Light Curve Viewer

Table of contents

December 19, 2025

Preface

Light Curve Viewer (LCV) is 'a test workbench for different light-curve-related procedures'.

Currently, it implements some methods from:

Andronov, I. L., (Multi-) Frequency Variations of Stars. Some Methods and Results, Odessa Astronomical Publications, vol. 7, p. 49-54 (1994) [1994OAP.....7...49A]

Andronov, I. L., Advanced Time Series Analysis of Generally Irregularly Spaced Signals: Beyond the Oversimplified Methods, Knowledge Discovery in Big Data from Astronomy and Earth Observation, 1st Edition. Edited by Petr Skoda and Fathalrahman Adam. ISBN: 978-0-128-19154-5. Elsevier, 2020, p.191-224 [2020kdbd.book..191A]

System Requirements

The program runs on both Windows and Linux. It has been tested under Windows 7, 10, and 11, as well as Debian 12 and 13, and Linux Mint Cinnamon.

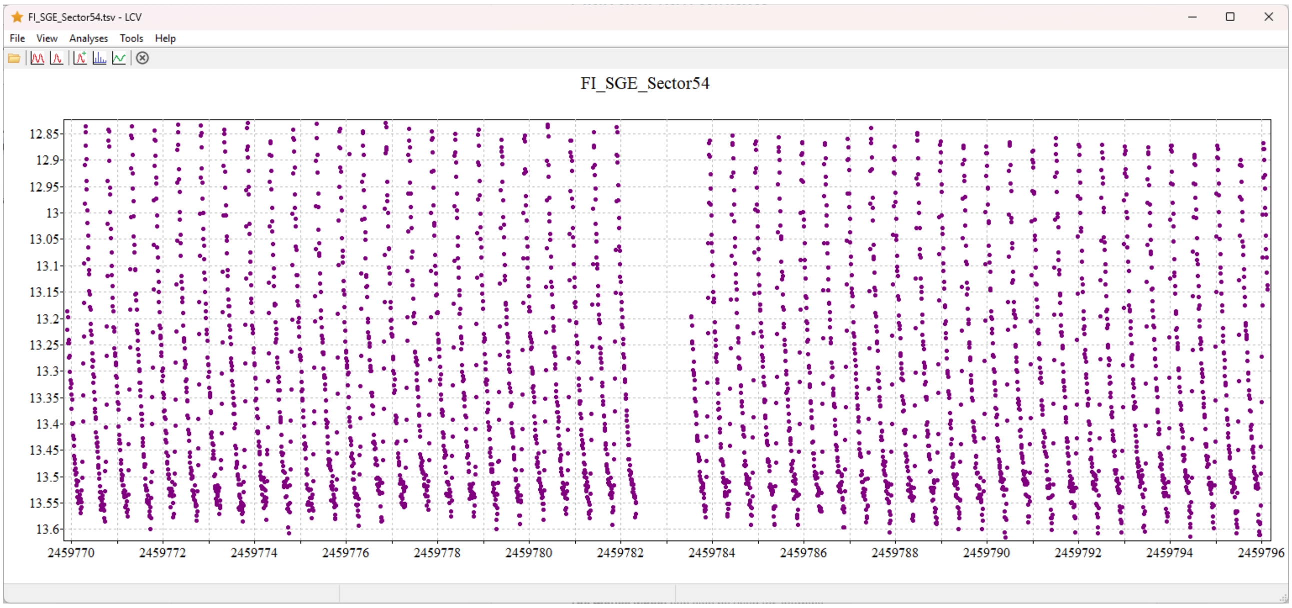
The source files can be compiled using Lazarus/Free Pascal. Testing was performed with Lazarus 3.8 on Linux, Lazarus 4.4 on Windows, and Free Pascal 3.2.2.

The program uses the precompiled libraries lapack_min.dll (Windows) and liblapack_min.so (Linux), which are included in the distribution.

Main program window

The main program window contains a chart showing loaded data. Use File->Open to load data from a text file (see ‘Input file format’).

After loading, the data is displayed as a ‘scatter chart’:



Manipulating chart

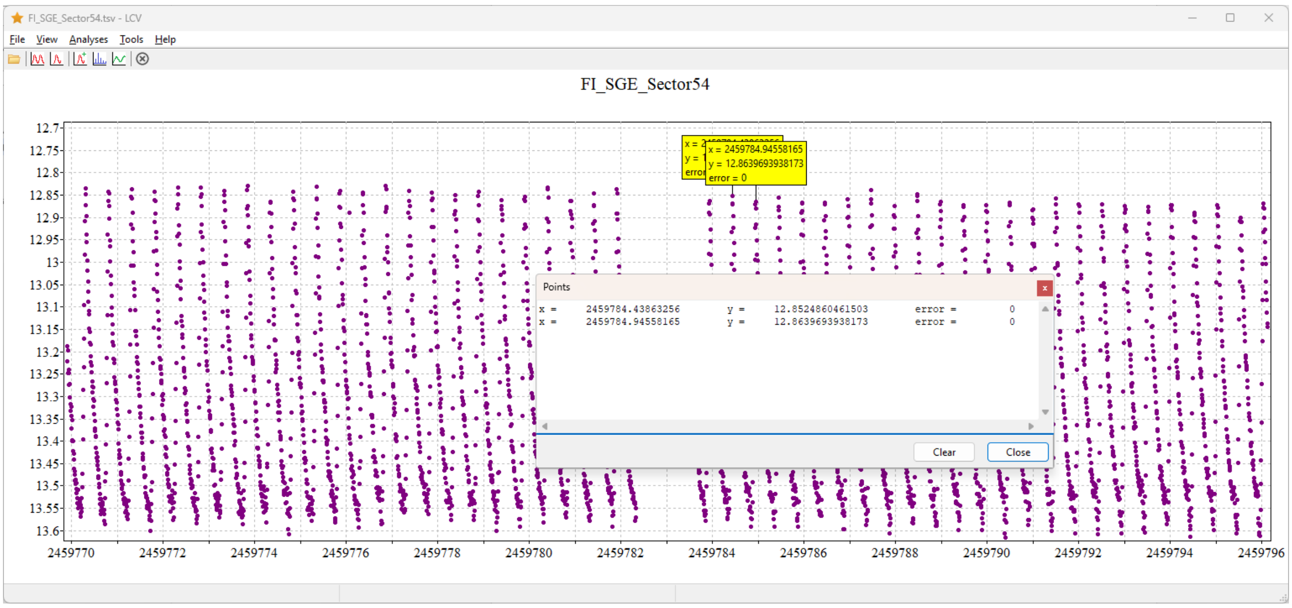
Ctrl + Left Mouse Button Dragging: select a part of the chart (zoom)

Shift + Left Mouse Button Dragging: shift the viewport (panning)

Ctrl + Left Mouse Button Clicking: restore the original view

Left Mouse Button Click on a point: add a label to the clicked point. To remove the label, click the point again.

Ctrl + Shift + Left Mouse Button Click: add a label to the clicked point and show the coordinates in a small window



The mouse wheel can also be used for zooming.

Clicking the right mouse button on the chart opens a pop-up menu with the following functions:

- copy the chart image to the Clipboard
- save the chart image to a PNG file
- set the chart extent

Main Menu

- File

• Open...	Open a data file
• Save a copy of Visible Data As...	Save a copy of the data (currently visible, after zoom) into a data file
• Exit	Close the program

- View

• Raw Data	Plot data as is
• Phase Plot	Plot the active phase plot or calculate a new one
• Cycle-by-cycle color	Plot each cycle in the phase plot in a different color
• Show Data	Display data (observations)
• Show Errors	Display error bars
• Show Model	Display the current approximation and its error corridor
• Inverted Y Axis	If checked, the Y axis is inverted
• Chart Properties...	Open the Chart Properties dialog
• Chart Extent...	Set the chart extent
• Show Observations...	Display data in a tabular form

- Analyses

• Phase Plot	Calculate a new phase plot
• Periodogram...	Open a dialog with the periodogram parameters
• Polynomial Approximation...	Open a dialog with the parameters of the polynomial (algebraic + trigonometric) approximation
• Approximation Info...	Display information about the current approximation
• Detrend	Subtract the approximation from the data
• Detrend Alg. Polynomial Only	Subtract the algebraic part of the approximation only

- Tools

• Magnitude Shift	Add a value to the magnitudes (Y-values)
• Descriptive Statistics	Show some data statistics
• Options	Tune the program settings

- Help

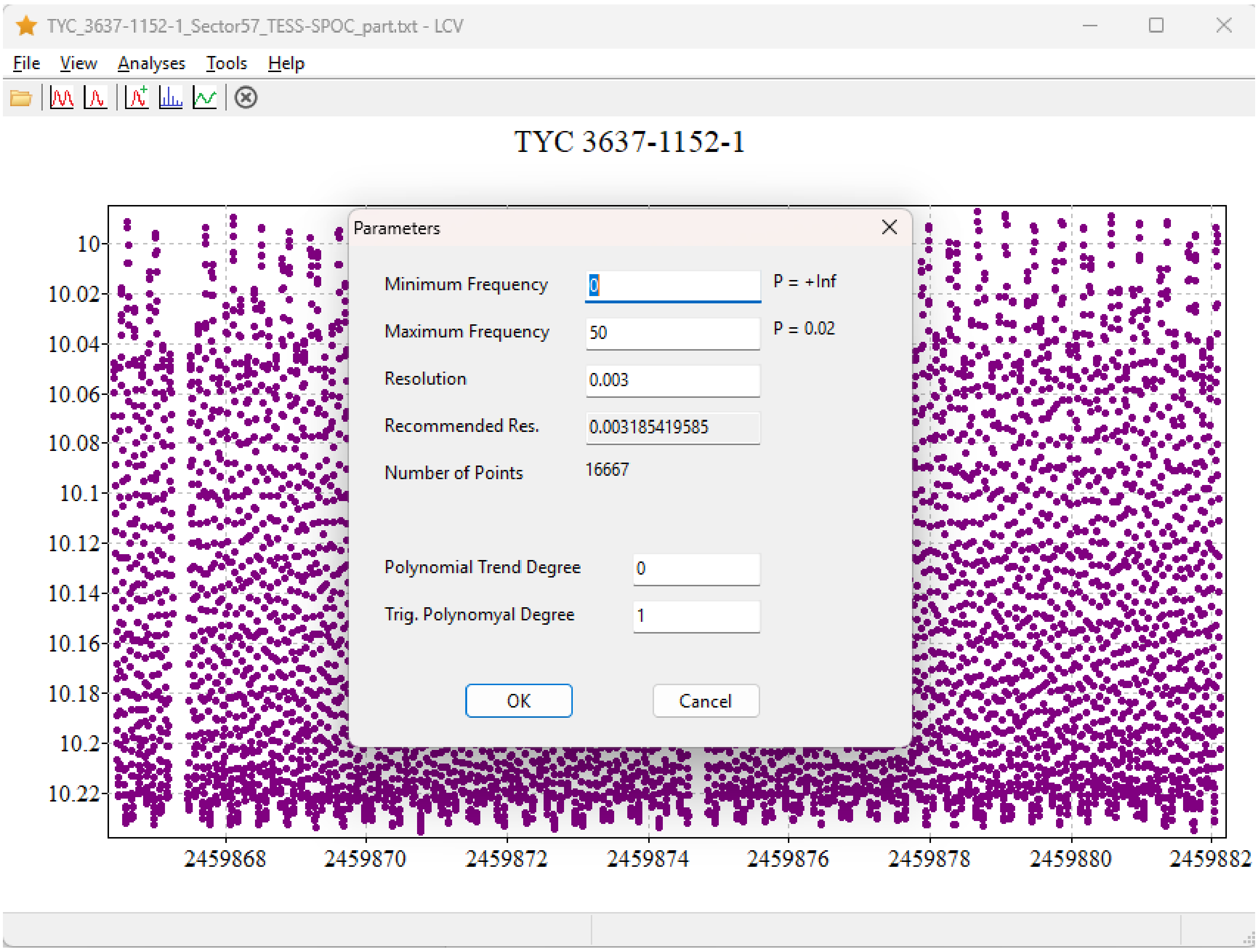
• User Manual Online...	Open the manual in the system web browser (from GitHub)
• User Manual (Local)...	Open the manual in the PDF viewer (from the local program's directory)
• About	

Periodogram

The periodogram analysis can be invoked via the menu command or by clicking the corresponding toolbar button.

In the example below, the file “TYC_3637-1152-1_Sector57_TESS-SPOC_part.txt” from the “lcv_testdata” folder is used.

If a data file is loaded, the “Periodogram” tool button and the “Analyses->Periodogram...” menu item become active. After clicking either, the following dialog appears:



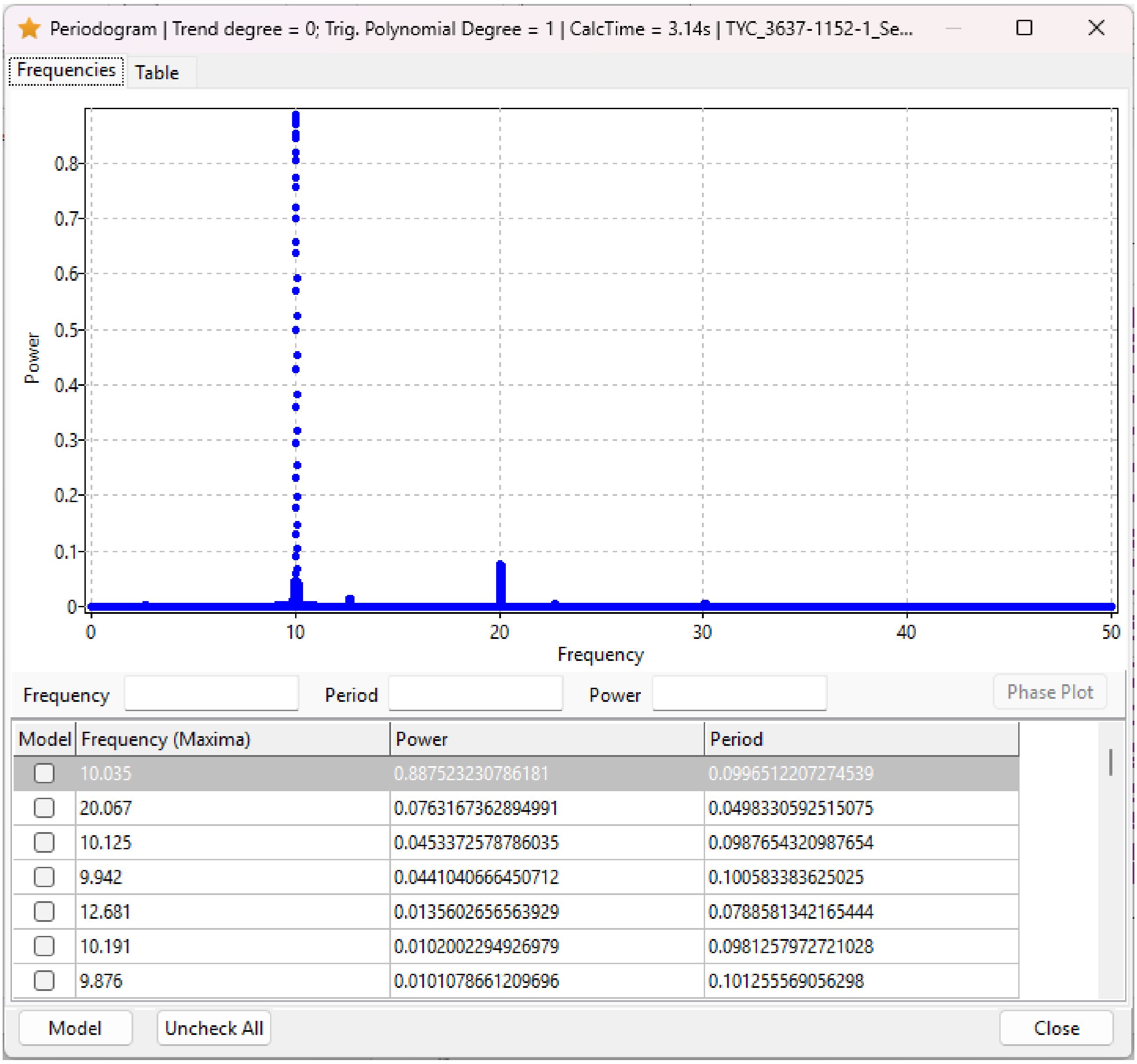
The user must specify the low and high frequency bounds as well as the resolution. Optionally, the degree of the polynomial trend can be defined; this trend is taken into account during periodogram calculation and suppresses near-zero frequencies that may arise if the input data contain a trend. If a trigonometric polynomial degree greater than 1 is specified, the analysis fits the corresponding trigonometric polynomial (a sinusoid with its harmonics) rather than a simple sinusoidal function at each test frequency (see the “Multi-harmonic fit” section in https://ui.adsabs.harvard.edu/abs/1994OAP.....7...49A/abstract for more information). Finally, click OK to start the analysis.

The analysis fits a sinusoidal function (or, if the trigonometric polynomial degree is greater than 1, a sinusoid with harmonics) for each test frequency. For each frequency, the following statistic is then calculated:

$$S(f) = 1 - \frac{\sigma^2_{O-C}}{\sigma^2_O}$$

where σ_O is the r.m.s. deviation of the observed magnitudes from the mean value; σ^2_{O-C} is the r.m.s. deviation of the observed magnitudes from calculated ones (see https://ui.adsabs.harvard.edu/abs/1994OAP.....7...49A/abstract for details). Note that, in its simplest form, the periodogram calculated in this way is equivalent to the Ferraz-Mello DC DFT (the "power" in the Ferraz-Mello periodogram is the statistic S(f) multiplied by the factor $(n-1)/2$, where n is the number of observations).

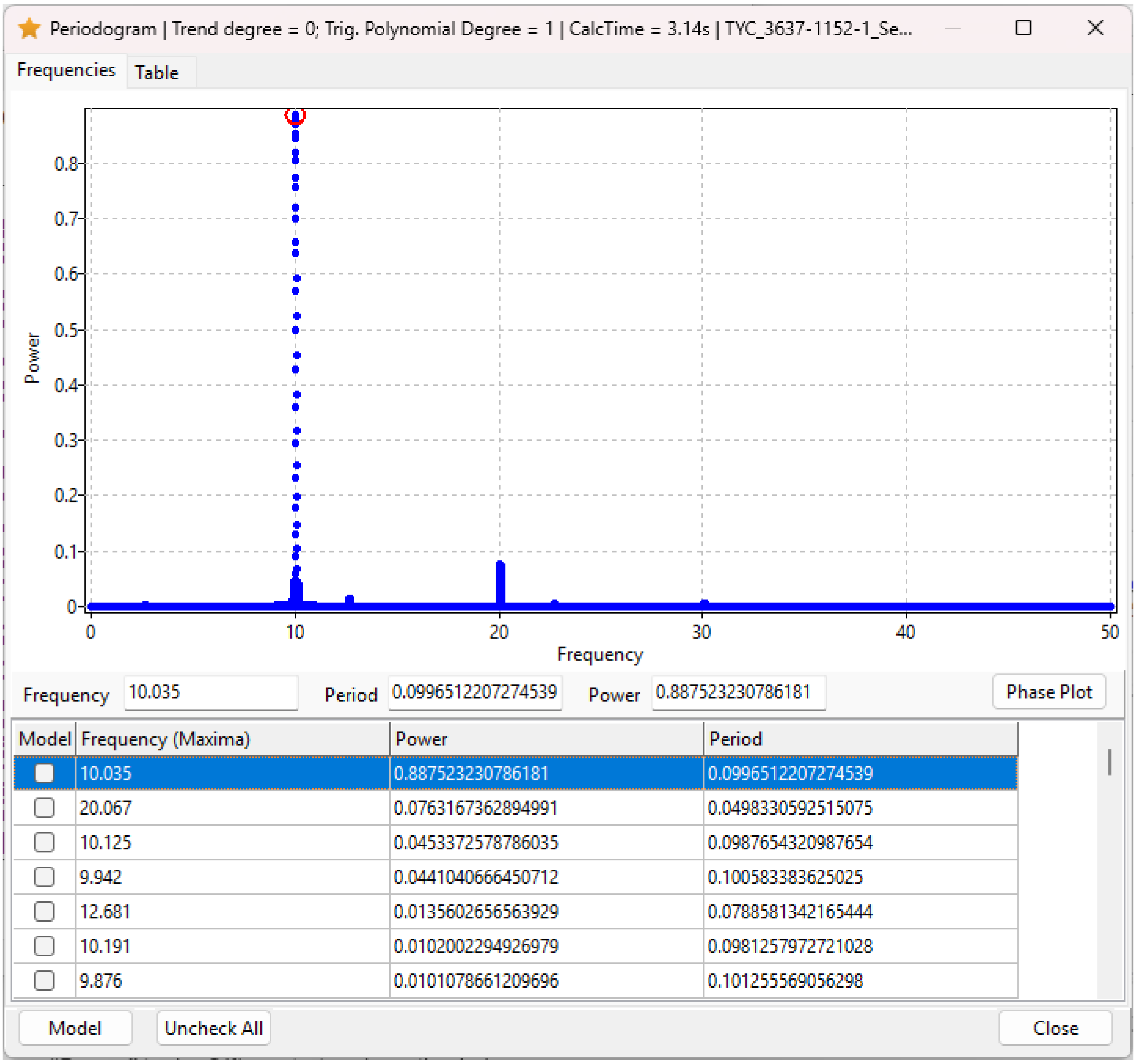
When the process is complete, the following dialog appears:



Model	Frequency (Maxima)	Power	Period
☐	10.035	0.887523230786181	0.0996512207274539
☐	20.067	0.0763167362894991	0.0498330592515075
☐	10.125	0.0453372578786035	0.0987654320987654
☐	9.942	0.0441040666450712	0.100583383625025
☐	12.681	0.0135602656563929	0.0788581342165444
☐	10.191	0.0102002294926979	0.0981257972721028
☐	9.876	0.0101078661209696	0.101255569056298

"Power" corresponds to the statistic S(f) described above.

The table below the chart lists the periodogram maxima in descending order. Clicking an item in the table highlights the corresponding maximum in the chart:



In turn, clicking a point in the chart highlights the nearest maximum in the table. If the selected point does not exactly correspond to a maximum, the table item is grayed. To select the exact position, click the table entry directly. The keyboard and mouse functions for zooming and panning the plot are similar to those described in the Manipulating Chart section.

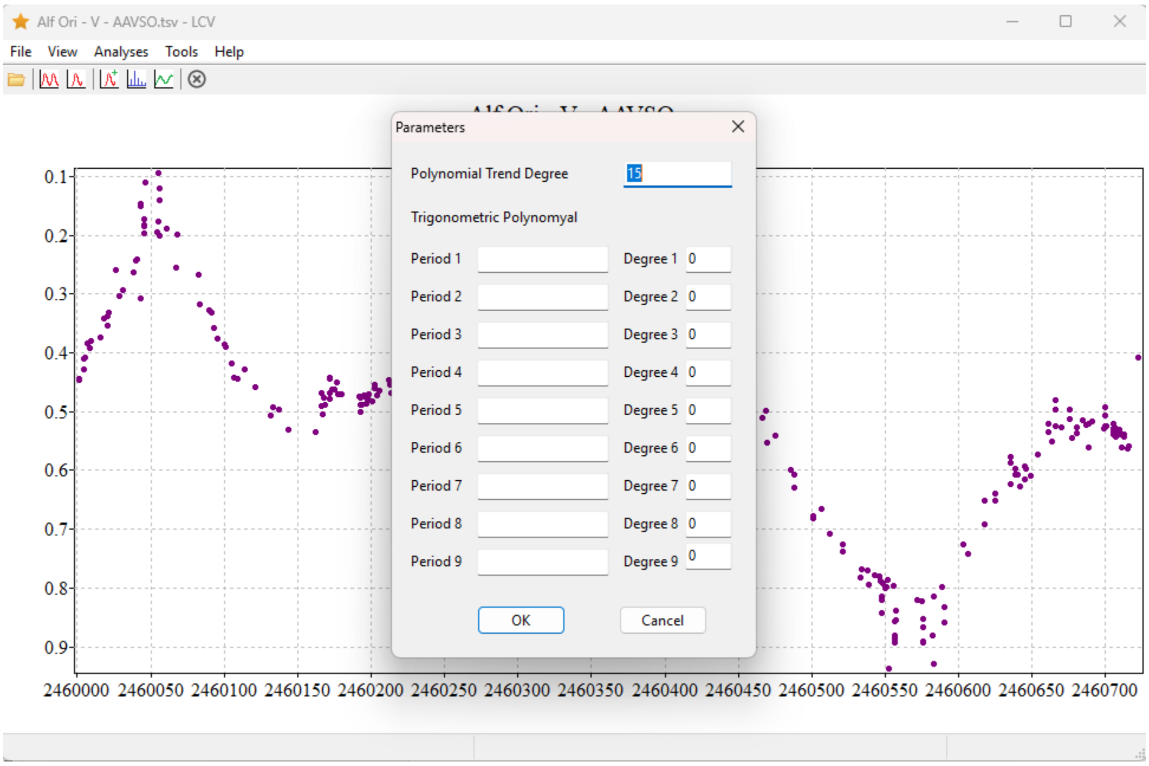
The [Phase Plot] button opens the Phase Plot dialog for the highlighted period.

The user can select one or more frequencies (in the “Model” column) and click the [Model] button. The Polynomial Fit dialog then opens, prepopulated with the selected periods.

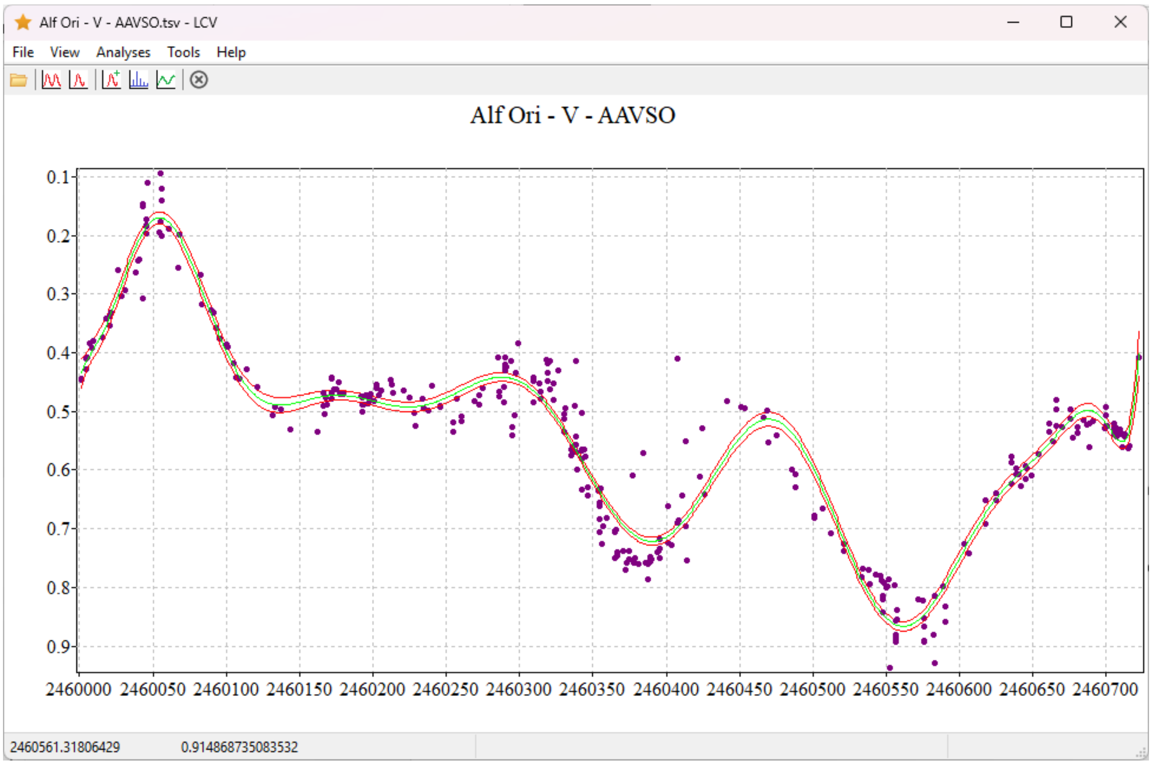
Polynomial approximation

The Polynomial Approximation analysis is invoked by clicking either the Analyses->Polynomial Approximation... menu item or the corresponding toolbar button.

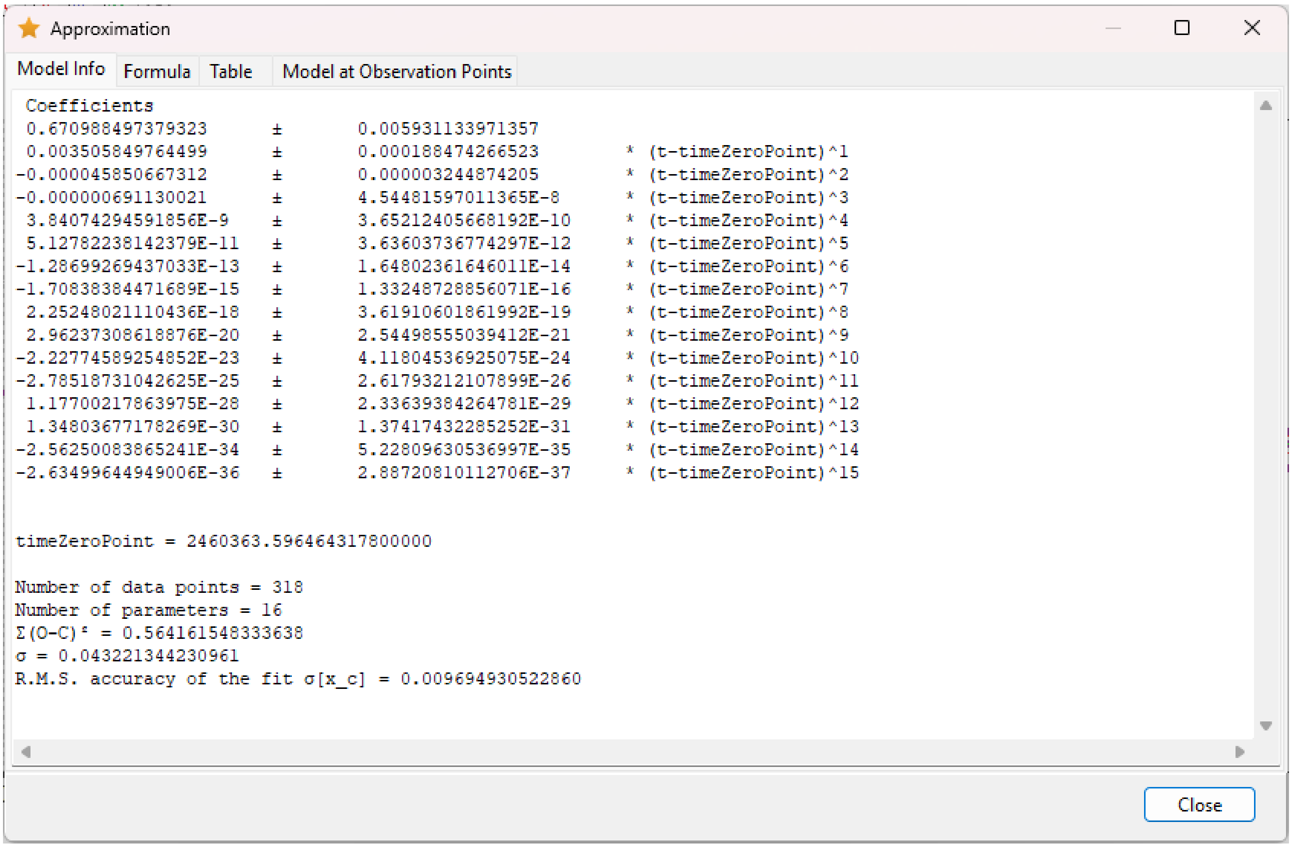
The approximation fits a combination of an algebraic polynomial with the trigonometric ones. To fit a pure algebraic polynomial, specify the polynomial trend degree and set all periods to zero (or set degrees corresponding to each period to zero):



Then press OK. The polynomial approximation, together with its error corridor, will be displayed:

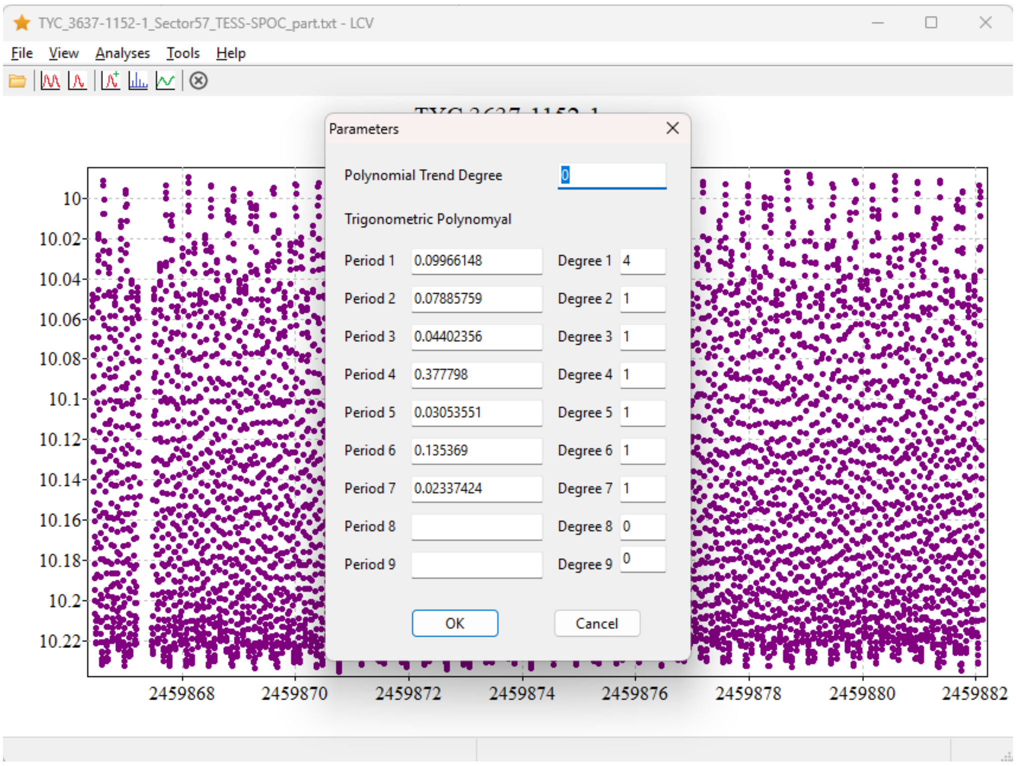


Use the Analyses->Approximation Info... menu item to see the approximation details:

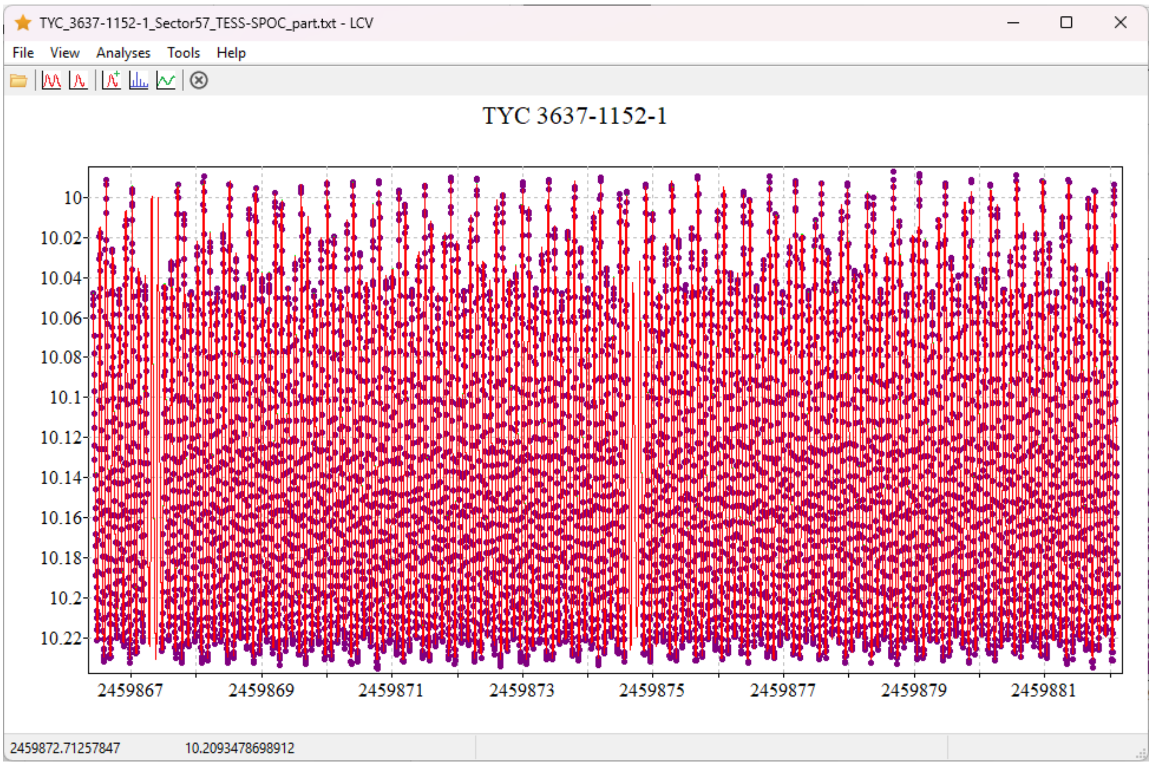


An approximation using trigonometric polynomials (with or without an additional algebraic component) is also available. The user may specify up to nine independent periods. For each period, a number of harmonics can also be defined. If the number of harmonics is set to zero, that period is ignored

In the example below, the file “TYC_3637-1152-1_Sector57_TESS-SPOC_part.txt” from the “lcv_testdata” folder is used.



Click OK to calculate and display the approximation together with its error corridor.



Details of the approximation are available through Analyses->Approximation Info…

Input file format

After installation, you can find example files in the **Documents\lcv_testdata** folder.

Text files with data must contain at least two columns, separated by spaces or tabs. If the columns are separated by tabs, each tab is considered one separator (spaces in this case are ignored). If the columns are separated by spaces, repeating spaces are considered one separator; leading spaces are ignored.

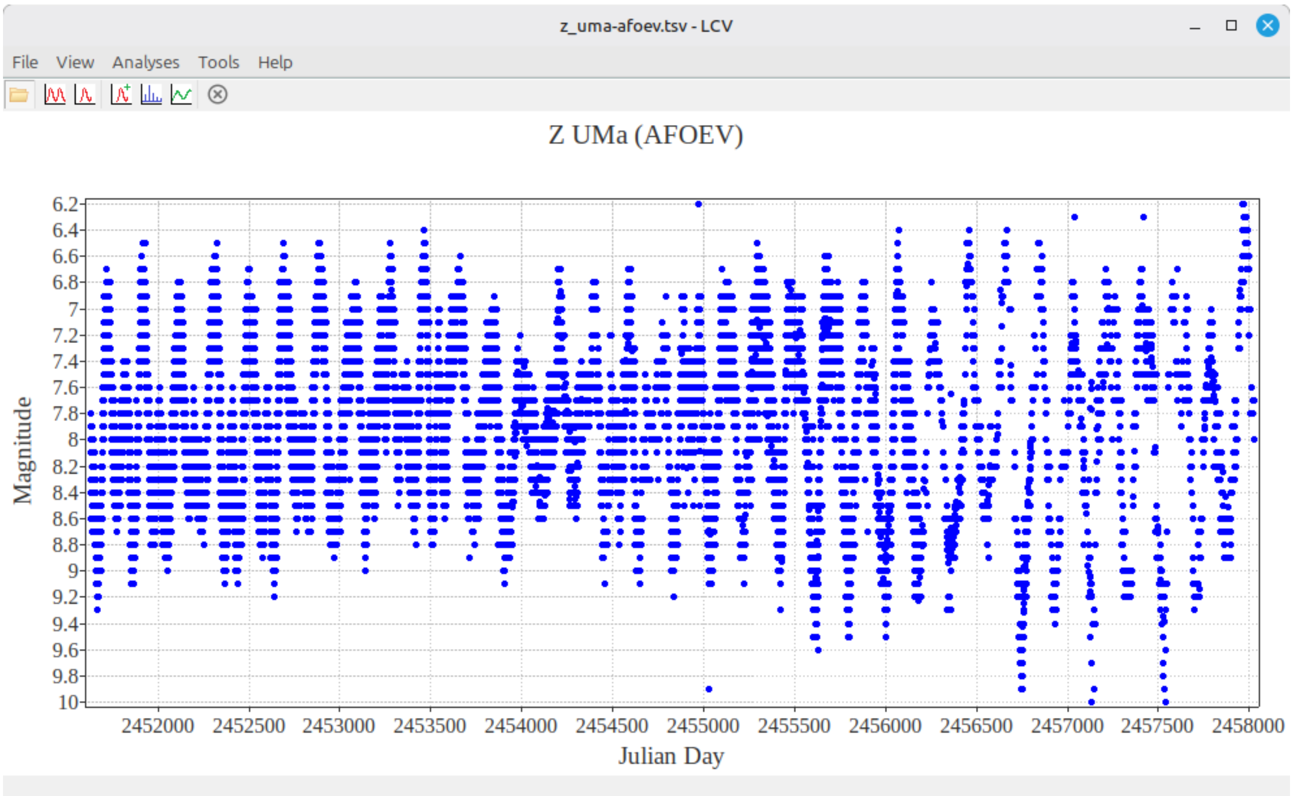
Lines starting with the '#' sign are ignored, as are empty lines.

The first column must contain X-values (i.e., dates) and the second – Y values (i.e., magnitudes or fluxes). The third column must contain Y-errors (uncertainties) if it is present. All other columns are ignored.

Appendix. Z UMa example

In the article[1], the pulsations of the Z UMa variable were analyzed. Here we repeat the frequency analysis of the variable and determine its main pulsation periods along with their uncertainties. We will use LCV for the periodogram analysis and the additional software V*-fit (see https://github.com/mpyat2/VS-fit) to refine the period values and estimate their uncertainties. See the Getting Started document for instructions on how to install and use V*-fit.

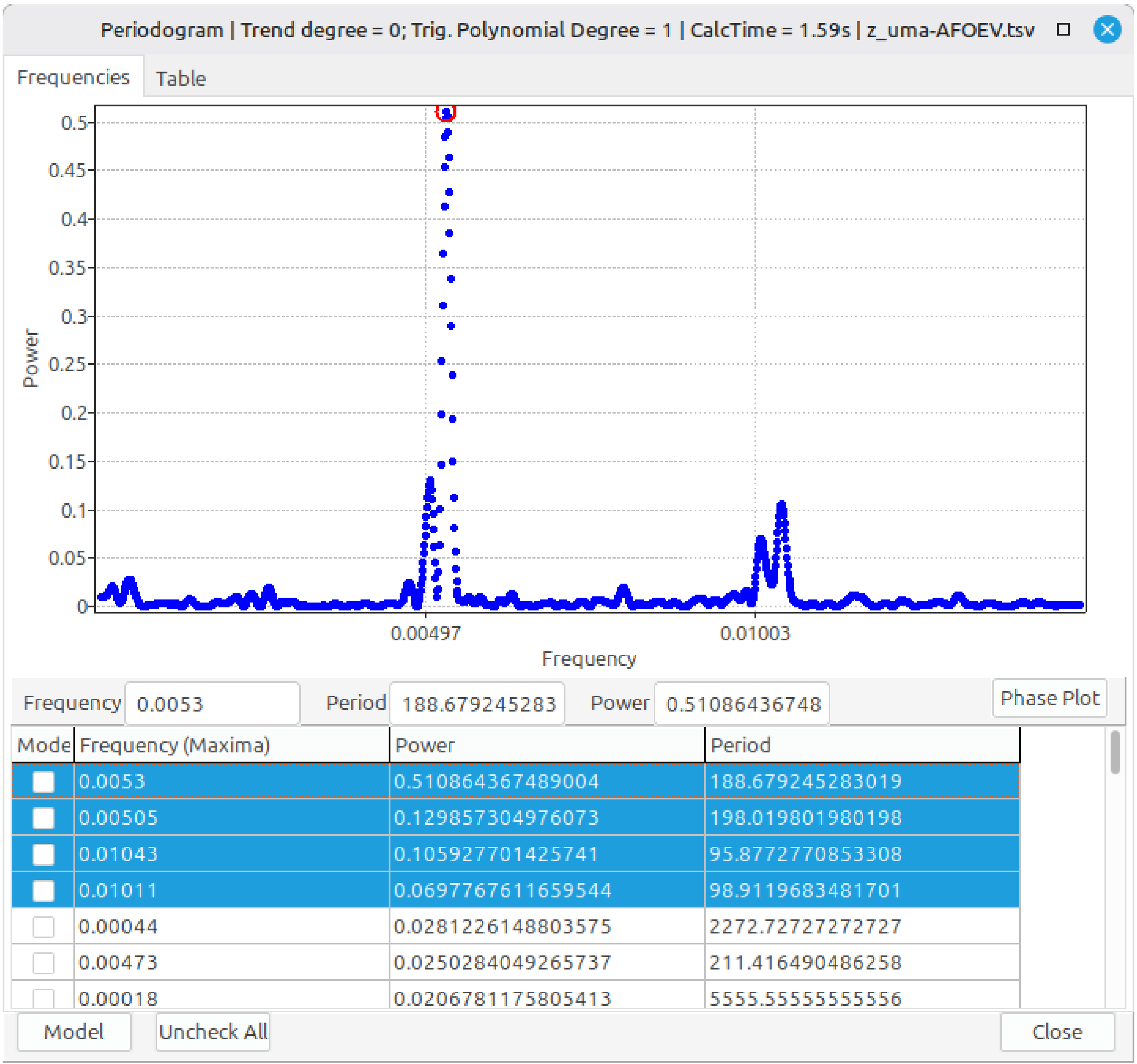
We will use the same source of Z UMa observations as in the article mentioned above: data from the AFOEF[2] database in the range from 2451630 to 2458026 Julian days. In total, 13205 observations were used; observations marked as “uncertain” or “fainter than” were excluded (see z_uma-afoev.tsv in the lcv_testdata folder).



[1] Andrych K. D., Andronov I. L., Chinarova L. L., 2020, MAVKA: Program of Statistically Optimal Determination of Phenomenological Parameters of Extrema. Parabolic Spline Algorithm And Analysis of Variability of The Semi-Regular Star Z UMa, Journal of Physical Studies, Vol. 24, No. 1, Article 1902 [10 pages], Bibcode: 2020JPhSt..24.1902A

[2] French Association of Variable Star Observers, https://cdsarc.u-strasbg.fr/afoev/

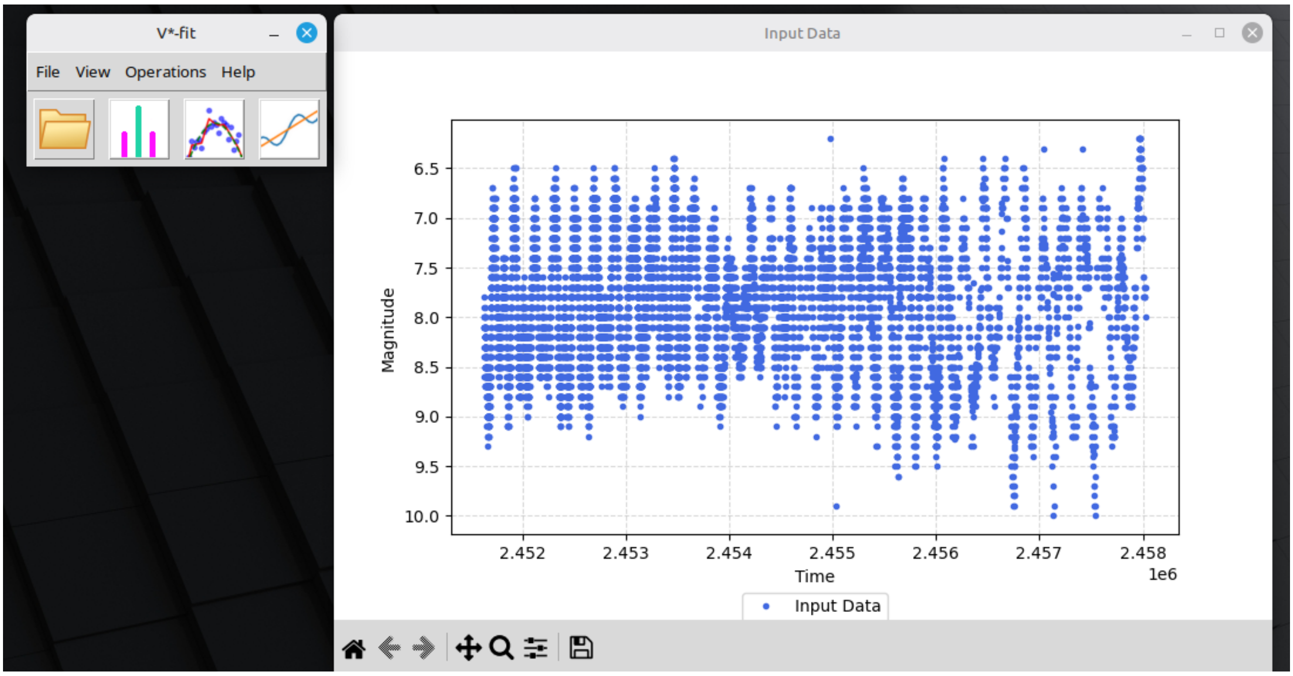
After performing the periodogram analysis in LCV (Analyses->Periodogram...), we can see four prominent peaks with the periods of 188.7, 198.0, 95.9, 98.9 days:



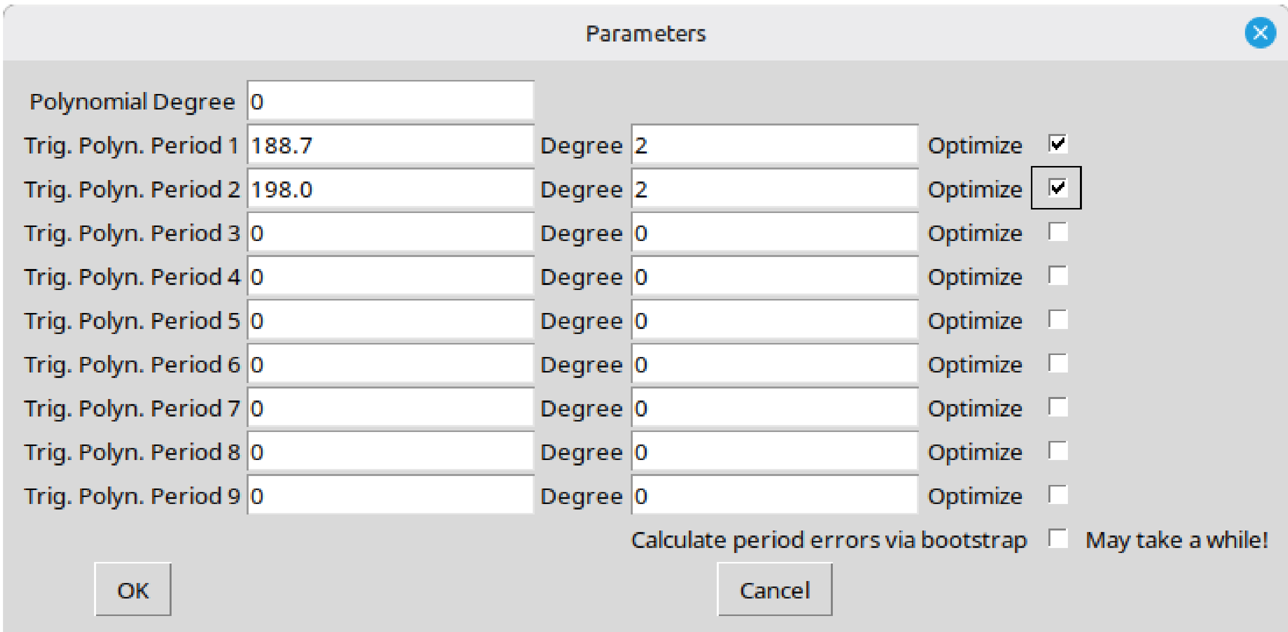
Mode	Frequency (Maxima)	Power	Period
	0.0053	0.510864367489004	188.679245283019
	0.00505	0.129857304976073	198.019801980198
	0.01043	0.105927701425741	95.8772770853308
	0.01011	0.0697767611659544	98.9119683481701
	0.00044	0.0281226148803575	2272.72727272727
	0.00473	0.0250284049265737	211.416490486258
	0.00018	0.0206781175805413	5555.55555555556

The period values are the same as the ones given in the article mentioned above.

The last two peaks are the second harmonics of the first two. We will now refine the periods using the V*-fit application. First, launch V*-fit and load z_uma-afoev.tsv:



Select Operations->Polynomial Fit… Enter the two main periods (188.7, 198.0) and set Degree = 2 for both. Also, check the 'Optimize' flags:



Then press OK. After a few moments, the approximation will appear in the 'Input' window. Inspect the Log window, where you will find the improved period values and their uncertainties: 188.85±0.03 and 197.92±0.04. The referenced article gives 188.88±0.03, 197.89±0.04, which are consistent with our values within the uncertainties. These values even offer a slightly better fit to the data.

Note. Using the MCV application (http://uavso.org.ua/mcv) with the same data, we obtained P1= 188.85±0.03, P2= 197.92±0.04, i.e., the same values as those produced by V*-Fit. In the cited article, 12578 observations were used, which is fewer than the number we used (13205). This probably explains the small differences in the estimated period values.

(end of document)