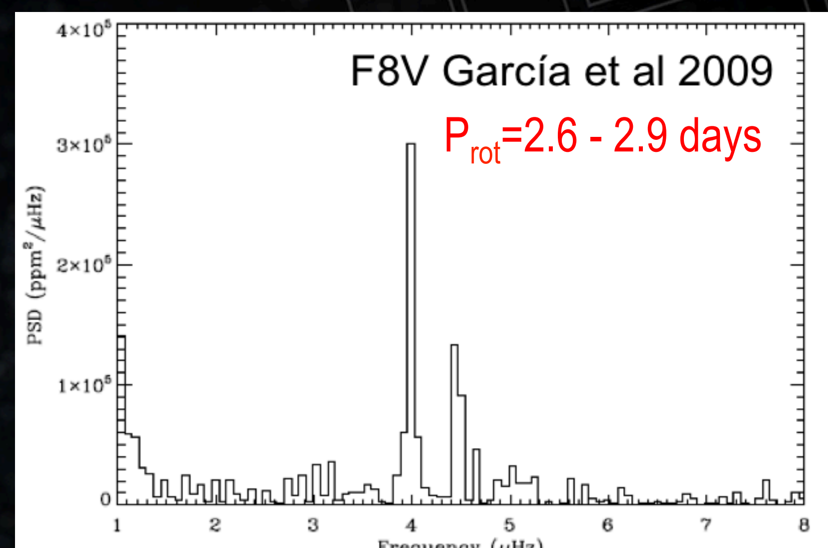
- Examples of two CoRoT F Stars





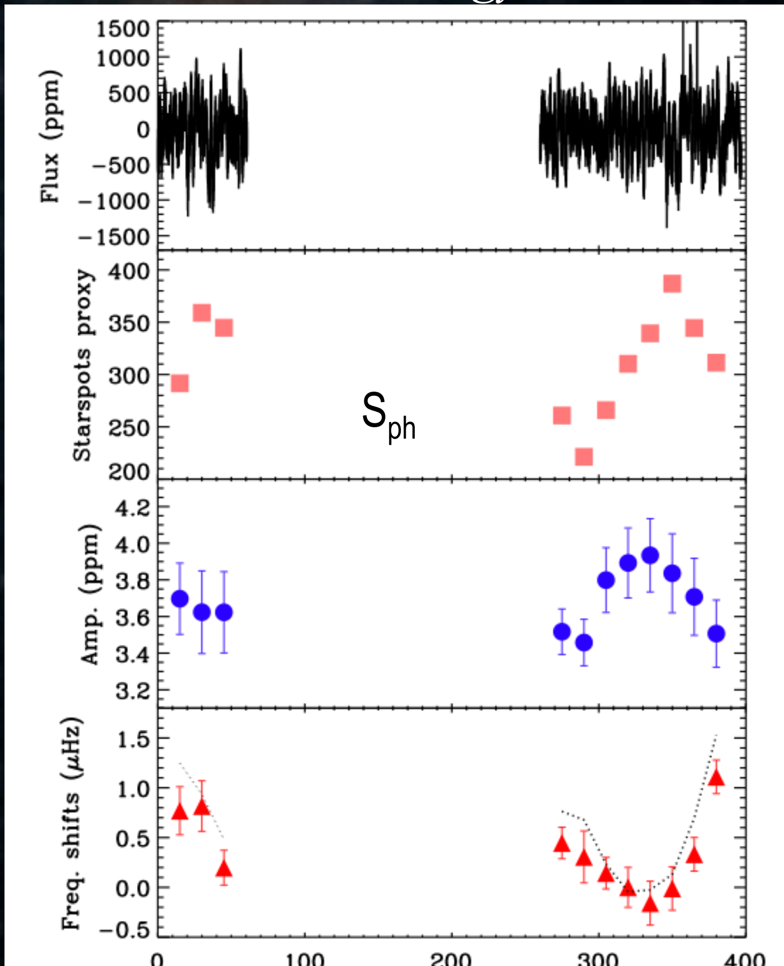
- Analysis of the low-frequency range of the periodogram





HINTS OF A MAGNETIC-ACTIVITY CYCLE

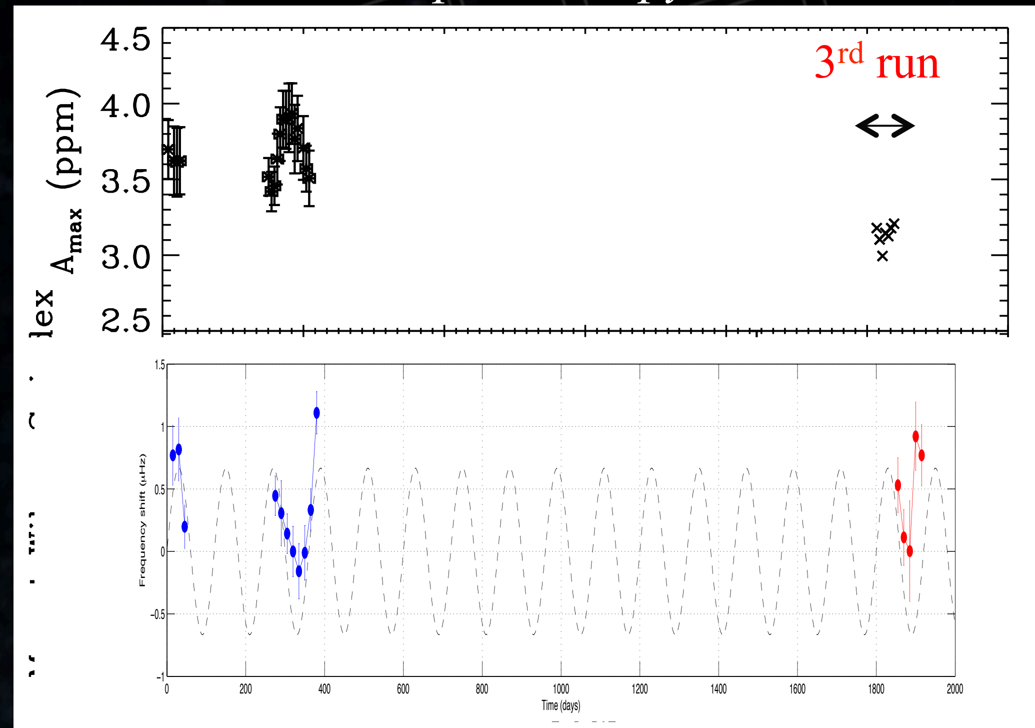
Seismology



[García et al. 2010]

HD49933

Spectroscopy



Anticorrelation between amplitude variation and frequency shifts

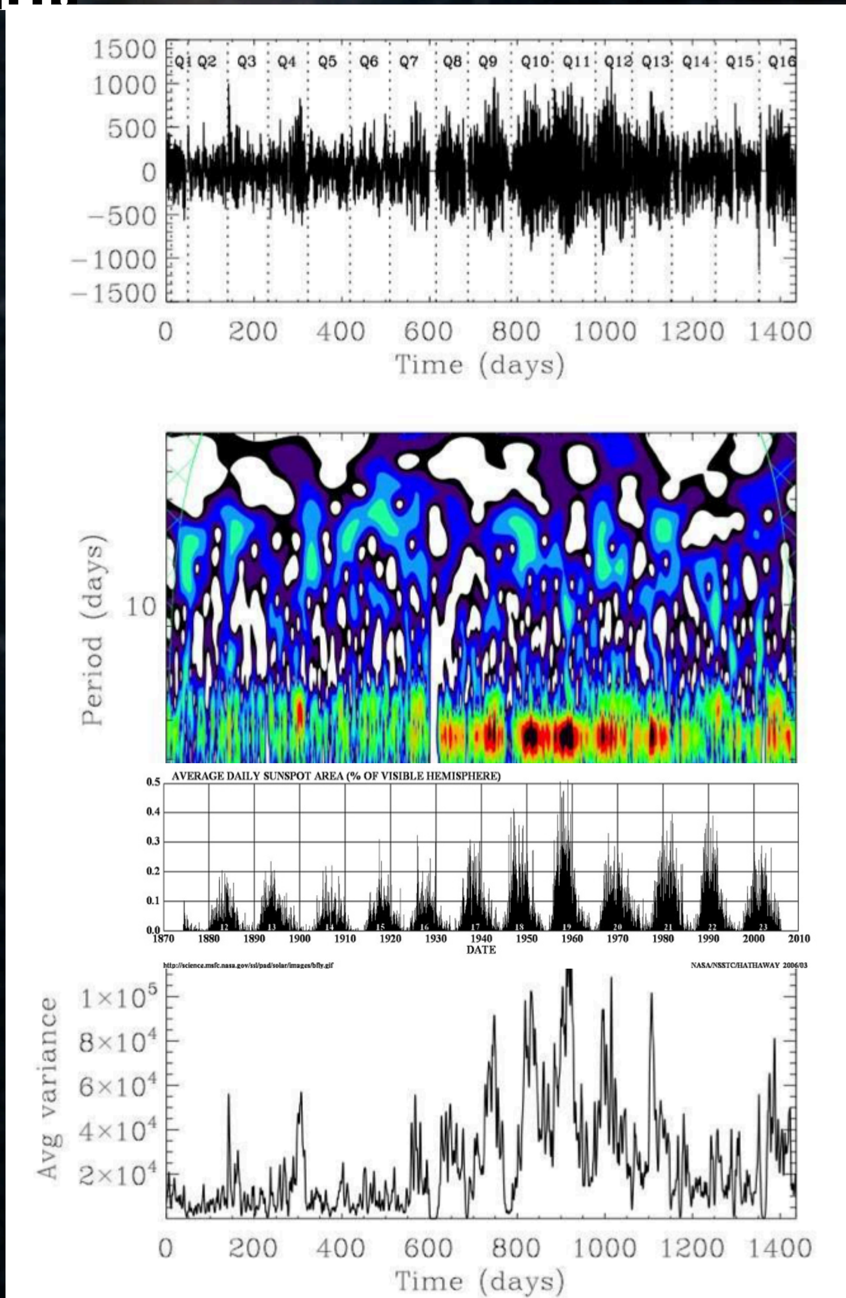
P_{cyc}>120days

- Complementary observations
  - ✓ Ca HK: Mount Wilson index of 0.31
    Active star

Modified S_{ph} also used by Chaplin et al. 2011

Campante et al. 2014

III-MAGNETIC ACTIVITY



Shere-Khan

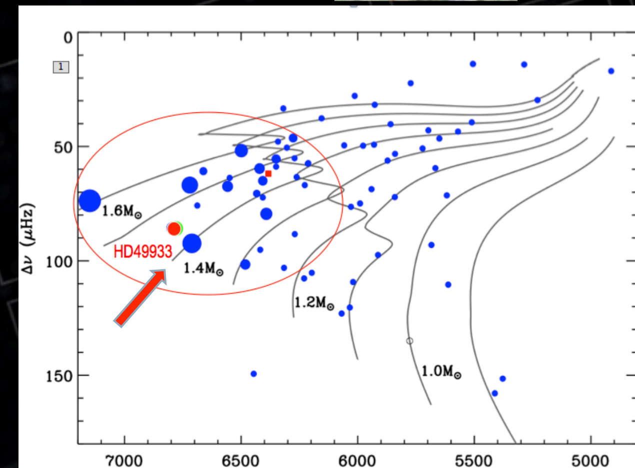
P_{rot}=2.5d

$\langle S_{ph} \rangle$ = 250 ppm

Asteroseismology:

M~1.4$M_\odot$

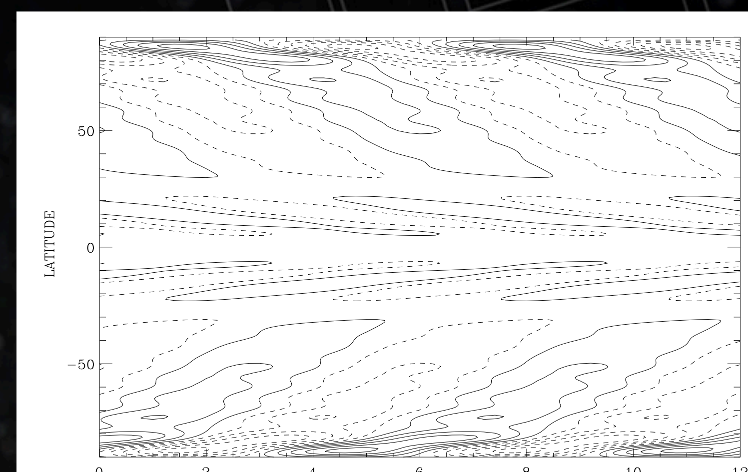
DCZ~1%



[Garcia et al. in preparation]

We observe:

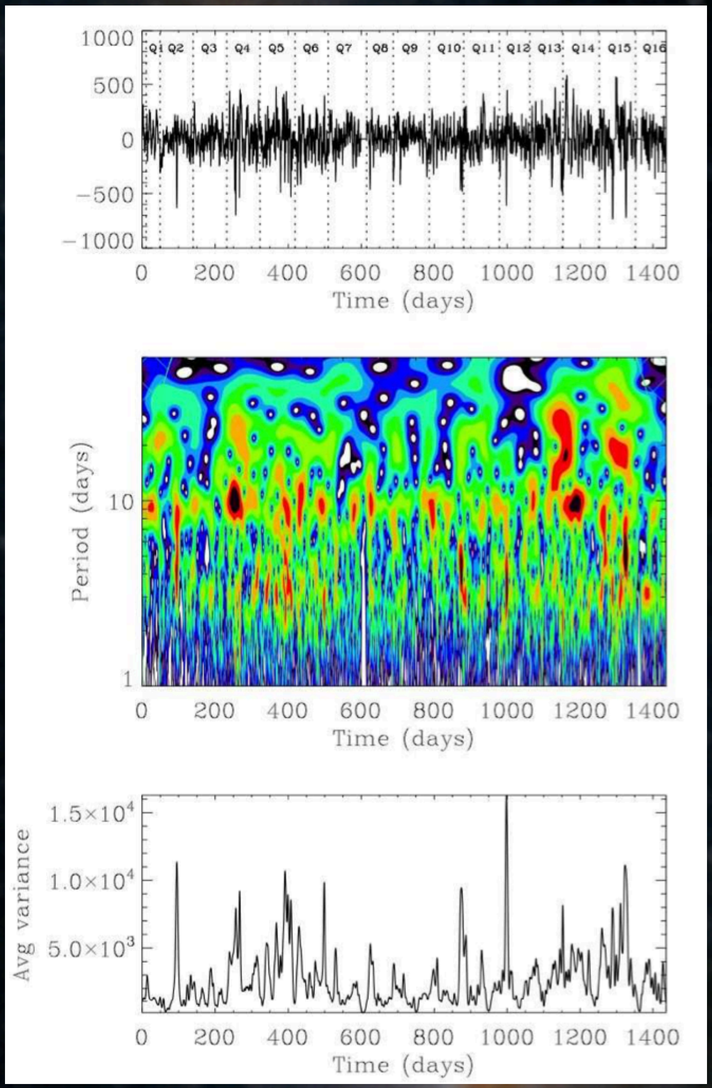
- Magnetic Cycle like behavior
- Presence of Active longitudes during maximum activity



García, Bonanno, Mosser et al. in preparation

[Mathur, Garcia, Ballot et al., ApJ, 2014]

III-NEXT STEP: 3D MODELS

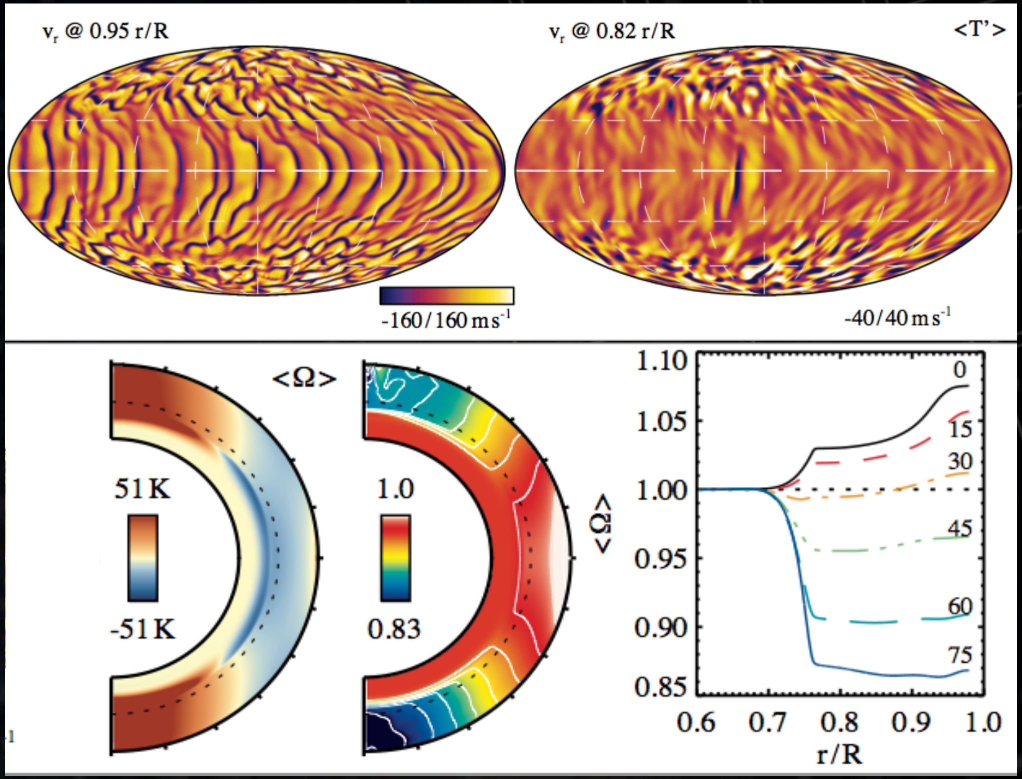


[Mathur, Garcia, Ballot et al. ApJ, 2014]

P_{rot}=9.5d
M~1.12$M_\odot$
$<S_{ph}>$ = 167.1 ppm
DCZ~20%

- Dushera
- 1D Seismic model
- 3D Model by ASH

Hidrodynamical models



[Augustson, Mathur, Brun et al. in prep.]

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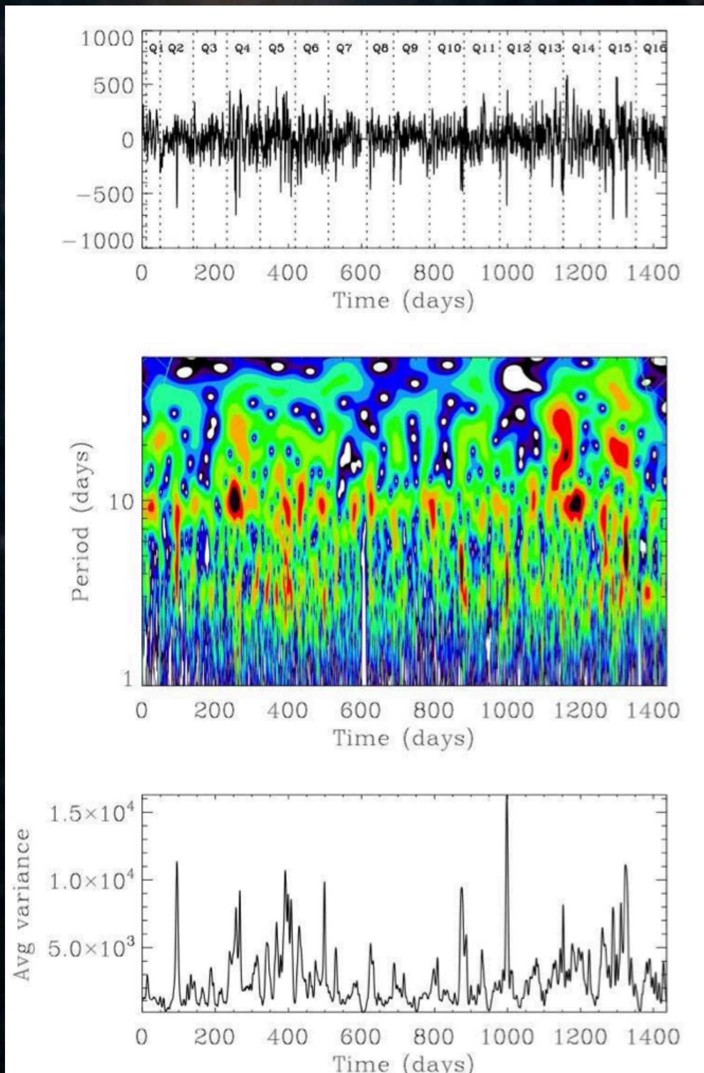
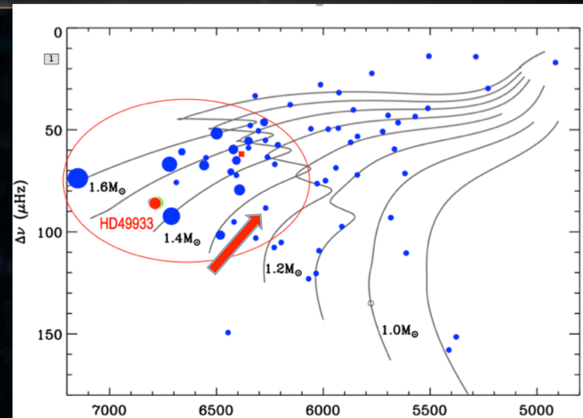
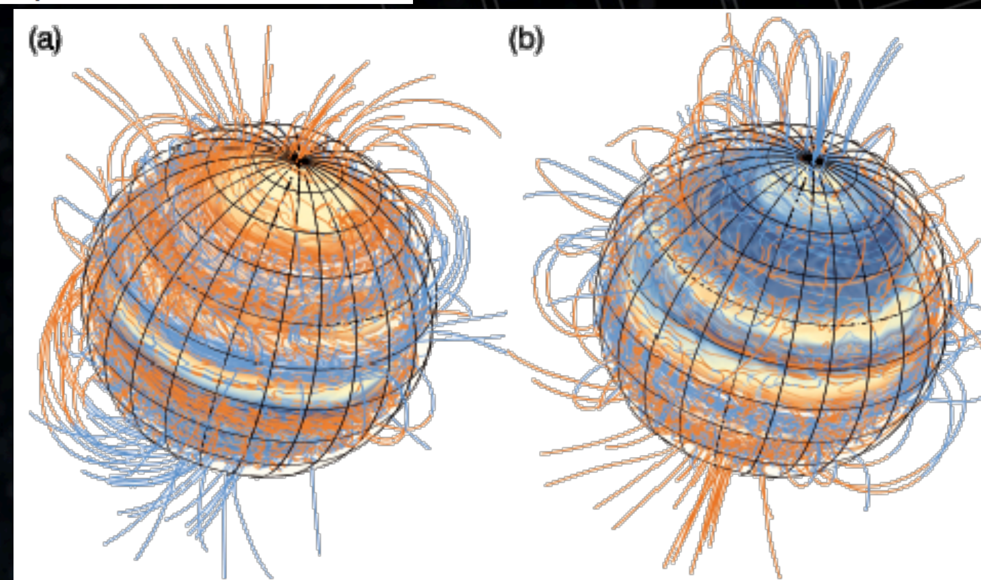


[Mathur, Garcia, Ballot et al. ApJ, 2014]



[Garcia et al. in preparation]

- Dushera
- 1D Seismic model
- 3D Model by ASH

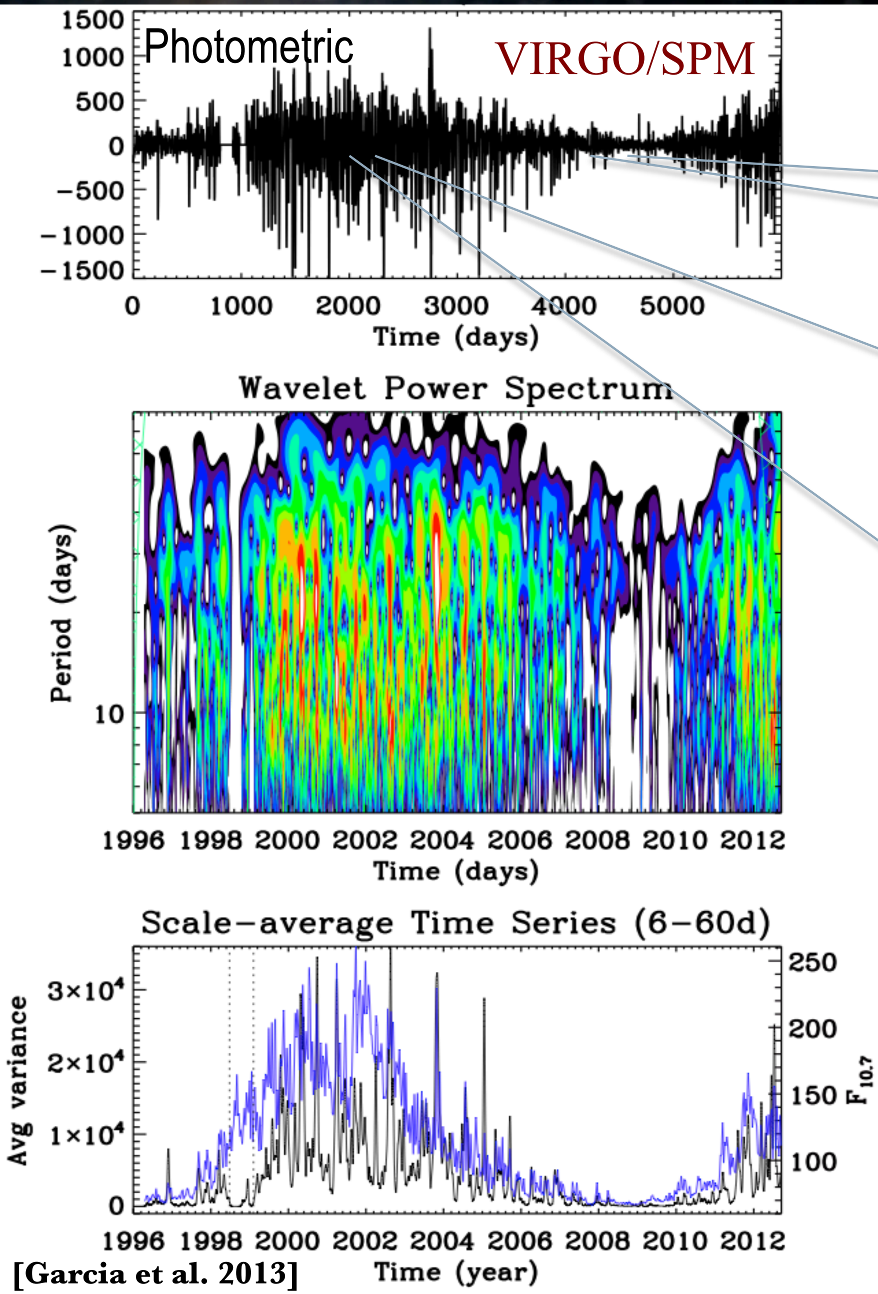


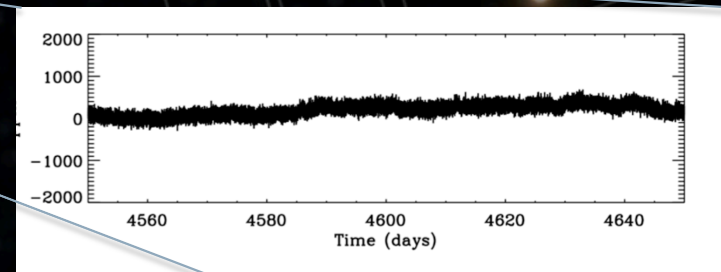
P_{rot}=9.5d
M~1.12$M_\odot$
$\langle S_{ph} \rangle$ = 167.1 ppm
DCZ~20%

[Augustson, Mathur, Brun et al. in prep.]

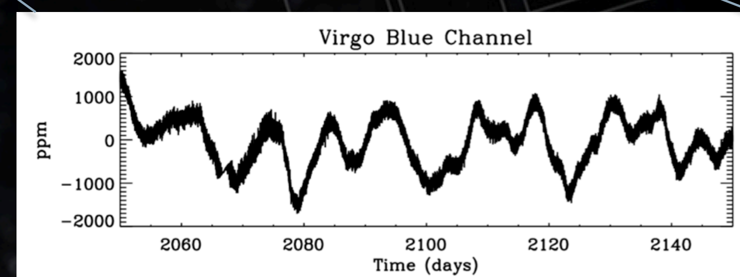
Preliminary results: a regular cycle has been established

III-STELLAR ACTIVITY



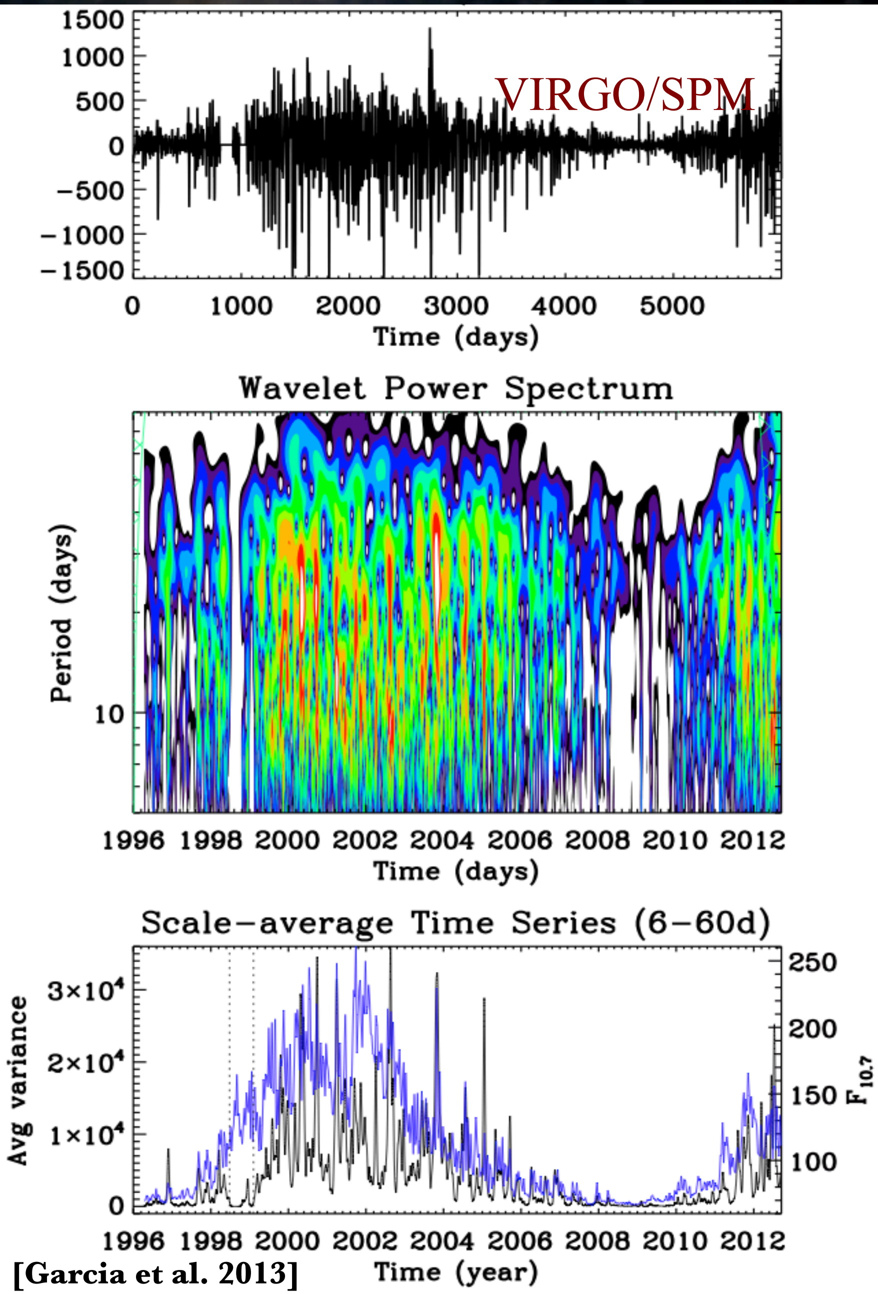


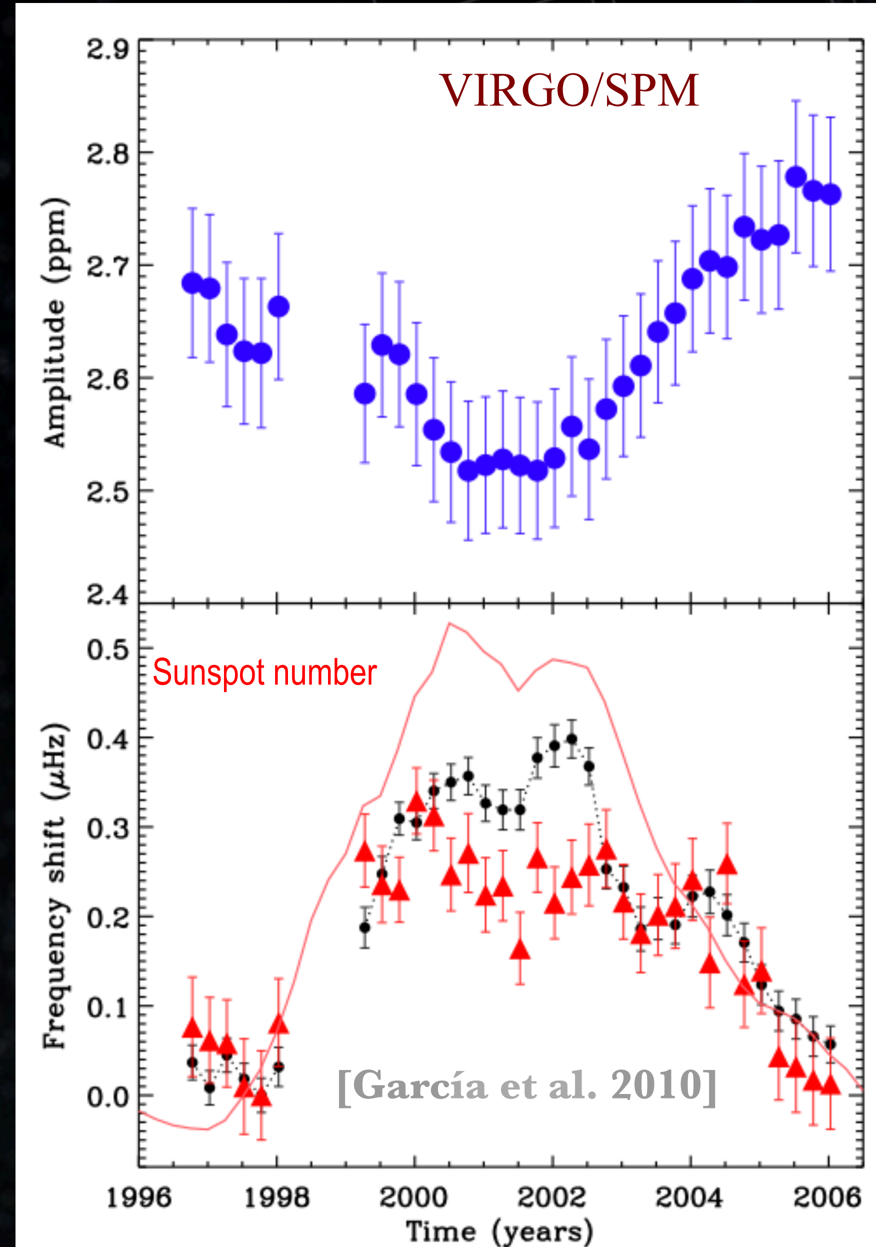
- Variance of the light curve (S_{ph})
  - Good proxy of the surface magnetic activity



[García, Salabert, Mathur et al. 2013]

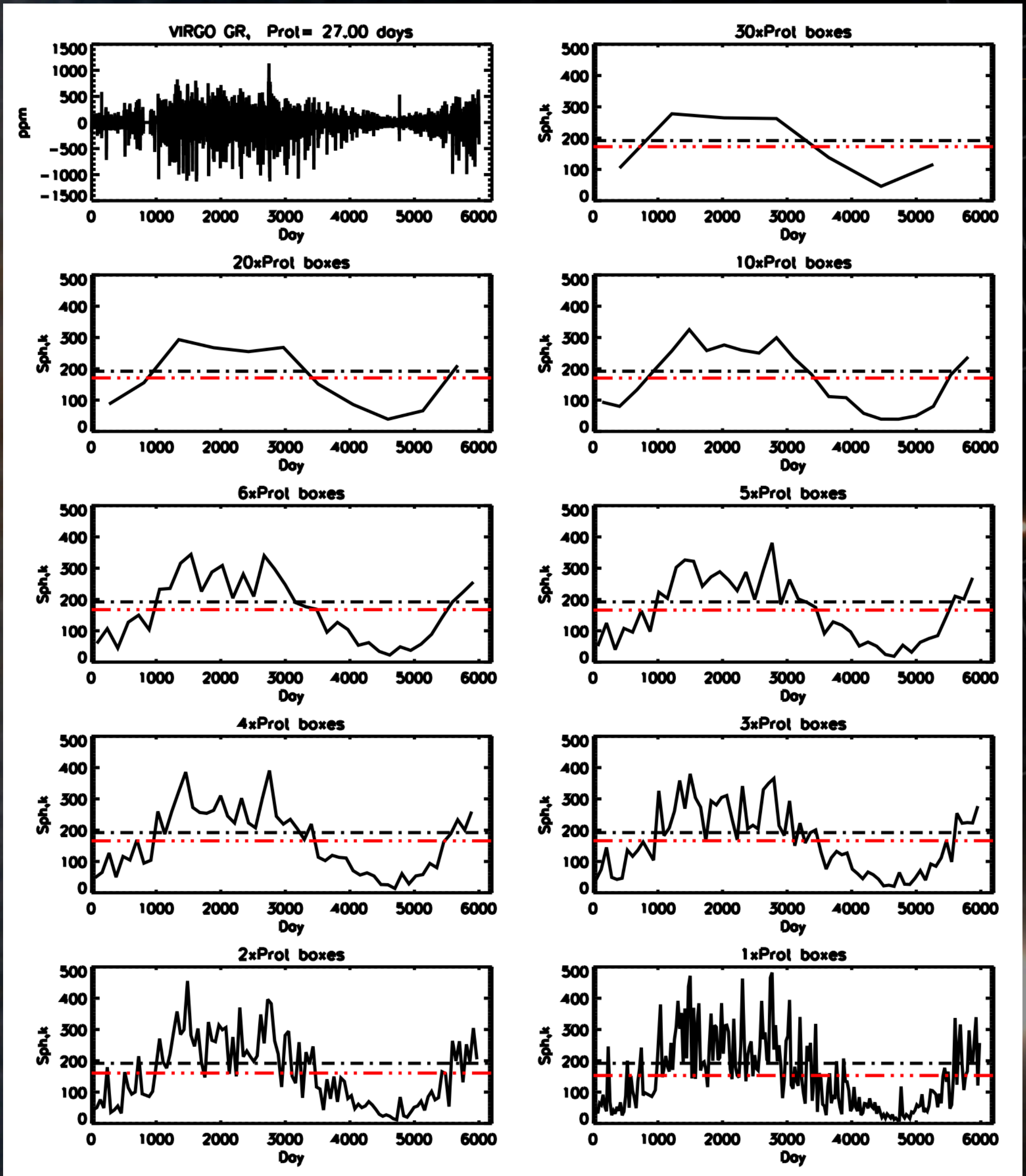
I-METHODOLOGY: THE SUN





V-Connexion between:

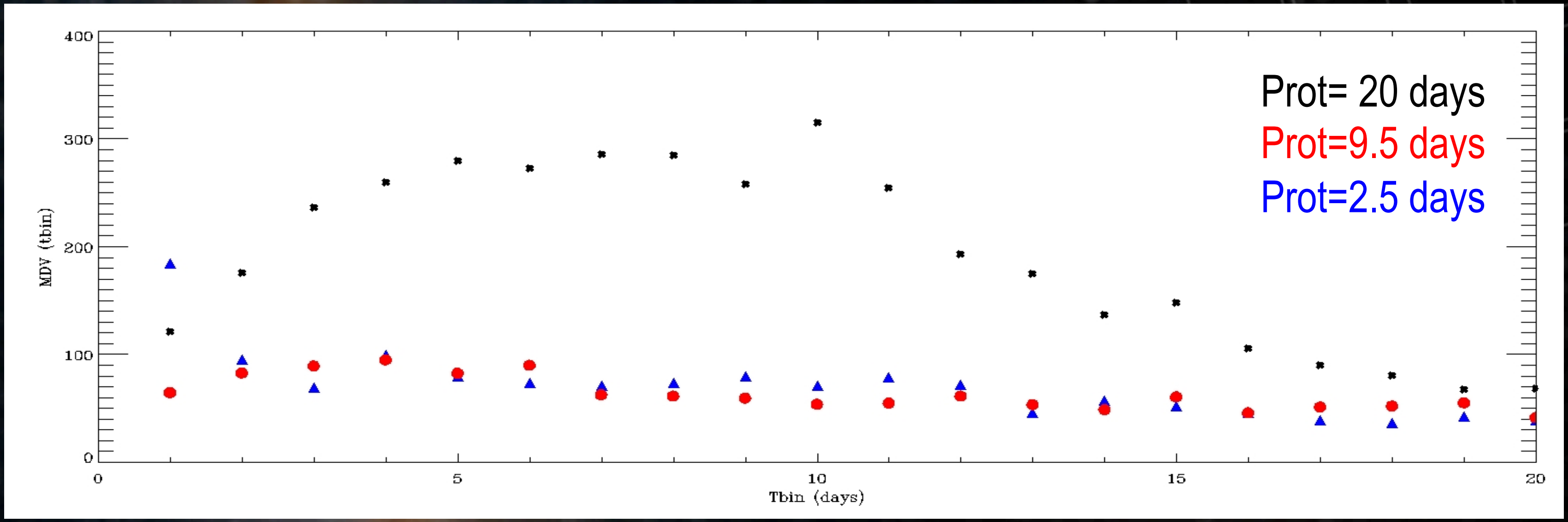
Rotation & the computations of magnetic activity proxies


VIRGO GR, Prot= 27.00 days
ppm
Day
30xProt boxes
20xProt boxes
10xProt boxes
6xProt boxes
5xProt boxes
4xProt boxes
3xProt boxes
2xProt boxes
1xProt boxes
Sph,k

V- ROTATION/ACTIVITY CONNECTION

- To study the photometric variability (Convection/pulsation/Magnetism) of a star:
  - It is common to parameterize the variability at a given time (e.g. rebinning the data)
  - Use as an activity proxy (driven by starspot coverage)
    - E.g. MDV (t_{bin}) (Median Differential Variability)
      - Median of the bin-to-bin variability for bins of a given timescale t_{bin}
    - This methodology is good to compare variability of stars at different timescales
  - Problem when used as an activity proxy
    - unless for each star t_{bin} is selected according to its P_{rot}

[Basri et al. 2013]



WORK TO DO

- Solar Case:
  - Produce in a regular basis the S_{ph} for GOLF and VIRGO/SPM
    - Link to the SPACEINN portal (Month #24, End 2014)
  - Should we also provide:
    - Frequency shifts?
    - Amplitude Variations?
  - Comparison of solar cycle #24 with previous ones
    - Month #36 (End 2015)
    - Better to wait till summer 2015 to have longest coverage of the cycle

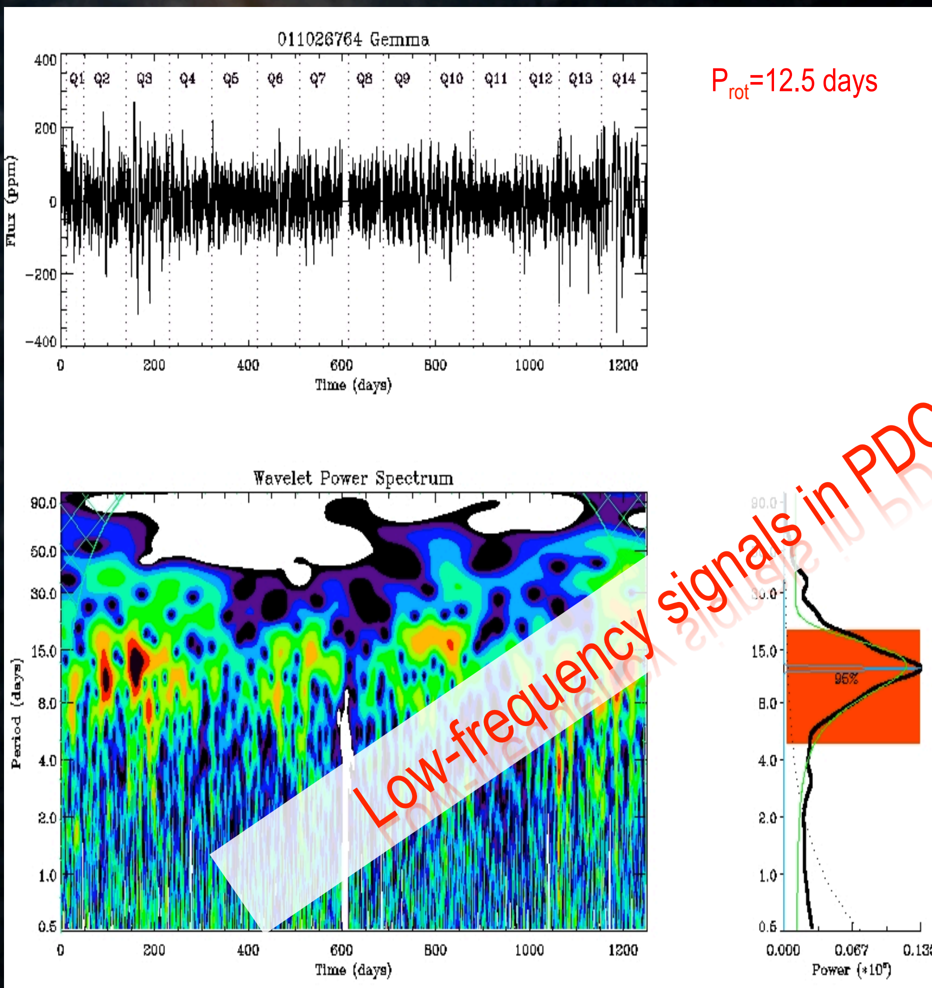
WORK TO DO

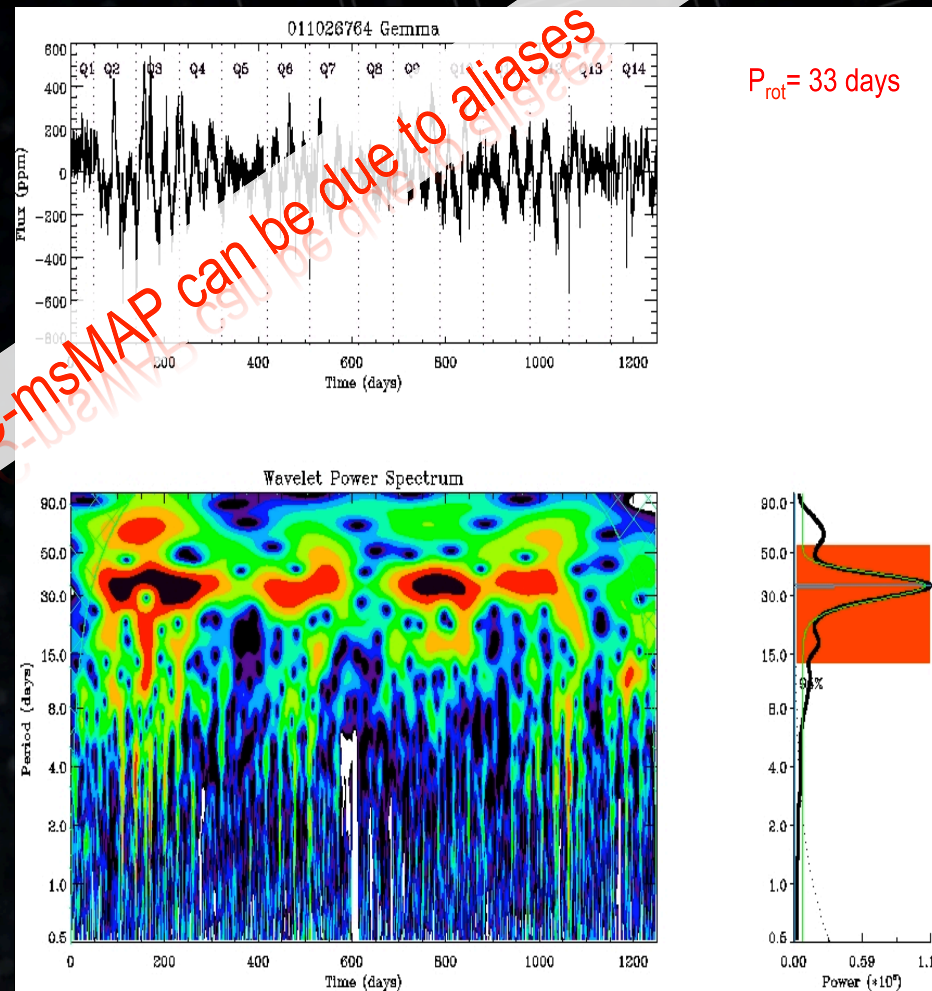
- Stellar case:
  - Provide Sph and Contrast

    [Garcia et al. 2014 in preparation]
  - Not completely understood:
    - Geometrical effects faculae/spots
    - Degeneracy with inclination angle
    - Magnetic-cycle dependency.
      - Hare & Hound Validation???
  - Stars with cycle-like variation
    - Peak bagging on short time series?
    - Pb on bloody F stars
  - Any suggestions?

II-PREPARATION OF KEPLER LC

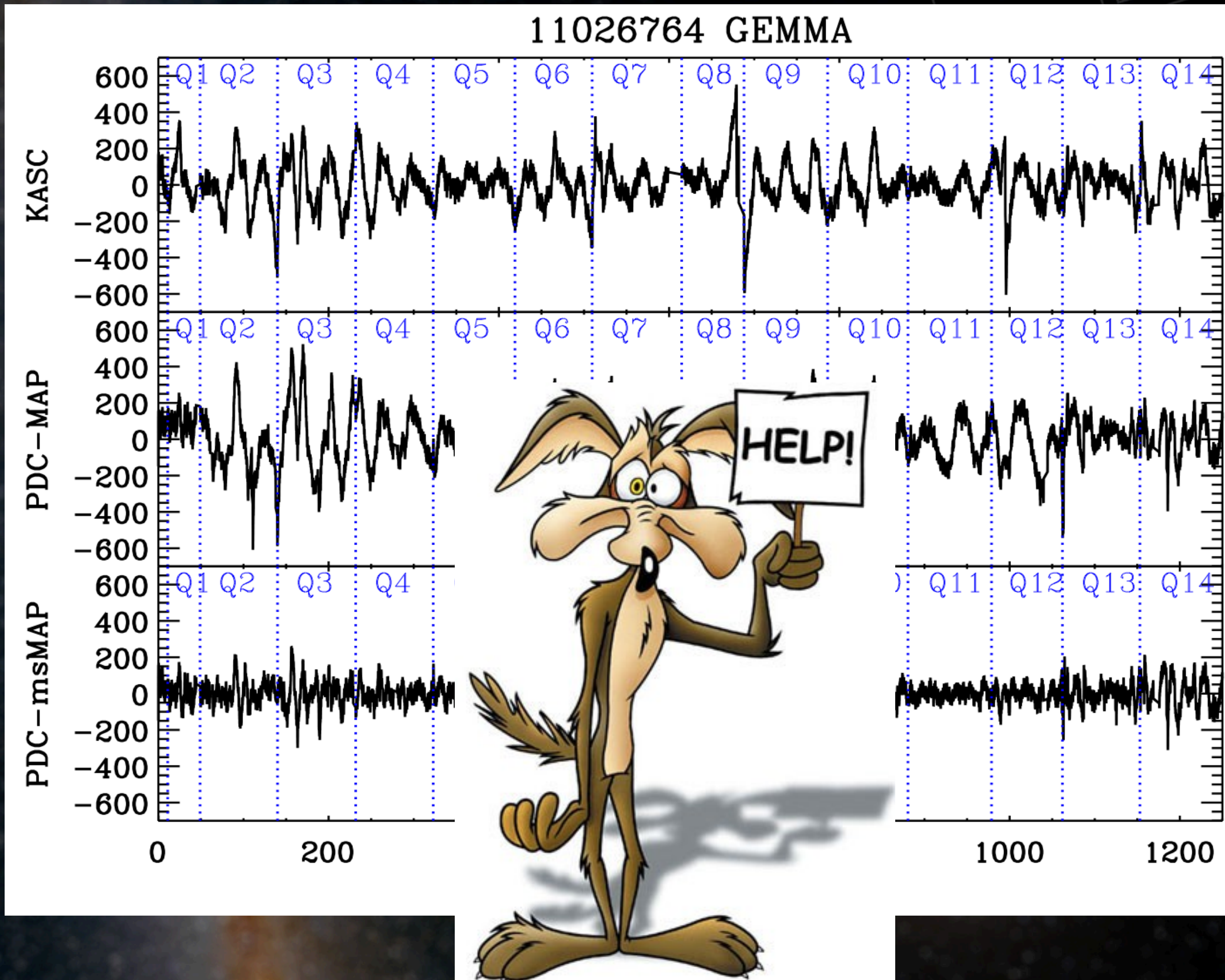
- Comparison between PDC-msMAP and PDC-MAP





Low-frequency signals in PDC-msMAP can be due to aliases

II-PREPARATION OF KEPLER LC



PDC-MAP CHANGE FROM Q2Q