The Rarity of Sun-like Cycles and their Dependence on the Rossby Number

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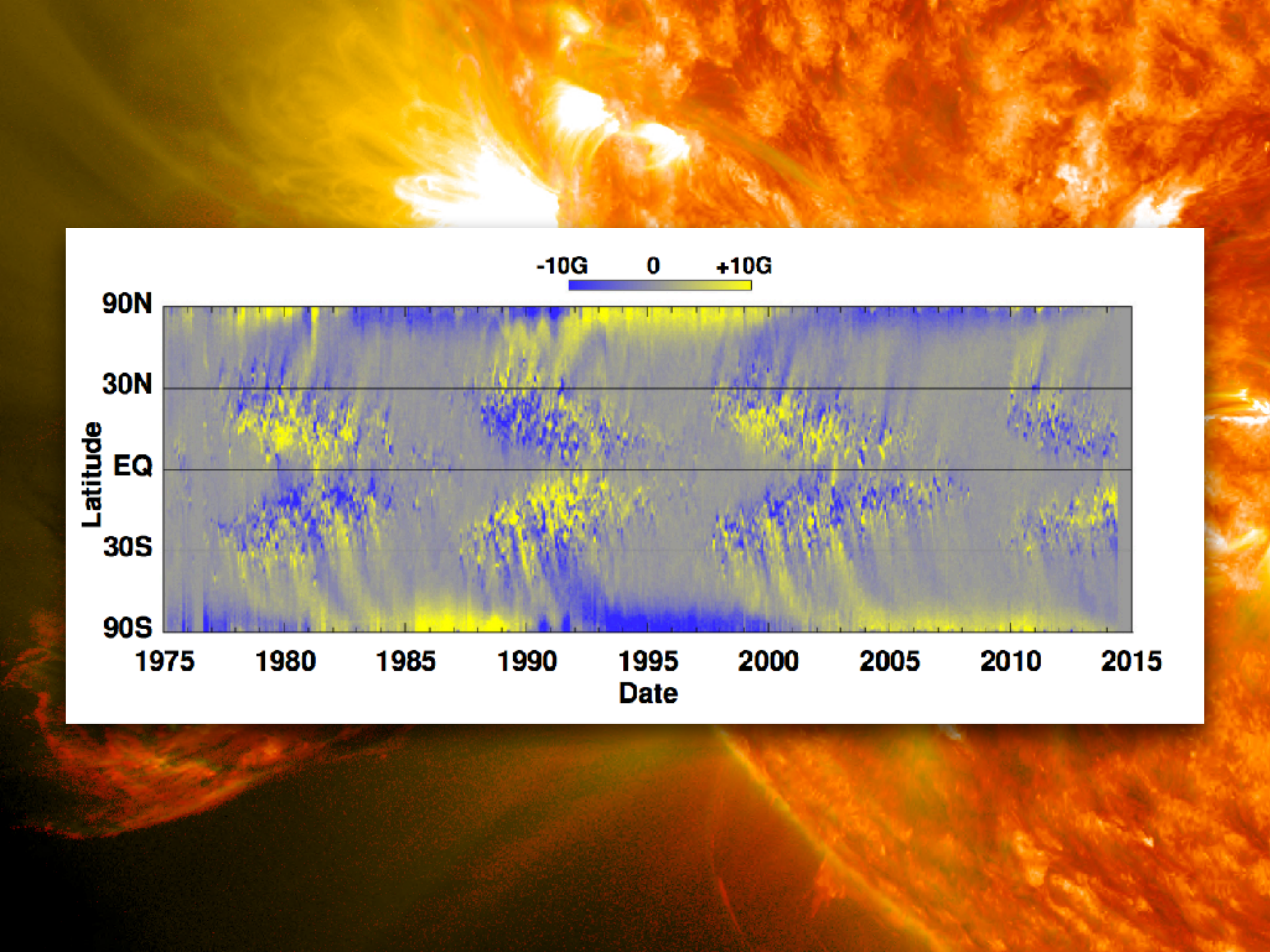
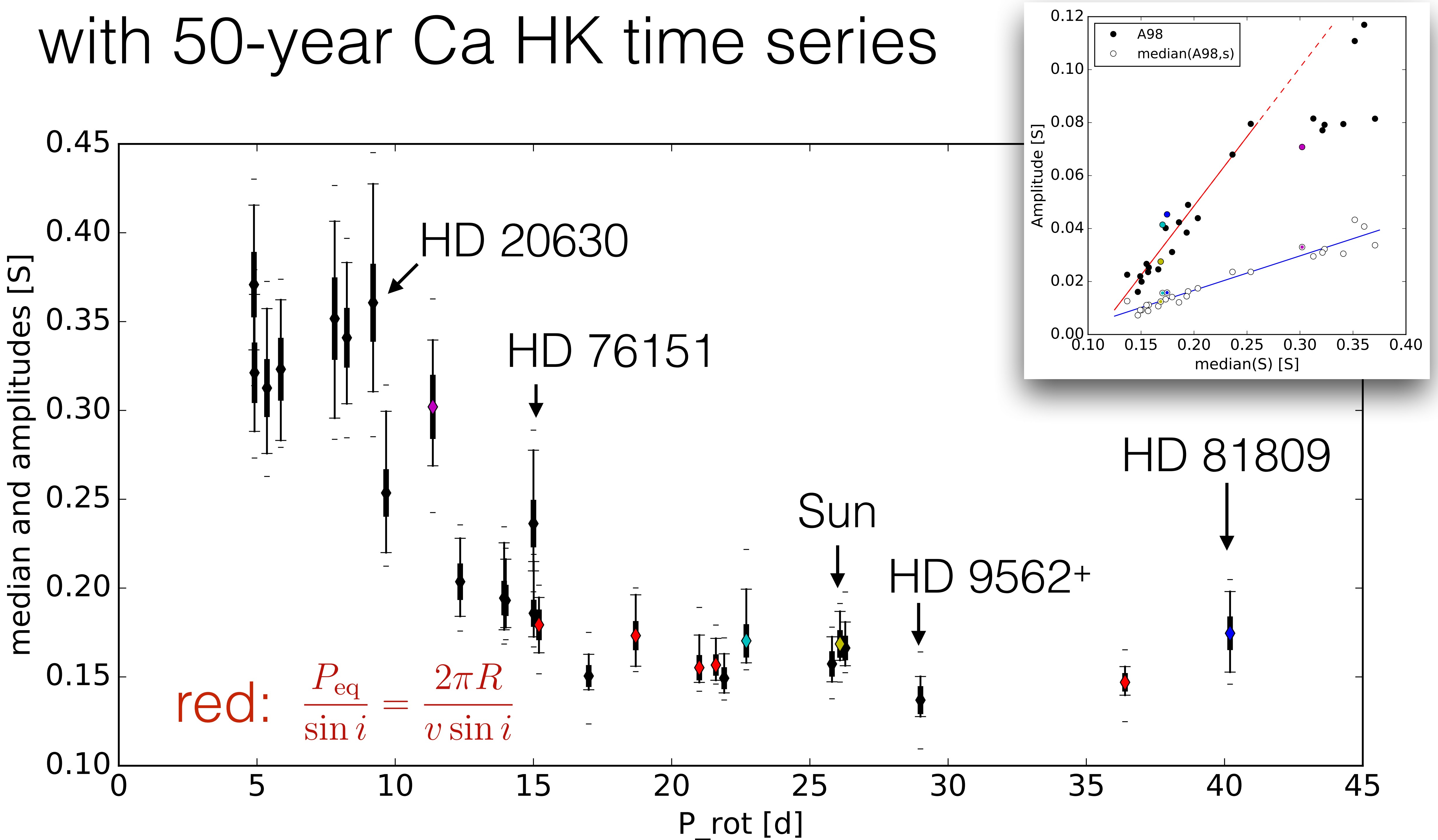

-10G
0
+10G
90N
30N
EQ
30S
90S
Latitude
1975
1980
1985
1990
1995
2000
2005
2010
2015
Date

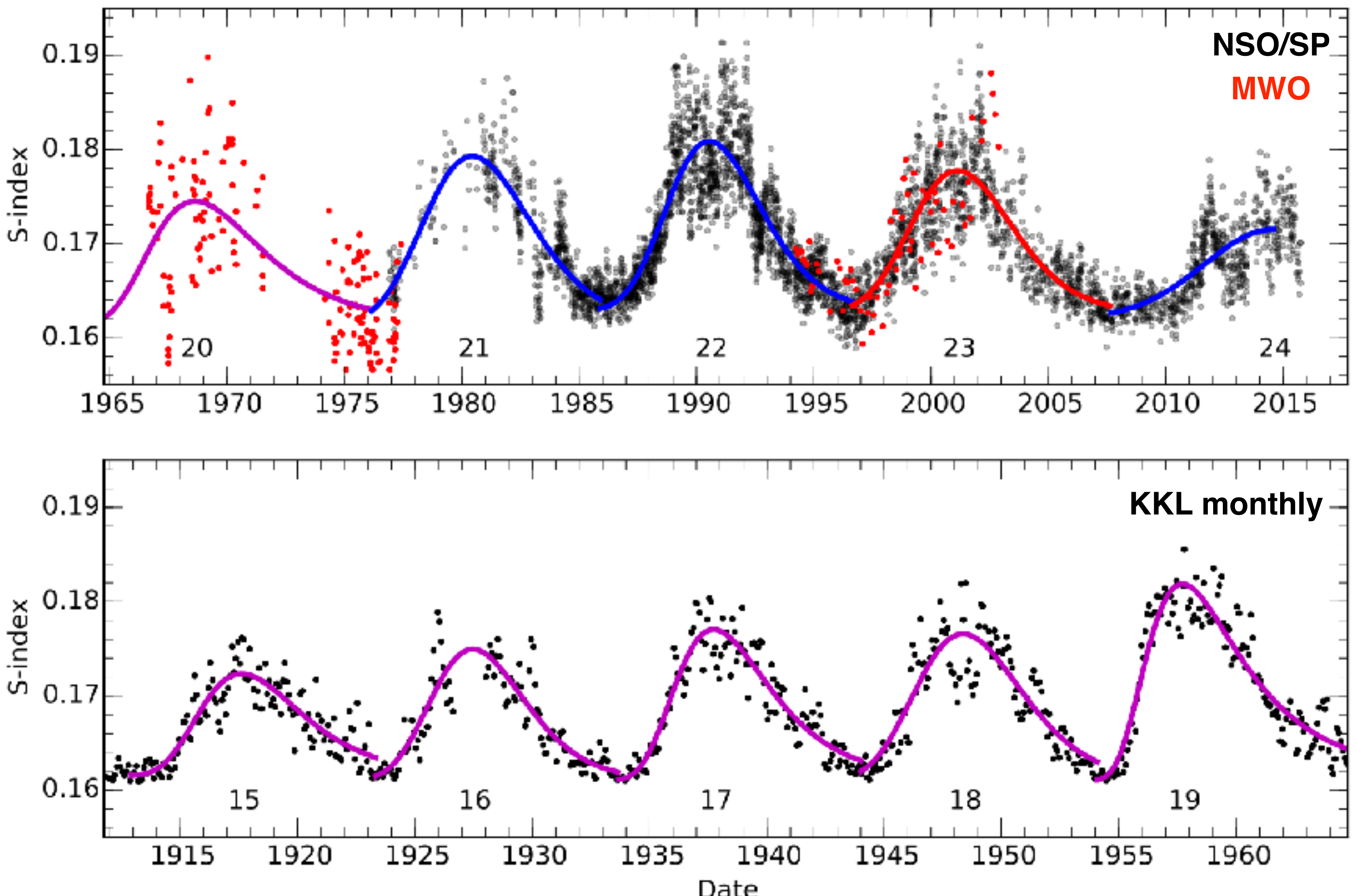
Activity, Amplitude, Rotation, and Variability of solar analogs (±5% solar T_{eff}) with 50-year Ca HK time series



(Egeland 2017, PhDT)

(Egeland et al. 2018, in prep.)

This is a Sun-like Cycle



⟨15–24⟩: ⟨S⟩= 0.1694 ± 0.0005

△⟨S⟩ = 0.0145 ± 0.0012 **(8.6%)**

(Bertello et al. 2016, SoPh)
(Egeland et al. 2017, ApJ)

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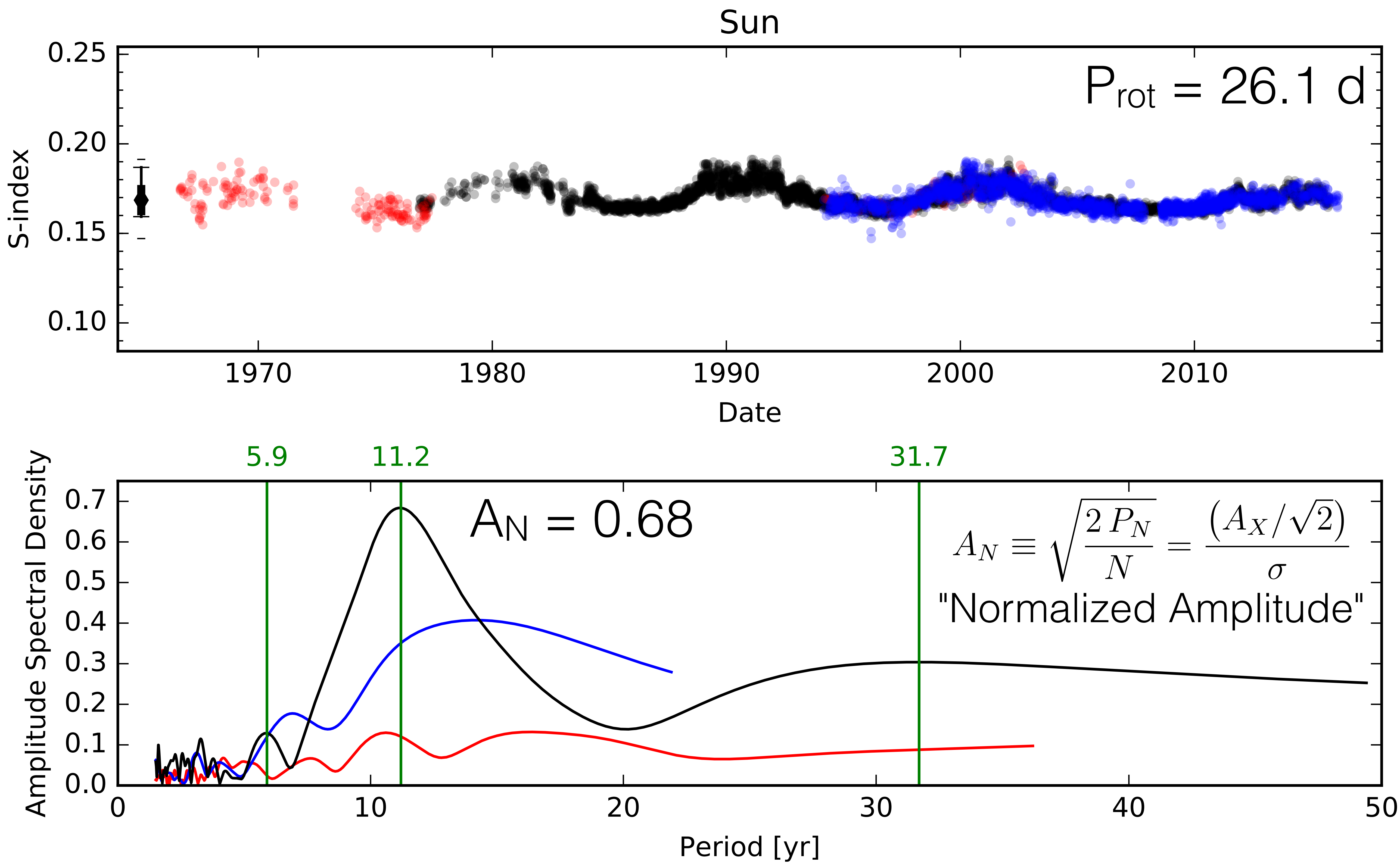
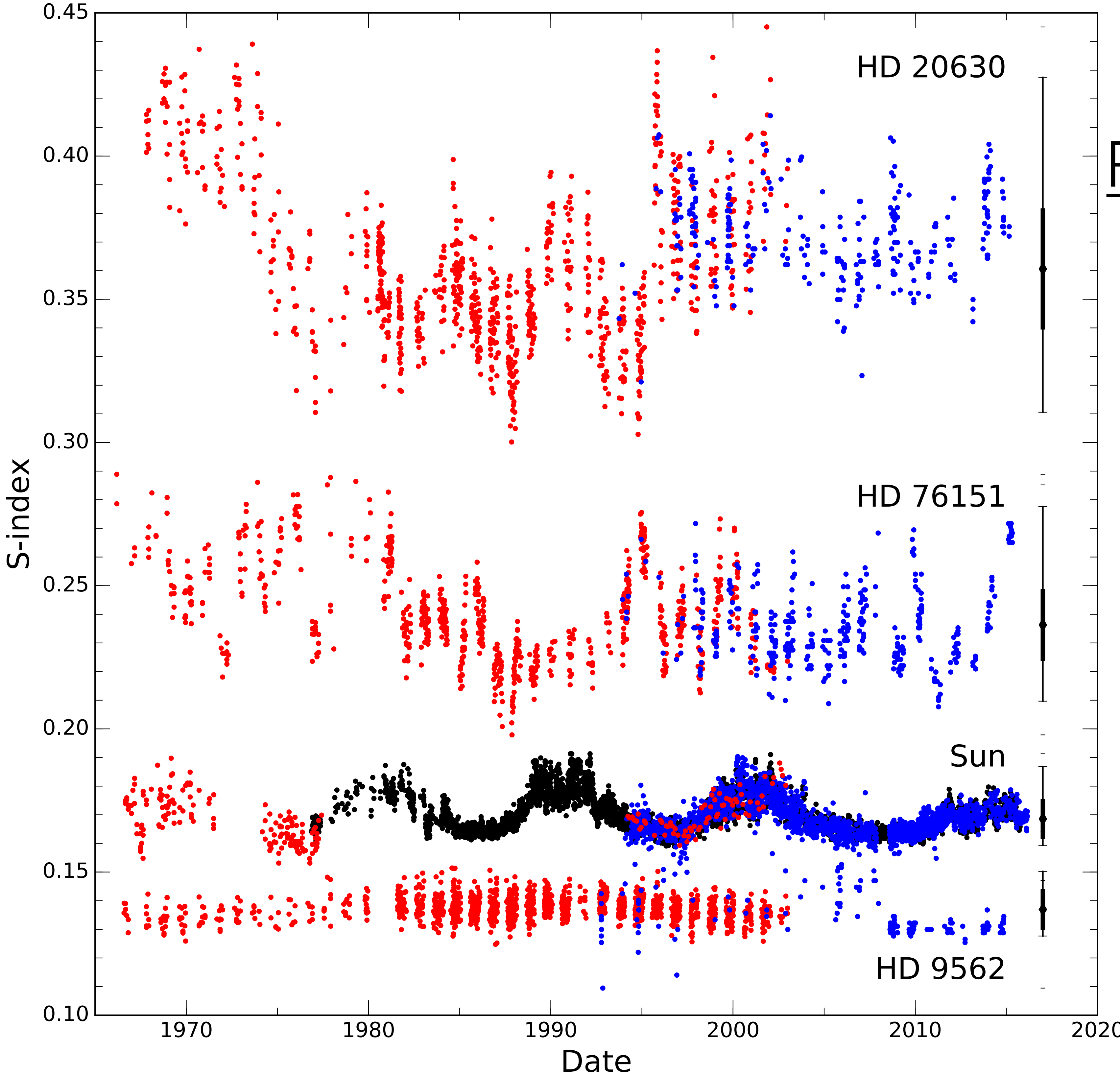
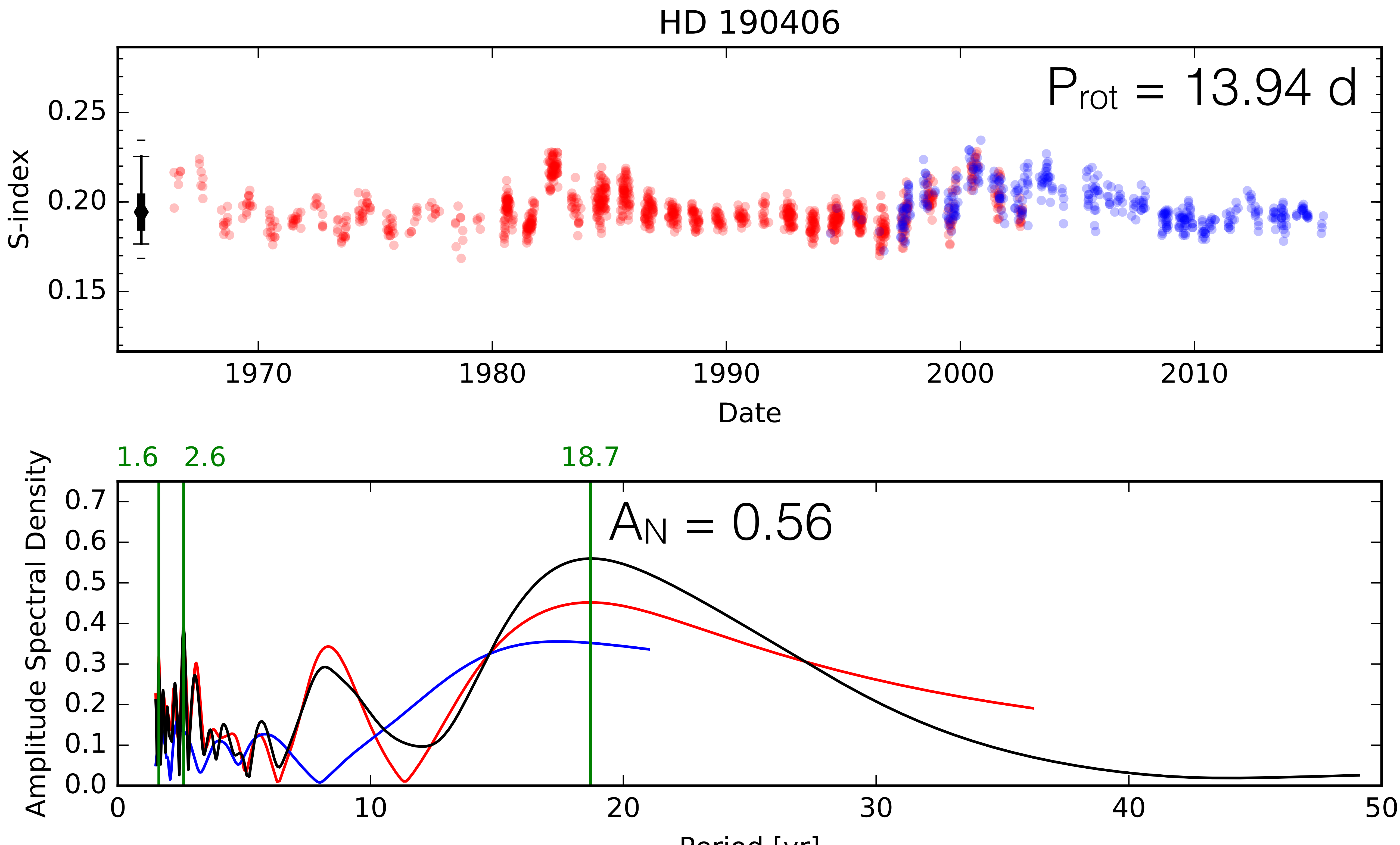


These are not Sun-like Cycles



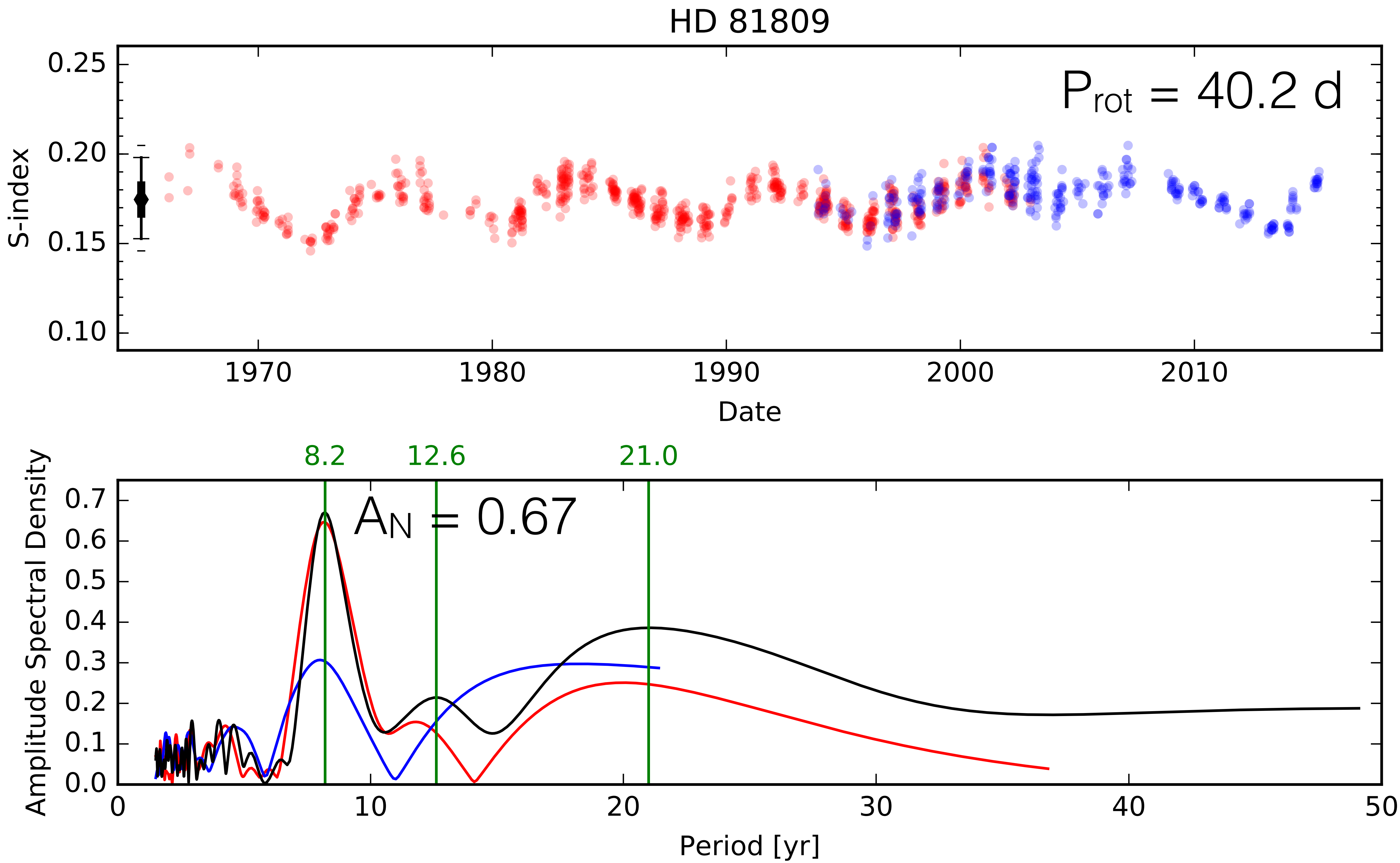
P_{rot} (d)	P_{var} (yr)	A_N
9.2	35.8	0.57
15.0	20.9	0.36
26.1	11.2	0.68
29.0	–	–

Also not Sun-like.



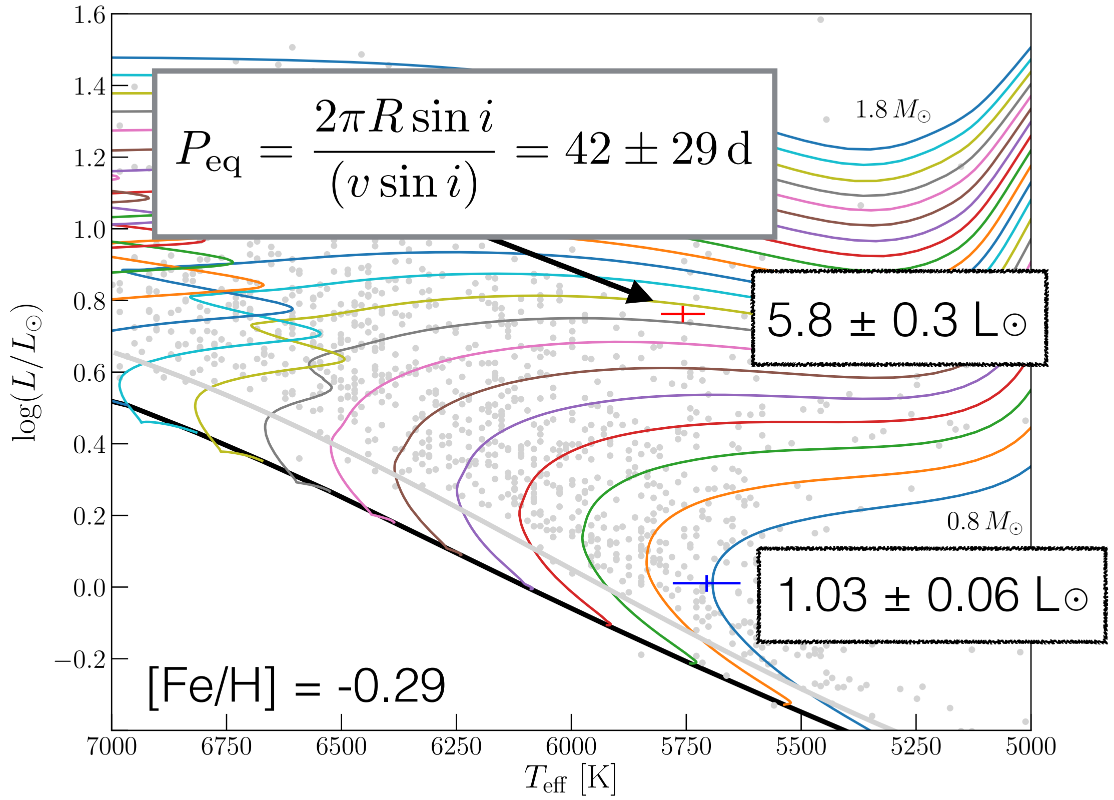
This is a Sun-like Cycle

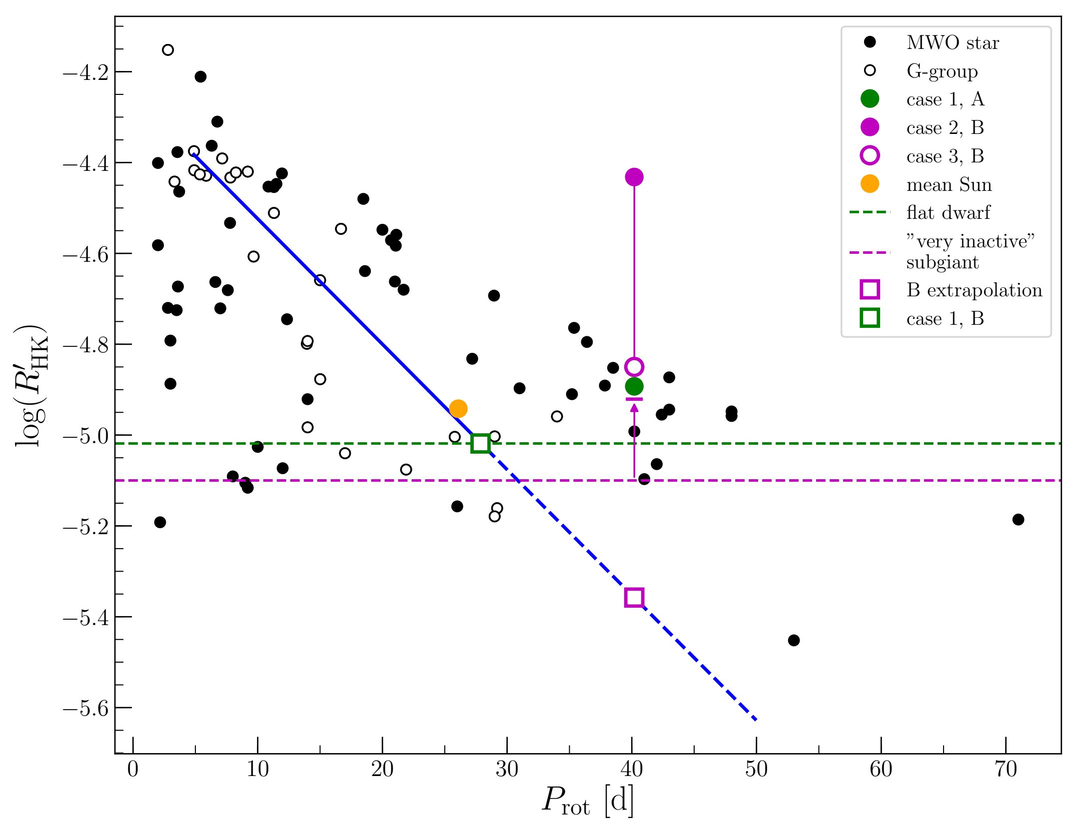
But what is the source?

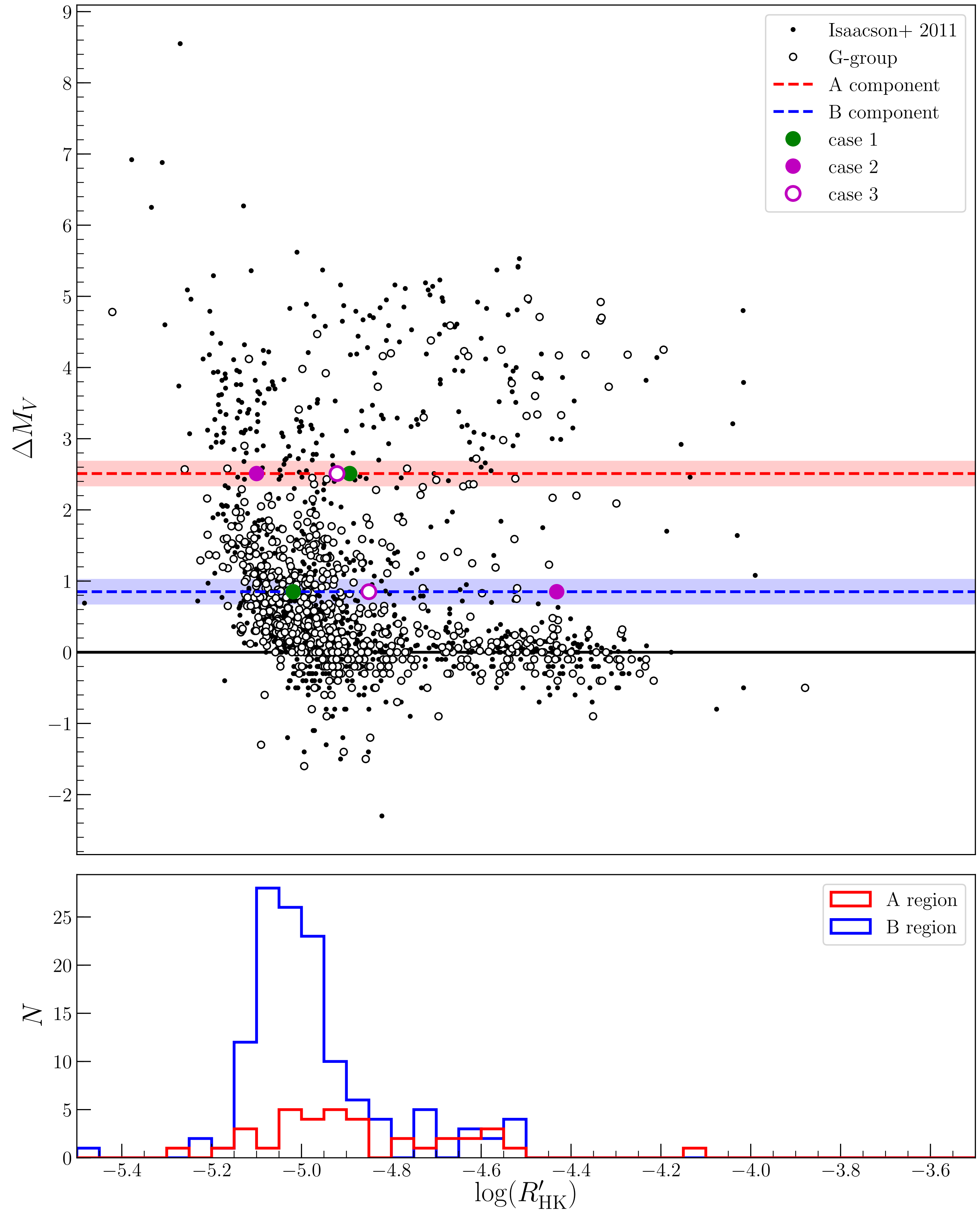


HD 81809 is a Cycling Subgiant

(Egeland et al. 2018, ApJ submitted; arxiv: 1807.10870)







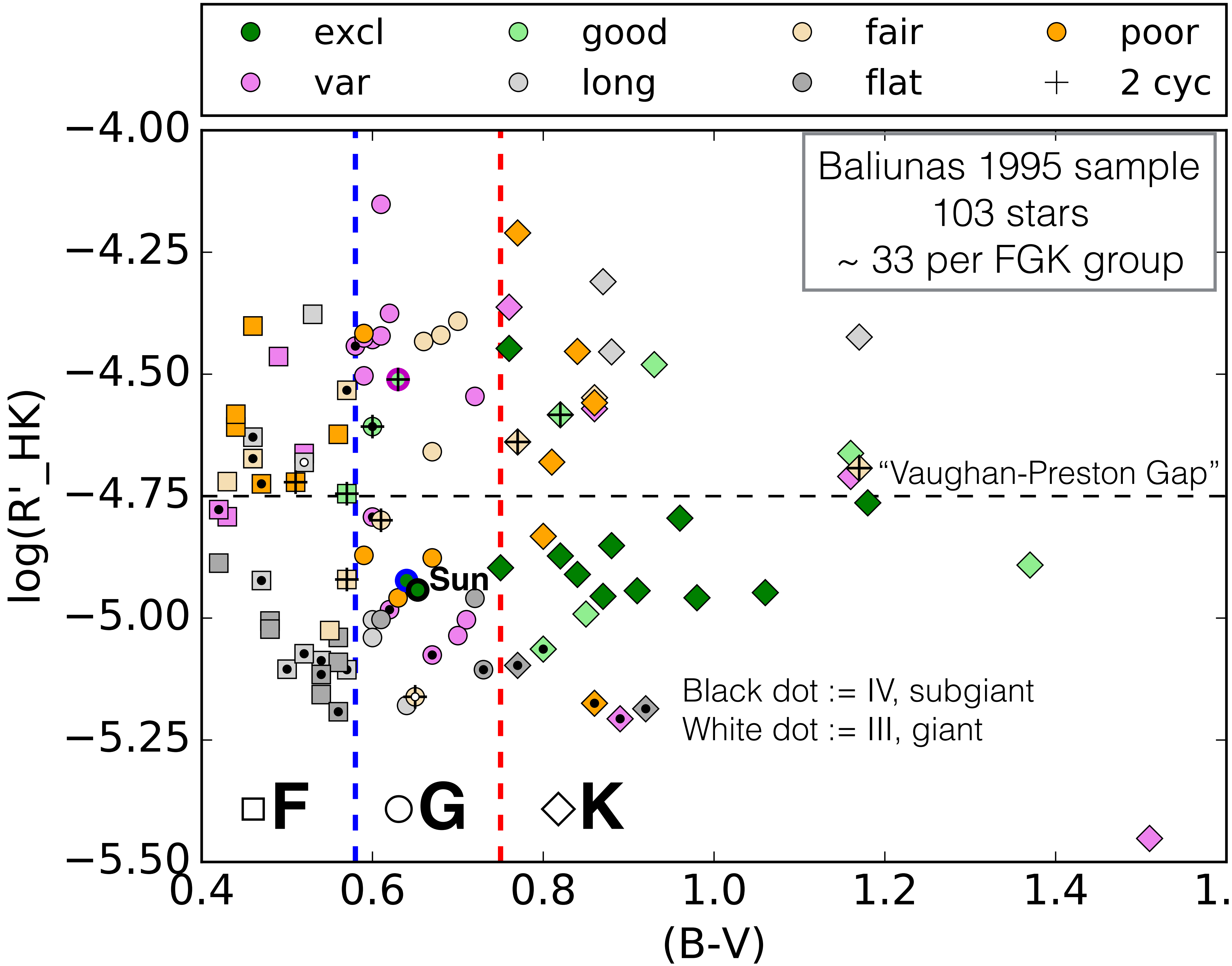
The Solar Cycle is Exceptional

$$Q_{\rm cyc} = 100\left(1 - 0.5\,\frac{P_{\rm var}}{T}\right)A_N \qquad Q_{\rm cyc,\odot} = 61$$

$Q_{\rm cyc,1}$ Bin	N Stars	N also with $Q_{\rm cyc,2}$
$Q_{\rm cyc} \geq 50$	3	0
$40 \leq Q_{\rm cyc} < 50$	5	2
$30 \leq Q_{\rm cyc} < 40$	11	8
$20 \leq Q_{\rm cyc} < 30$	6	2
$Q_{\rm cyc} < 20$	2	–

Considering $Q_{\rm cyc} > 40$ and no secondary cycle as "solar-like", only 5/26 (~19%) of the sample has a cycle similar to the Sun's.

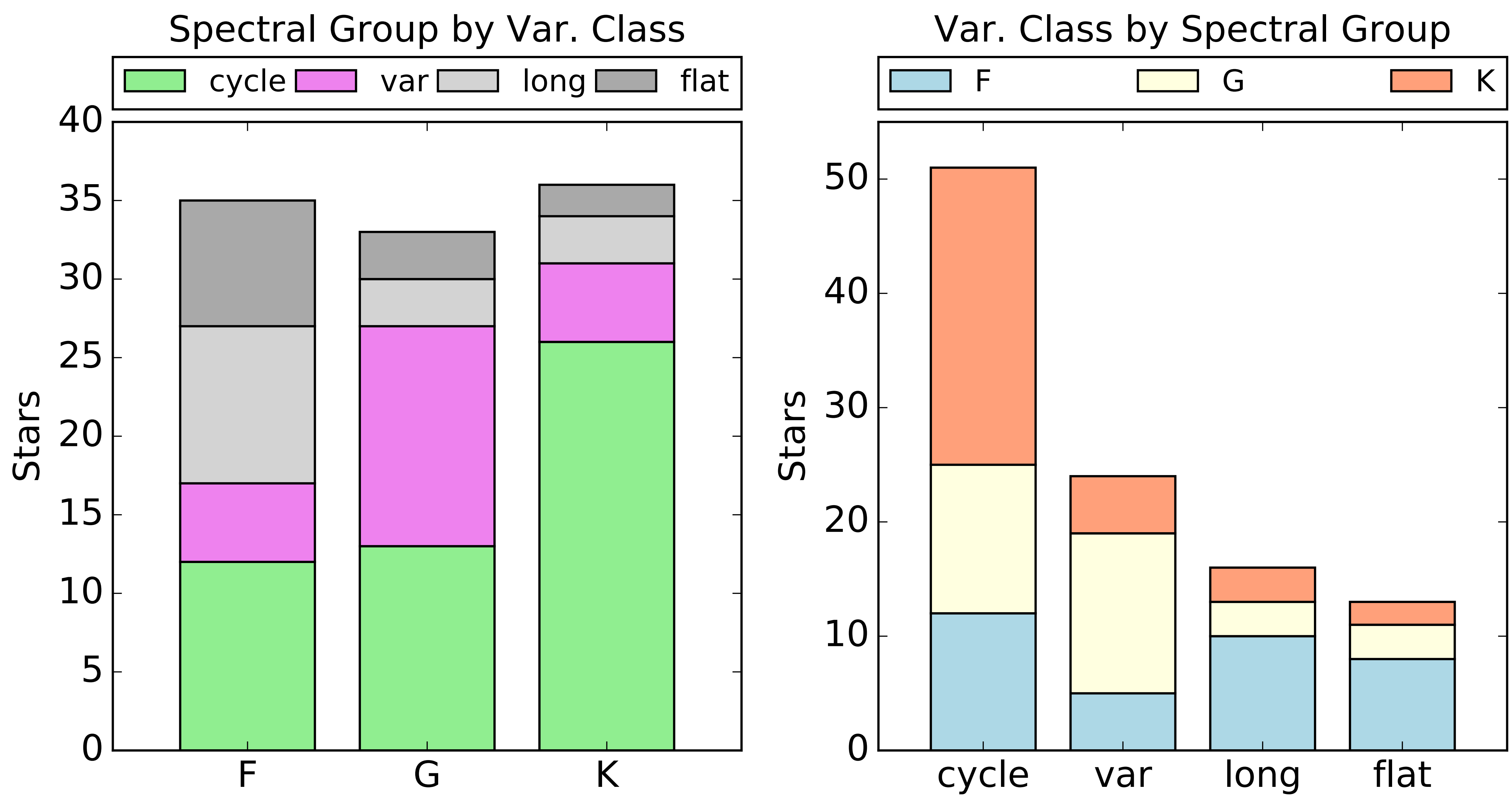
So where are the Sun-like cycles?



(Egeland et al. 2018, in prep.)

K-stars Have More & Better Cycles

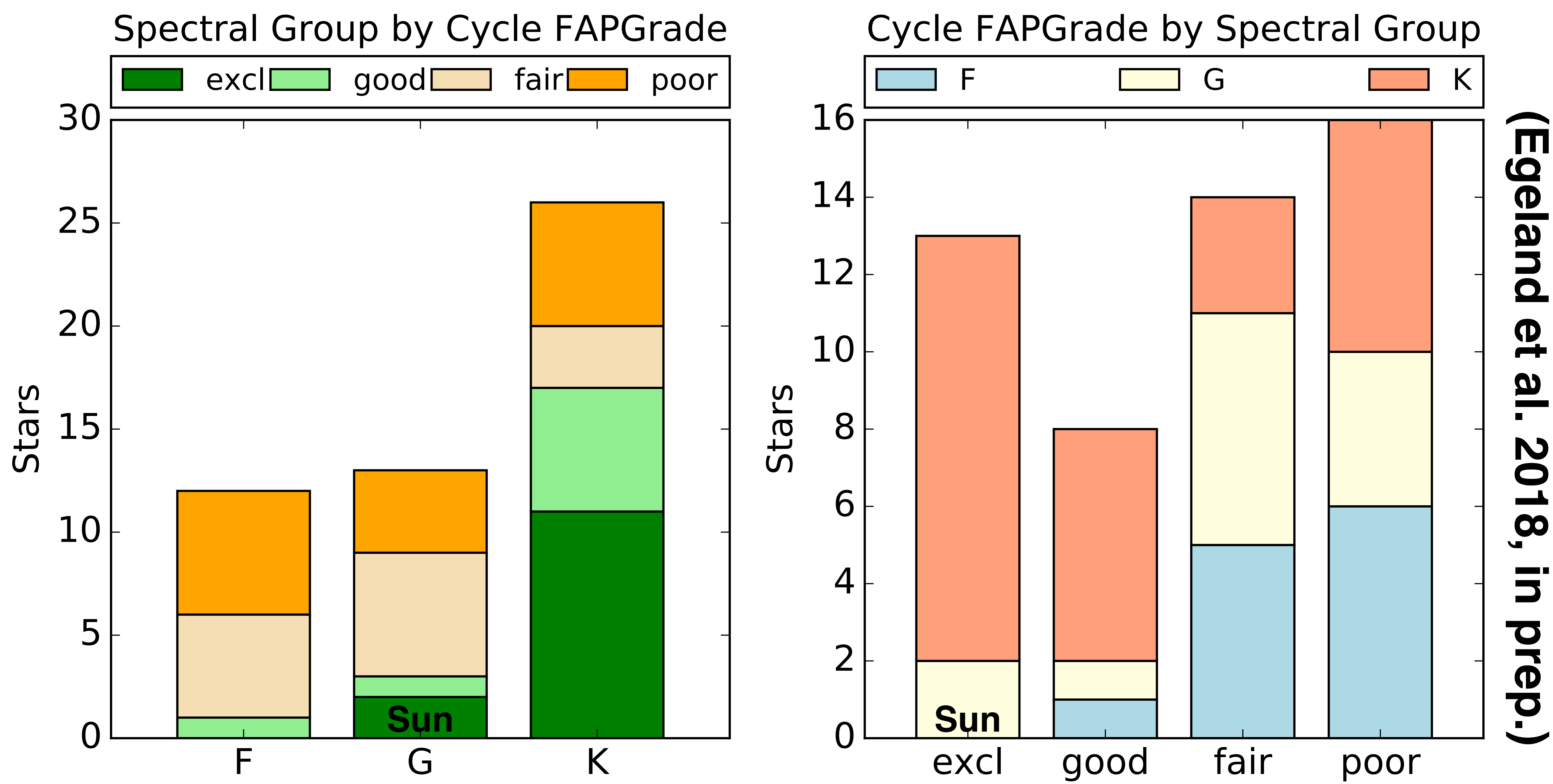
note: generous definition of "cycle": a statistically significant periodogram peak



(Egeland et al. 2018, in prep.)

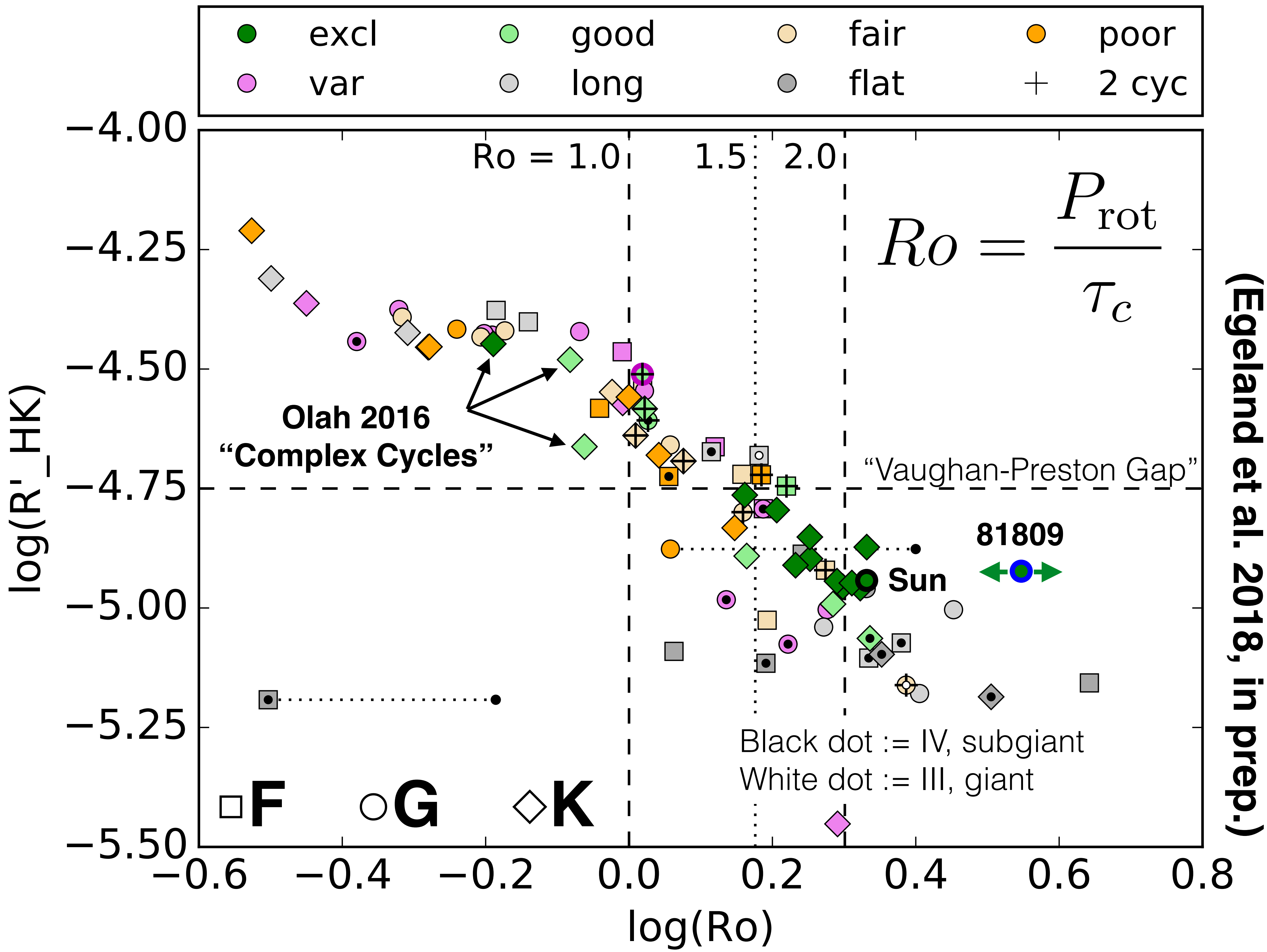
K-group most likely to be cycling: 71%
G-group and F-group cycling: ~34%
F-group most likely to be (flat + long): 49%
G-group most likely to be Var: 43%

K-stars Have More & Better Cycles



K-group most likely to be excl or good: 65% of K-cyclers, 47% of K-group
or, of the (excl + good) stars, **81% of them are K-group!**
G-group (excl + good): 23% of G-cyclers, **9% of G-group!**
F-group (excl + good): 8.3% of F-cyclers, **2.9% of F-group!**

Why does the Sun have a Sun-like cycle?



<u>Hypothesis</u>: For G & K main-sequence stars, Sun-like variability happens iff *Ro* > 1.5

Advertisement: sunstardb

sunstardb is a publicly accessible database of observations relevant to the study of stellar magnetism.

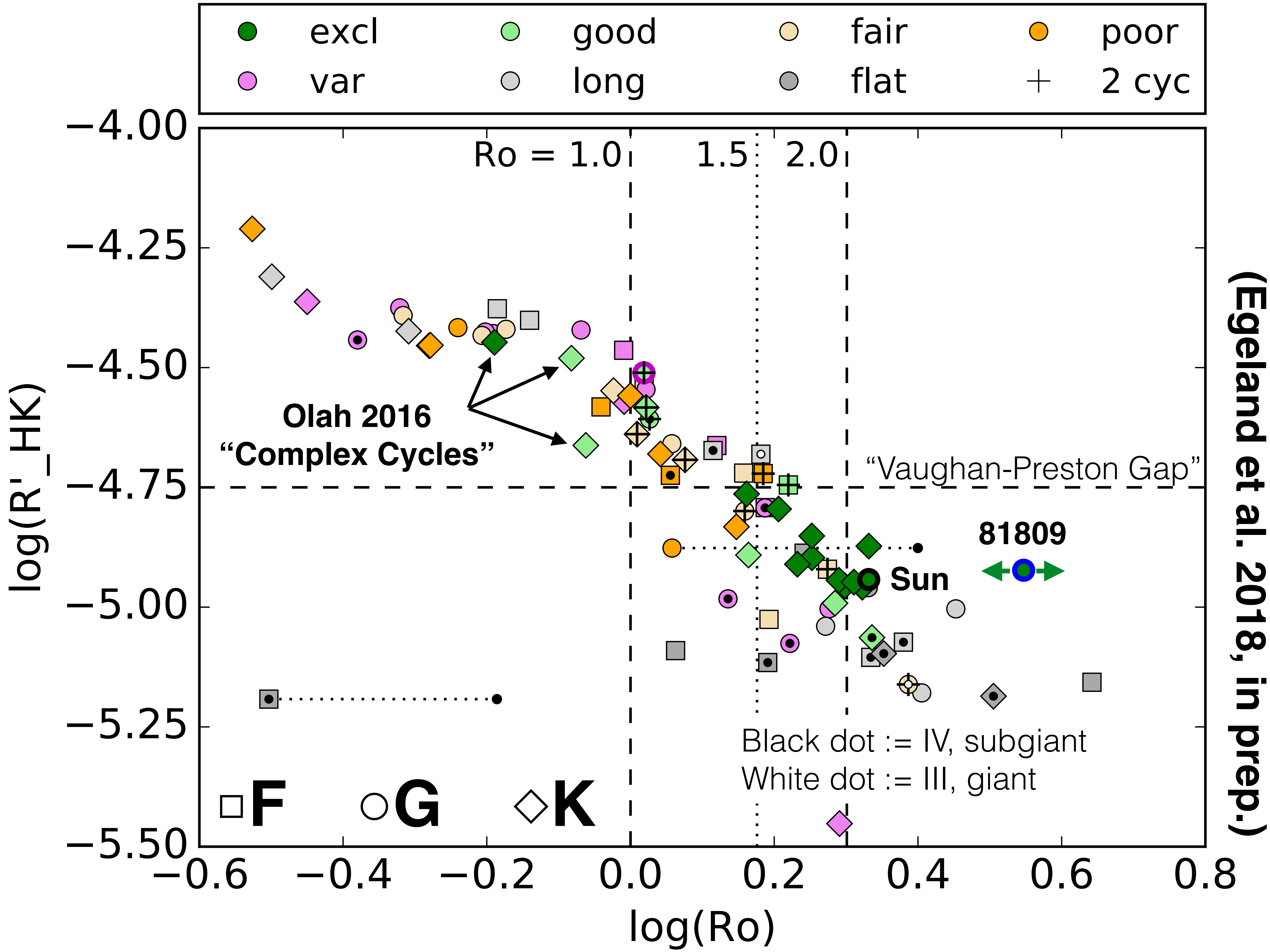
See Egeland 2018, ApJS or search "sunstardb".

It is designed to make it easy to extract stellar ensembles with the desired properties, with full provenance information attached to each datum.

It currently has a python interface and enough data to make most of the plots in this presentation, but it needs more work and more data.

Contributions welcome!

Conclusions



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