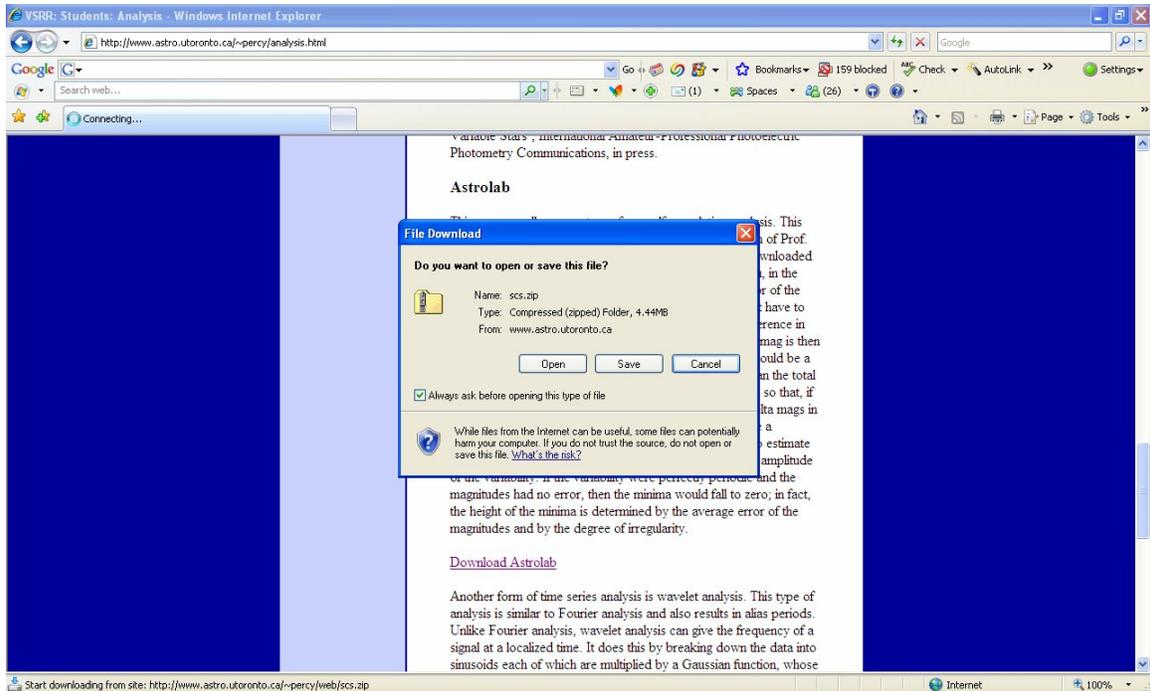


## I. Downloading Astrolab

1. Visit <http://www.astro.utoronto.ca/~percy/analysis.html> and download the Astrolab program by clicking on the link “Download Astrolab”. The link is located about two-thirds down the page.
2. A window should pop up like this one:

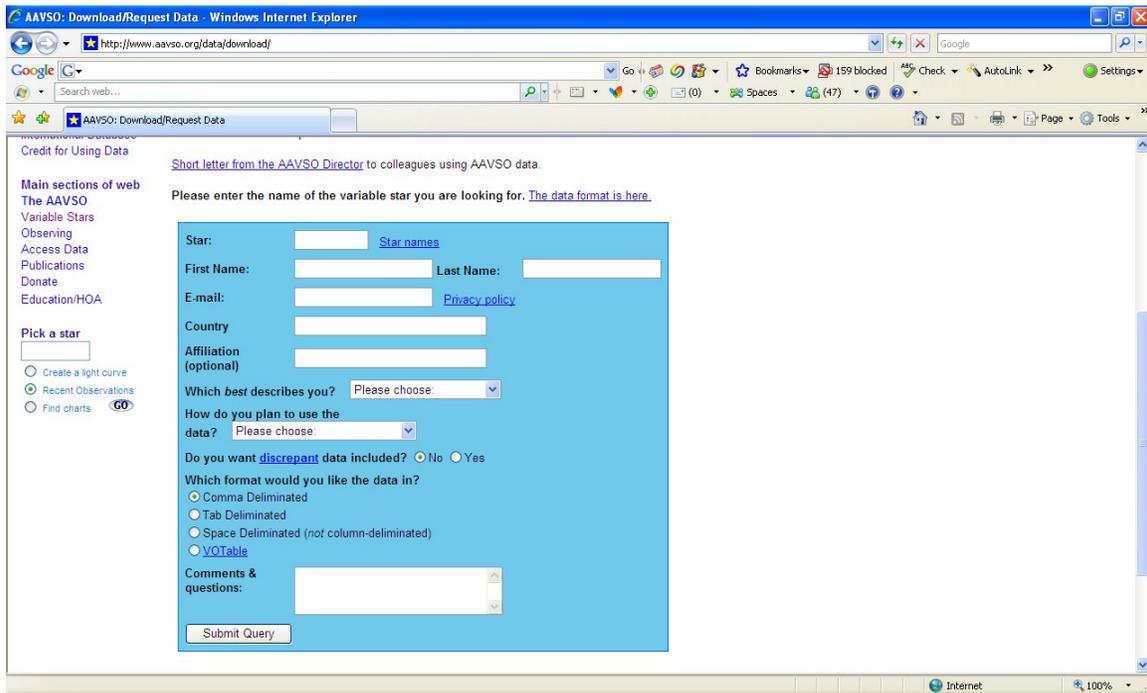


3. Save the compressed “scs” file in My Documents, or somewhere else that is easy to access and find.
4. Locate the “scs” file that you have saved. The folder that has been downloaded is compressed and might require unzipping. Follow the directions of the “unzip wizard” to open this folder. If unzipping is not required, simply open the “scs” folder by double clicking it.
5. Click on “setup.exe” to install the self-correlation program.

## II. Using data from the AAVSO for analysis:

1. Visit the site [www.aavso.org](http://www.aavso.org).
2. Under the navigation bar on the left called “Main Sections of Web”, click “Access Data”. On the new page, click “Download Data” which is located on the right under “In this Section”.

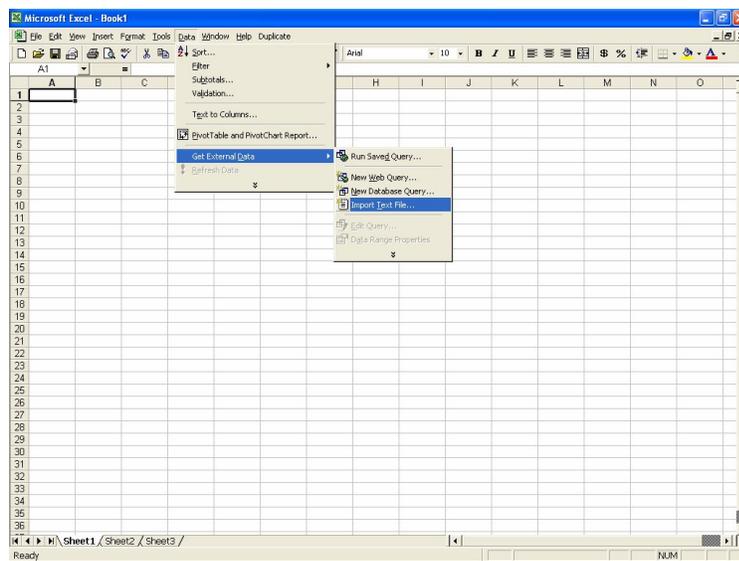
3. Fill in and submit the form to access a full set of data:



\*\*Choose the “Tab Delimited” format because it is easiest to manipulate

\*The data takes a couple of seconds to load. The length of time of the download depends on the length of the data.

4. Download the data by clicking on “Click Here to Download Your Data” on the top right hand side of the page. Save this page by using the save command under the “File” drop down menu. The web page should be saved as a text file.
5. Open a new spreadsheet in Microsoft Excel.
6. From the “Data” dropdown menu, select “Get External Data”, and then select “Import Text File”. “Import” your saved AAVSO data.



7. Follow the instructions in the Text Import Wizard that appears.
8. Delete any data from all but the first two columns from the left (i.e., JD and magnitude).
9. Delete data for “uncertain” or “less than” magnitudes.
  - a. Highlight the magnitude data column.
  - b. Under the “Data” dropdown menu, select “Filter” and “AutoFilter”.
  - c. Under the dropdown arrow that appears on the magnitude column, select “Custom”.
  - d. Use the Custom AutoFilter to filter out magnitudes that “does not begin with <” and magnitudes that “does not contain :”
  - e. Another option is to sort the magnitude from largest to smallest and expand the sorting selection to include the Julian Dates. The “uncertain” and “less than” magnitudes appear at the bottom of the list and can be deleted.
10. Save the Excel Document.

Because the self-correlation program was written a couple of years ago, newer versions of Microsoft Excel might conflict with it. The workbook containing the data should be saved as a “97-2003” workbook.

EXTRA: Try using your data to create a light curve using Microsoft Excel. Create a scatter plot and adjust the y axis to range from highest to lowest, instead of lowest to highest because the lower the magnitude, the brighter the star. To do this, double click or right-click the gridlines of the graph to “Format Gridlines”. Select the “scale” tab on the window that appears. Check the box near the bottom of the window that says “Values in reverse order” and click “ok”.

You can also use the AAVSO to create a light curve by clicking the “Light Curve Generator” link under the navigation bar of the AAVSO website. Light curves are a great

way to estimate the period and maxima and minima of a star, which will be very useful later in self correlation analysis.

### **III. Running Astrolab**

1. Open the Self Correlation Software.
2. Go to “File” and open the Excel document containing your data.
3. Click the “Graph” button on your right to create a light curve.
4. Click “Self-Correlate” to create the self correlation graph.
5. Input the number of bins. Bins contain all the data within a certain time span. If you input a large number of bins, less data is put into the bin and averaged. This, however, does not necessarily produce a more accurate graph. Once you have created the self-correlation graph, remember to check the spreadsheet to ensure that you have enough data to produce the amount of bins that you have input. If there is too much scatter in the data, this will cause the average to skew. Usually with sets of data with 2000 points, using 100 to 200 bins is a great place to start.
6. Input the minimum period length. Start at 0.
7. Input the maximum period length. The maximum period length should be about 2 to 5 times the length of the expected value of the period, but much less than the total duration of the data. As you continue to produce more graphs, you can change this value by increments of expected period to produce a graph that best represents the period of your data. For example if the known period of the star of interest is 100 days, try inputting maximum period lengths of 200 days, then 400, or 500 days. If you are able to, try using maximum period lengths that are beyond

\*\*To find a star’s known period, search the General Catalogue of Variable Stars through a tool called SIMBAD that you can access from [www.astro.utoronto.ca](http://www.astro.utoronto.ca) by clicking on "library".

8. A screen might pop up whenever a duplicate of the Julian Date is found. To remove the duplicates, you copy down each duplicated number and delete it manually from the Excel file. Another option is to purchase a duplicate destroyer from the internet to delete the duplicates.

Bin Start	Bin End	Midpoint	Avg. Value	Points
0	177.2	88.6	0.3015396	18
177.2	354.4	265.8	0.3180615	16
354.4	531.6	443	0.2855201	13
531.6	708.8	620.2	0.3079991	11
708.8	886	797.4	0.3214784	10
886	1063.2	974.6	0.3109354	8
1063.2	1240.4	1151.8	0.3210899	8
1240.4	1417.6	1329	0.3057716	5
1417.6	1594.8	1506.2	0.3236361	7
1594.8	1772	1683.4	0.3069222	4
1772	1949.2	1860.6	0.3355717	6
1949.2	2126.4	2037.8	0.3194506	4
2126.4	2303.6	2215	0.3364574	6
2303.6	2480.8	2382.2	0.3193816	5
2480.8	2658	2569.4	0.3556977	8
2658	2835.2	2746.6	0.2973545	6
2835.2	3012.4	2923.8	0.3569335	9

Error. The data set contains a repeated value - 2434901.6. Please remove it manually and restart the program.

Length of data set is:  Number of Bins:

First point is located at:  Minimum Period:

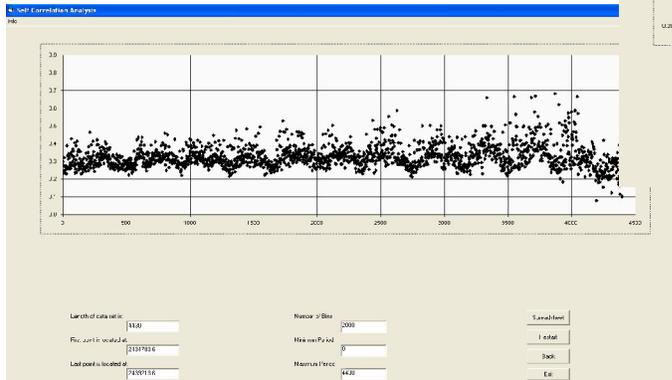
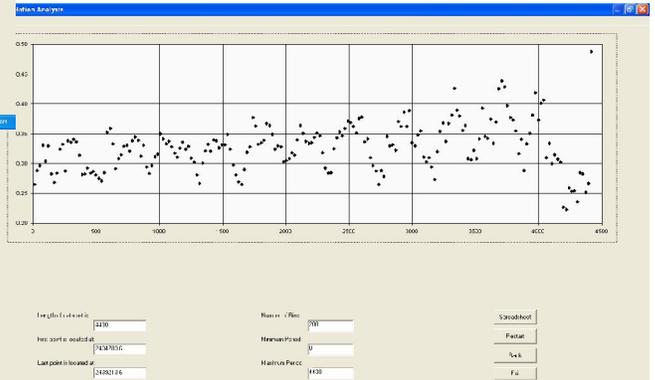
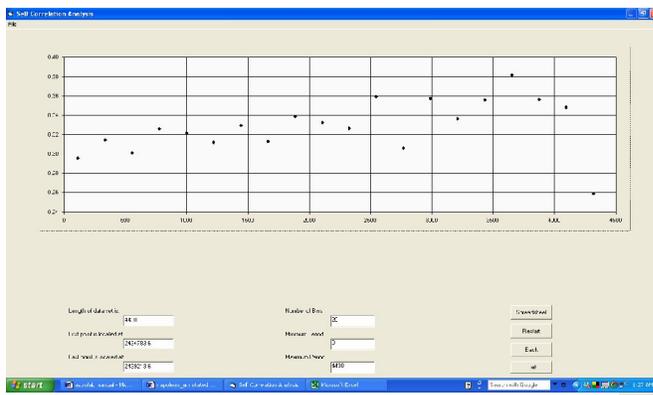
Last point is located at:  Maximum Period:

Graph Restart Back Exit

Amateur data from the AAVSO is data compiled from amateur astronomers around the world. The many dedicated individuals who contribute to AAVSO help to form a very reliable data source because the differences represent the variation in qualitative observation. Having two or more magnitude observations for a certain date provides for a more accurate measure of magnitude because the average can be found. The program, however, requires the user to delete the duplicates to function properly.

\*\*Creating a self correlation graph can require seconds to minutes depending on the model of the computer and the magnitude of the points inputted.

9. Try out other bin values, or minimum and maximum settings, click “Restart” to create a new self-correlation graph.



10. To print the graphs, hold down “control” and press the “print screen” button. Paste the image onto a Word document.

Excel can also be used to graph these numbers. Save the file as a text file (.txt) and use the scatter plot graphing tools in Excel.

#### **IV. Analysis:**

##### **a. LIGHT CURVE**

- a. Begin analysis by analyzing the light curve for estimates of the times of maxima and minima. These two values are useful because they reveal the period of the star. The period will be very important in the process of choosing the appropriate maximum change in time for the self-correlation graph.

##### **b. SELF-CORRELATION DIAGRAM**

- a. To estimate the period of the variable star, measure the time at which the first minimum of your self-correlation graph occurs. This time is your first estimate of the period. Measure the time at which the second minimum occurs and divided this time by two to obtain your second estimate for the star’s period. Continue measuring the remaining minima, dividing the time of the third minimum by three, and so on. Each estimate you obtain will give you a clearer idea of the star’s period.

- b. Remember that the units of the two axes are units of change. If there is no amount of magnitude difference, then the y-axis will have a very small scale near zero. The change in days of the x-axis represents points of certain distances in time apart that are compared. For example points plotted at a change of 200 days are a comparison all of the pairs of points that are 200 days apart.
- c. Refer back to the chart of all the bin values that appears after the self-correlation graph has been made. An ideal bin would contain at least 10 points to ensure that there is enough data in the bin. If there is less than 10 points, try decreasing the number of bins. Also, bin size should also be greater than the spacing of the time of the data. For example, if the data was compiled daily, the size of the bins should be greater than 1.
- d. The light curve can sometimes seem to be misinterpreted or distorted by points that vary greatly from the rest of the data. Delete points that are too high or too low to produce a light curve with a better range. Having too much data can also be a problem. Try deleting sets of data where there is little information about those years to create more legible light curve.

**V. Troubleshooting:**

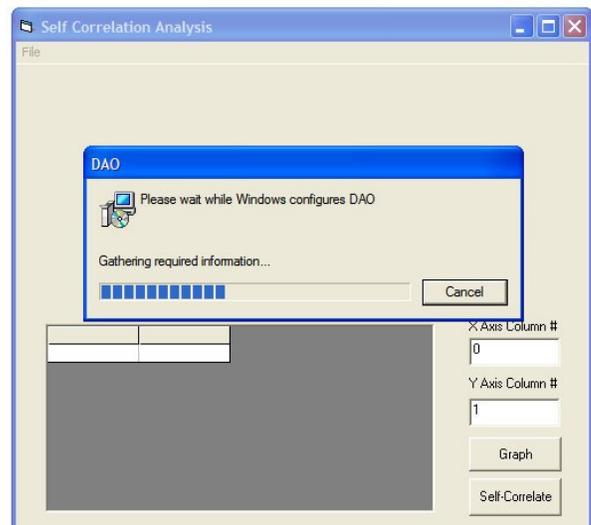
With such a complex system, there are bound to be a few bugs in the way the system initializes itself. The problem is easily circumvented and with no ill effects. When choosing a spreadsheet to use for your self correlation, one of two things could happen.

- 1) The system initializes with no problems
- 2) A DOS warning will appear on the screen

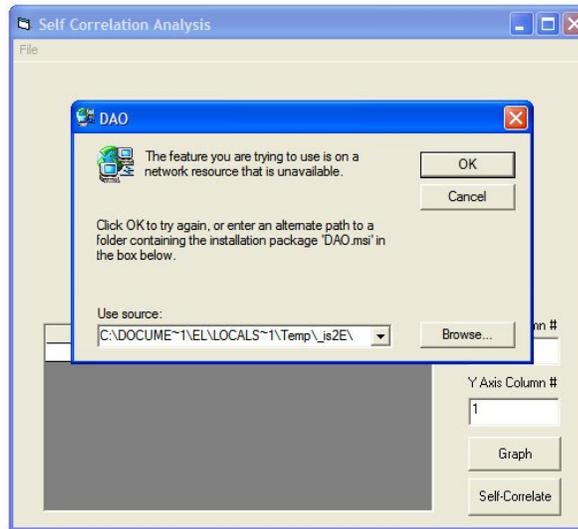
If option two is what is giving you trouble, follow these easy steps to circumnavigate the problem

1. The program will attempt to configure a DAO pathway.

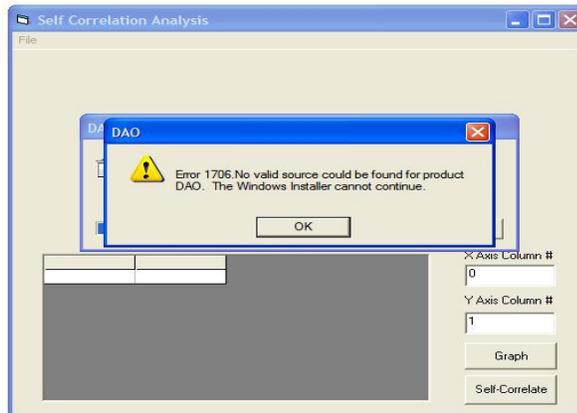
2. The second screen will look something like this, and unless you're a computer programmer you may end up with a



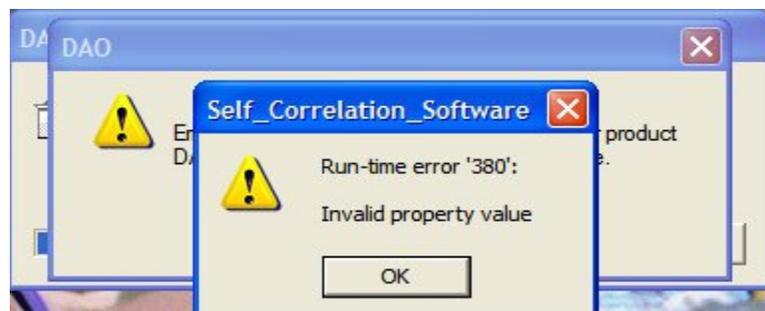
headache if you try to find another “source” to run the program on. From here, simply click “cancel”.



3. This error message will pop up when a proper pathway is not established. To continue, simply hit ok.



4. If at any time this warning pops up, simply close the entire application and start again.



# **Using Astrolab Self Correlation Software**

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