# AoV Period Analysis Plug-In

Introduction

The *AoV* plug-in implements a period search algorithm. Whereas Date Compensated Discrete Fourier Transform (DCDFT) uses Fourier Analysis to search over a period range given a loaded set of observations, AoV uses the ANOVA (One-way Analysis of Variance) algorithm to create a periodogram, a plot of period vs power.
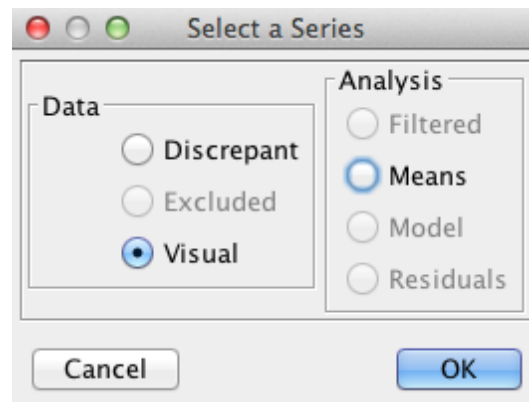
The plug-in can be installed via the *Plug-in Manager* item in the Tool menu. After VStar has been restarted, the *Analysis* menu will contain a new item for the plug-in:
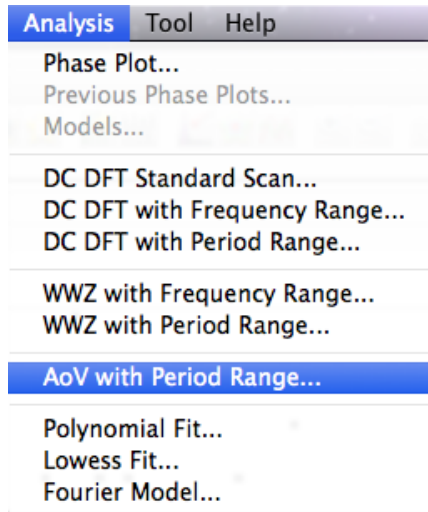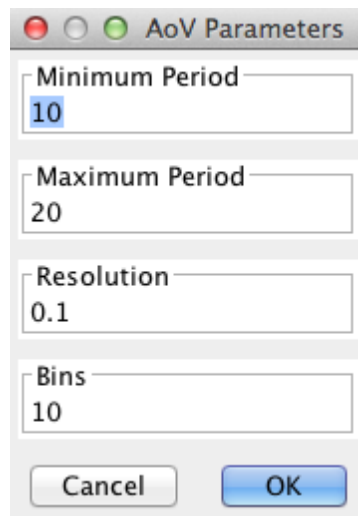

Suppose the following X Cyg data set (JD 2447000 to 2447960) is loaded into VStar:
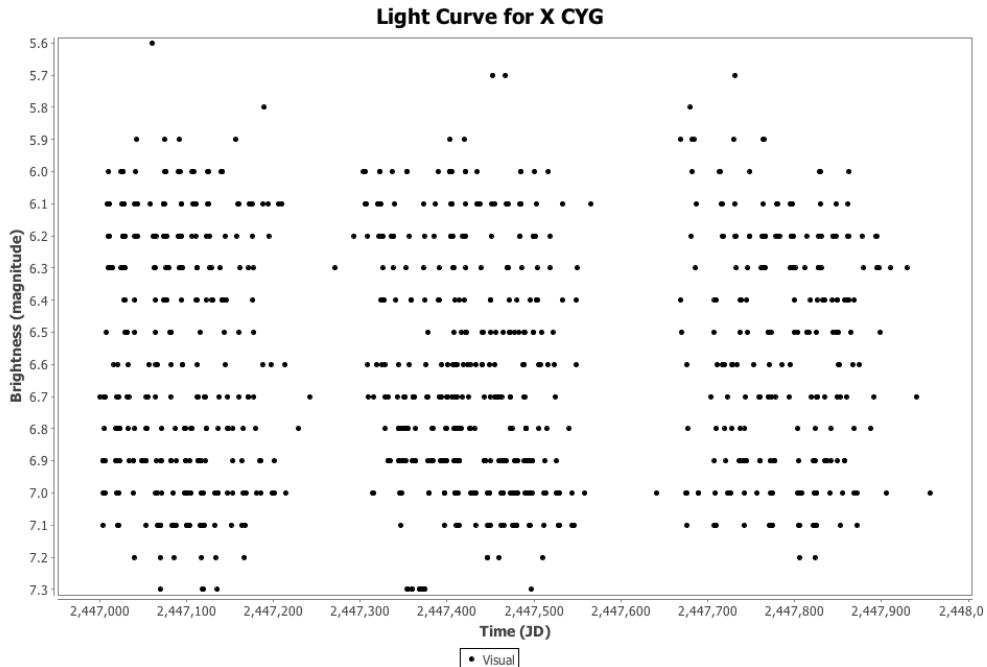
Invoking the *AoV with Period Range* item from the *Analysis* menu opens a series selection dialog:


Clicking the OK button with the Visual series selected results in a parameter entry dialog being opened:

A visual inspection of the light curve (e.g. by zooming in) suggests a period of around 16 days. The parameter dialog above shows manually entered values of minimum and maximum period that bracket this value along with a resolution of 0.1 days. A larger value for bins corresponds internally to a phased mean curve that has more data points. The default of 10 bins is often a reasonable choice however. See the next section for more discussion about this value.

The result of clicking the OK button with these parameters is shown below:
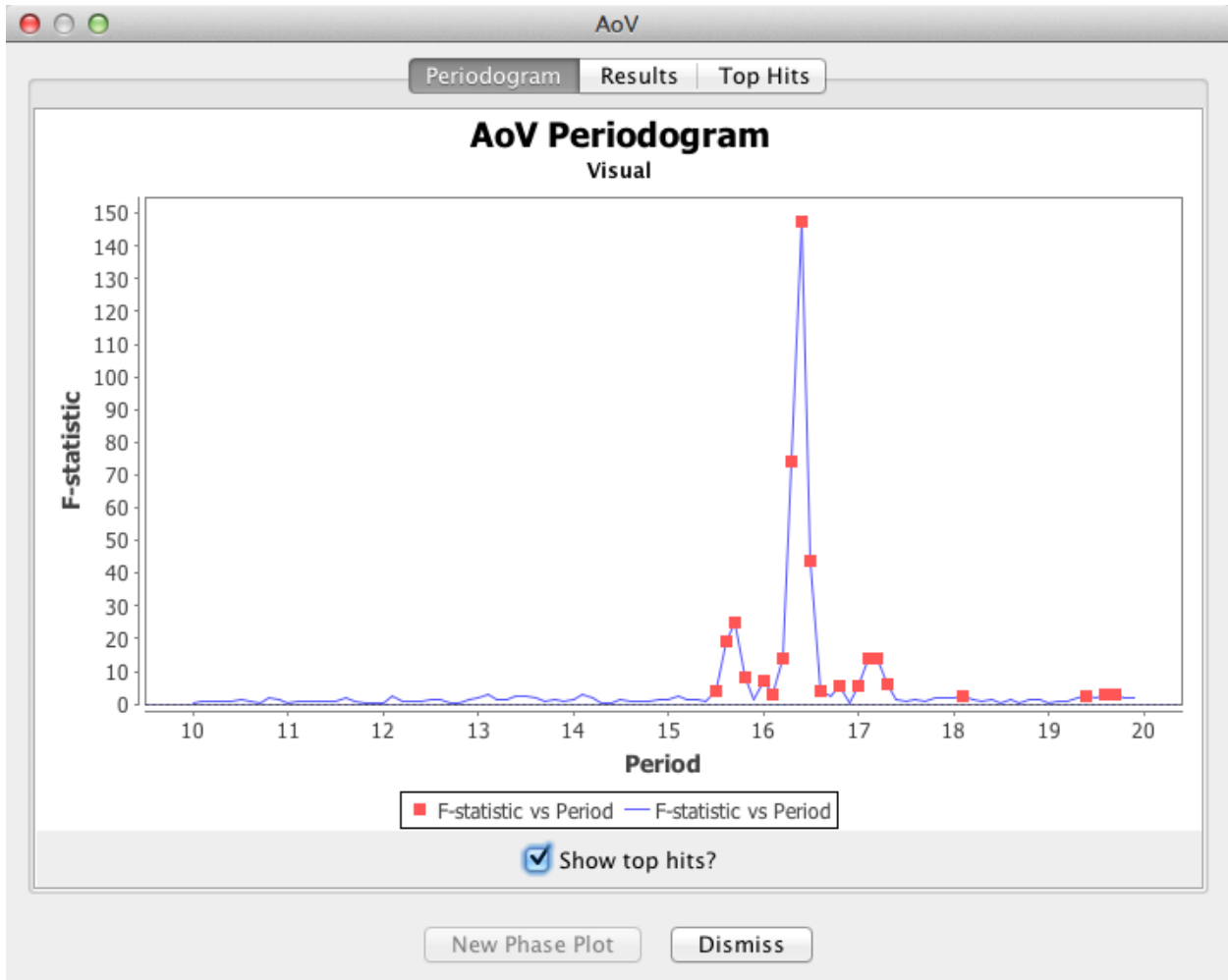
This should look familiar to anyone who has used DCDFT in VStar. All data from the period search is available on the *Periodogram* and *Results* tabs. As for DCDFT, top hits are shown on the *Periodogram* and *Top Hits* tabs.

AoV

| Frequency	Period	F-statistic	p-value
0.060976	16.4	147.537331	0
0.06135	16.3	73.975293	0
0.060606	16.5	43.556476	0
0.063694	15.7	24.726462	0
0.064103	15.6	19.035027	0
0.05814	17.2	14.167871	0
0.05848	17.1	13.872627	0
0.061728	16.2	13.792102	0
0.063291	15.8	8.446185	0
0.0625	16	7.209566	0
0.057803	17.3	6.153454	0
0.058824	17	5.559248	0
0.059524	16.8	5.35801	0
0.060241	16.6	3.923348	0.00003
0.064516	15.5	3.861016	0.000038
0.05102	19.6	2.968721	0.001095
0.050761	19.7	2.757205	0.003474
0.062112	16.1	2.751029	0.003544
0.055249	18.1	2.582449	0.006106
0.051546	19.4	2.567695	0.004579

New Phase Plot   Dismiss

A point on the plot or a table row can be selected and a phase plot created by clicking the *New Phase Plot* button.

Phase Plot for X CYG
period: 16.4, epoch: 2447478.139
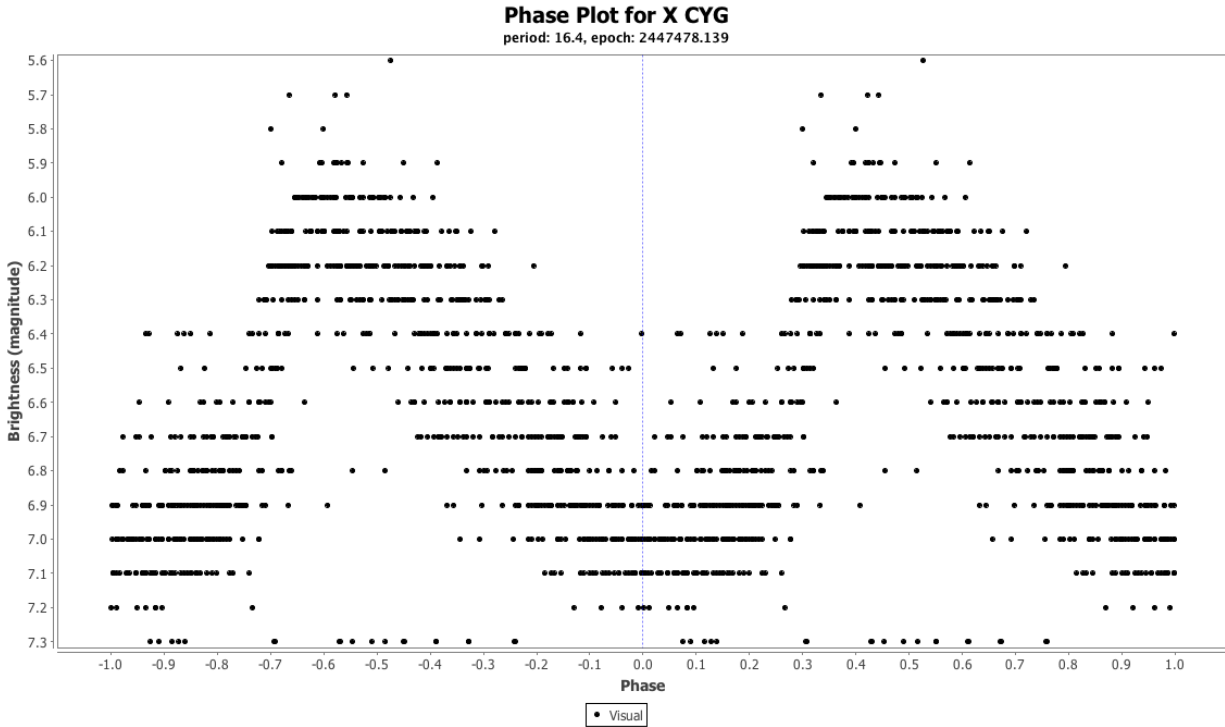
To get closer to the true period (e.g. as found on VSX), a higher resolution (e.g. 0.001 rather than 0.1) could be requested.

Understanding AoV

A simple way to understand AoV is to imagine a series of phase plots being created, one for every period in the requested range. For each such phase plot (in fact, just the phase values) the ANOVA algorithm is run and the resulting period, F-statistic and p-value are recorded, the second being used as the power value on the periodogram plot. Peaks on the plot correspond to phase plots for which the evidence for rejecting the null hypothesis that there is no significant signal (only noise) is strongest.

The number of bins requested in the parameter dialog corresponds to the bins used in mean series generation in VStar. Whereas for a mean series VStar asks for the number of days per bin in raw mode or (of more relevance to AoV) the number of phase steps per bin in phase plot mode, the AoV plug-in asks for the number of bins. From this, the phase steps per bin are internally computed. As mentioned above, a larger value for bins corresponds internally to a phased mean series that has more data points and potentially better approximates the phased observations at a given period. Of course, too many bins (so, data points) may lead to over-fitting the data so if you are getting useful results, leave the number of bins at 10. Of course, you should feel free to experiment (e.g. try 20 or 40 bins).

See Foster (2010) and links for more details.

Useful Links for AoV

A.Schwarzenberg-Czerny (1989) On the advantage of using analysis of variance in period search. http://articles.adsabs.harvard.edu/cgi-bin/nph-iarticle_query?1989MNRAS.241..153S&data_type=PDF_HIGH&whole_paper=YES&type=PRINTER&am p;filetype=.pdf

Grant Foster (2010) says in *Analyzing Light Curves: A Practical Guide*, Section 7.6

Useful Links for ANOVA

StatSoft, Introduction to ANOVA/MANOVA: An overview of ANOVA techniques from the publisher of a statistics textbook. The page links to a great deal of other information on statistical analysis. [http://www.statsoft.com/textbook/anova-manova/?button=1]

Wikipedia - One-way ANOVA (analysis of variance): Standard Wikipedia entry summarizing the basics of the ANOVA technique. [http://en.wikipedia.org/wiki/One-way_analysis_of_variance]

How to Calculate and Understand Analysis of Variance (ANOVA) F Test. [https://explorable.com/anova] (video)