JaSTA Manual

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1.1 Introduction:

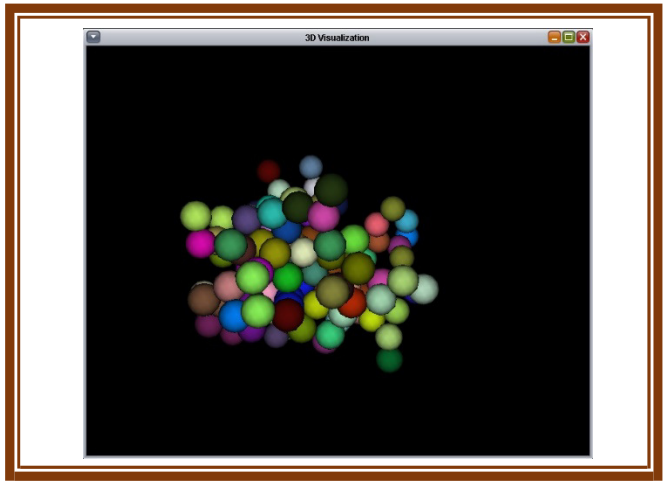
Optical properties of porous aggregate particles have been extensively studied through the use of various numerical techniques (viz. Superposition Transition Matrix (STM) code, Discrete Dipole Approximation (DDA) code etc.). The STM code, developed by Mackowski & Mishchenko, (1996, J. Opt. Soc. Am. A., 11, 1491), is widely used by researchers to study the light scattering properties of cosmic dust aggregates. This code is written in Fortran language.

Java Superposition T-matrix App (JaSTA) has been developed in the Department of Physics, Assam University, Silchar (India) to study the light scattering properties of cosmic dust aggregates. This software package is based on Superposition T-Matrix code of D. Mackowski, K. Fuller & M. Mishchenko. JaSTApackage consists of a Graphical User Interface (GUI) in the front hand and a database of related data in the backhand which can be updated periodically online. Both the interactive GUI and database package directly enables user to model by self monitoring respective input parameters (viz. wavelength, complex refractive indices, grain size parameter, etc.) to study the related optical properties (viz. extinction, polarization, etc.), of cosmic dust instantly, i.e. with zero computational time, which directly increases the efficiency of the user. The database of different optical properties of the cosmic dust aggregates is generated in a very wide range using STM code, with high computational accuracy. This package also has an option where users can compile and run the scattering code directly for aggregates in GUI environment. The current version of this software is developed for Linux and Windows platform (both 32 and 64 bit) which will be extended for other platform in future.

If your research work is benefited from JaSTA software package, please acknowledge us.

1.2 Aggregates:

To study the light scattering properties of cosmic aggregates, Ballistic Particle Cluster Aggregate (BPCA) and Ballistic Cluster-Cluster Aggregate (BCCA) are taken. The number of monomers can be taken to be 8, 16, 32, 64 and 128. The aggregates are built by random hitting and sticking particles together using Monte-Carlo simulation.



BPCA structure with 128 monomers

BCCA structure with 128 monomers

User can include the aggregate structures generated by his own code in JaSTA with the following format:

1, x, y, z, 1, 1 (where x, y and z are the positions of the monomers).

A sample file `'ml.usrstruct'` having BCCA structure with 32 numbers of monomers is provided with the software with package.

```
1     0.8508     1.1092     3.9907  1  1       1
1    -0.1890    -0.4082     4.7758  1  1       2
1    -0.0235     1.0163     2.1943  1  1       3
1    -0.4825    -0.8481     2.7541  1  1       4
1    -1.8200     3.6932     2.7338  1  1       5
1    -1.7194     1.7127     2.9936  1  1       6
1    -1.1077     4.6436     1.1246  1  1       7
1     0.7435     5.0680     1.7514  1  1       8
1     5.6175    -4.4657    -0.8492  1  1       9
1     5.4998    -4.0900    -2.8100  1  1      10
1     1.9364    -4.2749     0.0393  1  1      11
1     3.9057    -3.9262     0.0333  1  1      12
1     1.9089    -1.7538     2.7022  1  1      13
1     1.3595    -3.4286     1.7571  1  1      14
1     2.5870     1.3452     4.9549  1  1      15
1     2.7020    -0.3005     3.8242  1  1      16
1     1.4322     2.6457    -3.6942  1  1      17
1     2.2539     3.0014    -1.9058  1  1      18
1    -0.4559     2.6839    -3.0357  1  1      19
1     0.3855     2.3269    -1.2568  1  1      20
1    -1.0390     5.6228    -4.3423  1  1      21
1    -0.3071     4.6579    -2.7507  1  1      22
1    -2.5855     4.9680    -5.4284  1  1      23
1    -1.6190     3.9096    -6.8233  1  1      24
1    -3.0470     0.5223    -0.4658  1  1      25
1    -1.4626     1.5879    -1.0608  1  1      26
1    -1.2668    -2.1904     1.4959  1  1      27
1    -2.4393    -1.2786     0.1565  1  1      28
```

```
1     -2.5070     -5.2481     -0.1042   1   1       29
1     -1.9105     -4.0819      1.4072   1   1       30
1     -3.7555     -7.9303     -2.6311   1   1       31
1     -3.4456     -6.2892     -1.5308   1   1       32
```

If user wants to use his own structure, then he has to edit the 'ml.userstruct' file with the format described above. When user will choose option 'user_structure', then the contents of the file will appear in the screen, which can be edited and saved.

1.3 Input and Output parameters of JaSTA:

The list of input parameters of JaSTA are:

1. Size of the monomer (a_m) (in micron)
2. Wavelength of incident light (λ) (in micron)
3. Real Refractive Index (n) and
4. Imaginary Refractive Index (k)
5. Number of Monomers (N)
6. Aggregate Type (BPCA , BCCA & user_structure)

It is to be noted that the size of the cluster is $a_v = a_m.N^{1/3}$

The list of output parameters of JaSTA are:

1. The extinction efficiency factor (Q_{ext})
2. The absorption efficiency factor (Q_{abs})
3. The scattered efficiency factor (Q_{sca})
4. The coefficient of extinction (C_{ext})
5. The coefficient of absorption (C_{abs})
6. The coefficient of scattering (C_{sca})
7. Albedo (ω)
8. A dimensionless size parameter (xscale = $2\pi a_m/\lambda$), where a_m is the radius of the monomers, and λ is the incident wavelength and
9. The nonzero scattering matrix elements viz. "S11", "-(S12/S11)", "S33/S11" and "S34/S11" which are functions of scattering angle (θ).

Polarization is defined as Pol = - (S12/S11)

1.5 Download:

First version (jasta-1.0.1) release date: October 25, 2013.

The Windows (32 and 64 bit) and Linux (32 and 64 bit) versions of JaSTA can be downloaded from http://ausastro.in/jasta.html

1.6 System requirements:

Windows(32bitand64bit)OS:

1) Java runtime environment*
2) Java 3D (for 3D Visualization)** (with proper graphics driver)

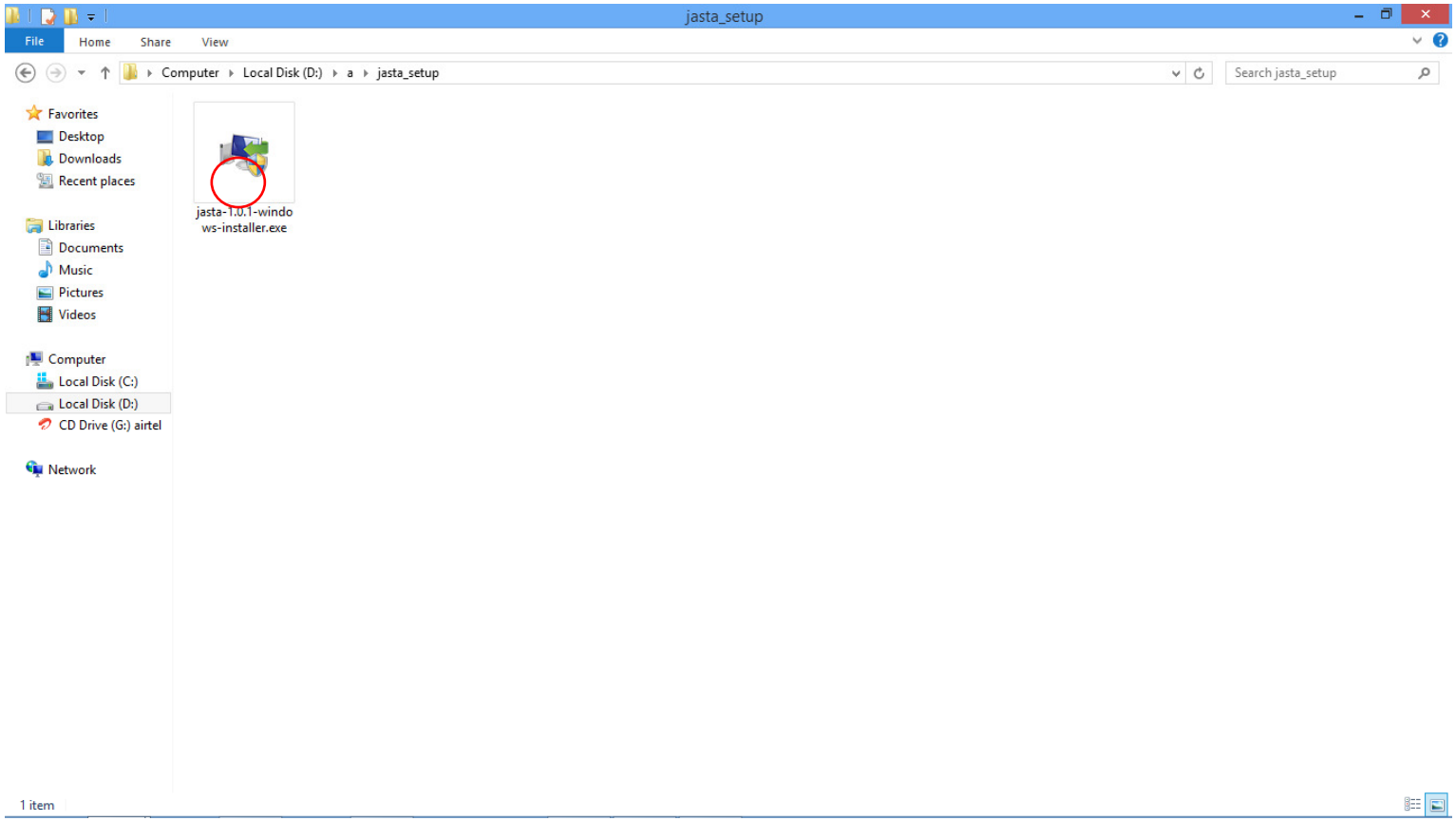
Linux(32bit and64bit)OS:

1) Java runtime environment*
2) gfortran.
3) Java 3D (for 3D Visualization)** (with at least GLX-1.3 or proper graphics driver)
4) xterm (for the workstation version).

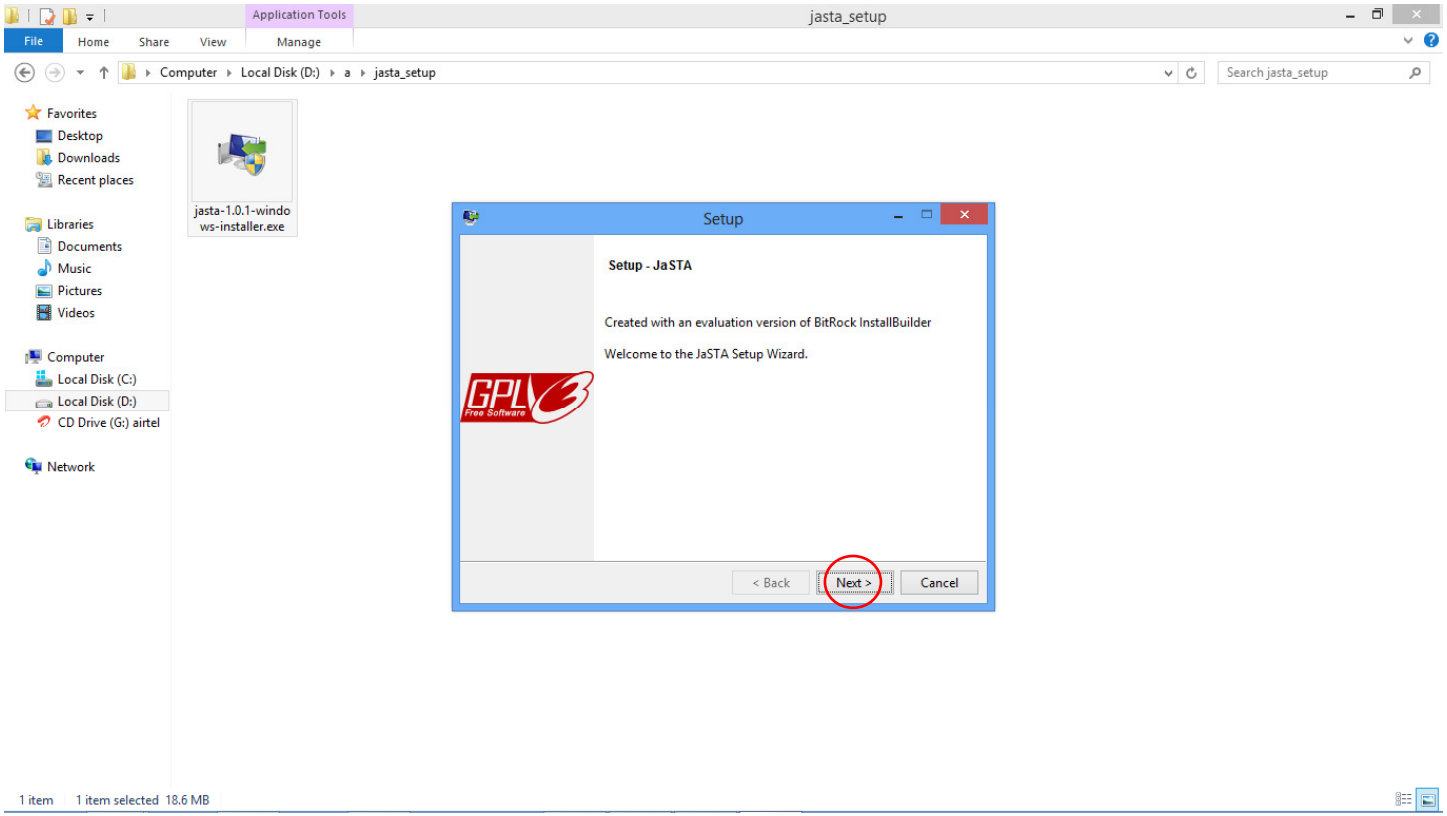
*for support regarding Java log on to http://www.oracle.com/technetwork/java/javase/downloads/index.html
**for support regarding Java 3D log on to https://java3d.java.net/

1.7 Installation Process:

Step 1: Double click the Installer to start the "Installation process".



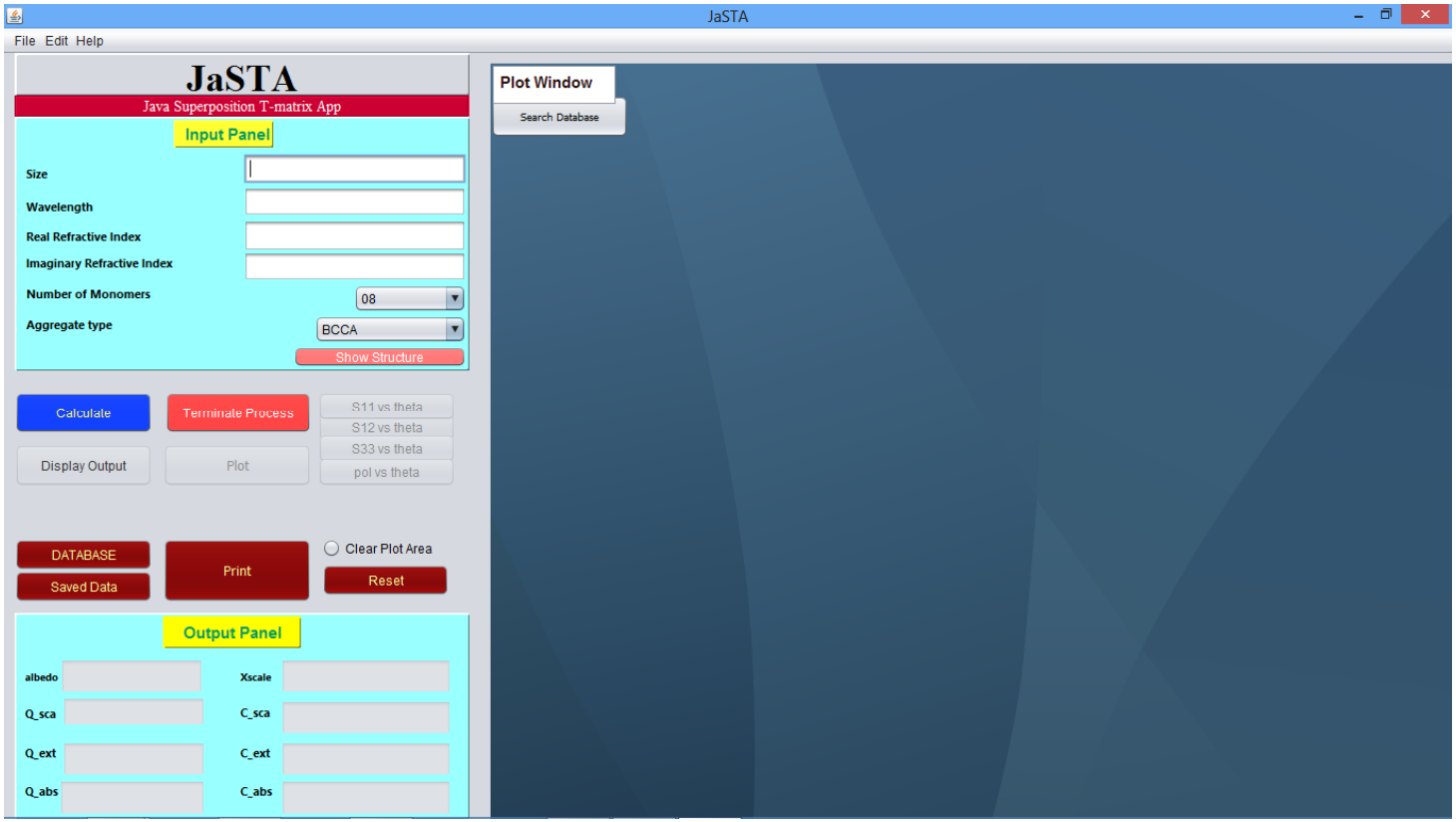
Step 2: Follow the onscreen installation guide to complete installation. After Installation the entire package will be installed to "C:\JaSTA" (Windows) or " /home/JaSTA" (Linux) directory and a desktop shortcut ("JaSTA") will be created.



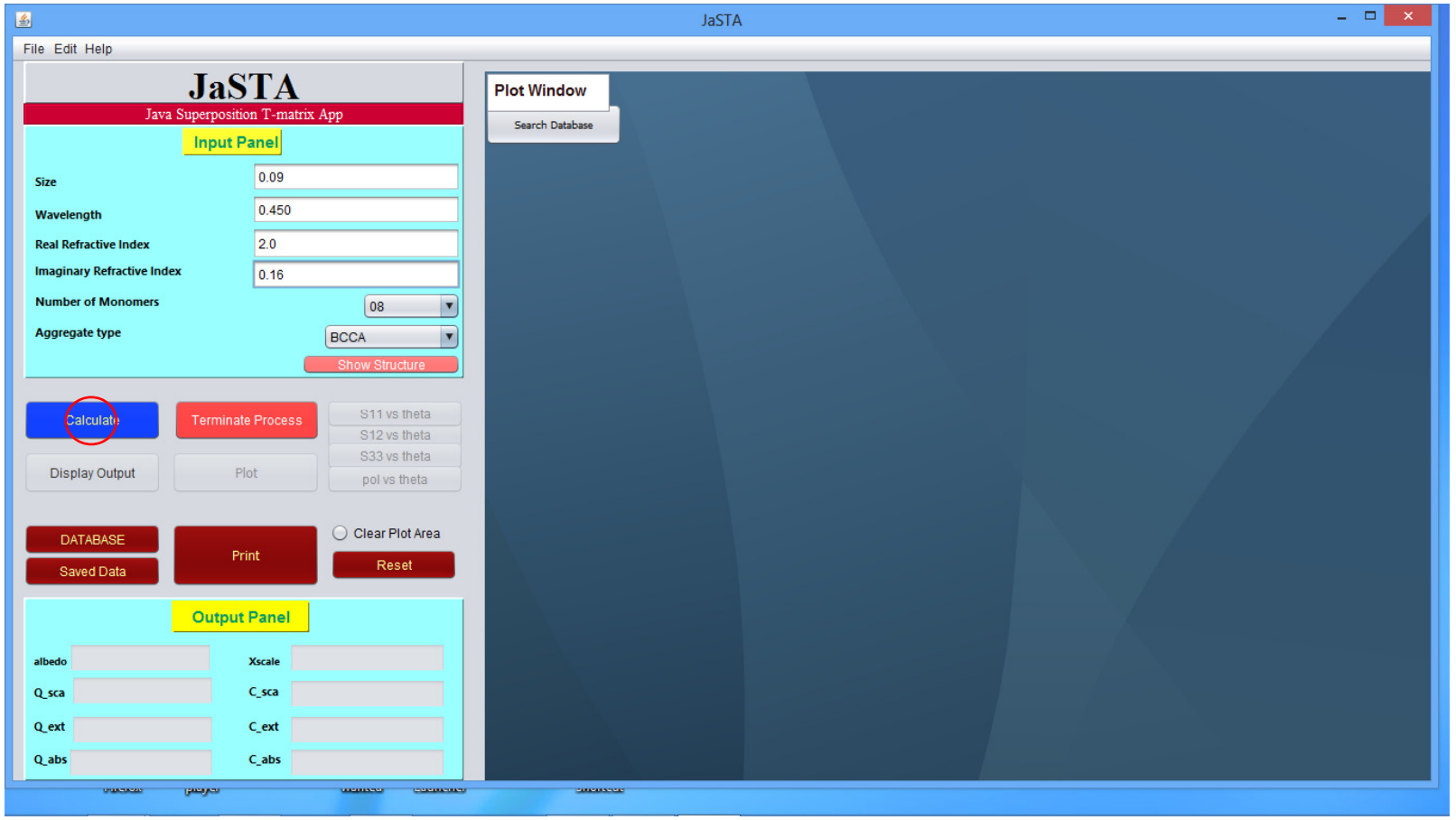
Step 3: Click the desktop icon of JaSTA to start, run or execute the GUI.
After installation, Linux user can run the software from terminal:
$ cd /home/user-name/JaSTA
$ sh JaSTA or $ ./JaSTA (for linux).

1.8 Calculation Process:

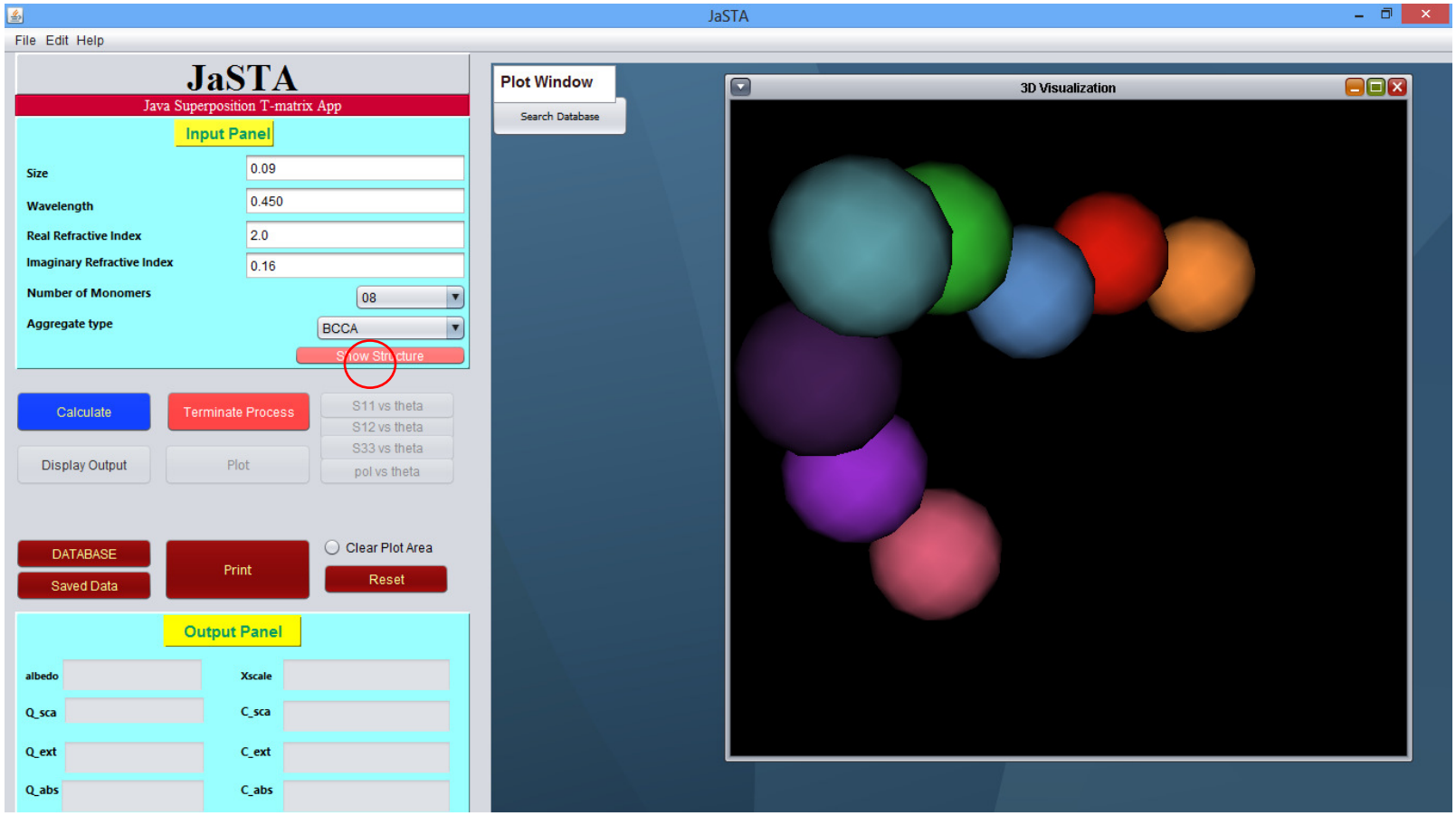
Step 1 : Enter the required input parameters, viz., size, wavelength, real refractive index, imaginary refractive index, number of monomers and aggregate type to the corresponding text boxes and combo boxes in the "Input Panel". User can also use the predefined structures generated by him as discussed earlier.



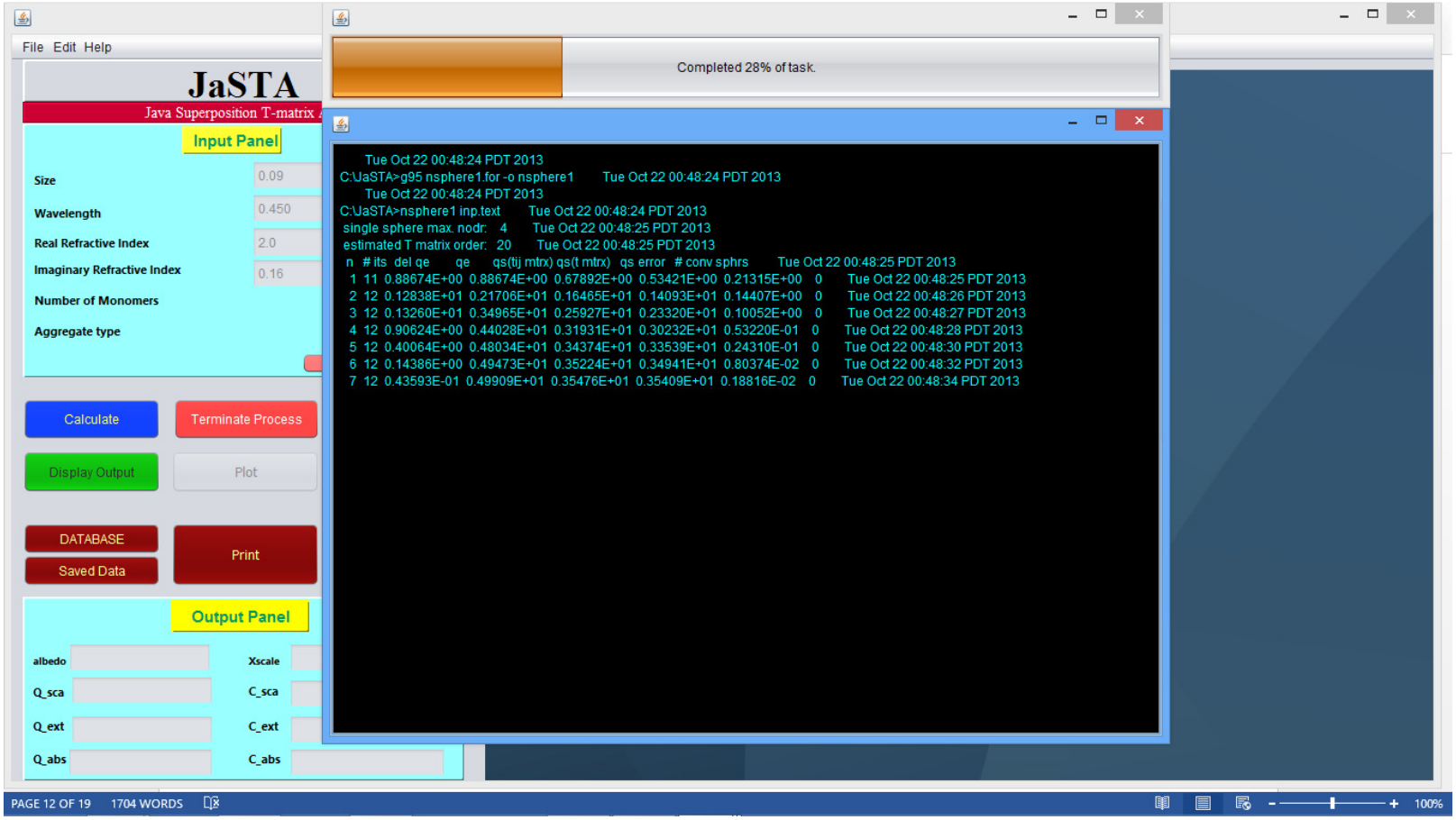
Step 2 : After entering the input parameters in the "Input Panel", click the "Calculate" button to start "Live Calculation". If the corresponding result already exists in the database, the software will directly call the result instead of "Live Calculation".



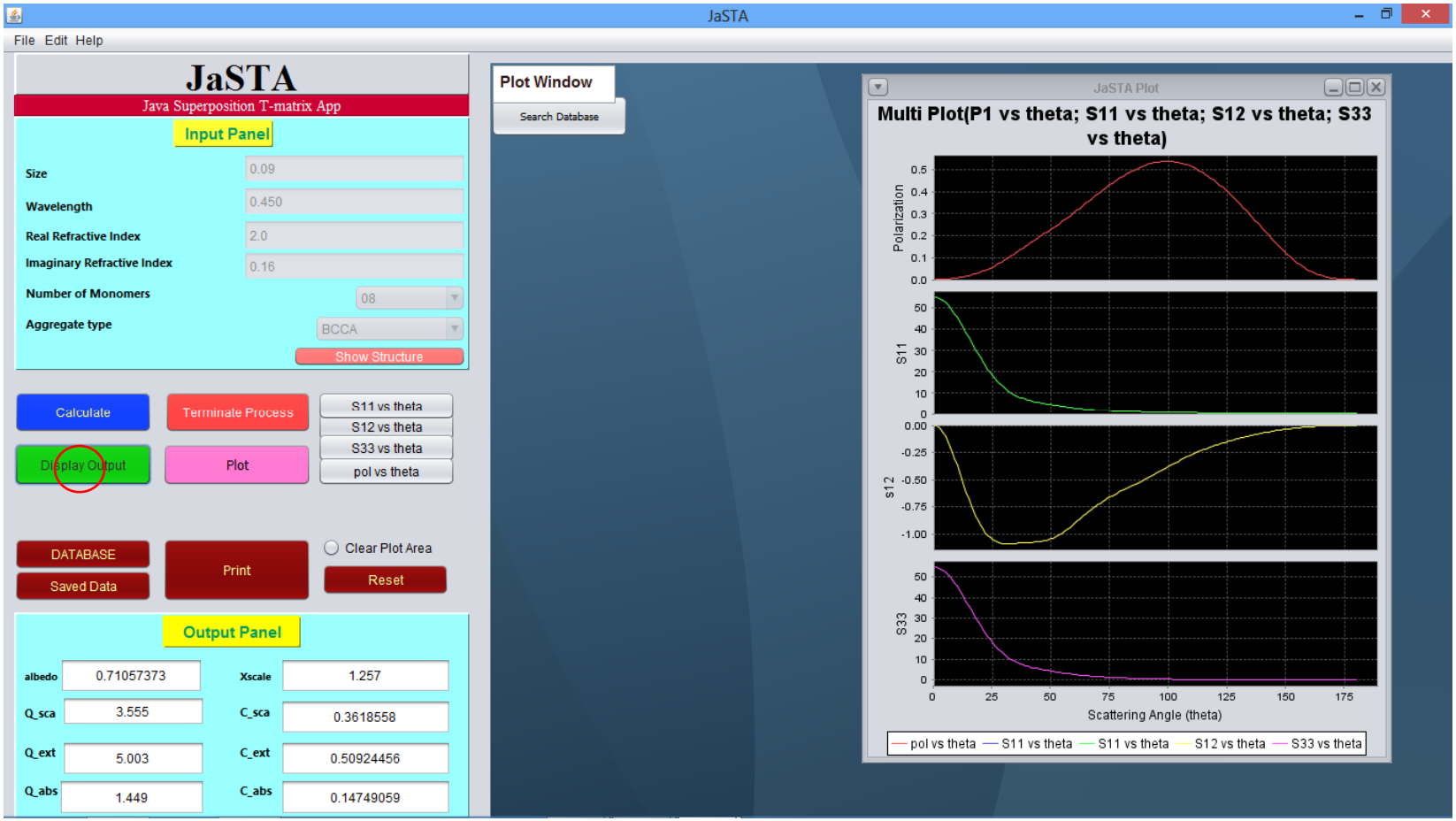
Step 3 : Click “Show Structure” button to view the 3D structure of the selected aggregate for the selected monomer number . The 3D Visualization window is kept on foreground by default to provide the attention on the shape and size of a particular structure. User may minimize or close the 3D visualization window before calculation starts.



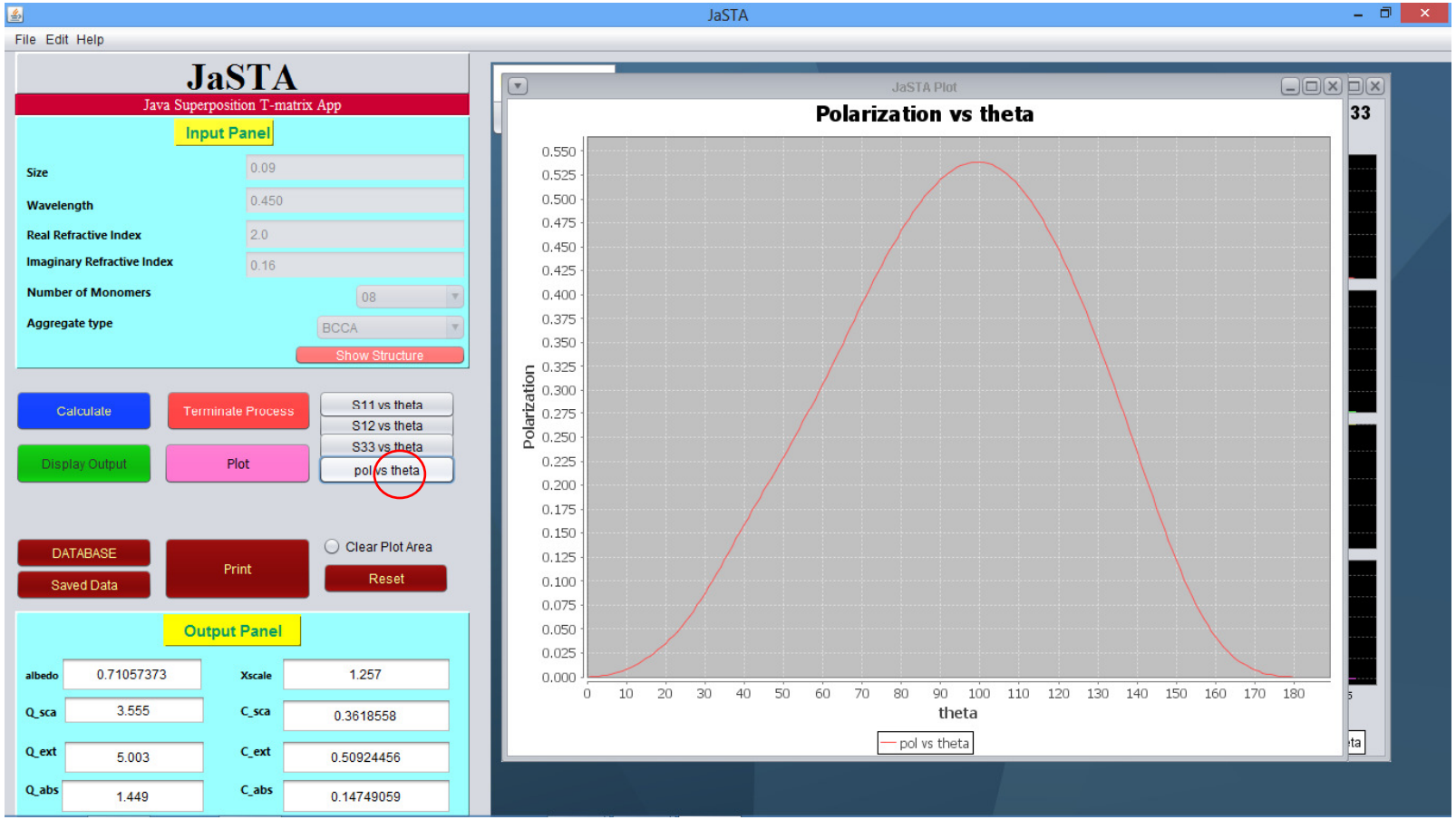
Step 4: Wait till the calculation ends. A progress bar at the top of the screen shows the progress percentage of the calculation process. A console window appears on the background which shows the calculation process. After completion of a particular calculation the progress bar disappears and the console window comes in front of the screen automatically. Here we have brought the console window in front to show the calculation process. User could close console terminal once computation is completed.



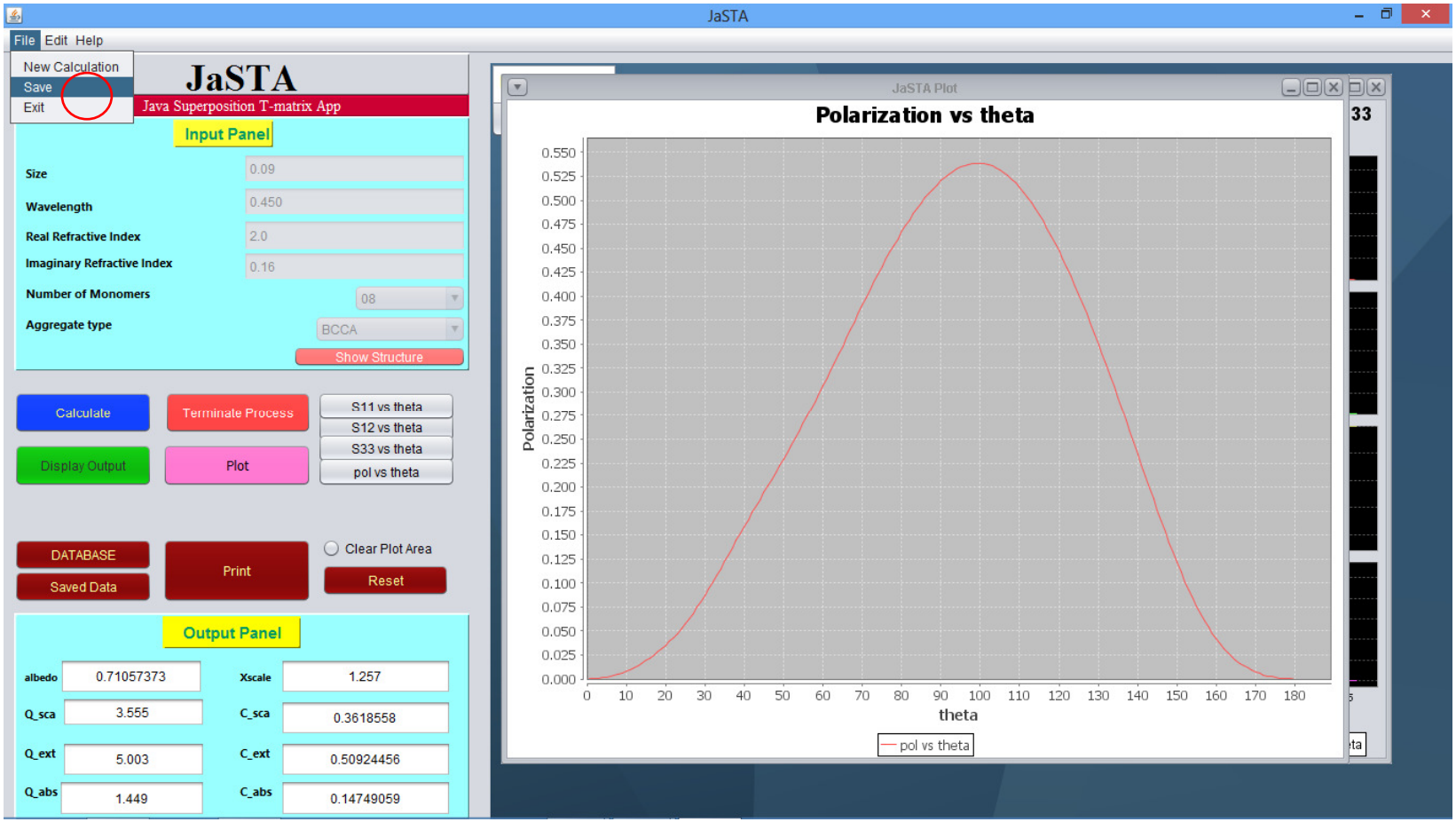
Step 5: When computation ends, click the "Display Output" button to see the various output parameters and corresponding plots on the screen. It is to be noted that if the 3D Visualization window is open then only "Multi Plot" window will move to the background of the 3D Visualization window as it is programmed to do so, but single plot window will appear in the foreground of 3D view if it is clicked.



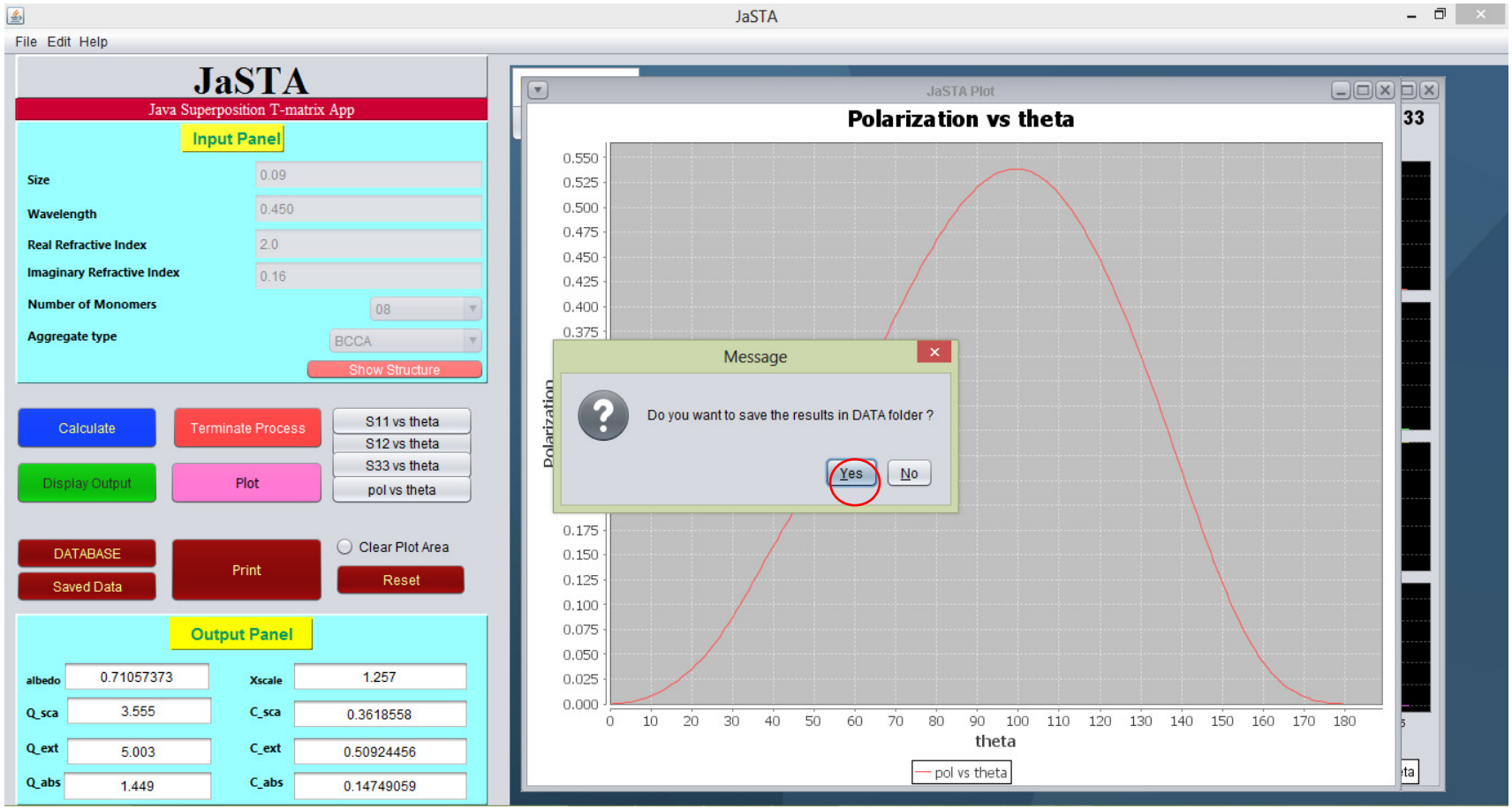
Step 6: To view the individual plots (viz, S11 vs theta, S12 vs theta, S33 vs theta and pol vs theta) click the corresponding buttons on the right hand side of the "Plot Button".



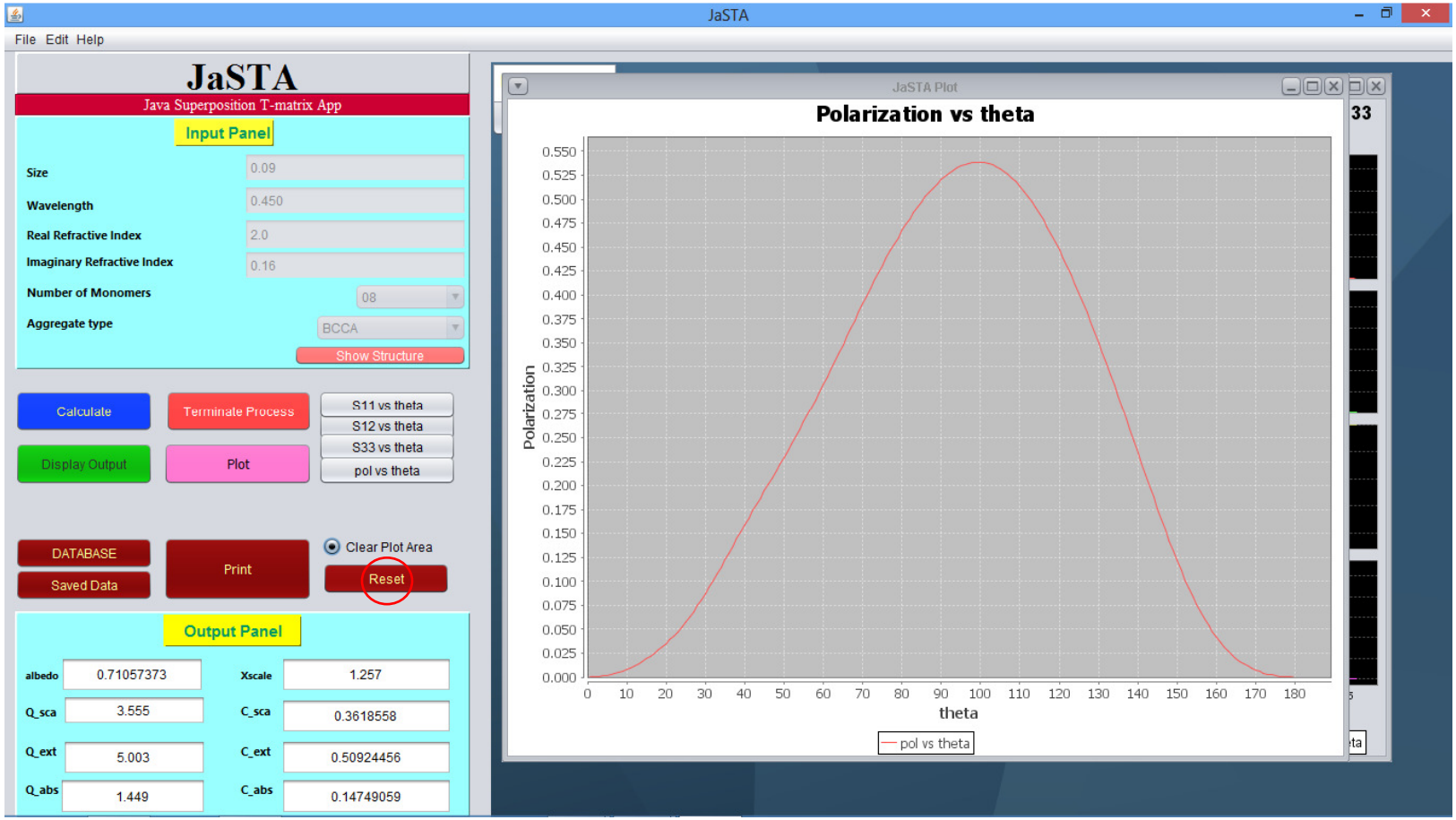
Step 7: To save the calculated data, go to 'File' menu and click the 'Save' option. File>Save.



Step 8: On clicking the "Save" option in the "File" menu the calculated data will be saved in the "DATA" folder and a message will pop out on the screen saying, "Do you want to save the results in DATA folder?". Press "Yes" to save and proceed.

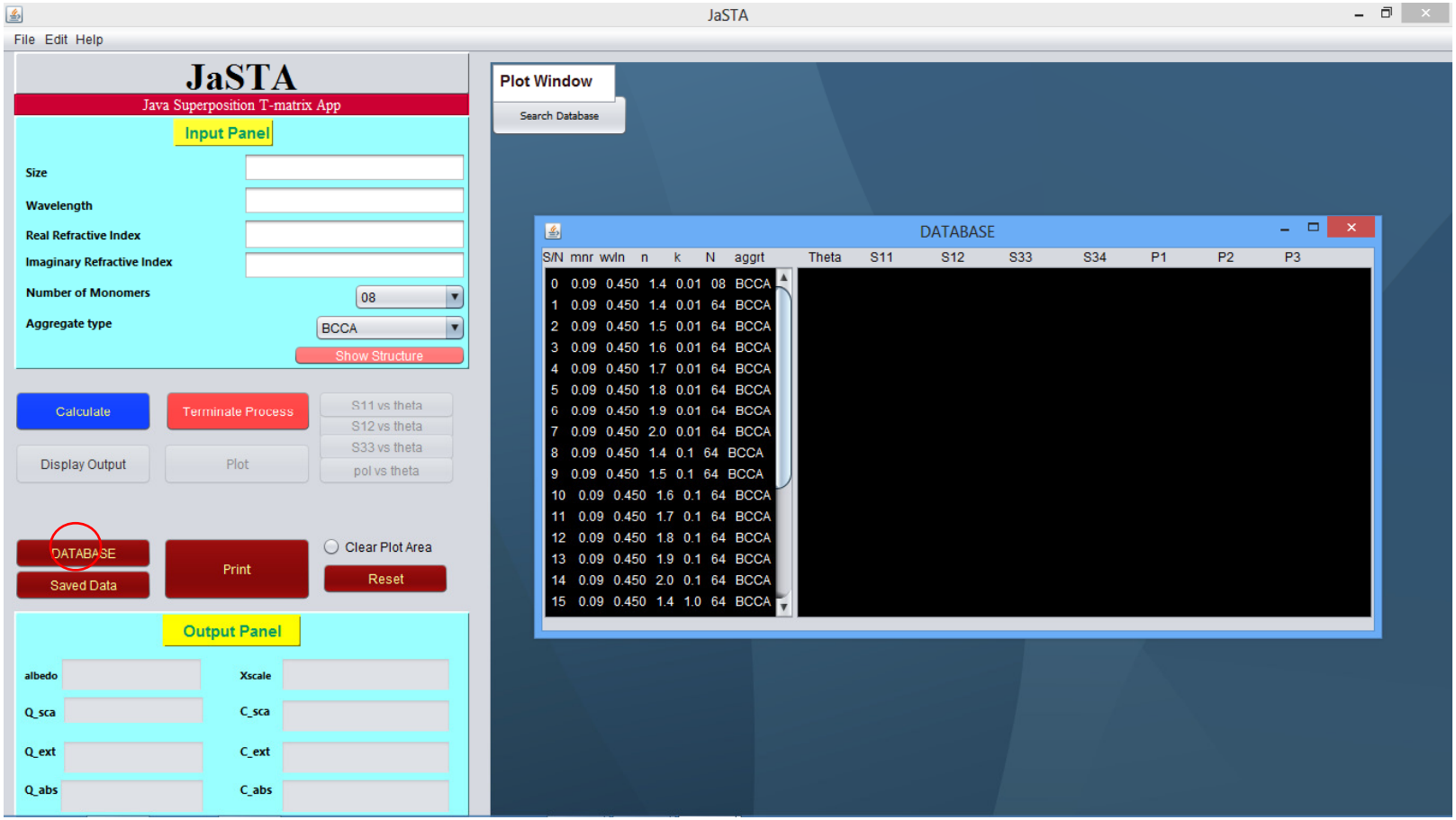


Step 9: In order to start a new calculation or to clear the screen from calculated data, click the "Reset" button. To clear the screen including the plots, click "Clear Plot Area", radio button and then press "Reset" button.



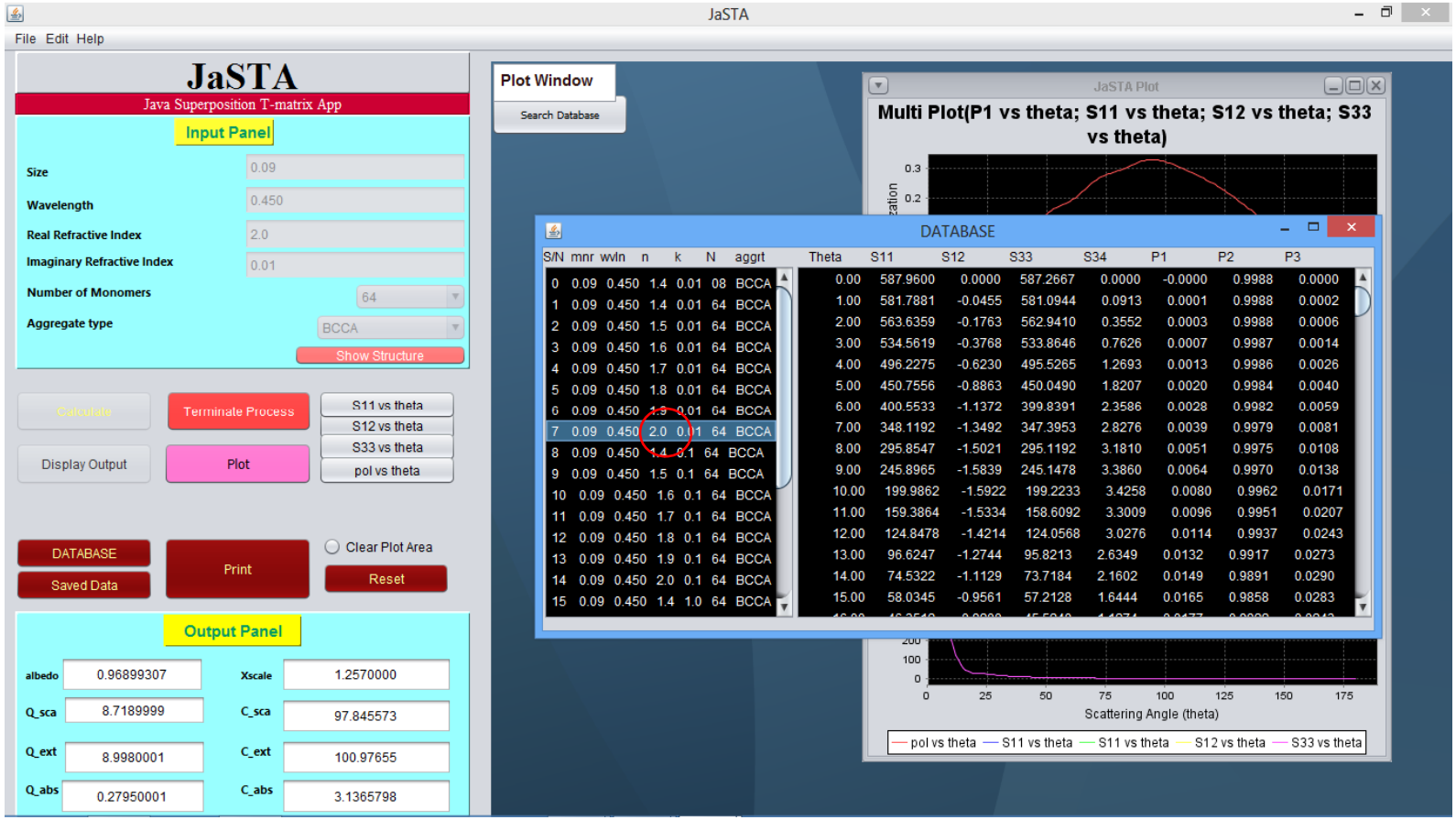
1.9 Database:

Step 1: To view the online database, click the "DATABASE" button.



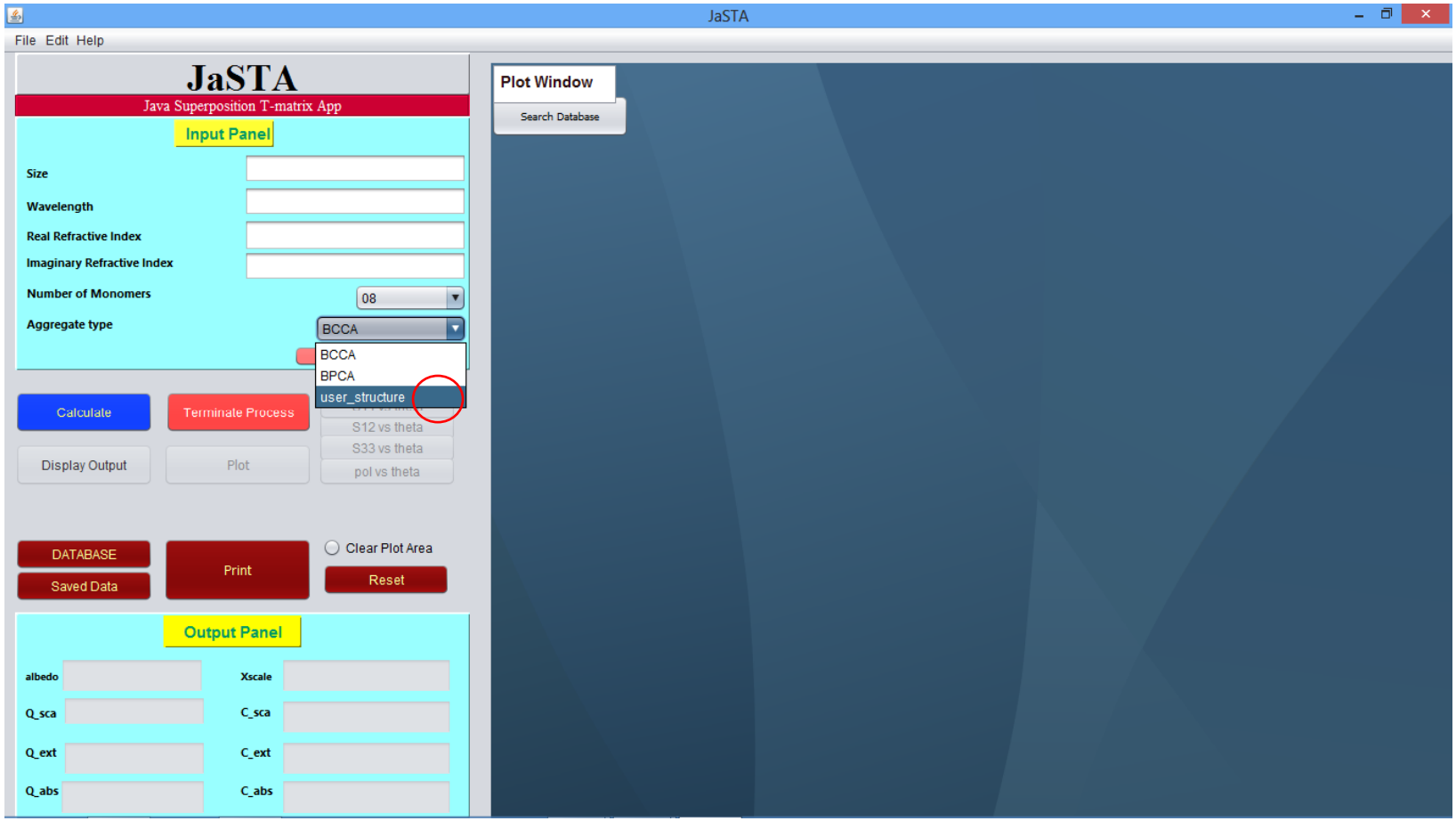
Step 2: To view the user saved data, click the "Saved Data" button.

Step 3: To view the output parameters of a particular set of data from either of the database, click a particular dataset in the left panel of the database window.

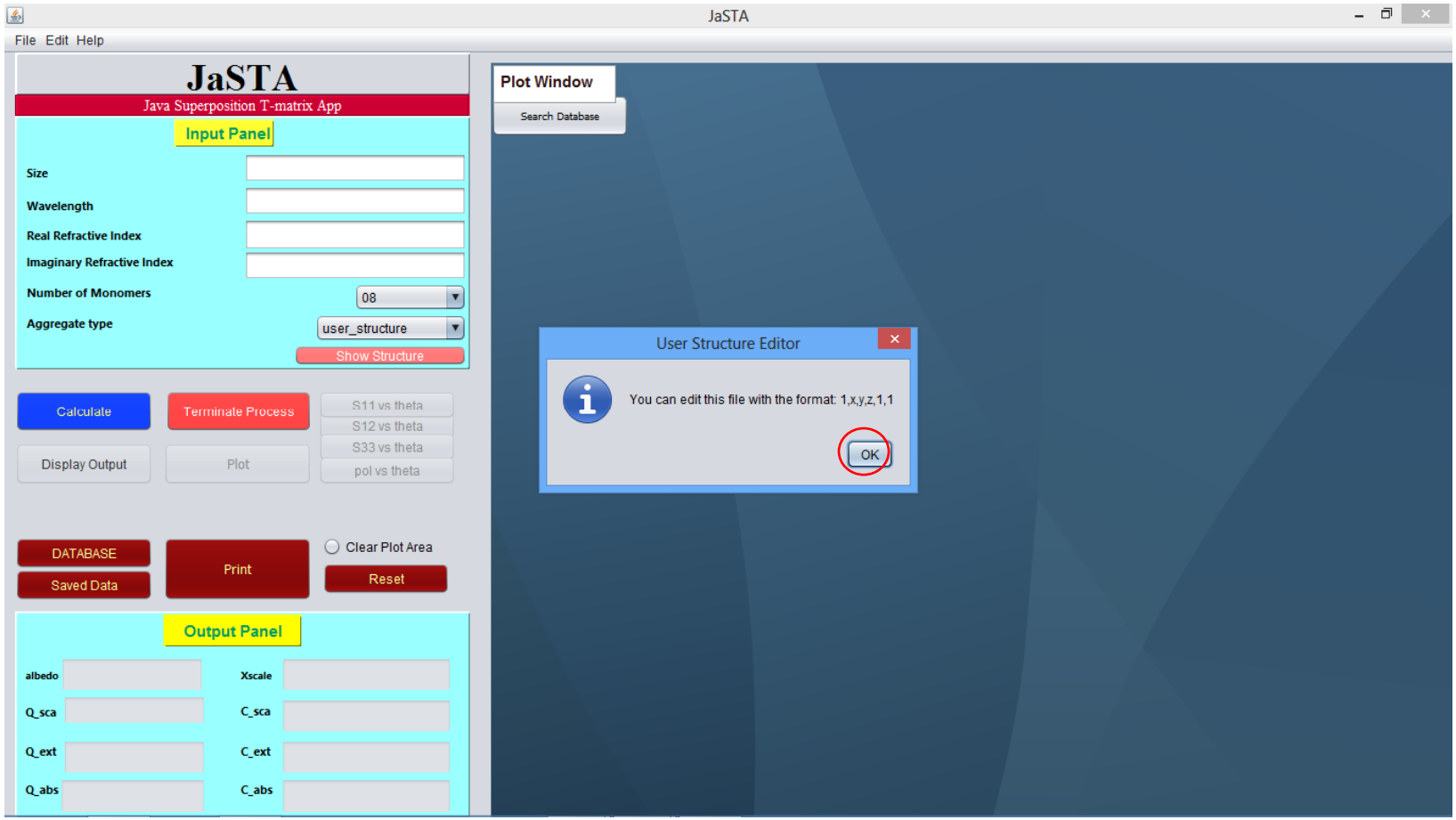


2.0 User Structure:

Step 1: Choose the "user_structure" option from the aggregate type combobox.

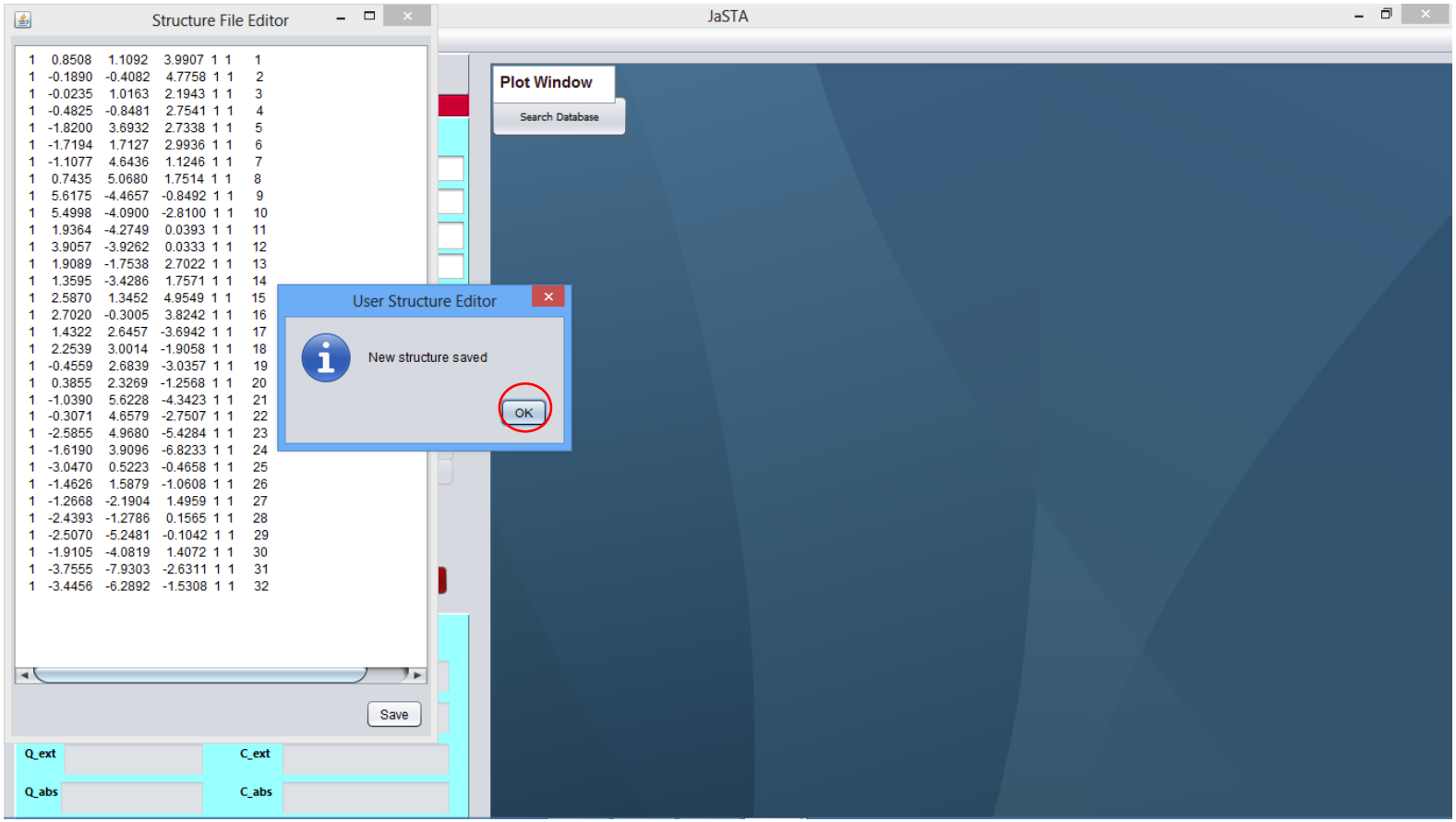


Step 2: Click “OK” on the user structure format notification message.



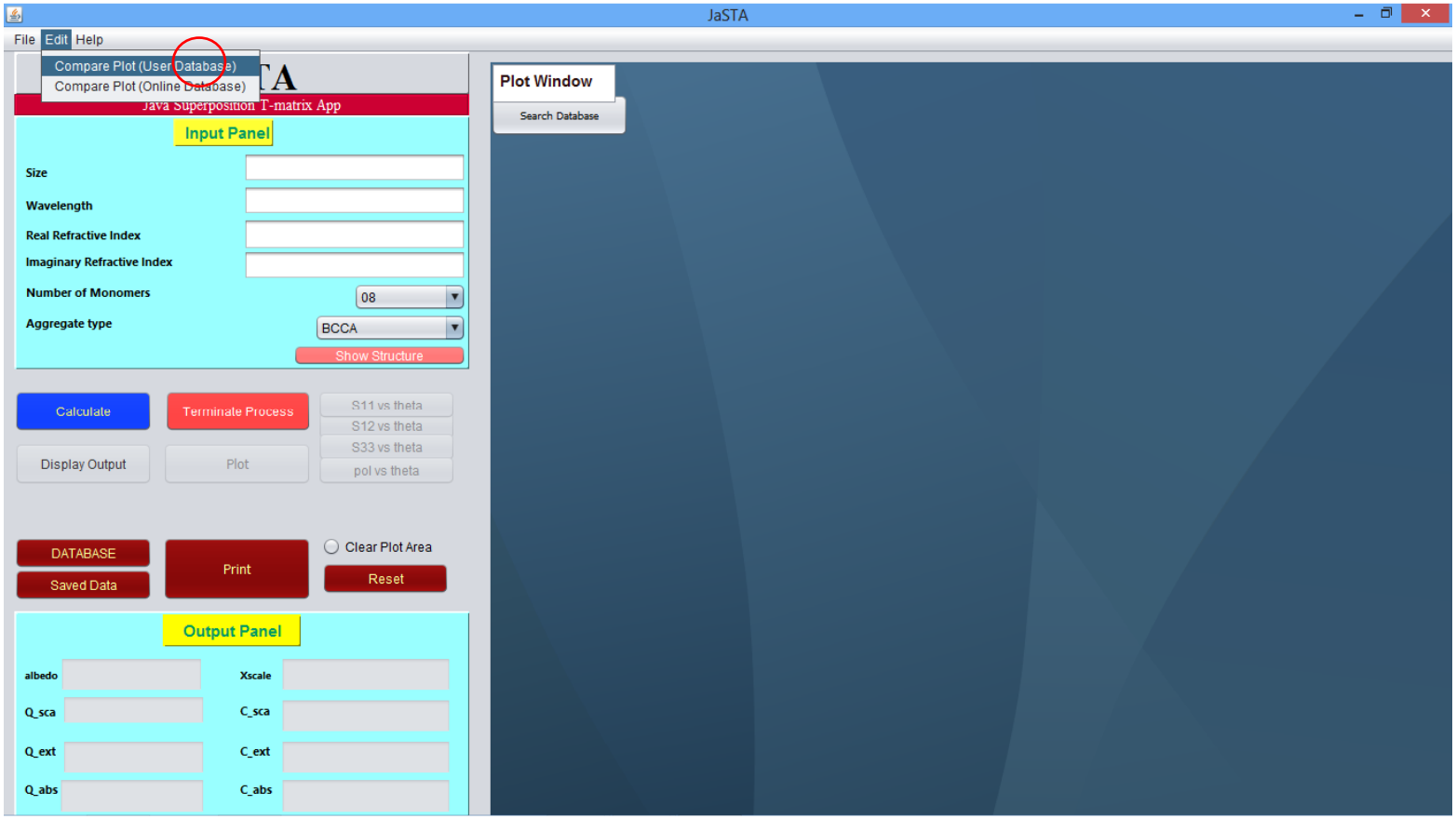
Step 3: Copy any set of co-ordinates of the required format and paste in the “Structure File Editor” text box.

Step 4: Click “Save” to save the user defined structure and proceed for further calculation.

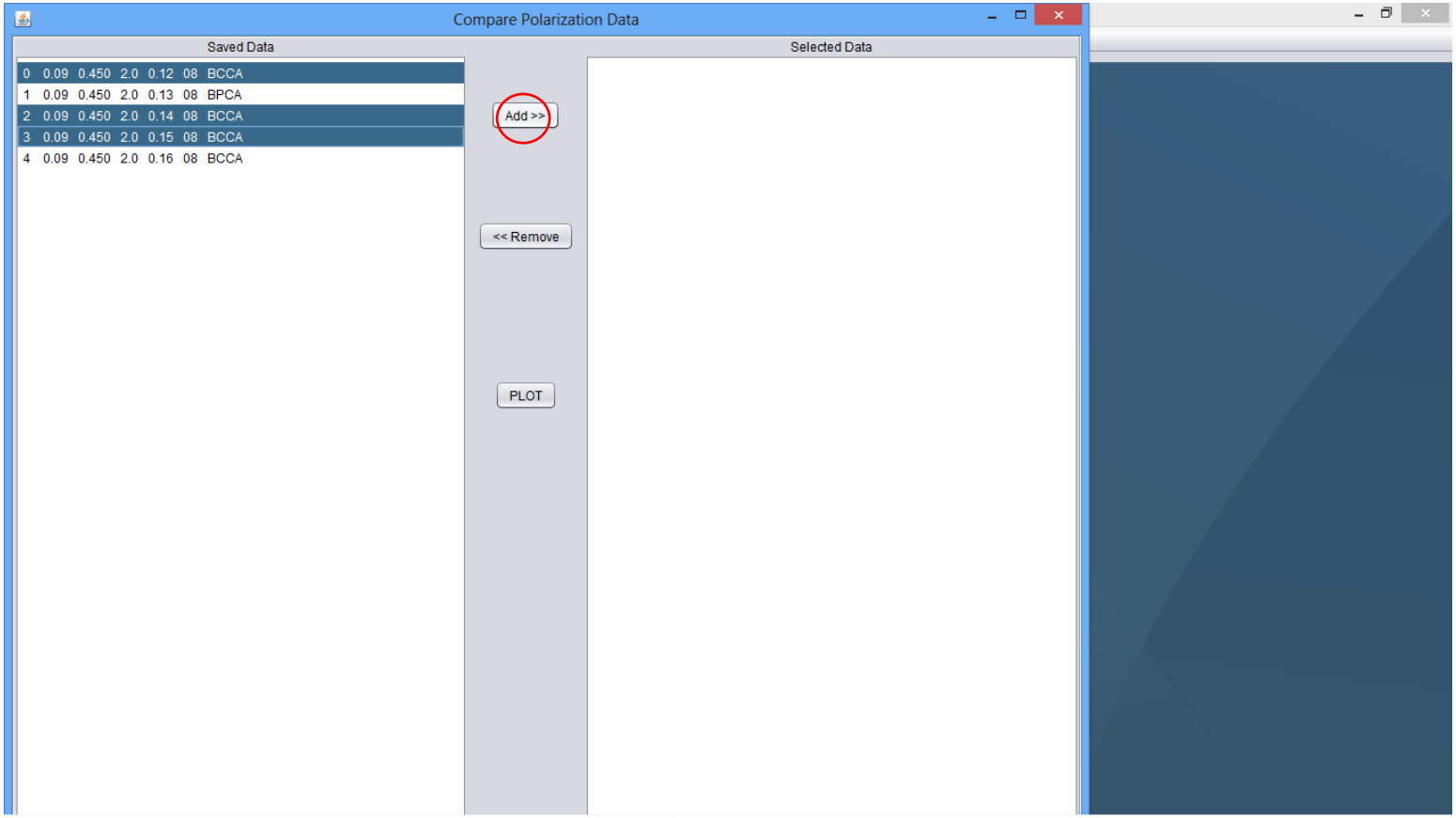


2.1 Compare Plot:

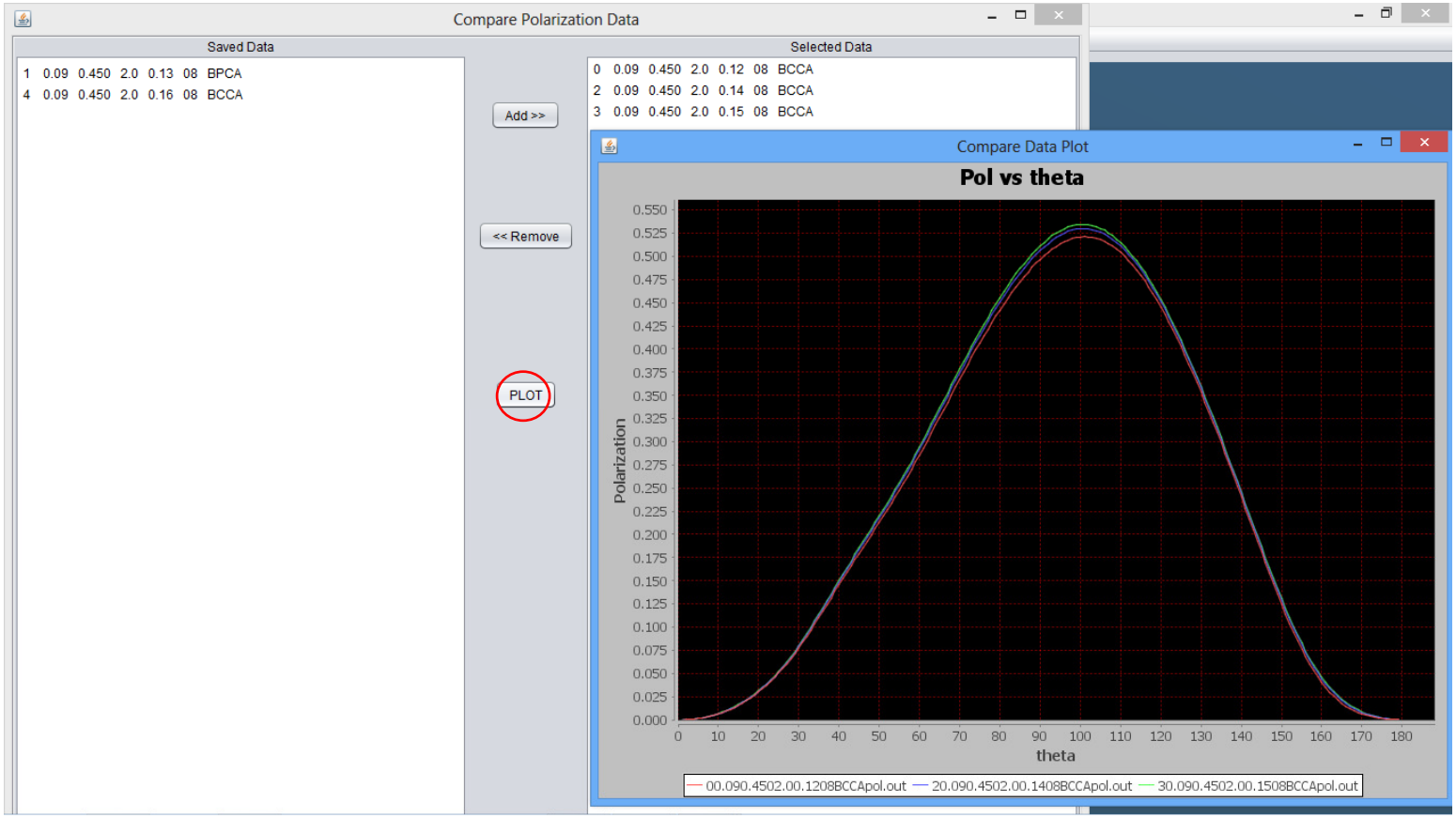
Step 1: Click “Compare Plot (User Database)” or “Compare Plot (Online Database)” option in the Edit menu to compare the polarization values for the set of data present in the user database or the online database respectively.



Step 2: Select the particular number of datasets to be compared from the left panel in the “Compare Plot” window and click “Add” to add the selected datasets in right panel.



Step 3: Click the "Plot" button to view compare plot of the selected datasets.



NOTE:
The JaASTA is also designed to work on *Workstations* with Linux OS. Due to multithreading problem on workstation the conventional progress bar and the console window have been removed from the linux workstation version. Instead an xterm terminal is added to show the real time update of the calculation process. Do not close the xterm window when live calculation is going on, otherwise the calculation process will terminate.

JaSTA workstation version for linux is also available to download from:
http://ausastro.in/jasta.html

Acknowledgements:

This JaSTA is dedicated to the creator of the T-matrix method Peter Waterman. The JaSTA uses "Double precision superposition codes" for multi-sphere clusters in random orientations. The original code is downloaded from the official webpage of National Aeronautics and Space Administration (NASA), Goddard Institute for Space Studies (http://www.giss.nasa.gov/staff/mmishchenko/t_matrix.html). D. Mackowski, K. Fuller and M. Mishchenko are highly acknowledged who made their SUPERPOSITION T-MATRIX code publicly available.

Contact Us:

All the queries related to this software may be reported to the feedback section webpage http://ausastro.in/jasta.html

Please visit http://ausastro.in for latest updates.

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