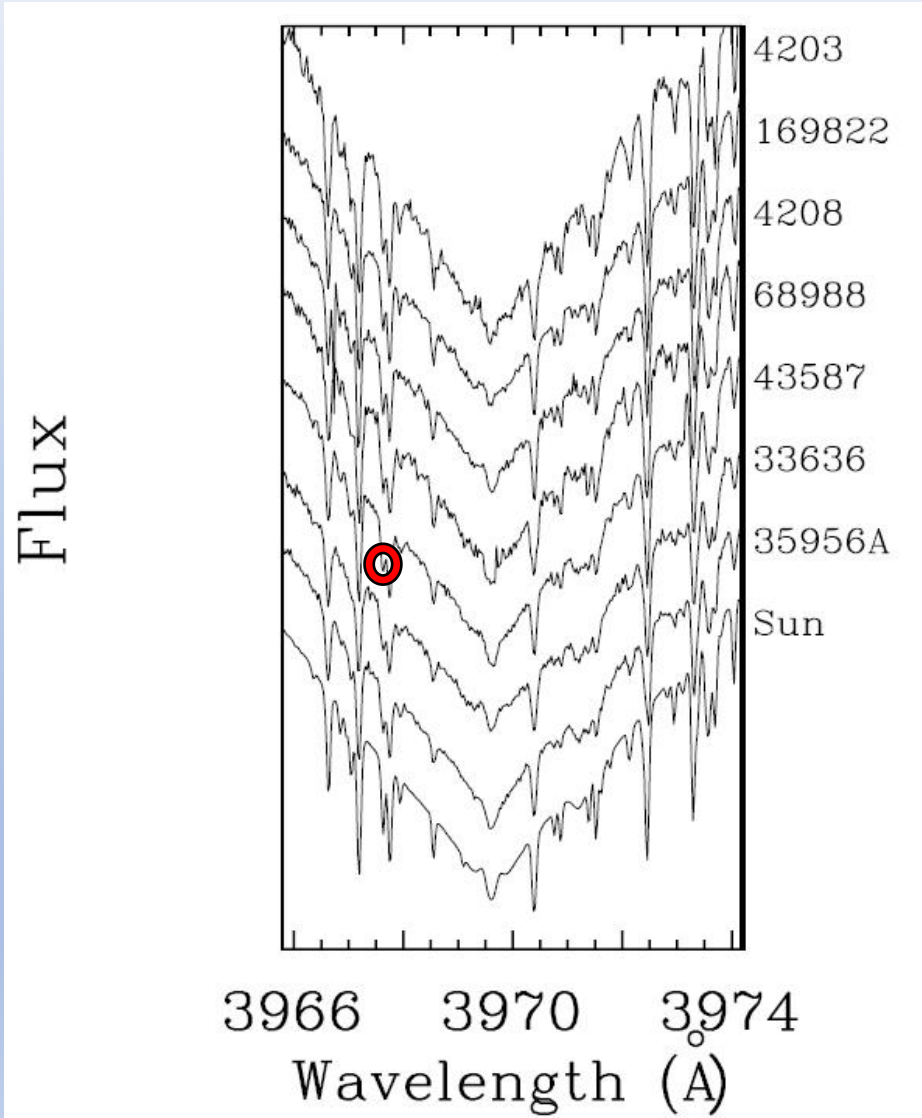


# Activity of HD 43587: A CoRoT primary target under a Maunder Minimum phase?

Rafael Ferreira, Matthieu Castro and José Dias do Nascimento Jr.

# The chromospheric activity

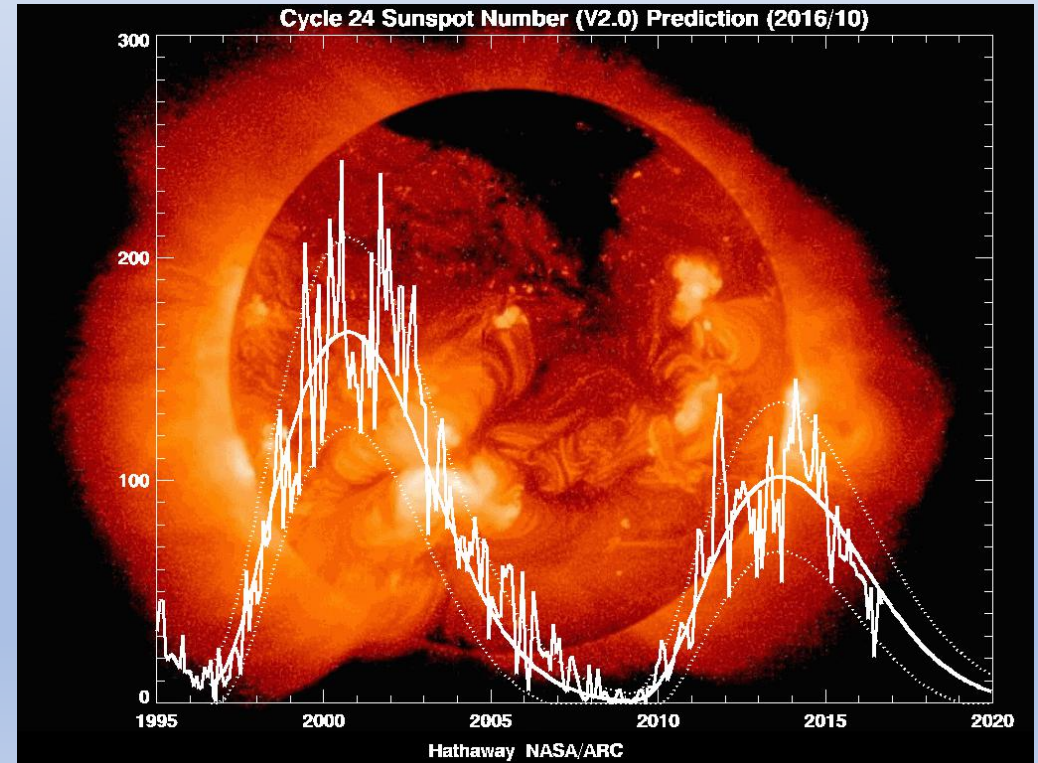
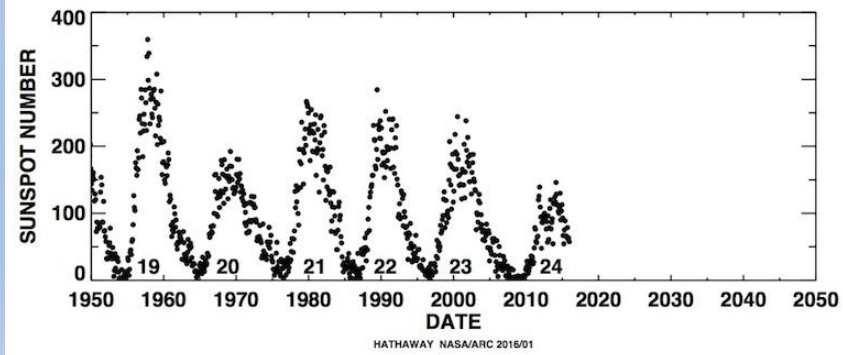
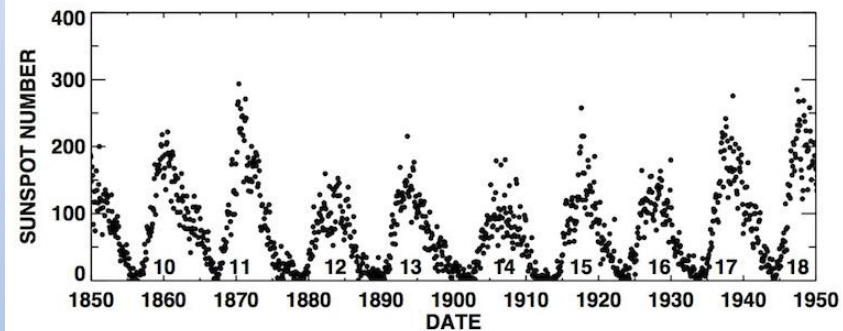
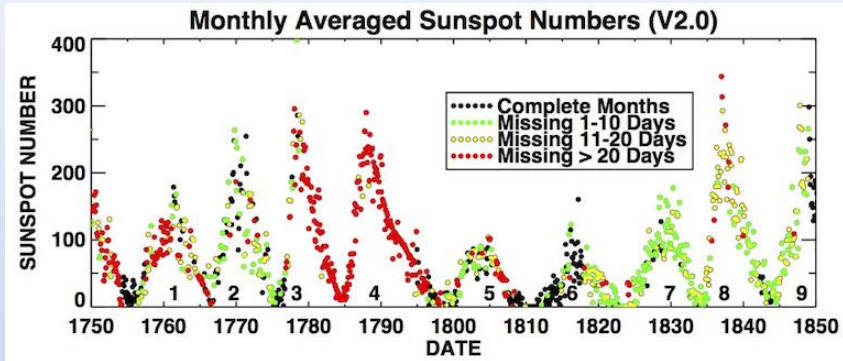


- Stellar magnetic activity ([Hall et al., 2008](#)).
- Matter and radiation emission outward of star.
- Maybe measured by Ca II H & K lines ([Cayrel, 1963](#); [Auer & Mihalas, 1969](#); [Skumanich, 1970](#)).
- Babcock (1961): activity and sunspots cycles.

Flows lines of Ca II H for G-type stars ([Vogt et al., 2002.](#))

# Solar Activity cycles

- Sunspots as activity manifestation;
- Measures since XVI century;
- 11-years solar cycles.
- Sunspots and Earth's climate connection?





# The Maunder Minimum (MM)

- Lowest solar activity between 1645 e 1715
- Based on studies of E.W. Maunder and his wife (Eddy,

18 June 1976, Volume 192, Number 4245

SCIENCE

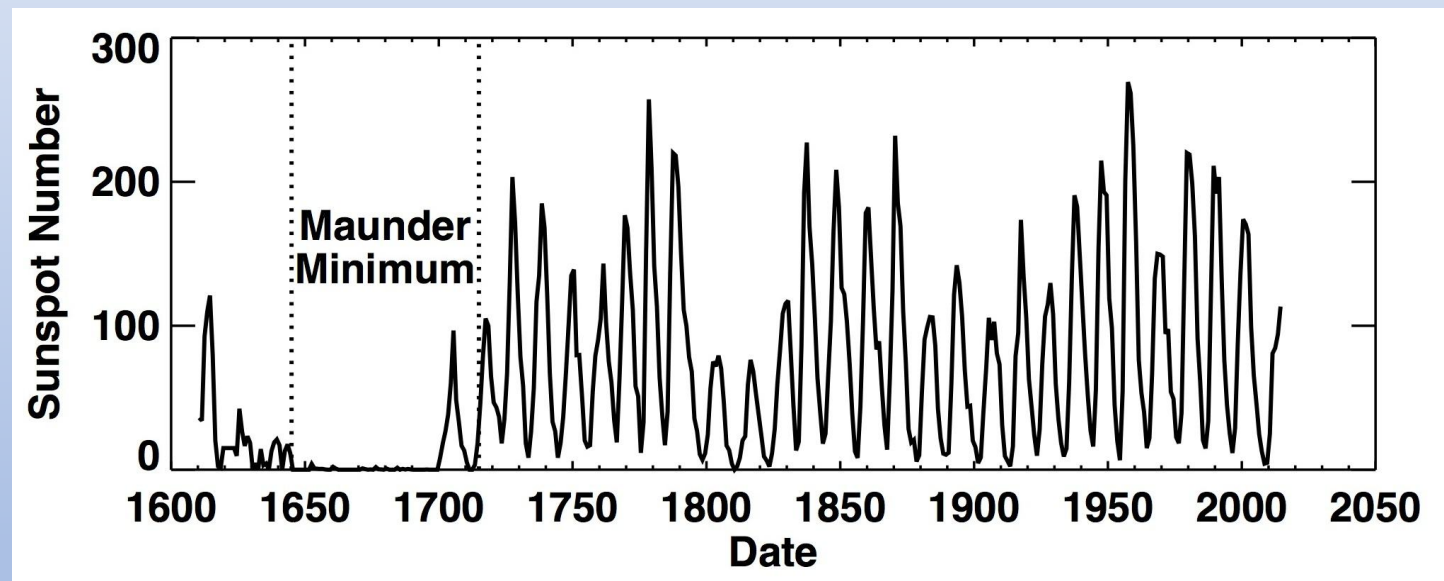
## The Maunder Minimum

The reign of Louis XIV appears to have been a time of real anomaly in the behavior of the sun.

John A. Eddy

zero. In contrast, in the years around a sunspot maximum there is seldom a day when a number of spots cannot be seen, and often hundreds are present.

Past counts of sunspot number are readily available from the year 1700 (3), and workers in solar and terrestrial studies often use the record as though it were of uniform quality. In fact, it is not. Thus it is advisable, from time to time, to review the origin and pedigree of past sunspot numbers, and to recognize the uncertainty in much of the early record.



All measurements of sunspots registered  
(*Marshall Space Flight Center - NASA*)



Tamisa river portrayed for Abraham de Hondt  
(*en.wikipedia.org/wiki/Little\_Ice\_Age*)

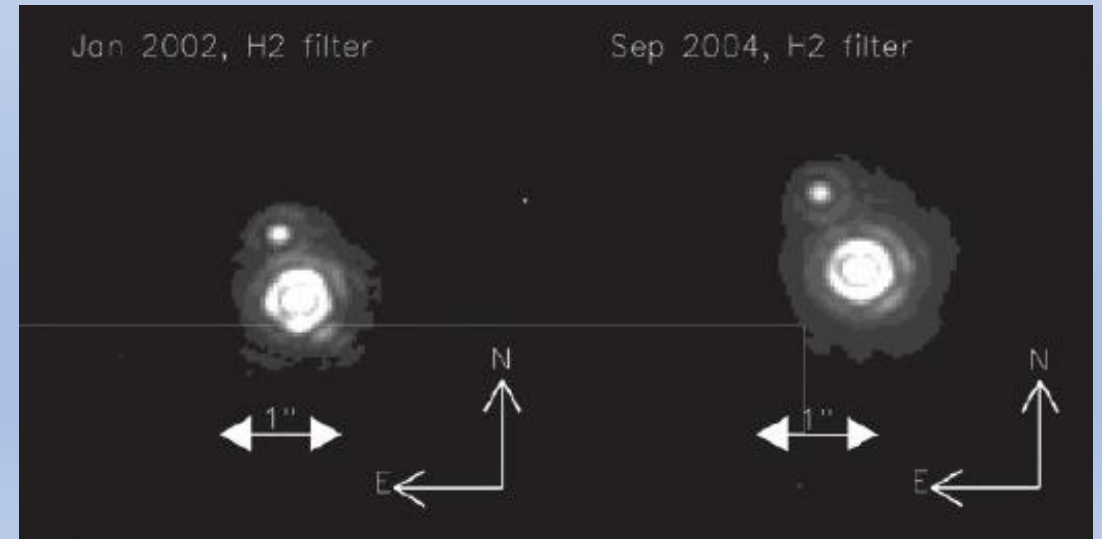
# The goal

- To investigate the activity of HD 43587:
  - CoRoT light-curves;
  - Spectroscopic measurements over 50 yrs.
- To study the (MM) phenomena.
- To investigate the possible occurrence of the MM in the HD 43587.

# Database

- MWO – 1967 until 1983 (Duncan et al., 1991)
- CORAVEL – 80's yrs (Duquennoy & Mayor, 1991)
- Lowell Observatory – 1996 until 2008 (Hall et al., 2009)
- HARPS – 2010, 2011, 2013 (Morel et al., 2013; Boumier et al., 2014).
- HEROS/TIGRE – 2013, 2014 (Hempelmann et al., 2 016)
- Database of CoRoT space mission.

Adaptative optics image. Observed at *Canadian-France Hawaii Telescope* between 2002 e 2004 (Catala et al. (2006) )



# HD 43587: Fundamental parameters

- HD 43587 : Binary system localized in Orion constellation (Vogt et al., 2002).
  - Primary: HD 43587Aa
  - Secondary: HD 43587B
- Age: 4.97 Gyr (Morel et al., 2013)
- Spectral type: G0V (Mamajek et al., 2011; Morel et al., 2013)
- B-V = 0.61 (van Leeuwen et al, 2007)
- $T_{\text{eff}} = 5947\text{K}$  (Morel et al., 2013)

# Activity of HD 43587

- HD 43587 is in a “flat” activity phase (Baliunas & Jastrow (1990)).
- $\langle S \rangle$  is the measures of chromospheric activity observed at MWO (Duncan et al., 1991).

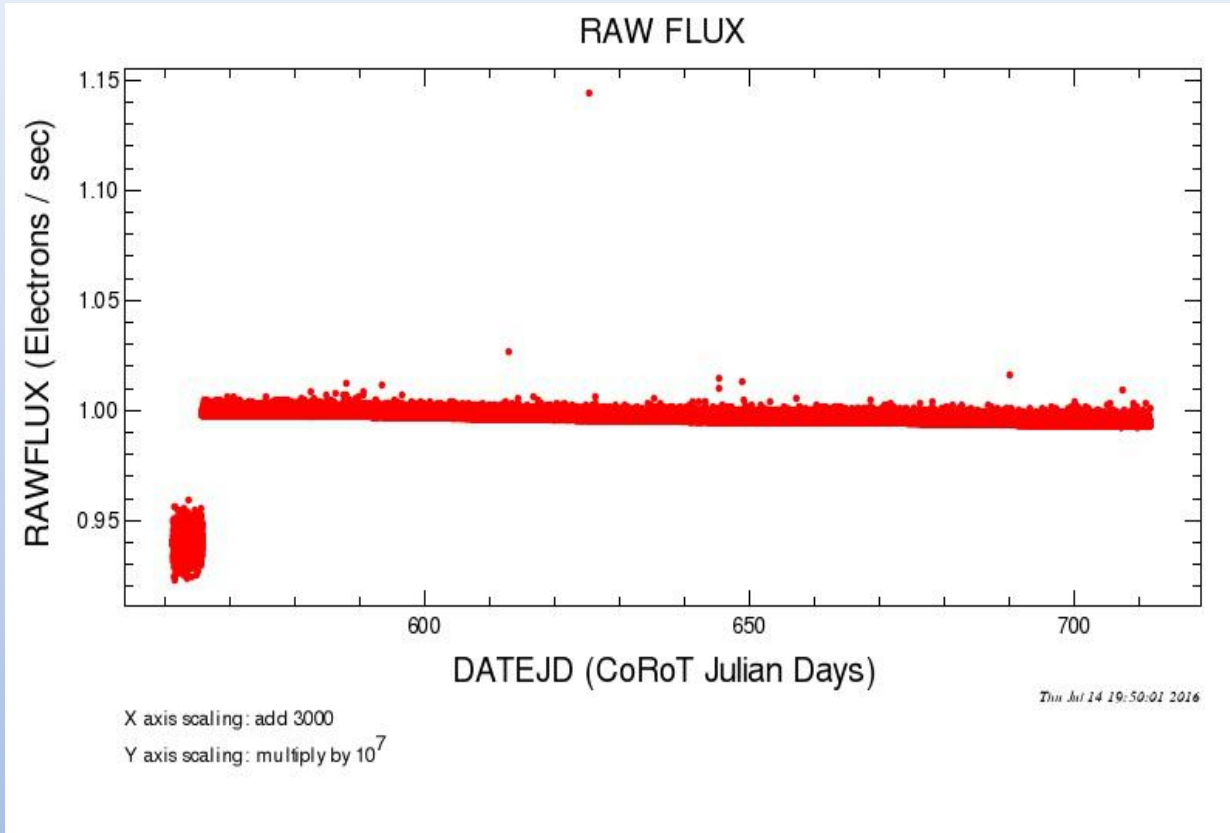
$$S_{MW} = \alpha \frac{H+K}{R+V}$$

- When  $\alpha = 2,4$  (Duncan et al., 1991)
- For HD 43587,  $\langle S \rangle = 0,158$  and for the Sun  $\langle S \rangle_{\odot} = 0,167$
- $T_{\text{eff}} = 5948\text{K}$  (Reddy et al. , 2003; Chen et al., 2000; Feltzing & Gonzalez, 2001; Bensby et al., 2003; Morel et al. , 2013)

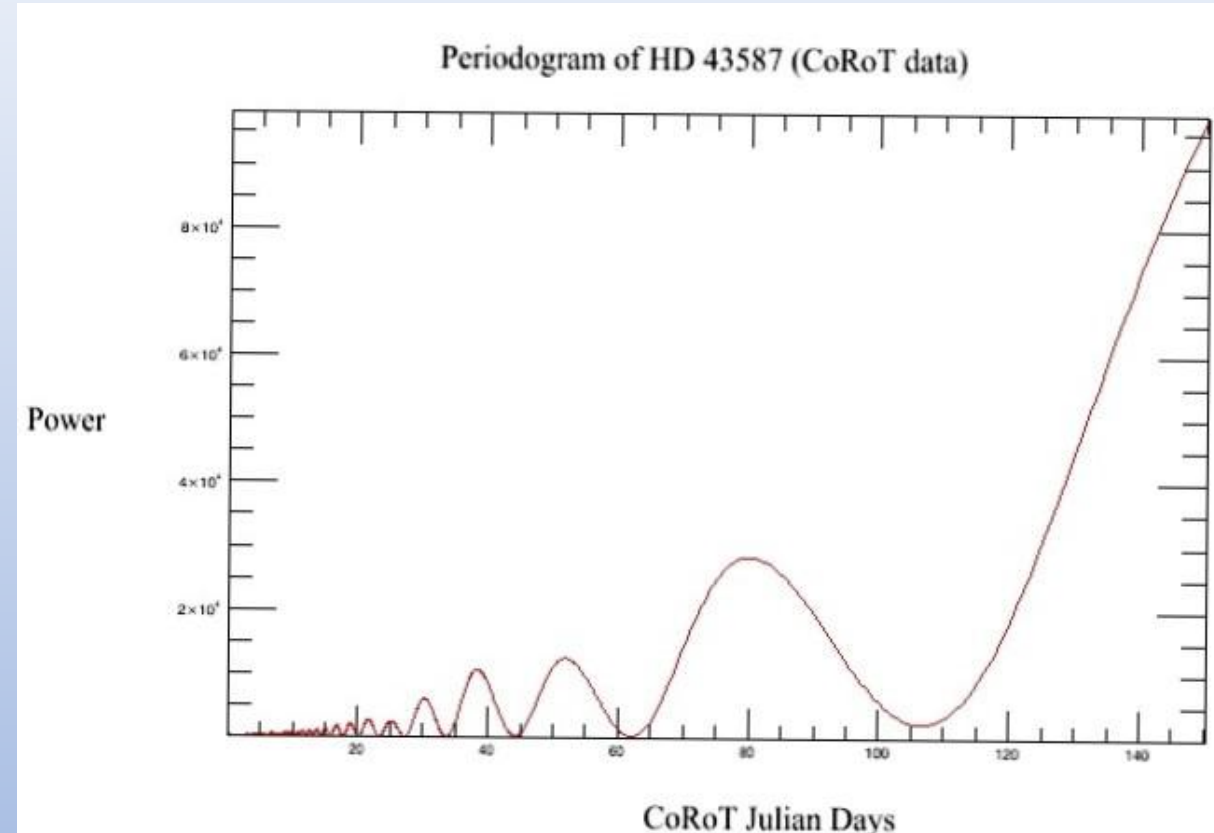
Morel et al. (2013)	
Massa [ $M_{\odot}$ ]	$1.049 \pm 0.016$
Raio [ $R_{\odot}$ ]	$1.15 \pm 0.01$
Metalicidade [dex]	$-0.02 \pm 0.02$
Idade [Gyr]	$4.97 \pm 0.52$



# Observational data of the CoRoT mission

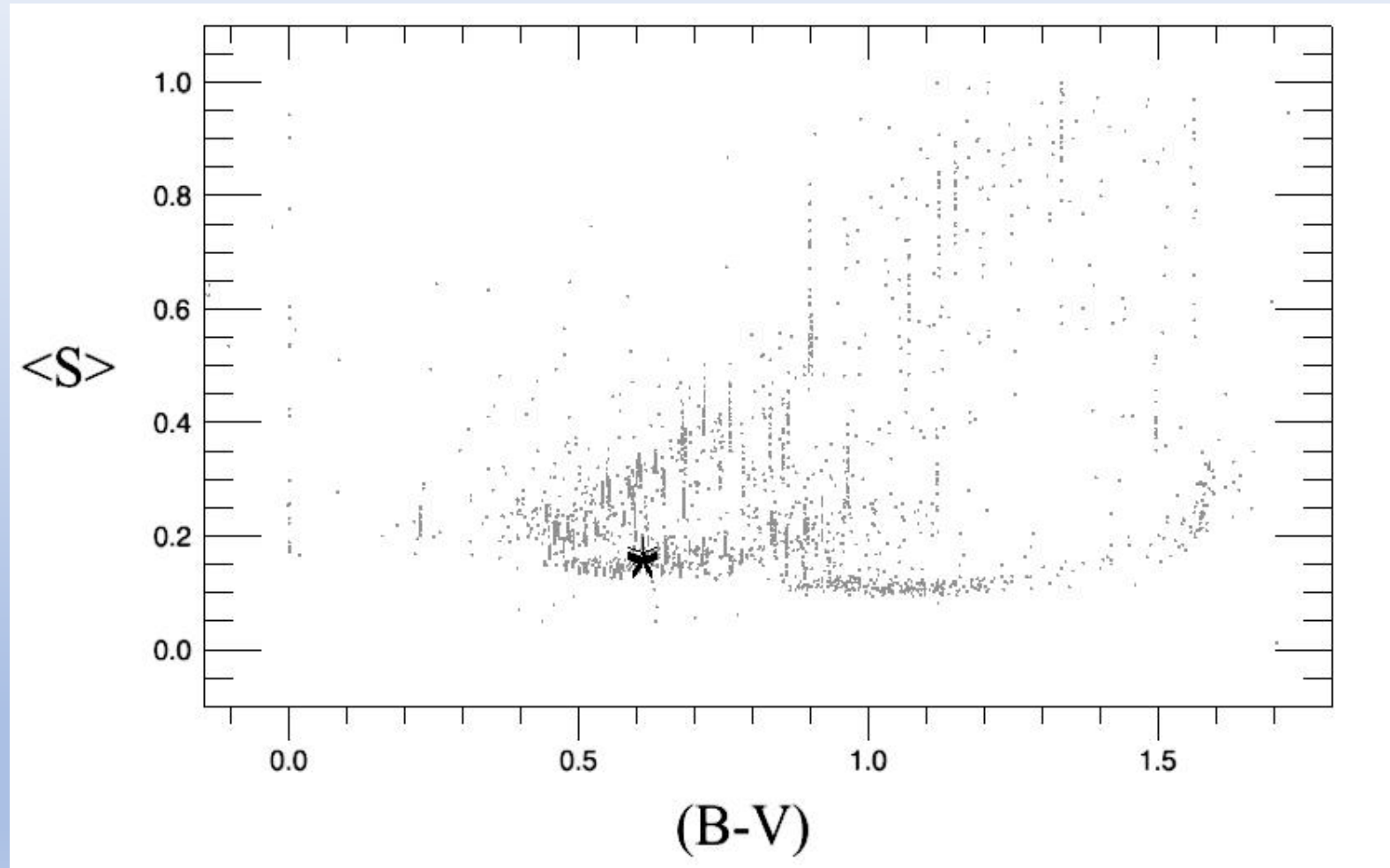


CoRoT light-curve for HD 43587  
(NASA Exoplanet Archive)



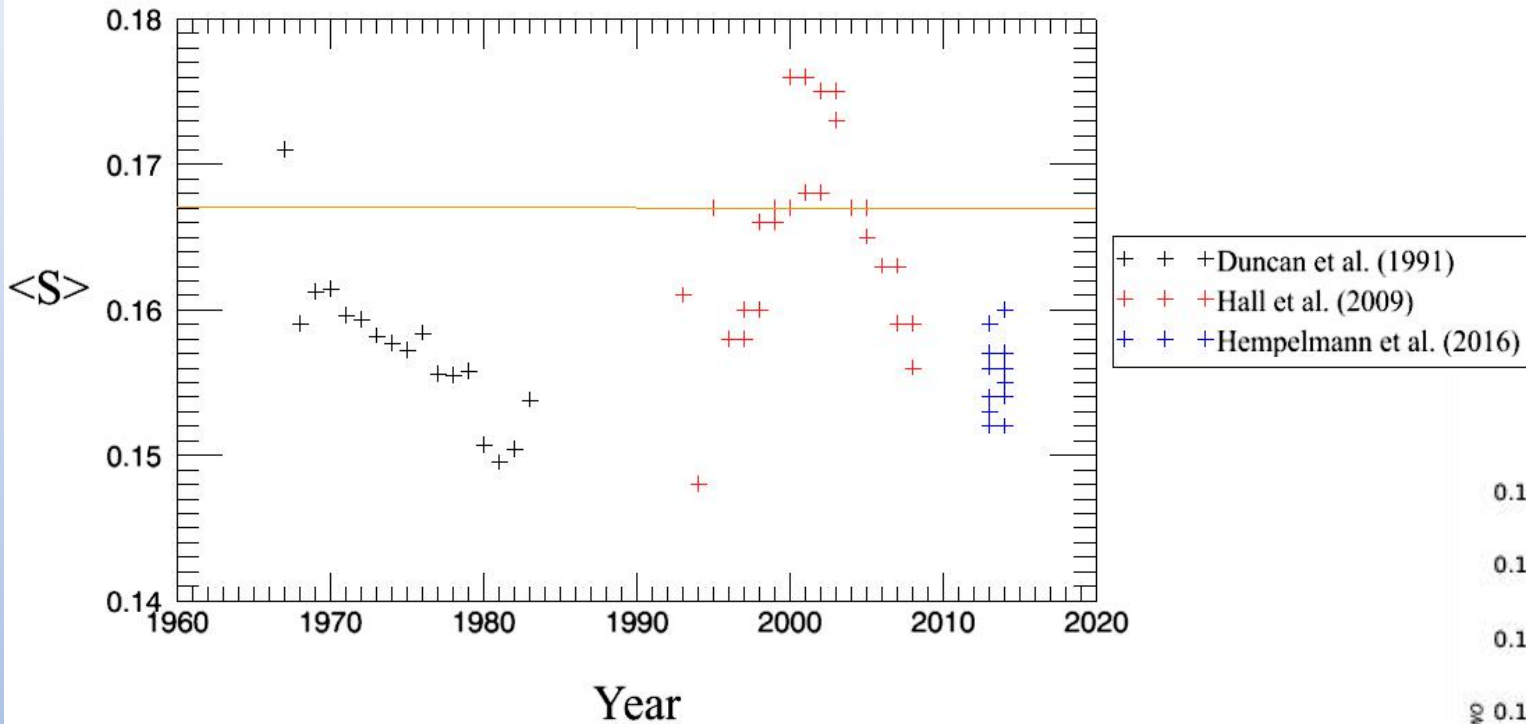
Lomb-Scargle Periodogram for the CoRoT light-curve HD 43587 (Ferreira et al, 2017 in prep.)

# Mount Wilson stars

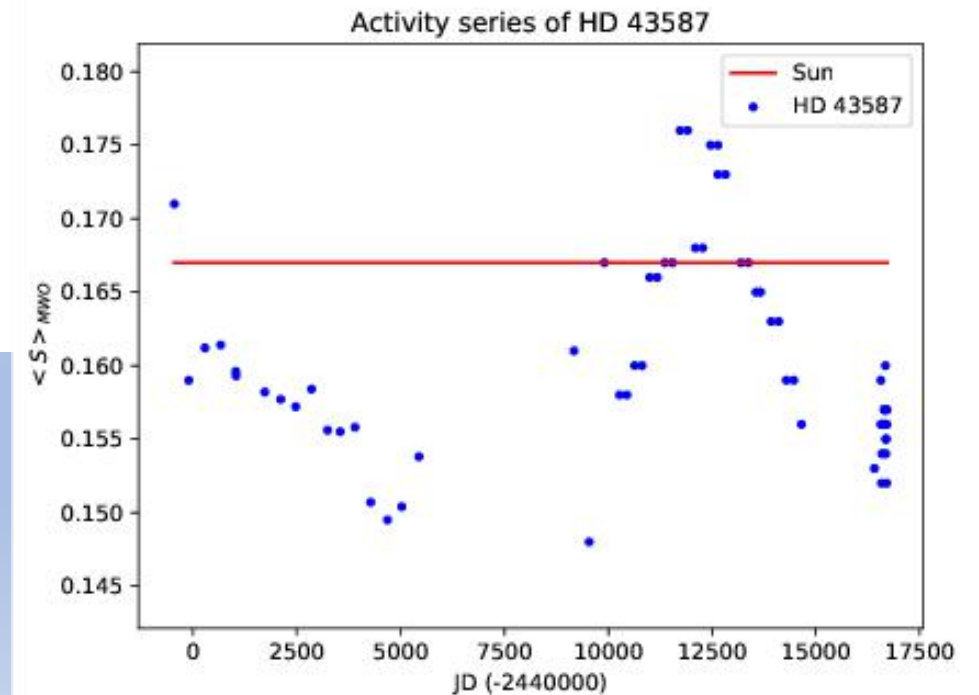


The stars in the inferior envelope are considered MM candidates (Schöder et al., 2012.)

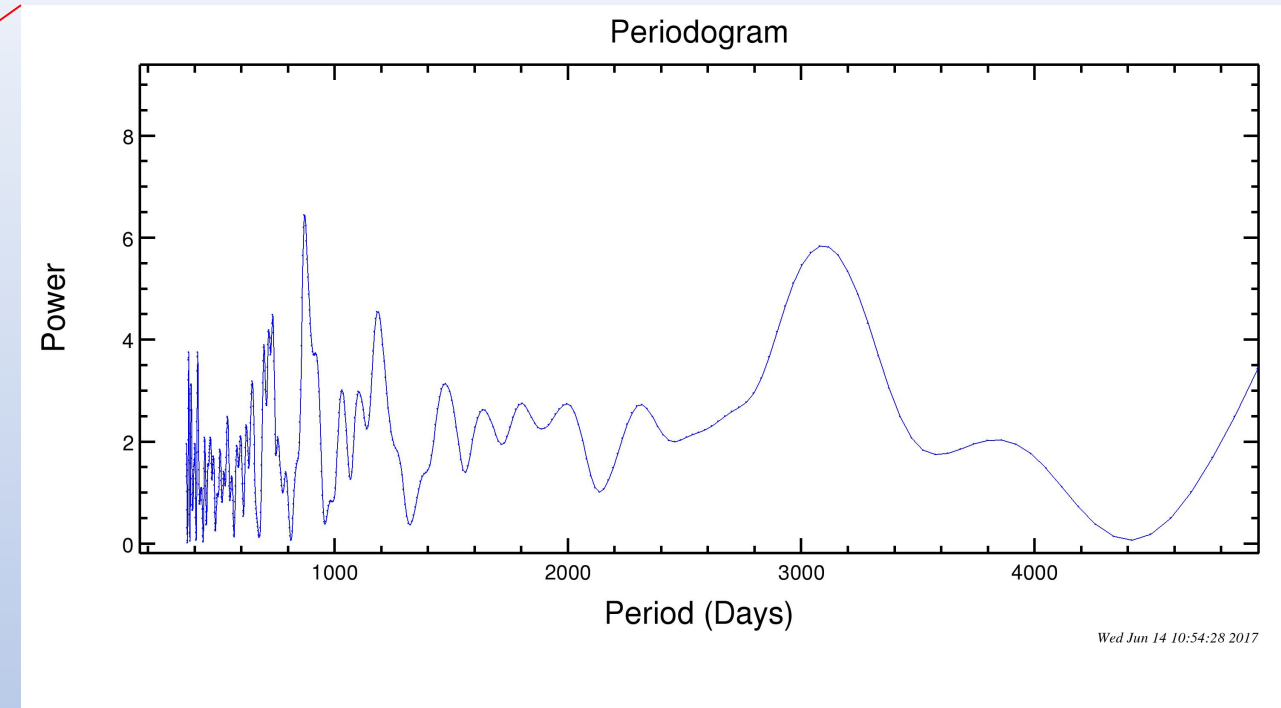
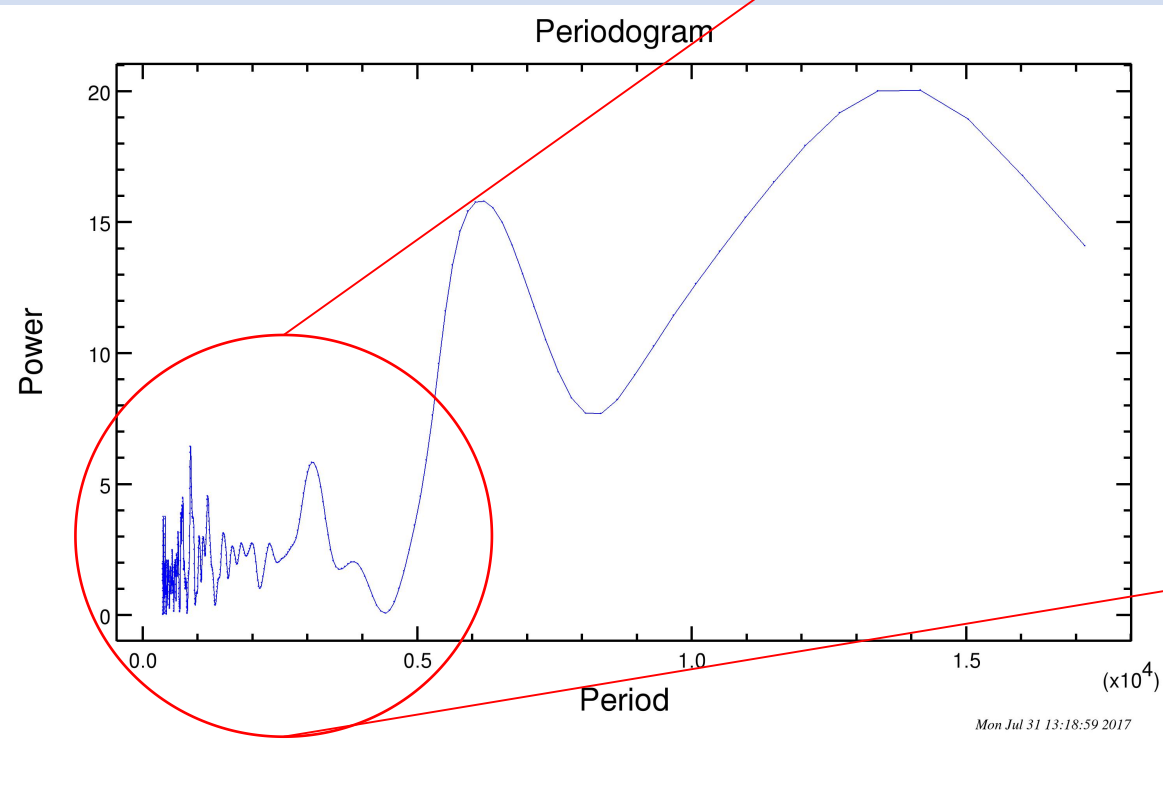
# All S-index measurements of HD 43587



$\langle S \rangle$  measurements realized between 1967 and 2014  
(Ferreira et al, 2017 in prep.)



# Lomb-scargle periodogram: spectroscopic data



Lomb-Scargle Periodogram for S-index series of HD 43587 (Ferreira et al, 2017 in prep.) .

# Conclusions and perspectives

- It's important to study stars as HD 43587 for the stellar evolution theory;
- HD 43587 possibly is in MM since 50 yrs, there isn't determined activity cycles;
- It's necessary to continue with spectroscopy and spectropolarimetric measurements;
- Are there Earth-like planets orbiting HD 43587?