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Summary

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Multigroup Cross Section and Cross Section Covariance Data Visualization with Javapeño

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Multigroup Cross Section and Cross Section Covariance Data Visualization with Javapeño

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INTRODUCTION

The Javapeño data visualization package was introduced to the Standardized Computer Analyses for Licensing Evaluation (SCALE) [1] code package in version 5.0. The initial version of Javapeño permitted the interactive visualization, in a two-dimensional (2-D) format, of data generated by the SCALE codes and sequences TSUNAMI, SMORES, KMART, and XSDRNPM. For SCALE version 5.1, Javapeño has been enhanced to allow the interactive visualization of multigroup cross section and cross section covariance data.

MULTIGROUP CROSS SECTION DATA

AMPX-formatted multigroup neutron, gamma, and gamma production cross section data are used throughout the SCALE system.[2] Until now, the capability to visualize the reaction cross sections and group-to-group transfer arrays was limited to converting the binary data to plain text using an AMPX utility module like PALEALE [3], then extracting the desired data from the text file and plotting it using a third-party software.

It was desirable to enhance Javapeño such that binary data files can be read directly by the plotting package and presented in a format that can be navigated by the user. The reaction cross sections can be visualized in a 2-D plot, consistent with previous capabilities of Javapeño. However, the transfer arrays require a contour or three-dimensional (3-D) surface plotting capability, neither of which was previously available in Javapeño.

MULTIGROUP CROSS SECTION COVARIANCE DATA

Several multigroup cross section covariance libraries in the binary COVERX format are distributed with SCALE version 5.1 for use with the TSUNAMI sensitivity and uncertainty analysis sequences.[4] These data libraries represent, in multigroup form, the uncertainties in data values and the shared uncertainty between groups. Additionally, the standard deviations in

the group-wise cross section values are the square roots of the diagonal terms of the group-to-group covariance matrix for a particular nuclide-reaction pair.

Similar to the AMPX data, the group-to-group arrays require visualization with contour or 3-D surface plots, where the standard deviations can be visualized with 2-D plots. Additionally, the standard deviations are directly linked to the group-to-group arrays, so simultaneous visualization of both plots is desirable.

ADDITION OF 3-D CAPABILITIES

To address the need to visualize the data in the AMPX and COVERX data libraries, a binary file reader was developed, and 3-D data visualization capabilities have been added to Javapeño. The 3-D visualization capabilities center on a central binned data type that can be displayed as either a surface or a “lego”-block plot. An example surface plot is shown in Fig. 1.

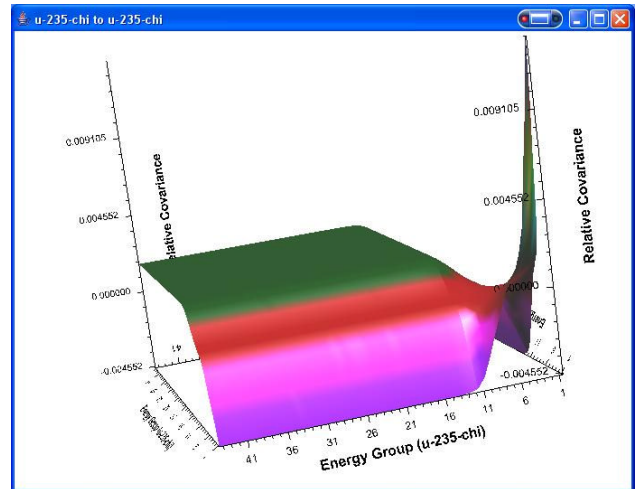


Fig. 1. Example of a surface plot.

Both AMPX and COVERX data can be displayed in either surface or lego plot form. The user can easily switch between forms through the “Format Plot” dialog box, which is located in the “Format” menu.

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The Format Plot also provides means for the user to focus on specific areas of the plots. The “Ranges” tab of the Format Plot has fields for the user to specify which section of the x, y, and z axes to focus on. The plot is then redrawn within the new ranges.

The user can also set a transparency level for a 3-D plot. The transparency level can range from fully opaque to fully transparent. With increasing levels of transparency, details behind the plot can be seen, such as axes and labels.

The Format Plot provides means for the user to customize plots. Under the “Options” tab, the user can choose text and border colors for the plot. Axis labels for the plots can be set under the “Titles” tab.

Javapeño also provides means to customize plots within 3-D space. Using just the mouse, the user is able to pan, zoom, or rotate the plot. The user can rotate the plot around all three axes. To further enhance data visualization, an auto-rotate feature was added. The user can specify the axes, step-size, and step-duration, and the plot rotates without user intervention. This allows the user to focus on the data and not on operating the software.

After the user configures the plot as desired, Javapeño provides capabilities for the user to print or export it. The plot can be printed in either portrait or landscape format and is automatically scaled to fit onto one page. The user can also export the plot as a graphics file. JPEG, GIF, PNG, and Windows bit map image types are supported. The user can specify any image dimension (in pixels) desired. The capability is limited only by the system’s hardware.

AMPX FILE SUPPORT

Support for both AMPX master and working cross section data libraries was added to Javapeño. To load a library, the user chooses “Open Dataset ...” from the “File” menu. A dialog box appears that prompts the user to select the desired library. Javapeño detects whether the file is a working or master library, parses it, and presents the user with the reactions contained in the library. The reactions are displayed in a grouped tree format. The tree contains both the 1-D reaction cross sections, which are visualized as a function of energy in a 2-D plot, and the 2-D transfer arrays, which are visualized as a function of source group and sink group numbers in a 3-D plot. To plot a reaction, the user double left clicks on the reaction.

Javapeño has additional features to manipulate the AMPX transfer arrays. If the user has currently selected an AMPX P_0 transfer array, the Format Plot will contain an option to plot the normalized probability of the P_0 data, as shown in the lego plot in Fig. 2. If the currently selected plot is a P_1 transfer array, then the Format Plot will contain an option to plot the average cosine of the scattering angle ($\bar{\mu}$) corresponding to the P_1 array.

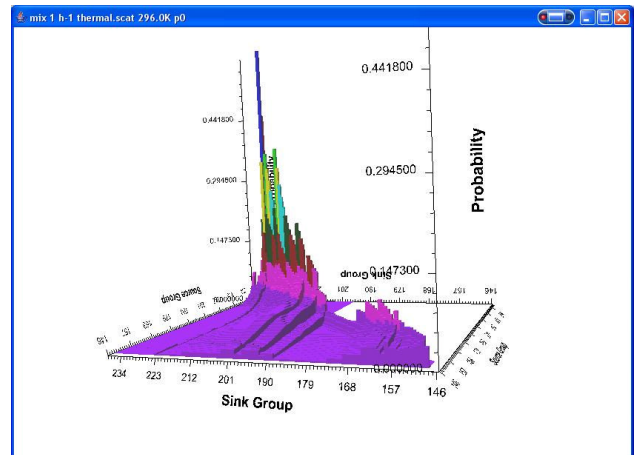


Fig. 2. Example of AMPX P_0 normalized probability.

COVERX FILE SUPPORT

Support for COVERX-formatted cross section covariance data libraries was added to Javapeño. As with the AMPX library, the user selects Open Dataset... from the File menu. A dialog box appears that lets the user select the desired library. Javapeño loads the file, parses it, and displays a list of nuclide-reaction-to-nuclide-reaction energy matrices on the library. To plot a particular matrix, the user double clicks on the desired entry in the list.

Javapeño has additional COVERX specific options. If the currently selected plot is a cross section covariance matrix, then the Format Plot will contain an option to plot the correlation coefficients corresponding to the covariance data.

The Format Plot presents an option to show or hide the standard deviation for the covariance data presented. The standard deviation is calculated for both on and off diagonal COVERX plots. The standard deviation is displayed in a 2-D plot that is attached to the 3-D covariance plot as shown in Fig. 3.

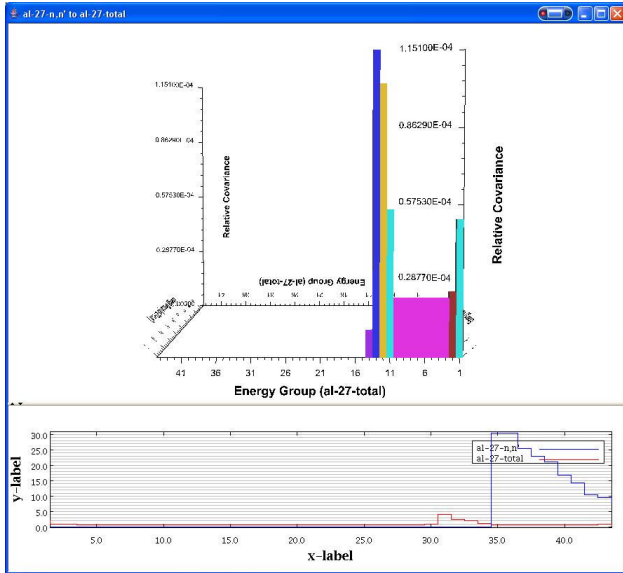


Fig. 3. Example of cross section covariance data with standard deviation shown.

ADDITIONAL FEATURES

To further aid the user in the data visualization process, Javapeño now includes additional capabilities, such as filtering the reaction list to make finding the desired reaction easier. An example of a filtered list of cross section covariance data is shown in Fig. 4. Only entries that contain the text “u-238” are shown. All data types, with the exclusion of AMPX data, support filtering.

Javapeño now allows the user to perform simple mathematical operations on 2-D data in the same plot. To perform the operations, the user first loads multiple reactions in a plot, then right clicks on the legend. A dialog box appears that allows the user to select which reactions to include in the operation and whether to add or subtract the reaction. Finally, the user can select whether to keep the source reactions in the plot with the derived reaction or to remove them.

Additional capabilities have been added to the applet form of Javapeño, which is used in SCALE HTML formatted output. The applet can now perform all of the functions available in the stand-alone application, including exporting, loading addition files, and displaying multiple plots.



Fig. 4. Example of a filtered list.

RESULTS

New capabilities have been added to Javapeño. Three-dimensional data can now be visualized with either a surface or a lego plot. The plots can be manipulated in 3-D space and printed or exported if desired. Support for visualization of multigroup cross section and cross section covariance libraries have been added with library-specific plotting options. The capabilities of the applet version of Javapeño have been expanded to include all capabilities found in the application.

With the new capabilities, SCALE version 5.1 users can gain significant new insight into data contained in the cross section and cross section covariance libraries used in their analyses.

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