The Solar Dynamo Zoo

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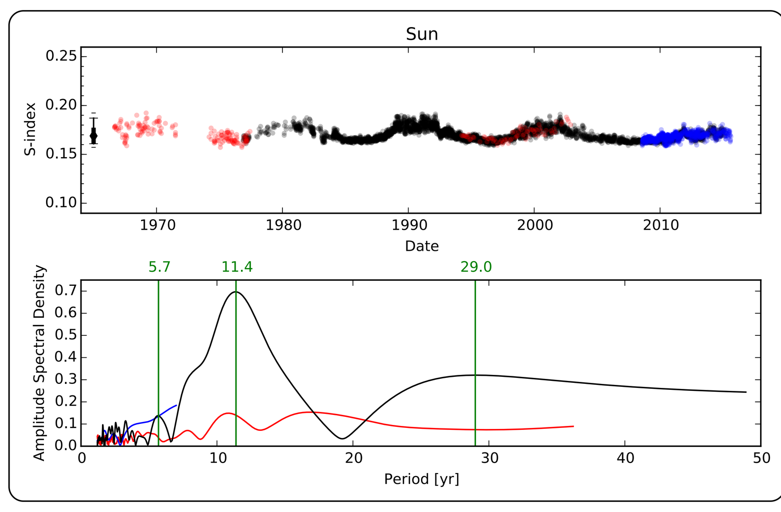
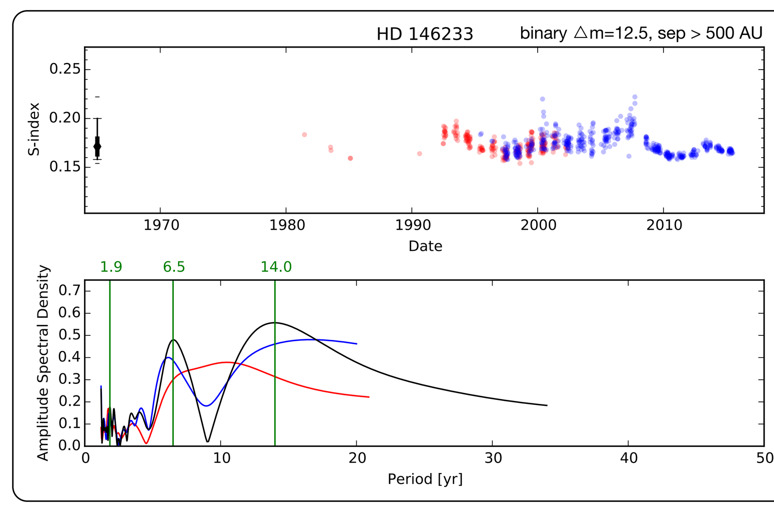
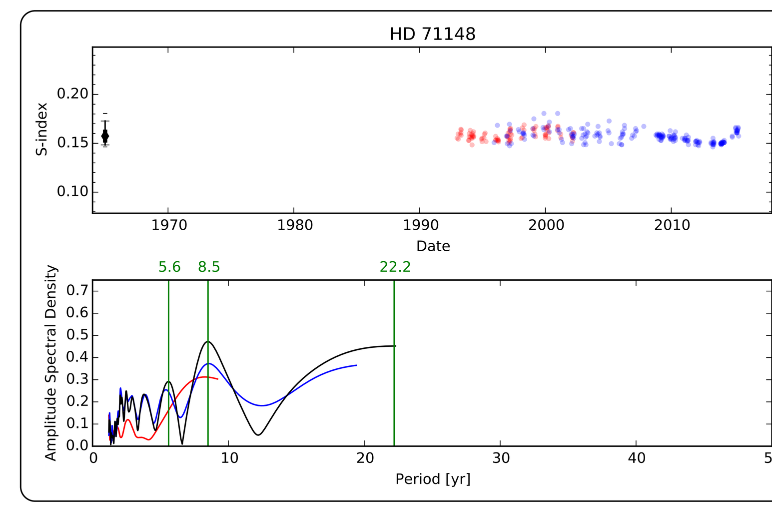


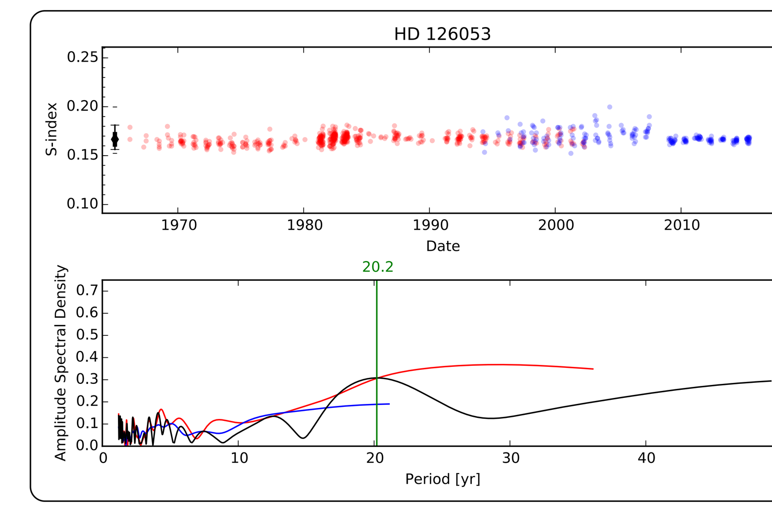
T_{eff}	1
R	1
L	1
P_{rot}	26
[Fe/H]	0
$\bar{S}$	0.169
A_{98}	0.026
$\bar{A}_{98,s}$	0.013
P_{var}	11.4
Q_{cyc}	59



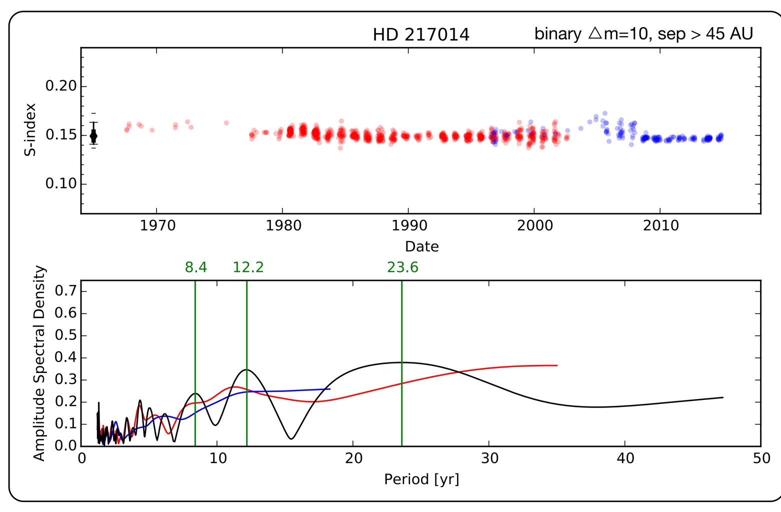
T_{eff}	1.00
R	1.02
L	1.03
P_{rot}	22.7
[Fe/H]	-0.02
$\bar{S}$	0.171
A_{98}	0.042
$\bar{A}_{98,s}$	0.016
P_{var}	14;6.5
Q_{cyc}	44;43



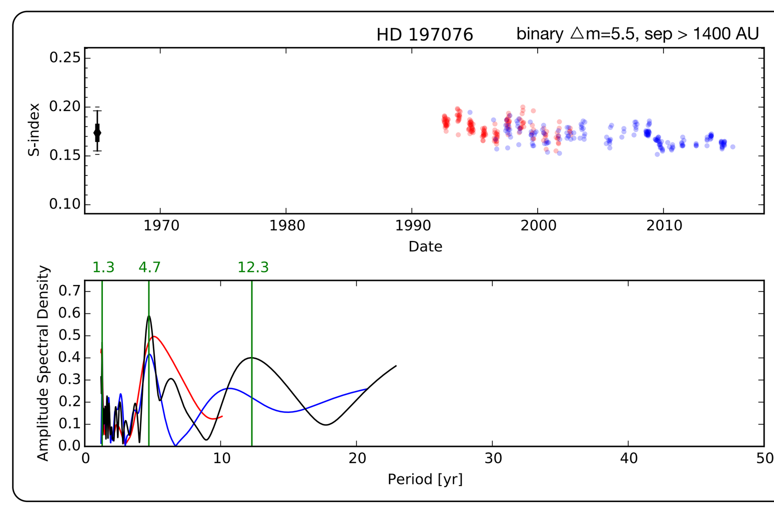
T_{eff}	1.00
R	1.11
L	1.24
P_{rot}	>21.6
[Fe/H]	-0.10
$\bar{S}$	0.157
A_{98}	0.025
$\bar{A}_{98,s}$	0.009
P_{var}	8.5
Q_{cyc}	38



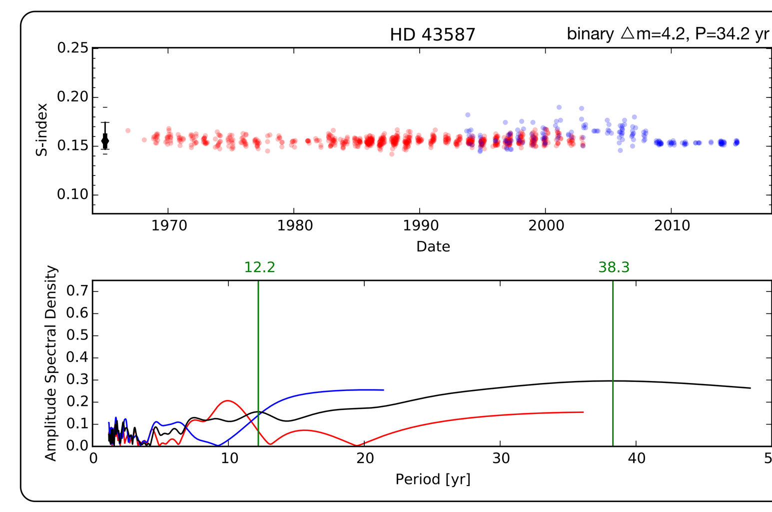
T_{eff}	0.98
R	0.92
L	0.79
P_{rot}	21.1
[Fe/H]	-0.39
$\bar{S}$	0.167
A_{98}	0.025
$\bar{A}_{98,s}$	0.011
P_{var}	20.2
Q_{cyc}	25



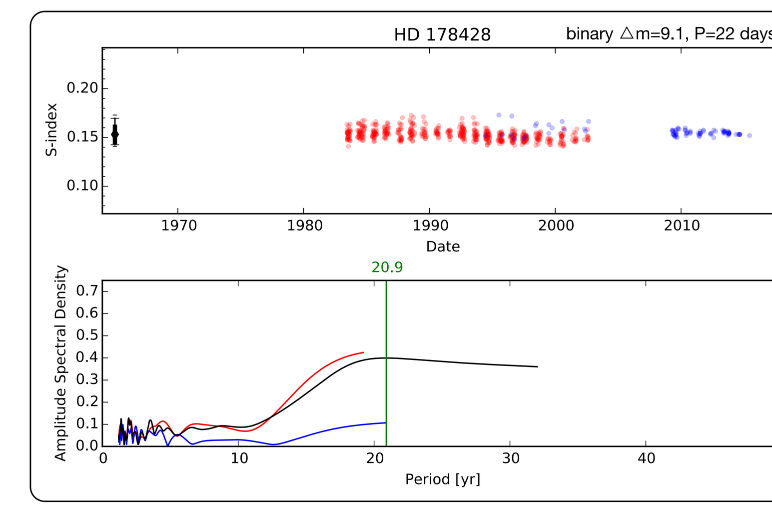
T_{eff}	0.99
R	1.19
L	1.37
P_{rot}	21.9
[Fe/H]	+0.12
$\bar{S}$	0.149
A_{98}	0.022
$\bar{A}_{98,s}$	0.009
P_{var}	12.2
Q_{cyc}	30



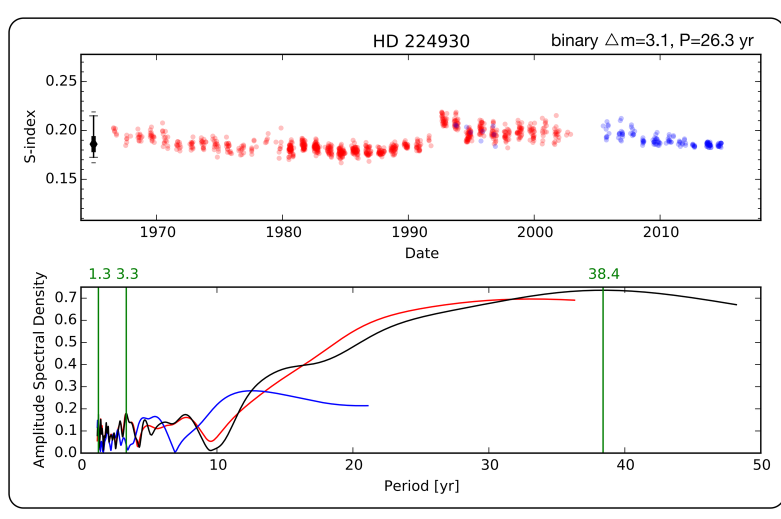
T_{eff}	1.00
R	1.00
L	0.99
P_{rot}	>18.7
[Fe/H]	-0.22
$\bar{S}$	0.174
A_{98}	0.041
$\bar{A}_{98,s}$	0.014
P_{var}	4.7
Q_{cyc}	53



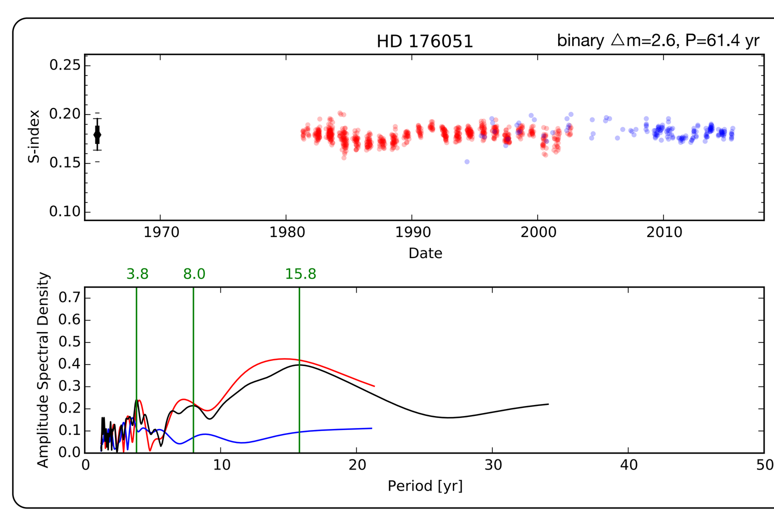
T_{eff}	1.02
R	1.24
L	1.62
P_{rot}	>21.0
[Fe/H]	-0.11
$\bar{S}$	0.155
A_{98}	0.028
$\bar{A}_{98,s}$	0.011
P_{var}	–
Q_{cyc}	–



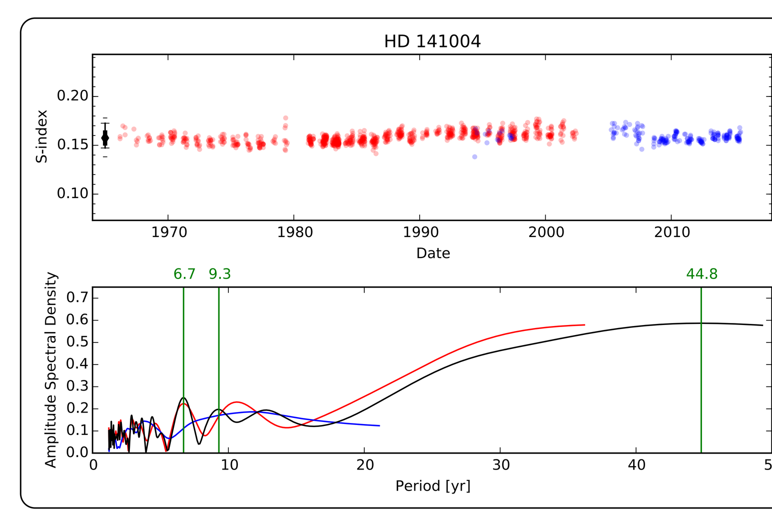
T_{eff}	0.97
R	1.30
L	1.48
P_{rot}	22?
[Fe/H]	+0.05
$\bar{S}$	0.153
A_{98}	0.027
$\bar{A}_{98,s}$	0.016
P_{var}	20.9
Q_{cyc}	27



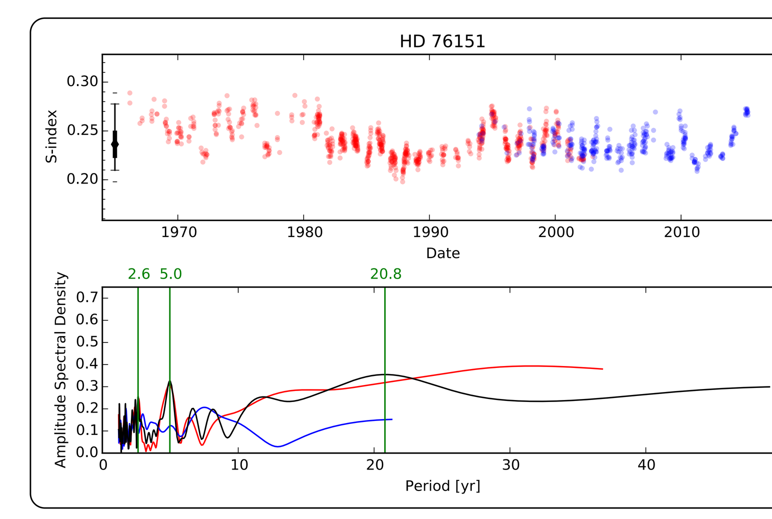
T_{eff}	0.95
R	0.91
L	0.67
P_{rot}	33
[Fe/H]	-0.78
$\bar{S}$	0.186
A_{98}	0.042
$\bar{A}_{98,s}$	0.012
P_{var}	38.4
Q_{cyc}	44



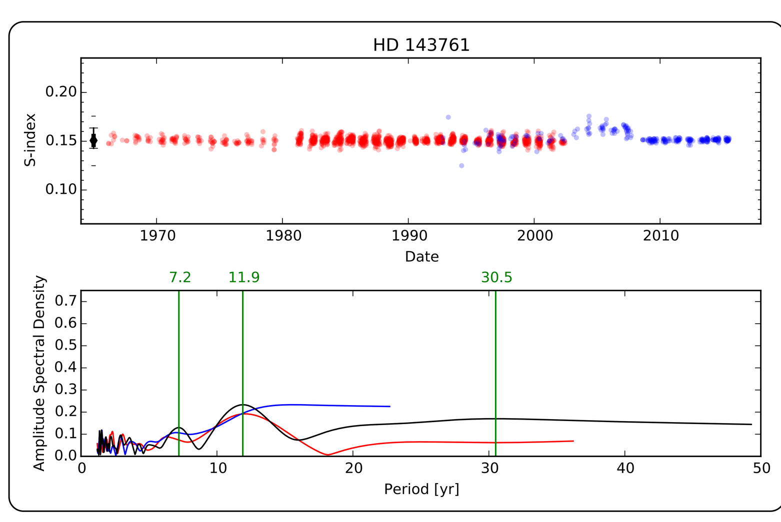
T_{eff}	1.01
R	1.20
L	1.51
P_{rot}	17.5
[Fe/H]	-0.19
$\bar{S}$	0.179
A_{98}	0.032
$\bar{A}_{98,s}$	0.012
P_{var}	15.8
Q_{cyc}	31



T_{eff}	1.02
R	1.38
L	2.07
P_{rot}	25.8
[Fe/H]	-0.01
$\bar{S}$	0.156
A_{98}	0.022
$\bar{A}_{98,s}$	0.011
P_{var}	6.7
Q_{cyc}	23



T_{eff}	0.98
R	1.05
L	1.03
P_{rot}	15
[Fe/H]	-0.04
$\bar{S}$	0.236
A_{98}	0.069
$\bar{A}_{98,s}$	0.024
P_{var}	5.0;21
Q_{cyc}	31;28



T_{eff}	1.00
R	1.31
L	1.74
P_{rot}	17
[Fe/H]	-0.25
$\bar{S}$	0.151
A_{98}	0.021
$\bar{A}_{98,s}$	0.009
P_{var}	11.9
Q_{cyc}	21

Observations: A wide variety of patterns in long-term variability are demonstrated in these composite time series of the Ca II H and K emission index *S* for a selection of solar-analog stars (mass within ±10% solar) with observations from both the Mount Wilson Observatory HK Photometer (MWO; 1966–2003; **red**) and the Lowell Observatory Solar-Stellar Spectrograph (SSS; 1994–present, **blue**). Solar observations (top left diagram) were made using reflected light from the Moon at MWO, and using a direct fiber feed to the SSS. The majority of the solar observations are from the National Solar Observatory Sacramento Peak K-line measurements (NSO-K; 1975–2016; **black**), which were calibrated to the MWO S-index flux scale using overlapping measurements during cycle 23. All time series are plotted with a y-axis range of 0.17 in *S*, to make it easy to see the variety of amplitudes in this sample. Each instrument has a daily observation precision of ~1%, determined by taking the standard deviation of the time series of flat activity stars, or during the long 2008 minimum in the case of the Sun.

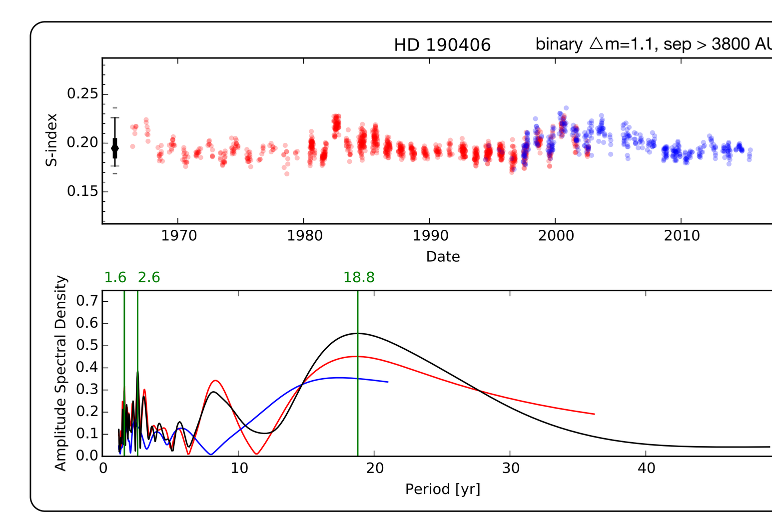
Stellar properties: Fundamental stellar properties are shown in upper portion of the table attached to each diagram. The table includes the effective surface temperature T_{eff} , the stellar radius R, luminosity L, and the logarithmic iron abundance fraction [Fe/H], all in solar units. The latter values were derived using data from the Geneva-Copenhagen Survey and have a precision within 2%. Rotation periods P_{rot} are given in days and are taken from multiple sources in the literature, usually based on periodgram analysis of time series modulated by active region transits. Rotation periods shown in red are lower limits derived from spectroscopic vsini measurements. **The diagrams are presented in (row, col) order of similarity to the Sun in (T_{eff}, R, P_{rot}) using a similarity metric.**

Statistics: The lower section of each table gives $\bar{S}$, the median value of the composite time series, A_{98}, the inner-98% range, and $\bar{A}_{98,s}$, the median of the seasonally-binned inner-98% range. The latter statistics are also indicated with the black bar symbol in each time series, with the center diamond at $\bar{S}$, the thick black bar having a height of $\bar{A}_{98,s}$, and the thin capped bar indicating A_{98}. The minimum and maximum observation are marked by small dashes outside the A_{98} bar.

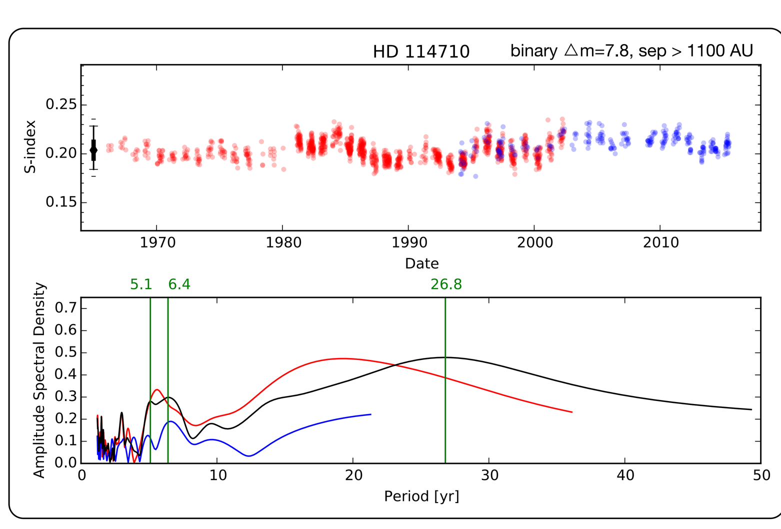
Period analysis: Below each time series is a Lomb-Scargle periodogram of the observations, with the MWO observations in **red**, the SSS observations in **blue**, and the composite time series in **black**. Each periodogram covers a range of periods from 1.2 years to the duration of the time series. The periodograms are expressed in terms of the amplitude spectral density (ASD) of the zero-mean time series normalized by its standard deviation. The advantage of the ASD over the power spectral density is that it does not scale with the number of observations. In the ASD periodogram, a perfect sine wave has an ASD peak value of 1.0 σ at the proper period. Non-sinusoidal signals, such as the solar cycle necessarily have lower peak values along with a series of harmonics. Sub-harmonics are also present when a signal does not have a constant amplitude or period. The top three statistically significant period peaks are indicated by green vertical lines. Each peak period is ranked by a quality function

$$Q_{cyc} = 100 (1 - 0.5 P_{var}/T) A,$$

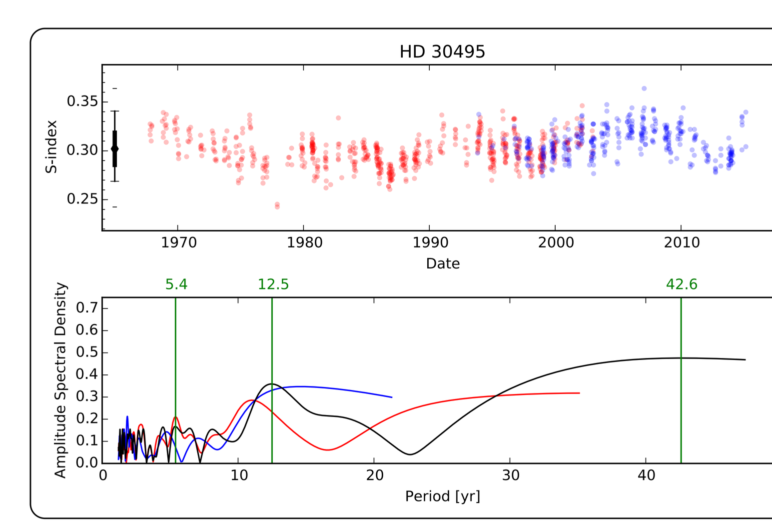
where P_{var} is the peak period, T is the duration of the time series, and A is the peak amplitude spectral density. Q_{cyc} is in the range [0, 100] where 100 can only be achieved for an infinitely long sinusoidal time series. Clean, regular cycling behavior such as for the Sun have **$Q_{cyc} > 50$**. Peaks with $Q_{cyc} < 15$ are neglected.



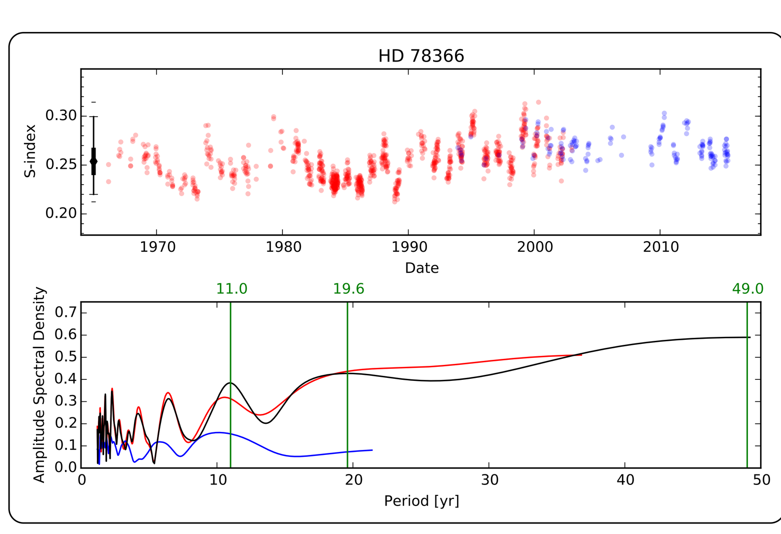
T_{eff}	1.01
R	1.10
L	1.27
P_{rot}	13.94
[Fe/H]	-0.12
$\bar{S}$	0.195
A_{98}	0.049
$\bar{A}_{98,s}$	0.016
P_{var}	19;2.6
Q_{cyc}	45;38



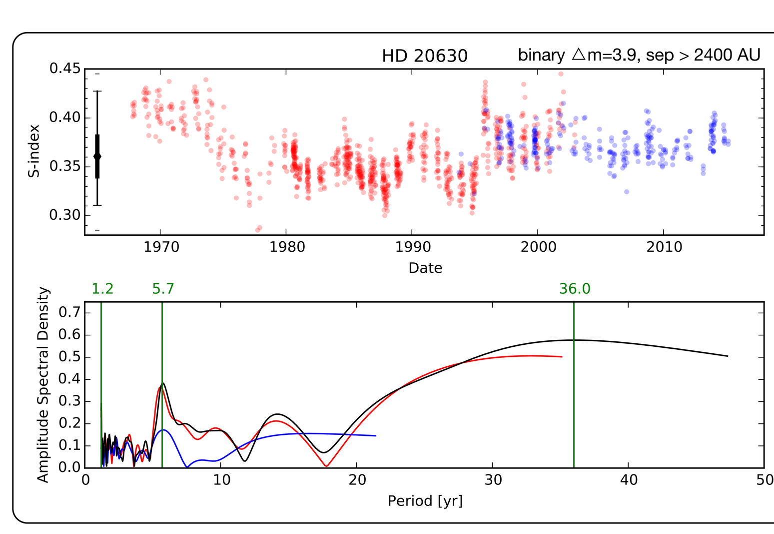
T_{eff}	1.03
R	1.09
L	1.35
P_{rot}	12.35
[Fe/H]	-0.06
$\bar{S}$	0.204
A_{98}	0.044
$\bar{A}_{98,s}$	0.017
P_{var}	27;6.4
Q_{cyc}	35;28



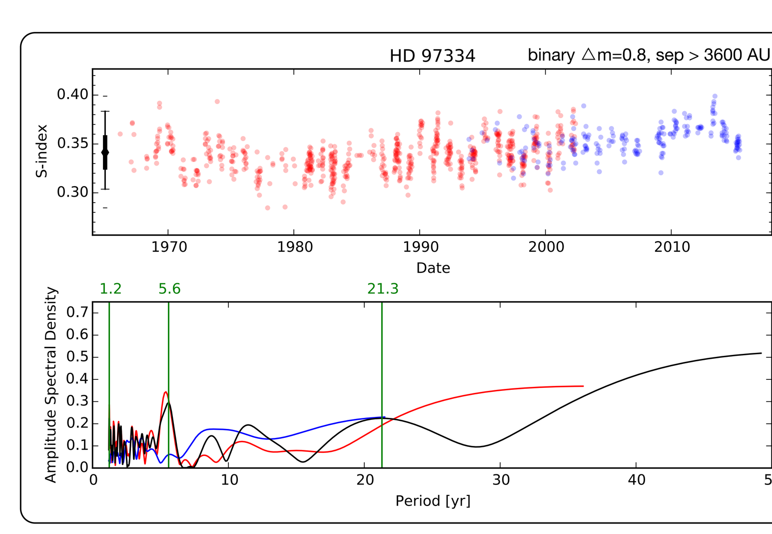
T_{eff}	1.00
R	0.97
L	0.95
P_{rot}	11.2
[Fe/H]	-0.08
$\bar{S}$	0.303
A_{98}	0.072
$\bar{A}_{98,s}$	0.033
P_{var}	12.5
Q_{cyc}	35



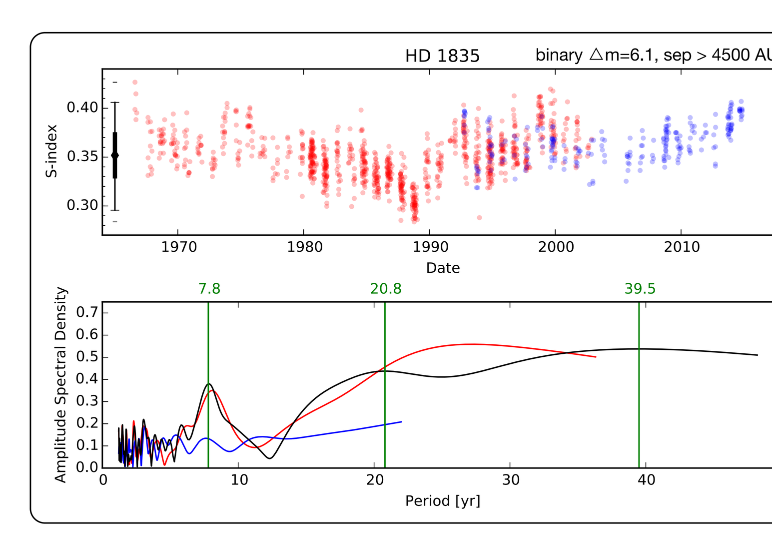
T_{eff}	1.03
R	1.08
L	1.28
P_{rot}	9.67
[Fe/H]	-0.01
$\bar{S}$	0.254
A_{98}	0.049
$\bar{A}_{98,s}$	0.024
P_{var}	20;11
Q_{cyc}	34;34



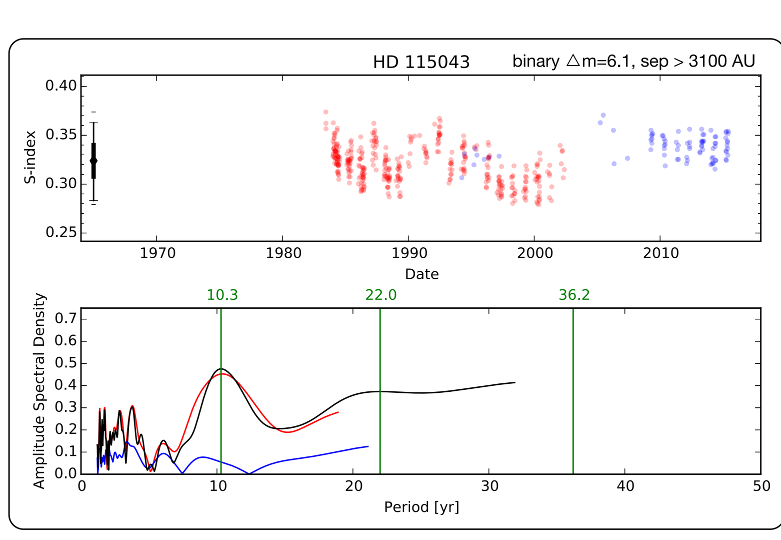
T_{eff}	0.99
R	0.93
L	0.83
P_{rot}	9.24
[Fe/H]	0.00
$\bar{S}$	0.361
A_{98}	0.117
$\bar{A}_{98,s}$	0.041
P_{var}	5.7;36
Q_{cyc}	36;36



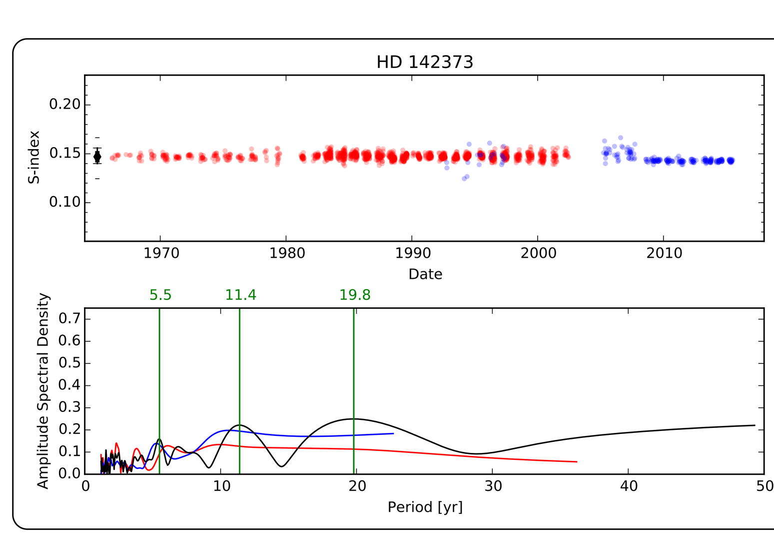
T_{eff}	1.01
R	1.03
L	1.10
P_{rot}	8.25
[Fe/H]	-0.09
$\bar{S}$	0.341
A_{98}	0.080
$\bar{A}_{98,s}$	0.031
P_{var}	5.6
Q_{cyc}	28



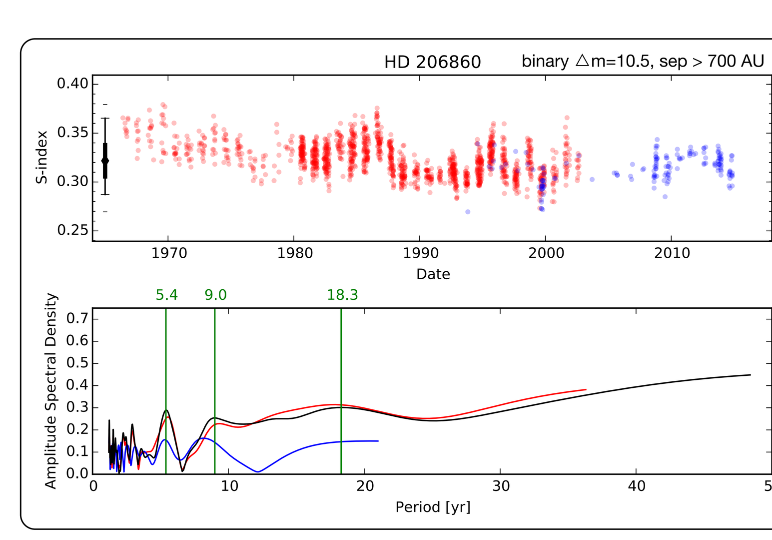
T_{eff}	0.99
R	1.05
L	1.03
P_{rot}	7.78
[Fe/H]	-0.02
$\bar{S}$	0.352
A_{98}	0.110
$\bar{A}_{98,s}$	0.043
P_{var}	21;7.8
Q_{cyc}	35;33



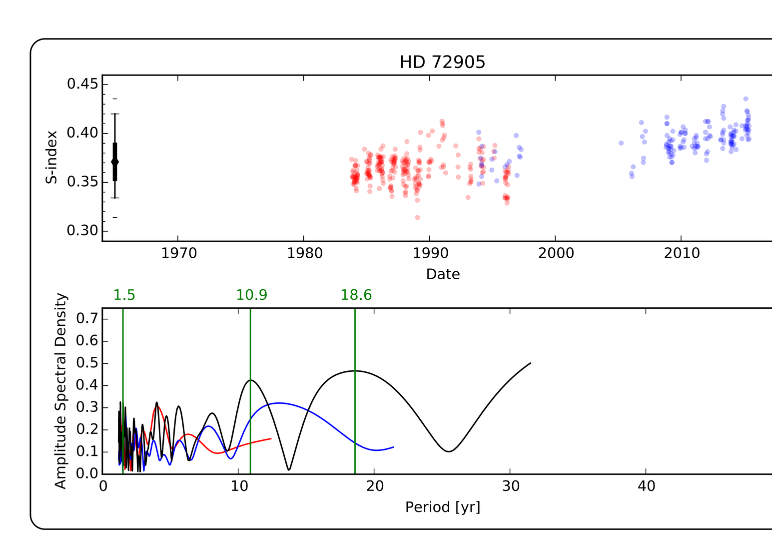
T_{eff}	1.00
R	1.01
L	1.02
P_{rot}	6
[Fe/H]	-0.22
$\bar{S}$	0.324
A_{98}	0.080
$\bar{A}_{98,s}$	0.032
P_{var}	10.3
Q_{cyc}	40



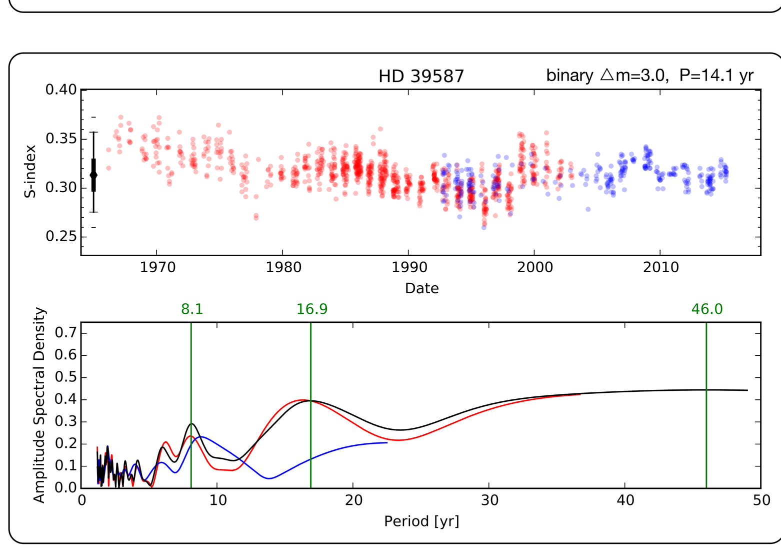
T_{eff}	1.01
R	1.73
L	3.06
P_{rot}	16.8
[Fe/H]	-0.50
$\bar{S}$	0.147
A_{98}	0.016
$\bar{A}_{98,s}$	0.007
P_{var}	–
Q_{cyc}	–



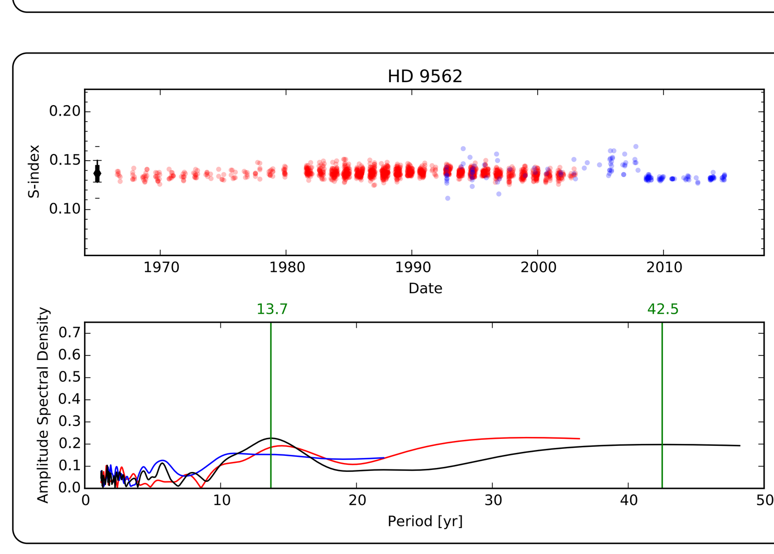
T_{eff}	1.02
R	1.00
L	1.08
P_{rot}	4.86
[Fe/H]	-0.19
$\bar{S}$	0.322
A_{98}	0.078
$\bar{A}_{98,s}$	0.032
P_{var}	5.4;18
Q_{cyc}	27;24



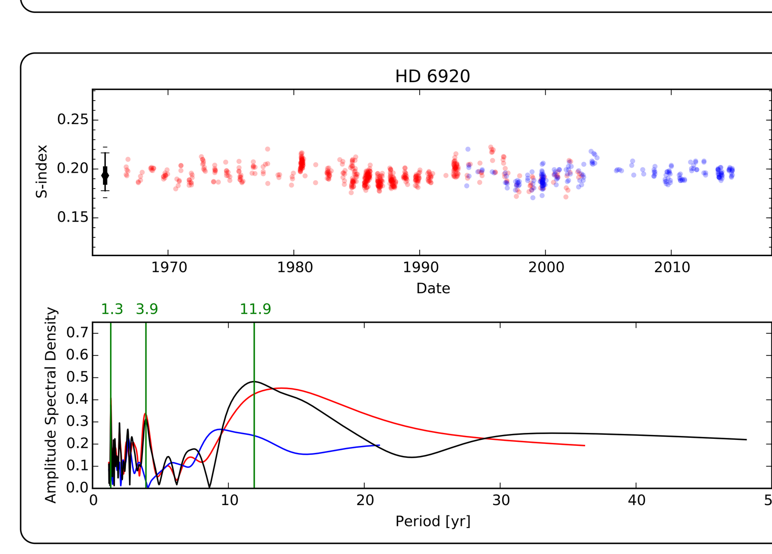
T_{eff}	1.00
R	0.98
L	0.97
P_{rot}	4.69
[Fe/H]	-0.25
$\bar{S}$	0.371
A_{98}	0.086
$\bar{A}_{98,s}$	0.035
P_{var}	–
Q_{cyc}	–



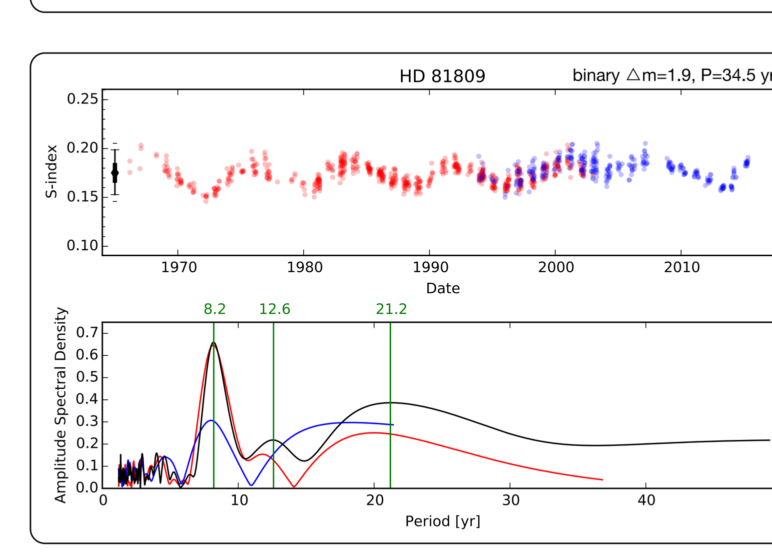
T_{eff}	1.02
R	0.99
L	1.08
P_{rot}	3.56
[Fe/H]	-0.16
$\bar{S}$	0.313
A_{98}	0.082
$\bar{A}_{98,s}$	0.030
P_{var}	17;8.1
Q_{cyc}	33;27



T_{eff}	1.01
R	1.85
L	3.62
P_{rot}	29
[Fe/H]	+0.13
$\bar{S}$	0.137
A_{98}	0.022
$\bar{A}_{98,s}$	0.013
P_{var}	13.7
Q_{cyc}	19



T_{eff}	1.01
R	3.42
L	12.34
P_{rot}	14
[Fe/H]	-0.14
$\bar{S}$	0.193
A_{98}	0.039
$\bar{A}_{98,s}$	0.014
P_{var}	12;1.3
Q_{cyc}	42;37



B-V	0.638 0.654
mass	1.7 1.0
M_V	2.88 4.77
P_{rot}	40.2
[Fe/H]	-0.29
$\bar{S}$	0.175
A_{98}	0.049
$\bar{A}_{98,s}$	0.016
P_{var}	8.2
Q_{cyc}	61

version date: May 26, 2016