Isotope Explorer Users Manual

S.Y.F. Chu[*], R.B. Firestone[*], and L.P. Ekström[*%]

[*]Isotopes Project, Lawrence Berkeley National Laboratory, Berkeley, CA
[%]Department of Physics, Lund University, Sweden

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CONTENTS

I. Introduction

The Isotope Explorer (previously called VuENSDF) is a 32-bit Windows program for retrieving, displaying, listing, manipulating and searching nuclear structure and decay data. Information from the Evaluated Nuclear Structure Data File (ENSDF) and the Nuclear Science Reference file (NSR) can be viewed with Isotope Explorer.

Data can be traced to the original publications through keynumbers contained in the ENSDF file. These keynumbers are decoded into complete references using the NSR file. The NSR file can be searched by author, isotope, subject, keyword, and publication year.

Isotope Explorer also supports a chart data format with a chart interface that serves as an alternative user interface for selecting nuclides, bands, etc., and a general tool for preparing nuclear charts. It is provided with a script language which makes the chart interface a very powerful tool for displaying systematic trends of nuclear properties, for producing custom-made nuclear charts, and for selecting data for display by the program.

In addition to displaying ENSDF data, Isotope Explorer can also retrieve data by nuclear properties from the ENSDF database with the script language. These properties can be displayed with color coding on a nuclear chart. Functions can also be defined with the script language to perform calculations with the retrieved data.

Isotope Explorer supports a variety of data sources to

- Access the *Table of Isotopes* databases directly via the WWW Internet from the Berkeley or Lund (Sweden) servers.
- Use data from a local disk (e.g. from the *Table of Isotopes* CD-ROM). The ENSDF database on the 1999 update CD-ROM was retrieved from the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory September, 1998, and the NSR database was retrieved from the NNDC December, 1998.
- Operate as a helper application for WWW browsers to access and display ENSDF format data directly from the WWW.
- Read chart data from standard experimental, theoretical, or user-generated databases and display horizontal properties by color-coding a nuclear chart.

II. Installation of Isotope Explorer

Isotope Explorer requires a Windows 95 or NT operating system. VuENSDF 1.0, available for Windows 3.1, has only limited capabilities. At least 8 MB of RAM and a Pentium processor are recommended. To install Isotope Explorer copy the toi/www/isoexpl/IsoExpl.exe to a directory on your hard disk and run this file. The file will automatically be decompressed and installed appropriately on your hard disk. Alternatively, Isotope Explorer can be installed directly from a link on the *Table of Isotopes* local Internet home page. Periodic updates of the Isotope Explorer software are posted at the WWW *Table of Isotopes* home page at

(http://ie.lbl.gov/toi.html).

III. Getting Started

Reading Nuclide Data
When Isotope Explorer is launched, it displays an empty screen with most menus disabled.

If you have ENSDF files stored locally, you may open them with **File, Open local file**... on the menu bar, and the level scheme drawing of the first data set in the file will be displayed on the screen. You can also choose to open a chart file; the program will display a nuclear chart instead of a level scheme.

Alternatively, you may select a nuclide by clicking the **Nucleus** button. Depending on the setting in the **Configuration** menu, the program will then look for the data on the local disk or transfer data via the Internet. The latter requires an active connection to the Internet.

Viewing Data
Isotope Explorer has many options that change the way data are displayed. You may select subsets of the data, e.g. rotational bands (**Data, Band**...), or you may choose to see the data in tablular form (**AddView..., Table**).

Isotope Explorer can also display nuclear charts prepared either using existing chart files or chart files created by retrieving data from ENSDF using a script language.

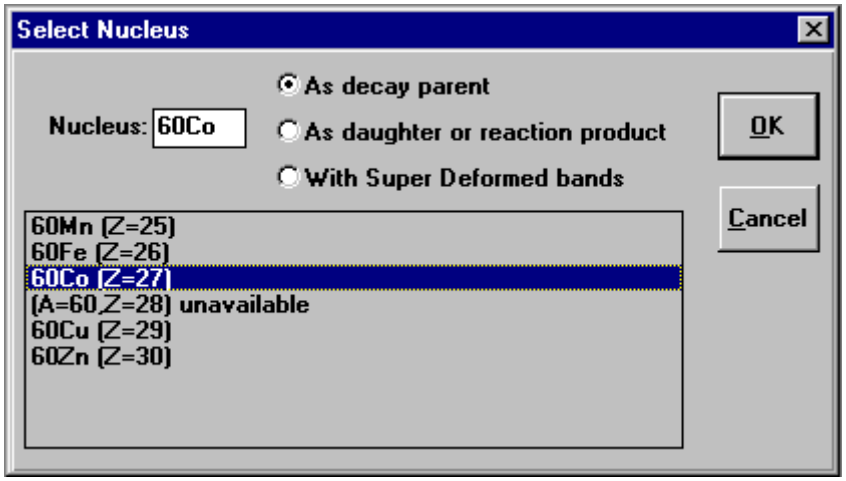
IV. Accessing Data

There are three ways to access nuclear data for use with the Isotope Explorer:

- Transfer data via the Internet from a HTTP-server
- Use data stored on a local disk or CD-ROM
- Obtain data from the WWW, with Isotope Explorer working as a helper application for the browser

Internet Transfer
Data can be transferred directly by Isotope Explorer from the LBNL Isotopes Project Web server.

If the file CATALOG0.LOG (see Isotope Explorer files) is available, the user can select an available nuclide from the **File, Select Nucleus** menu.



The user first selects a database by choosing from three options:

As decay parent - ENSDF decay data sets indexed by parent nucleus

As daughter or reaction product – ENSDF data sets indexed by daughter nucleus (final nucleus)

With superdeformed bands – A frequently updated database containing superdeformed band information

The user can then enter the nuclide specification (e.g. *60Co*) in the text box. While the user is writing the mass number of the nuclide, the program displays pre-existing entries in the list box below. The intended nuclide may be selected by double-clicking the corresponding entry in the list box.

Data from Local Disk or the *Table of Isotopes* CD-ROM
A locally stored file in the ENSDF or ENSDF/2 format is opened using the **File, Open local file**… menu.

The entire ENSDF database is available in a convenient form on the *Table of Isotopes* CD-ROM. When this data structure is used, the nuclide can be selected with the command **File, Select Nucleus.**

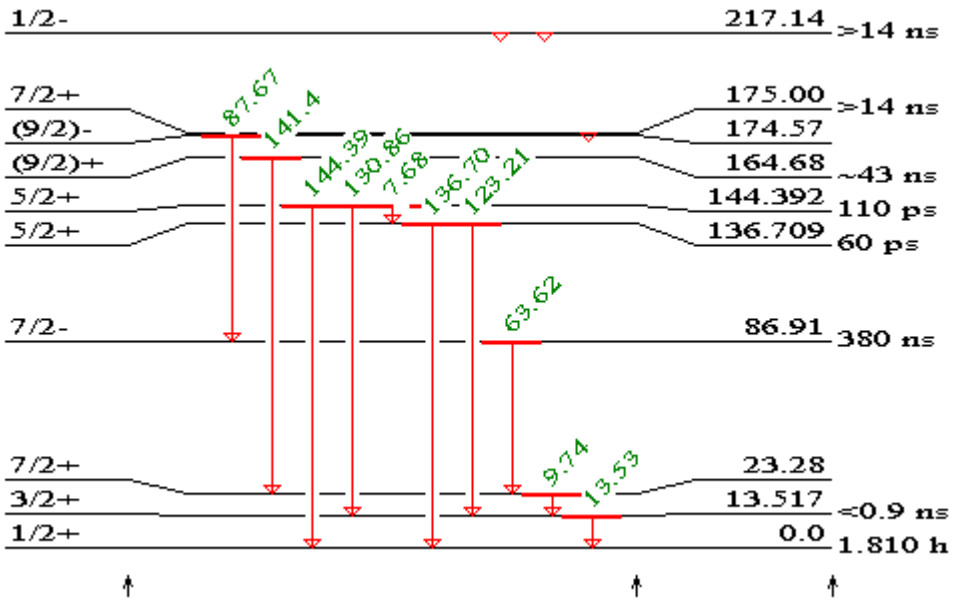
Isotope Explorer as Helper Application to a Web Browser
Nuclear data files can be distributed on the WWW in the ENSDF, ENSDF/2 format or as chart databases. The Web browser will recognize these file types, and launch Isotope Explorer provided that

1. The **server** has been configured to transmit **MIME type Application/ENSDF** for ENSDF (extension **.ENS**), ENSDF/2 (extension **.ENX**) files and chart files (extension **.CHR**).

2. The **browser** has been configured to launch Isotope Explorer for the **MIME type Application/ENSDF** with extensions **.ENS, .ENX** and **.CHR.**

V. Level Scheme Mode

After selecting “Nucleus” and choosing a nuclide, that nuclide’s level scheme will be drawn as in the following example.



The arrows at the bottom can be dragged horizontally by the arrow-cursor to adjust the width of the different areas of the level scheme-the **spin/parity label**, the **gammas area,** and the **energy label.**

If the decay scheme contained many gammas, it would become too crowded to display them simultaneously. Therefore, the program displays only one row or layer of gammas in the gammas area, and other transitions are indicated with an arrowhead at the initial level. The following tool bar buttons are provided to facilitate browsing through these layers.

The Menu Bar
The Menu bar for the drawing mode has the following entries:

The menus and the equivalent item in the tool bar (if available) are described as follows.

File menu

Get Reference – Decode the NSR Keynumber(s) or search for NSR Authors

Select Nucleus – Get nuclide data

File menu (continued)

New chart – Not yet implemented
Open chart – Open an existing chart
Open local file – Open a local data file
Save as – Not yet implemented
Close – Close the active window
Print – Print the current view
Print preview – Print preview the current view
Printer setup – Change printer or properties of the current printer
..... – Open recently used files
Exit – Exit Isotope Explorer

Edit menu

Undo – Undo the last operation

Set Scale – Set the vertical scale
Set Layer – Set layer for gamma display

Operation menu

Coincidence – Display coincidences with the selected gamma(s)

Set Energy Gate – Set an energy gate for the coincidences
Logical operations – Perform logical operations with the spectra

Data menu

Select Data Set – Select a dataset in the current file
Reset selection to all levels – Deselect band and level selections
Select Levels – Bring up the level selection panel, see *Selecting levels*
Select Band(s) – Bring up the bands selection panel, see *Selecting bands*

AddView... menu

Level Scheme – Display the level scheme of current selection
Table – Display the table of current selection
Plot – Plot the current selection
Editor – View input ENSDF file in a text editor

Configuration menu

Save the size of the current view – Save the font sizes, width etc. to the file IsoExpl.INI
Set level font size – Set the font size of energy and spin/parity labels
Set gamma font size – Set the font size of gamma labels
Set decay font size – Set the font size of $t_{1/2}$ and other information
Reset to default settings – Reset all options above to the default values
Nuclear data source – Select: Internet database/local database. Upon selecting a local database the user has to locate it on the disk
Reference data source – Select: Internet database/local database. Upon selecting a local database the user has to locate it on the disk

Window menu

Cascade – Make the windows overlap
Tile – Tile all windows side-by-side
Arrange Icons – Arrange icons of *iconized* windows at the bottom of the main window
Close All – Close all open windows
..... – List of currently opened windows

Help menu

About – Isotope Explorer version, author information, etc.

Report problem – Requires a network connection. Allows the user to report problems with Isotope Explorer or the databases directly to the Berkeley server
Isotope Explorer news – Requires a network connection. Latest news about the program and databases
Help – Isotope Explorer Help function

The Tool Bar

The tool bar, providing access to the most often used commands, is a row of buttons with symbols defined from left to right as

Open an existing chart file

Get nuclide data

Undo last operation

Show no gammas

Show all gammas

Show next higher layer of gammas

Show next lower layer of gammas

Automatic scaling (vertical)

Increase vertical scale

Decrease vertical scale

Select arrow cursor (for selecting objects)

Select hand cursor (for moving display)

Show parent level data (for decay data sets)

Show data legend (for decay data sets)

Tool Bar (continued)

Display coincidences with selected gamma(s)

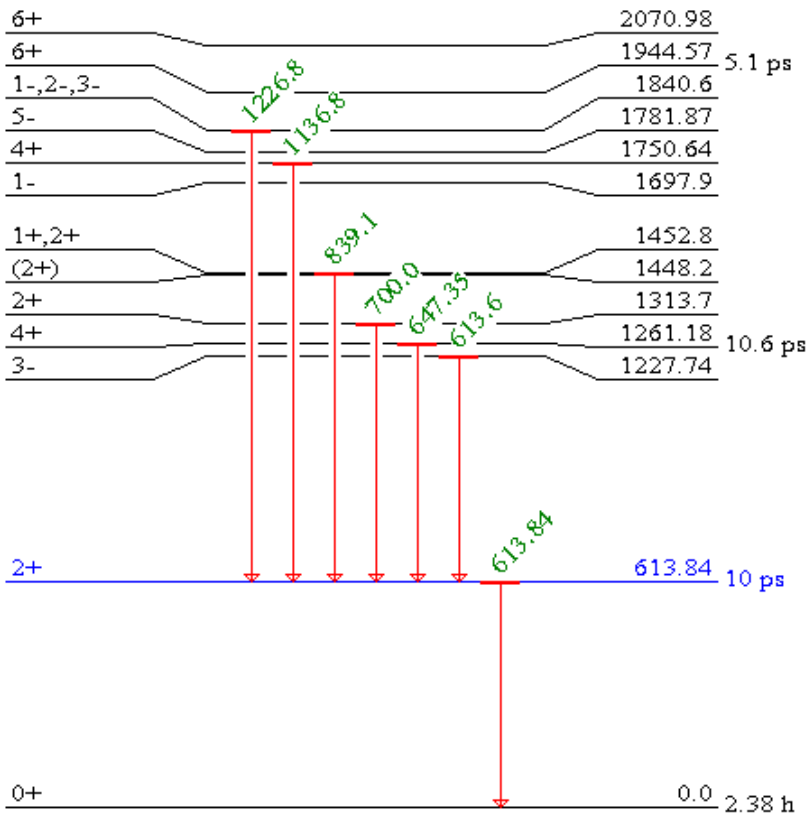
About Isotope Explorer (version information)

Get literature references for dataset

Isotope Explorer help

Manipulation of Display Drawings

For a complex decay scheme it may be difficult to see which gammas populate and depopulate a level. In order to facilitate this, there is a level selection option. **Control-click** on the level energy with the arrow-cursor and the level (613.84 in the figure below) is then shown in blue with only transitions feeding or depopulating the level displayed.



Clicking on a level without pressing the control key will select that level. This feature will be used in later implementations. Gammas can also be selected by **clicking** on them with the arrow cursor. Gammas selected in this way may be used for examining coincidence relationships.

Selected gammas or levels are deselected by **clicking** on them again. Any selection is reset by clicking on an area of the level scheme drawing away from the levels and gammas. The previous state can always be obtained with the **Undo** button.

Shortcuts

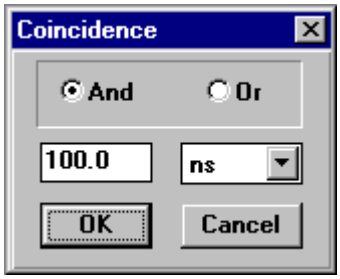
All supported commands are available as entries to the menu bar. Some of the most commonly used commands are also available in the tool bar. In addition, there are useful mouse-shortcuts that are described below.

Click on a gamma – The gamma is selected and shown in purple
Click on a level – The level is selected and shown in blue
Ctrl-click on a level – Highlight the level in blue and show only populating and depopulating gammas
Click on selected gamma or level – Deselect gamma or level
Click on empty part of drawing area – Deselect all gammas and levels
Click anywhere with the right mouse button – Open the band/levels selection panel

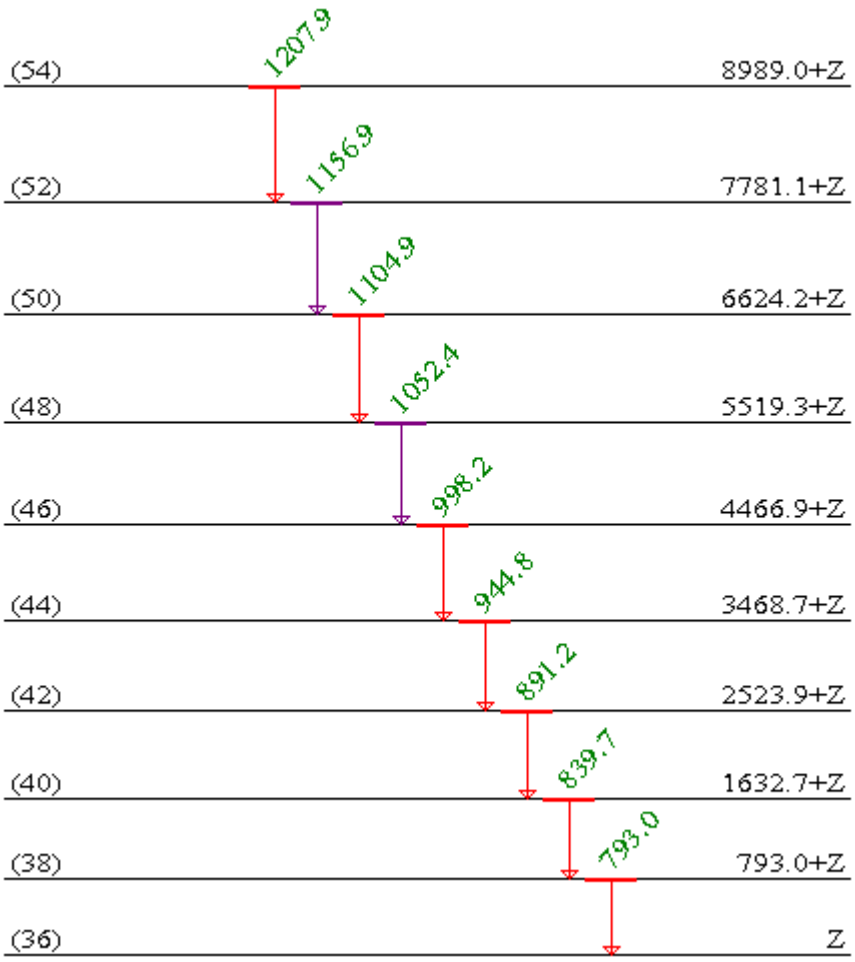
Operation: Coincidence

The simplest way to show coincidences is to select one or more gating gammas with the arrow cursor and click the coincidence button.

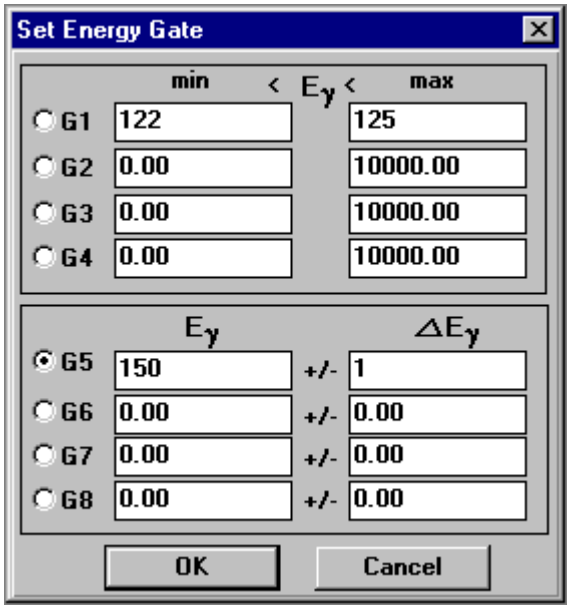
The user is asked to specify the type of coincidence, **And** or **Or,** if more than one gamma has been selected. The time window specifies the maximum level half-life for which gammas feeding from above are defined to be coincident with deexciting gammas.



Upon clicking **OK**, the program displays all gammas in the current decay scheme that are in coincidence with the selected gamma(s) within the specified time gate. Coincident gammas are displayed in red, and gating gammas in blue. If more than one gamma is selected, the displayed coincidences correspond to **Or** or **And** operations with the gates. In the figure below, gates have been set on two transitions with the **Or** condition selected. Since the gating transitions are also in coincidence, they are shown in purple (1052.4 and 1156.9) rather than blue as shown in the figure below:



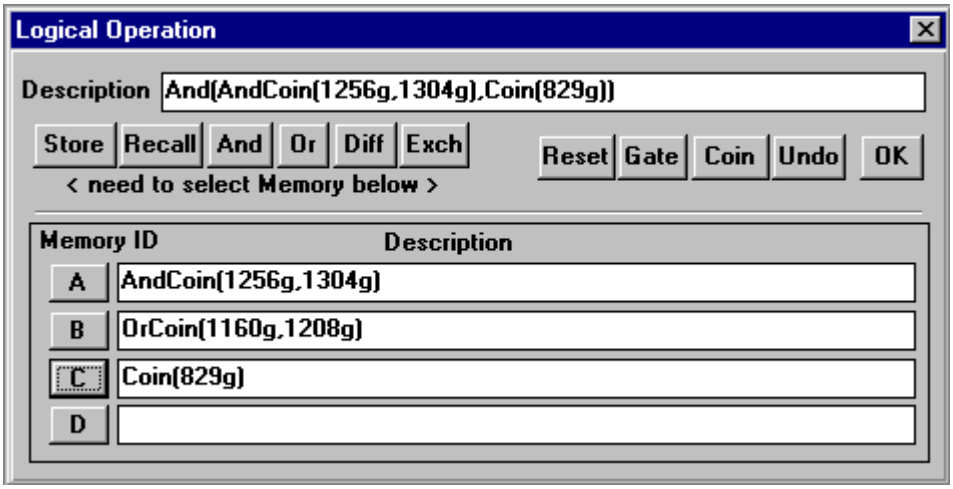
Operation: Set Energy Gate.
The user may alternatively specify gates either as an energy interval or as an energy with a width as shown below.



In the example above the gate **G1** is set between 122 and 125 keV. The gate **G5** is set as 150±1 keV (i.e. 149-151 keV). The user can set all the gates **G1-G8,** and perform Boolean operations on them (see below). The gates **G1-G4** and **G5-G8** are equivalent except that the gating conditions are specified in different ways.

The user should note the difference between selecting a specific gamma with the cursor and setting an energy gate. In the first case, only the selected gamma is used in the coincidence gate. In the second case, more than one gamma may occur within the energy gate. Then, the coincidences result will correspond to all coincidences of the gammas in the selected energy range. Advanced operations can be performed with the Logical Operation option described in the following section.

Operation: Logical Operation
Logical operation can be used for storing gated spectra to which more complicated coincidence relations will be applied. It is important to recognize the difference between the effect of **coincidence** and **logical operation** on spectra. Double coincidences are always unambiguous, while the logical operations compare spectra using Boolean operations. When the gating transitions are in coincidence both methods are equivalent. When the **Operations, Logical operation** is selected, the following panel appears.



The panel contains a field describing the current gate and four memory locations A–D. The white fields contain only labels, and entering text in them does not affect their properties. The buttons do the following:

Store

Store current gate and spectrum in a memory location (A–D)

Recall

Recall a gate/spectrum from a memory location (A–D)

And

Perform a logical AND between the current gate and a gate from memory location A–D

Or

Perform a logical OR between the current gate and a gate from memory location A-D

Diff

Perform a logical XOR (exclusive or) between the current gate and a gate from memory location A–D

Exch

Exchange current gate with gate in memory location A–D

Reset

Reset current gate to display all gammas

Gate

Set energy gate

Coin

Calculate coincidences with currently marked gamma(s)

Undo

Undo last operation

OK

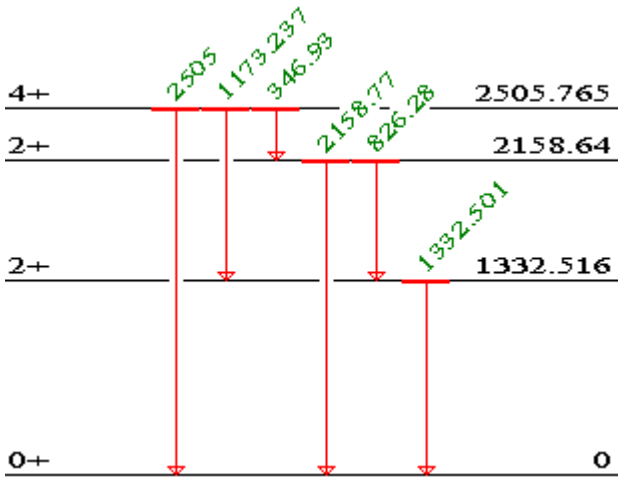
Close logical operations box

A gate is entered into memory A as follows.

1. Click on the gating gamma(s). The selected gamma(s) will turn purple.
2. Click the button.

3. Select **AND** or **OR**, and click **OK**. The gating gammas are shown in blue (purple if they are in the gate), and coincident gammas are shown in red.
4. Select **Operation, Logical operations**.
5. The top panel will now contain a description of the gating condition.
6. Store this gating condition (and the resulting spectrum) by clicking **Store,** then **A**.

The following simple example illustrates the use of logical operations. The initial decay scheme is shown below.



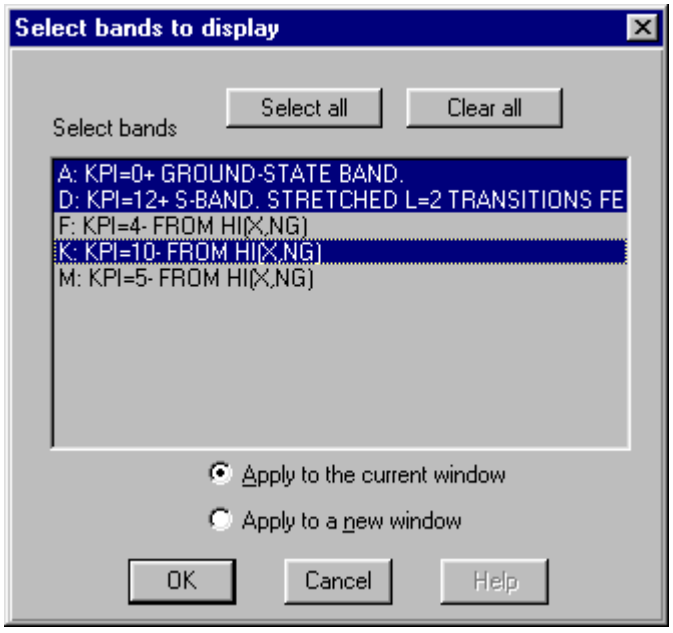
The following table shows the results of gating on the 347 and 826 keV transitions. It can be seen that since the two transitions are **in coincidence**, the result of double coincidences (either **And** or **Or**) is identical to the result of logical operations on the gated spectra.

	Singles	**Coin.**		**Double Coin.**		**Logical operations**		
E(gamma)		**347**	**826**	AND	OR	AND	OR	DIFF
347	1	**0**	**1**	0	1	0	1	1
826	1	**1**	**0**	0	1	0	1	1
1173	1	**0**	**0**	0	0	0	0	0
1333	1	**1**	**1**	1	1	1	1	0
2159	1	**1**	**0**	0	1	0	1	1
2505	1	**0**	**0**	0	0	0	0	0

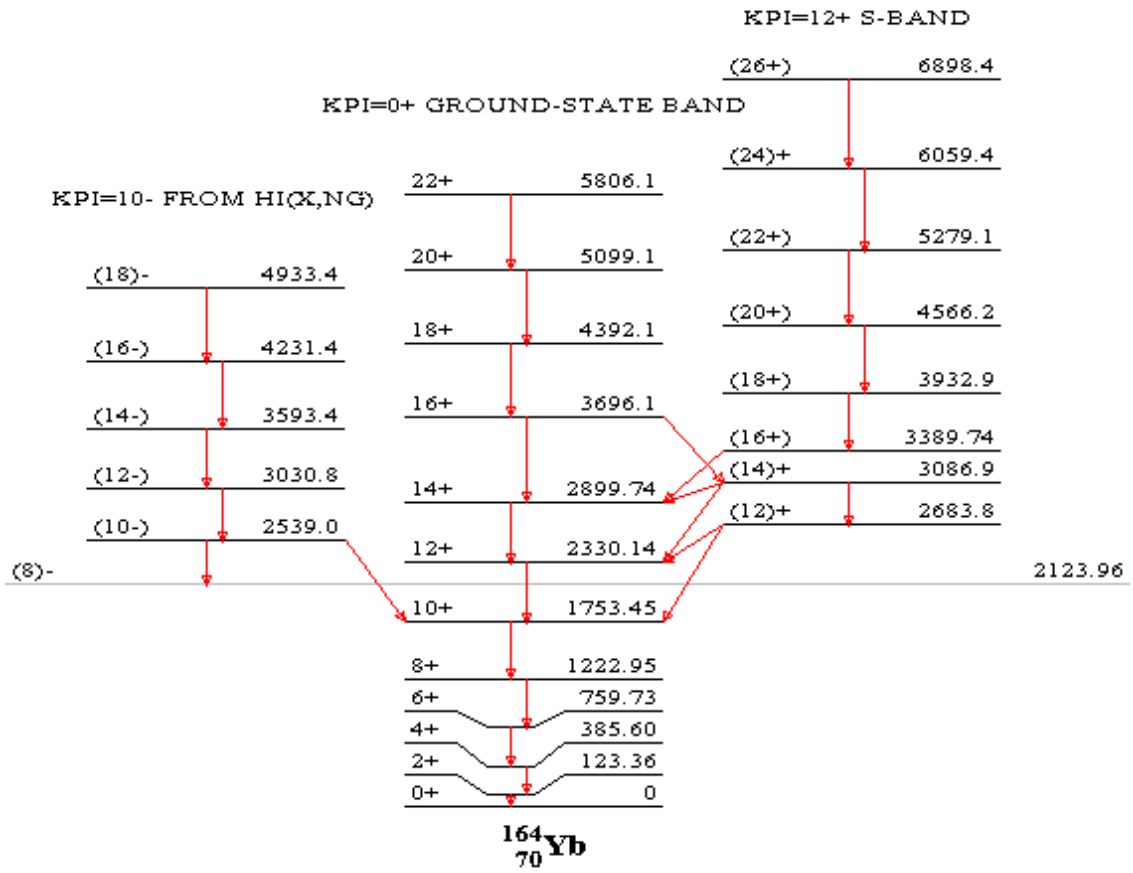
The second table shows the results of gating on the 347 and 1173 keV transitions. It can be seen that since the two transitions are **not in coincidence**, the result of the double **And** coincidence is different from the result of the logical **And** operation on the gated spectra.

	Singles	**Coin.**		**Double Coin.**		**Logical operations**		
E(gamma)		**347**	**1173**	AND	OR	AND	OR	DIFF
347	1	**0**	**0**	0	0	0	0	0
826	1	**1**	**0**	0	1	0	1	1
1173	1	**0**	**0**	0	0	0	0	0
1333	1	**1**	**1**	0	1	1	1	0
2159	1	**1**	**0**	0	1	0	1	1
2505	1	**0**	**0**	0	0	0	0	0

Data: Select Band(s)
In level scheme mode, the band selection panel shown below is displayed.



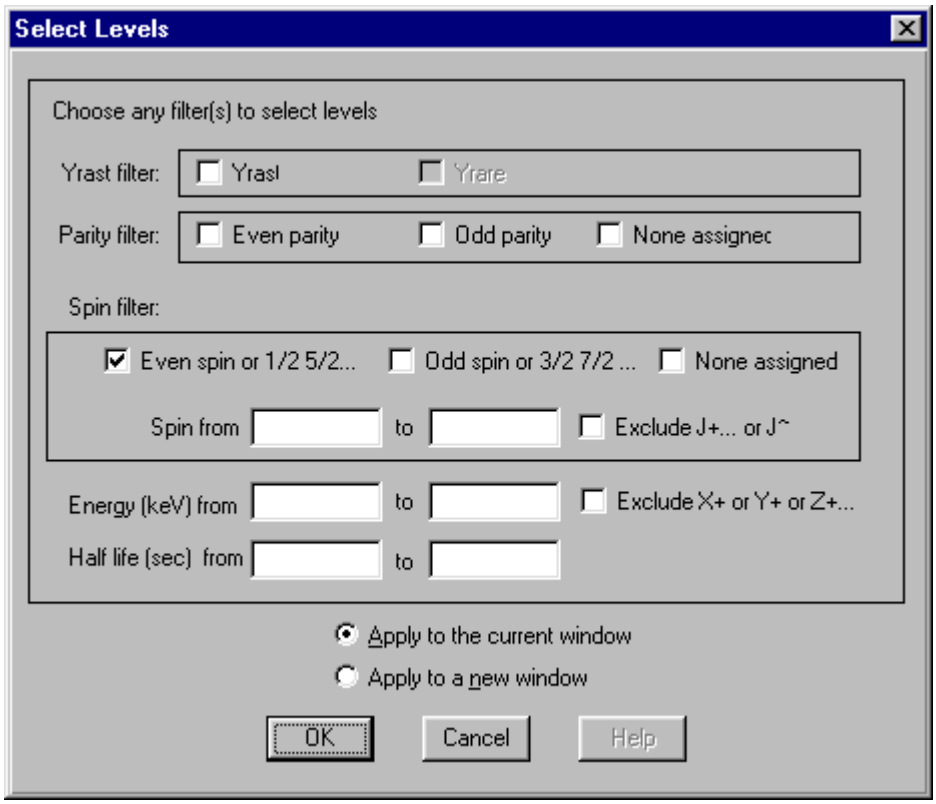
The bands available in the current dataset will be displayed in the list. The user can select any band(s) by clicking on the entries to the list. When the **OK** button is selected, a level scheme in the band mode will display the chosen bands.



The order of the bands is determined by optimizing the drawing of out-of-band transitions. When there are gammas connecting levels in nonadjacent bands, the daughter level is extended horizontally as a gray line. Levels from unselected bands or non-band members which are fed by gammas from selected bands are shown as horizontal gray lines the full width of the display.

Levels and gammas cannot be selected in band mode. However, the properties of any gamma (energy, initial/final level energy and spin-parity, relative intensity and multipolarity) are displayed in the status bar at the bottom of the screen when the mouse pointer is placed over that gamma.

Data: Selecting Levels
On selecting **Data, Select Levels** in level scheme mode, the level selection panel is displayed.



This panel contains a number of filters that can be applied to the selection of levels that are displayed in the drawing, table, or plot.

Yrast Selects yrast levels (the level of lowest excitation energy for any given spin)

Parity Selects levels with odd parity, even parity unassigned parity. More than one option may be selected

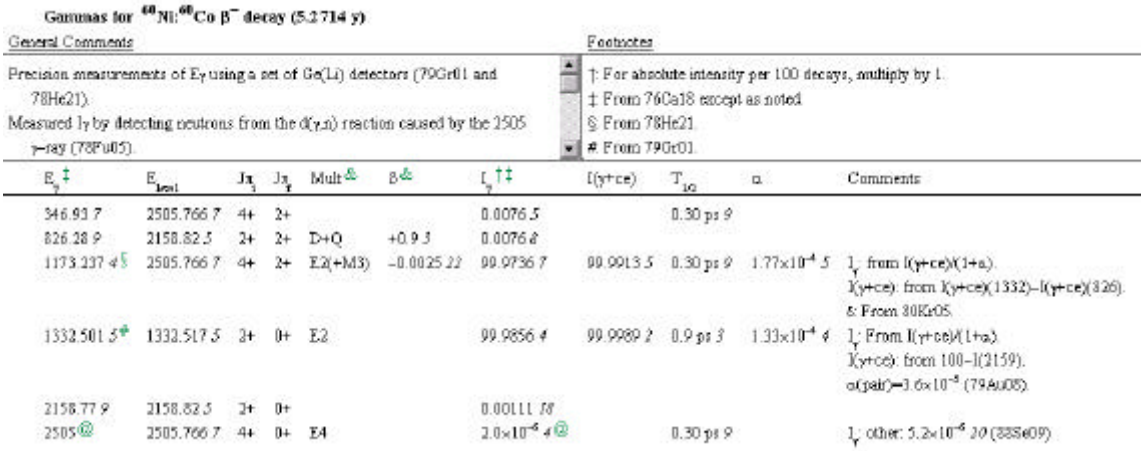
Spin Selects levels with even and odd spin and on a range of spin values

Energy Selects levels within a range of excitation energies

Half-life Selects levels within a range of half-lives

VI. Table Mode

The program can produce Nuclear Data Sheets style Level, Gamma, Beta, or a β^+/EC Tables with the command **Addview, Table**. An example of a Gamma Table follows.



Gammas for ^{68}Ni:^{68}Co β$^-$ decay (5.2 714 y)

General Comments

Precision measurements of E_γ using a set of Ge(Li) detectors (79Gr01 and 78He21).
Measured I_γ by detecting neutrons from the d(γ,n) reaction caused by the 2505 γ-ray (78Fu05).

Footnotes

†: For absolute intensity per 100 decays, multiply by 1.
‡: From 76Ca18 except as noted.
§: From 78He21.
#: From 79Gr01.

E_γ ‡	E_{level}	$J\pi_i$	$J\pi_f$	Mult &	δ &	I_γ †‡	I(γ+ce)	$T_{1/2}$	α	Comments
346.93 7	2505.766 7	4+	2+			0.0076 5		0.30 ps 9		
826.28 9	2158.82 5	2+	2+	D+Q	+0.9 3	0.0076 8				
1173.237 4 §	2505.766 7	4+	2+	E2(+M3)	−0.0025 22	99.9736 7	99.9913 5	0.30 ps 9	1.77×10^{-4} 5	I_γ: from I(γ+ce)/(1+α). I(γ+ce): from I(γ+ce)(1332)−I(γ+ce)(826). &: From 80Kr05.
1332.501 5 #	1332.517 5	2+	0+	E2		99.9856 4	99.9989 2	0.9 ps 3	1.33×10^{-4} 4	I_γ: From I(γ+ce)/(1+α). I(γ+ce): from 100−I(2159). α(pair)=3.6×10^{-5} (79Au05).
2158.77 9	2158.82 5	2+	0+			0.00111 58				
2505 @	2505.766 7	4+	0+	E4		2.0×10^{-6} 4 @		0.30 ps 9		I_γ: other: 5.2×10^{-6} 20 (88Se09)

The user has full control over the layout of the table, which properties are listed, font size, column spacing, etc. The tables can be sorted on almost any property by clicking on the corresponding column header. A second click re-sorts the data in the reverse order. General comments, footnotes, and band comments can be scrolled, and hypertext links are provided between footnotes and band labels in the tables and their associated comments. Hypertext links are also provided between reference NSR Keynumbers in the comments and the NSR keyword abstracts.

The Menu Bar

The following menu items are available in the table mode:

File menu

Get Reference – Decode NSR Keynumber, search for NSR Authors

Select Nucleus – Get nuclide data

New chart – Not yet implemented
Open chart – Open an existing chart
Open local file – Open a local data file
Save as – Not yet implemented
Close – Close the active window
Print – Print current view
Print preview – Print preview current view
Page setup – Change printer or properties of current printer
Include on Page – annotate printed page with page numbers, dataset name, and date stamp
..... – Open recently used files
Exit – Exit Isotope Explorer

Data menu

Select Data Set – Select data set in the current file
Reset selection to all levels – Deselect band and level selections
Select Levels – Bring up the level selection panel, see *Selecting levels*
Select Band(s) – Bring up the bands selection panel, see *Selecting bands*

Table menu

General comments – Toggle; activate to display general comments.
Footnotes – Toggle; activate to display footnotes.
Xreferences – Toggle, levels only; activate to display cross-index to reactions where the level is populated.
Level – Display level table
Gamma – Display gamma table
Beta – Display β^- table
Alpha – Display α table
EC – Display EC/β^+ table
Column width mode – Toggle; activate to minimize spacing between columns.

Sorting menu

Select quantity on which the table should be sorted. Quantities not relevant for selection are grayed out.

AddView... menu

Level Scheme – Display level scheme of current selection
Table – Display table of current selection
Plot – Plot current selection
Editor – Not yet implemented

Configuration menu

Save the size of the current view – Save font sizes, width, etc. to the ISOEXPL.INI file
Set table font size – Set font size for table
Set table column width – Set column width for table in points (72 points/inch)
Reset to default settings – Reset all options above to the default values
Nuclear data source – Select Internet database or local database; on selecting local database the user has to locate it on the disk
Reference data source – Select Internet database or local database; on selecting local database the user has to locate it on the disk
Debug Mode - Debug mode on/off (in debug mode all operations performed are logged in the file LOG)

Window menu

Cascade – Overlap windows
Tile – Tile all windows side by side
Arrange Icons – Arrange icons of iconized windows at the bottom of the main window
Close All – Close all open windows
..... – List of currently opened windows

Help menu

About – Isotope Explorer version information, authors, etc.

Report problem – Requires network connection. Allows the user to report problems with Isotope Explorer or the databases directly to the Berkeley server

Isotope Explorer news – Requires network connection. Latest news about the Program and databases

Help – Isotope Explorer Help function

The Tool Bar

Since some items in the tool bar are not applicable to table mode, they are grayed out. The following, from left to right, are active:

Open an existing chart file

Get nuclide data

Get reference

Print table

Print Preview

Display General Comments

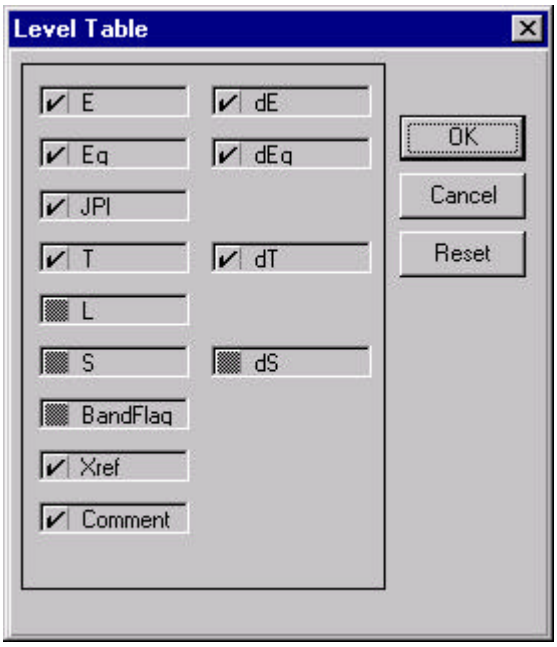
Display Cross references

Display Footnotes

About Isotope Explorer (version information)

Isotope Explorer help

Controlling Table Appearance
If you select **Table, Level** in the menu bar, the program will display the panel shown below. From this panel you may choose which properties should be displayed in the table. Unavailable properties are grayed out. Similar panels are available to choose data for other types of tables.



For sorting on different properties, you may either click on the caption of the appropriate column or select **Sorting, By level energy**, ...

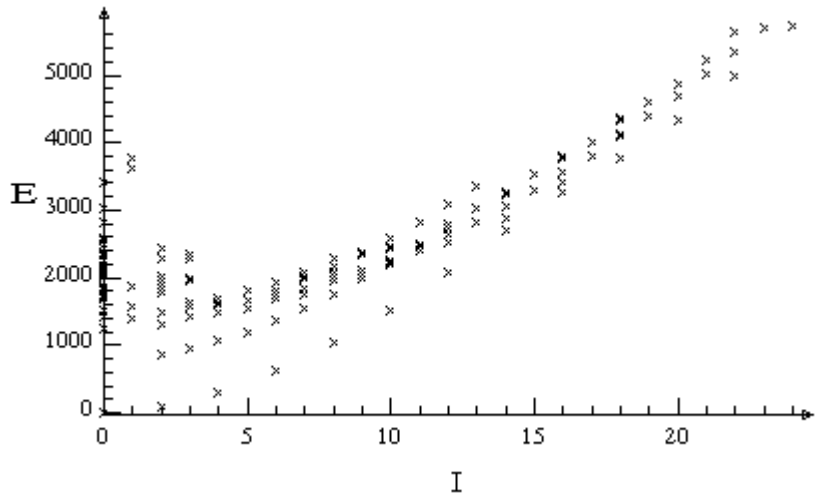
The column spacing can either be controlled with **Configuration, Set table column width** (all columns) or with the mouse (one column at a time) in the following way:

1. Put the cursor over a header item.
2. Move the cursor to the left.
3. When a vertical line appears, hold down the left mouse button and drag the column to the new position.

VII. Plot Mode

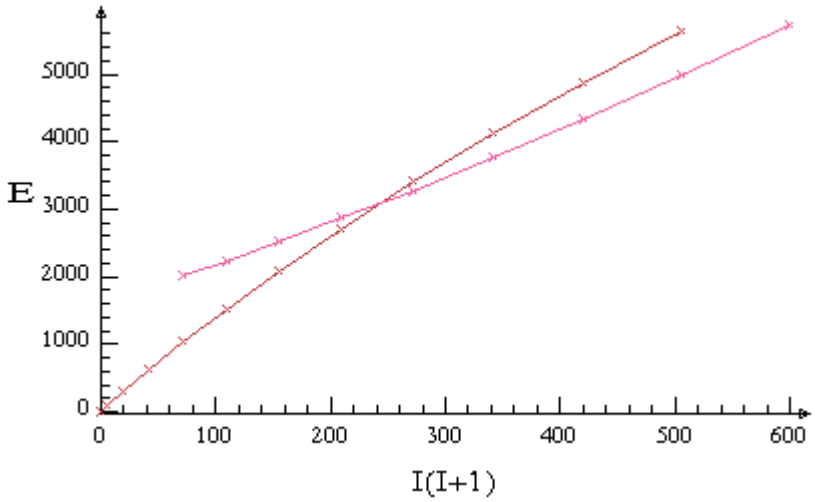
The program can produce two-dimensional plots of selected quantities with the command **AddView, Plot**. The quantities plotted will depend on the current level selection.

If no levels are selected, a plot showing the distribution of level energies *versus* spin will be drawn:



By clicking the **I** on the horizontal axis and selecting **I(I+1)**, the distribution is plotted against I(I+1). The scale on any axis can be manually selected with a dialog box which appears when you click on any of the axes.

If bands have been selected, a band plot will be generated:



Here, two bands (the G band and the S band) were selected. For band plots the following axis variables are available:

Horizontal axis: *I, I(I+1),* the frequency ω and w^2

Vertical axis: *Excitation energy*, first moment of inertia I_1, second moment of inertia I_2, I_1^2 and I_2^2.

VIII. Editor Mode

Displays the selected ENSDF database file in a text editor. **FIND** command available to locate specific text strings.

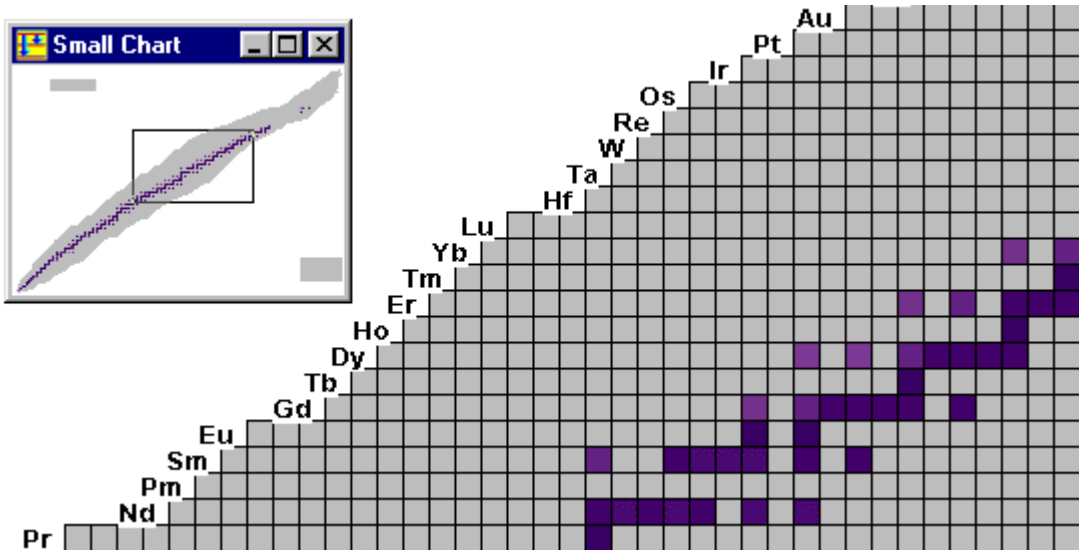
XI. The Chart Interface

The chart interface serves a dual purpose as

1. An alternative **user interface** for selecting nuclides, bands, etc.
2. A general tool for **generating nuclear charts**

Combined with the script language described in Section X it provides a very powerful tool for **displaying systematic trends** of nuclear properties, **producing custom-made nuclear charts,** and **selecting data** to be displayed by the program.

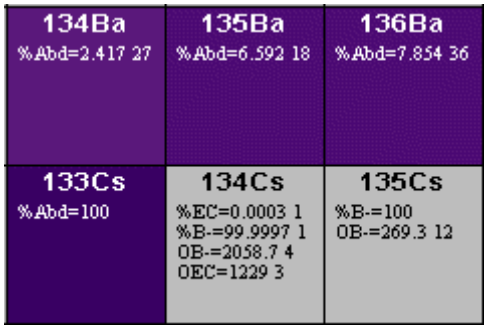
A part of the chart may look like this:



In this case the chart is color-coded according to the isotope abundance. The small navigation window is used for moving about in the chart. This is achieved in two ways:

- Click and drag the small rectangle to the required position
- Click anywhere on the small chart, and the selected point becomes the center of the display

If the view is expanded, the selected data are displayed in the nuclide box:



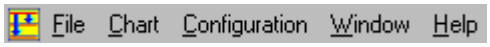
One data item (in this case the abundance) is chosen for the color coding, and the other selected data items are displayed in the nuclide boxes together with the nuclide identification.

In addition to displaying ENSDF or chart data, Isotope Explorer can retrieve nuclear properties from the ENSDF database using the script language. These properties can then be used to color code the nuclear chart. Functions defined by the script language allow calculations to be performed using the data that are retrieved.

Nuclear chart data can also be stored in separate files using the **Files, Save as…** command.

Currently, many options are controlled in data files that must be edited to change them. In the future, these options will be controlled by menus, tool bars, and panels provided by the Isotope Explorer.

The Menu Bar
The following menu items are available in chart mode:



File menu

Get Reference – Decode the NSR Keynumber(s) or search for NSR Authors

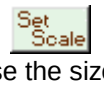
Select Nucleus – Get nuclide data

New chart – Create a new chart window

Open chart – Open an existing chart file
Open local file – Open a local data file
Save as – Save the chart as a new .chr file
Close – Close the active window
Print – Print the current view
Printer setup – Change printer or properties of the current printer
..... – Open recently used files
Exit – Exit Isotope Explorer

Chart menu

Set scale – Set the size of nuclide box in nuclear chart



Zoom in – Increase the size of nuclide box in nuclear chart

Zoom out – Decrease the size of nuclide box in nuclear chart

Display decay chain – Toggle; when this mode is active, the decay chain of a selected nuclide is indicated

Chart menu (continued)

Design chart – Not yet implemented
Select color scheme – Brings up a menu to determine which field to color the chart by, the number of data bins and their interval limits, and the associated color scheme.

Hide data in nuclide box – Toggle; selected data are not shown in nuclide boxes
Select field – Brings up a menu for selecting which data should be loaded into the chart; when selection panel is closed with OK, the chart is rebuilt

Build chart – Rebuilds chart (used when a new chart has been opened)

Cancel building chart – Stop the chart-building process

Set nuclide ID font size – Set the font size of nuclide identification label
Set title font size – Set the font size of chart title
Set data font size – Set the font size of data in nuclide boxes
Set legend title font size – Set the font size of legend title
Set legend font size – Set the font size for labels in color legend
Print/Print preview – Chart or Navigator window

Display navigation window – Toggle; display the navigation window

Open editor – Open the editor with the current chart
Add view – Copies the current chart file into a new window

Configuration menu

Save the size of the current view – Save font sizes, width, etc. to the ISOEXPL.INI file
Nuclear data source – Select: Internet database or local database; on selecting a local database, the user has to locate it on the disk
Reference data source – Select: Internet database or local database; on selecting a local database, the user has to locate it on the disk
Debug mode – Debug mode on/off (in debug mode all operations performed are logged in the file LOG)

Window menu

Cascade – Make windows overlapping
Tile – Tile all windows side-by-side
Arrange Icons – Arrange icons of *iconized* windows at the bottom of the main window
Close All – Close all open windows
..... – List of currently opened windows

Help menu

About – Isotope Explorer version and author information, etc.

Report problem – Requires network connection. Allows the user to report problems with Isotope Explorer or databases directly to the LBNL server

Isotope Explorer news – Requires network connection. Latest news about the program and databases

Help – Isotope Explorer Help function

The Tool Bar

The following items, from left to right, are active:

Open an existing chart file

Get nuclide data

Get reference (not yet available)

Print/Print preview

Rebuilds chart (used when a new chart has been opened)

Set size of the nuclide box in nuclear chart

Increase size of the nuclide box in the nuclear chart

Decrease size of the nuclide box in the nuclear chart

Brings up a menu for selecting which data should be loaded into the chart. When selection panel is closed with OK, the chart is rebuilt

Brings up a menu to determine the color scheme and bin intervals.

Toggle. When this mode is on, the decay chain of a selected nuclide is displayed

Toggle. Display the navigation window

Tool bar (continued)

About Isotope Explorer (version information)

Isotope Explorer help

Chart Databases

An experimental database (TOI) containing ground state and isomer properties from the *Table of Isotopes*, and a theoretical database (Møller) containing calculated ground state properties for over 9000 isotopes (P. Møller, J.R. Nix, and K.-L. Kratz, LA-UR-94-3898(1994)) are provided.

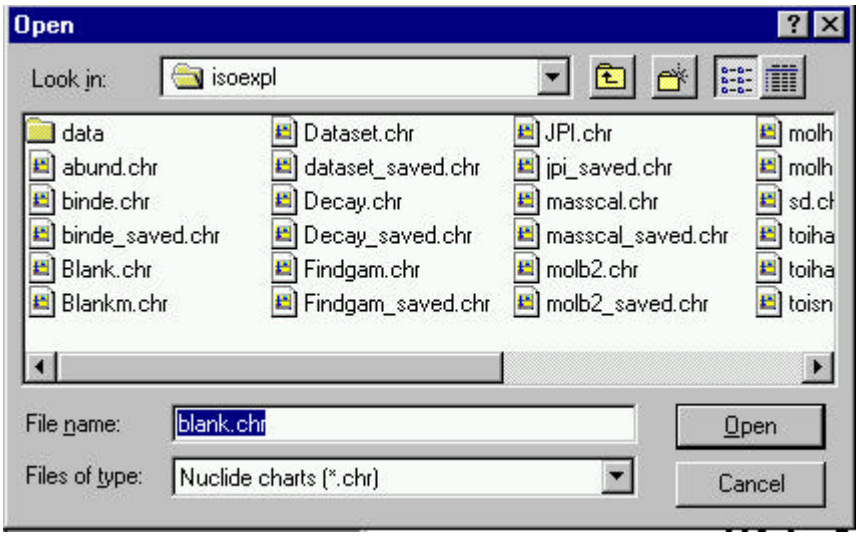
Users can also generate their own databases. Data definitions are defined at the beginning of the database (text) file, delimited by square brackets, and followed by the chart data as shown below.

```
[
Ede=E level
Jpi=Jpi
T1/2s=T1/2(sec)
.
.
]
  1n  (Z=0,0):Ede=0;Jpi=1/2+;T1/2s=614.8;..
  1H  (Z=1,0):Ede=0;Jpi=1/2+;…..
   .
   .
  24Na (Z=11,0):Ede=0;Jpi=4+;T1/2s=202.8;..
  24Na (Z=11,1):Ede=472.207;Jpi=1+;T1/2s=0.0202;..
   .
   .
```

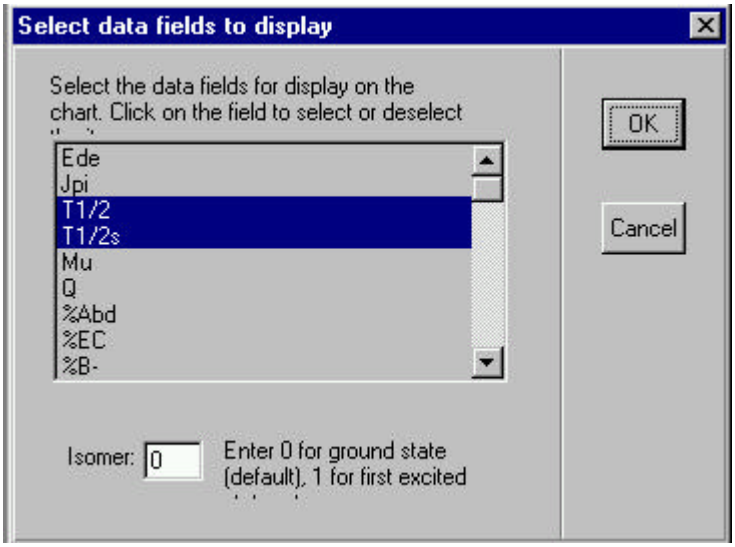
The data field abbreviation and its full definition are given on opposite sides if the equalities. The isotope display name and coordinate information, (Z=ZZ,n) or (Z,N) for each chart box are separated by a colon from the chart data which are separated by semicolons as shown above. Here ZZ is the atomic number, n is the isomer number (0 for ground state), and (Z,N) contains the proton/neutron numbers. Users can define any desired quantities for display on the chart.

Creating a Chart

Selecting the ***Chart*** button opens a dialogue box shown below where you can select an existing chart script with the extension **.CHR**. The "**file_saved**" chart file names are "built" charts which contain data selected from the chart or ENSDF databases using chart "scripts" defined below. The other chart names are only chart scripts ready to be built and customized by the user. **Blank.chr** and **Blankm.chr** are generic chart scripts for the TOI and Møller chart databases, respectively.



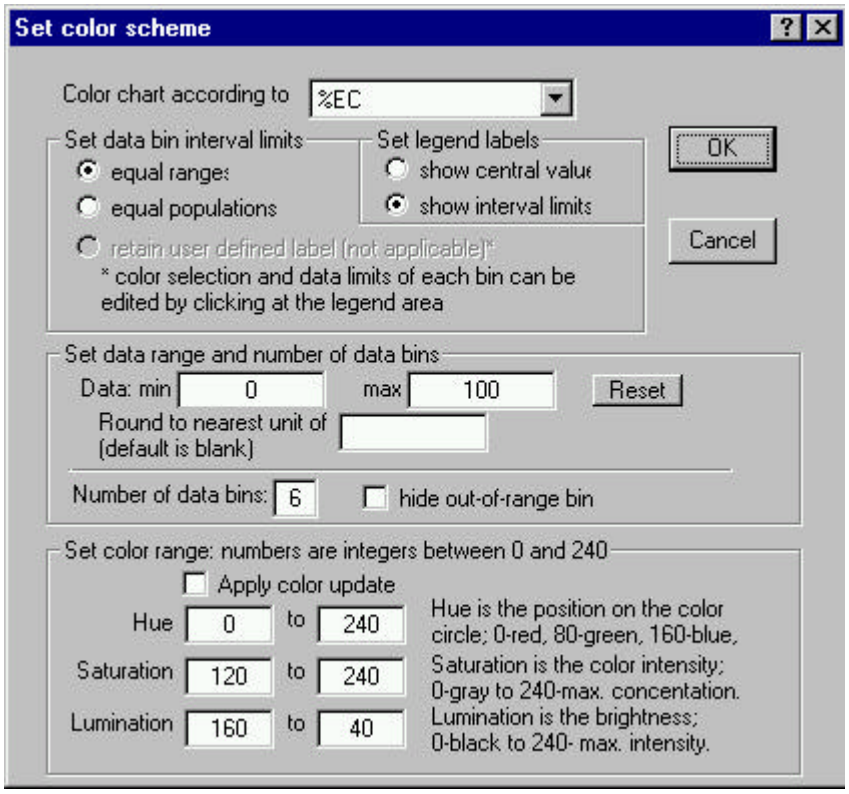
For new charts, select **Blank.chr** or **Blankm.chr** and choose **Chart, Select field** to open the dialogue box shown below to select data for the chart.



Select the desired chart fields and isomer number as shown and click **OK** when done. Then select **Build** to construct the chart. When the chart has been constructed the color scheme menu will automatically appear to facilitate customizing the data bins and chart colors.

Controlling Chart Color Scheme

If you select **Chart, Select color scheme** in the menu bar or click on the ***color scheme*** button, the program will display the panel shown below.



The chart is colored according to the field selected in the drop-down menu at the top. Automatic bin intervals can be selected to divide the data into equal value or population ranges. The data value range can also be constrained by user selected limits. The number of bins can be selected, with out-of-range values either displayed with the last bin or hidden. Legend labels can show either the central value or interval limits for each bin.

A color scheme can be automatically assigned to each bin by partitioning ranges of Hue, Saturation, and Lumination, as shown in the panel. Conversely, data limits and colors can be selected interactively by clicking on the legend labels and color boxes respectively.

The Chart Files
Chart files have the extension .CHR, and contain the following (optional) four sections:

1. TITLE: Ground state properties
   Contains only one line giving the title for the chart; if present, it must be the first line of chart file.
   Default: Untitled

2. INIT:
   ....
   END INIT
   Contains information concerning scaling, layout and coloring of the chart

3. BUILD:
   DataBase(Ensdf)
   Nucleus(a=80-200)
   ....
   END BUILD
   Contains the basic information concerning how to build the chart; see the section discussing the Script language.

4. CHART:
   ....
   133La (Z=57):
   133Ce (Z=58):3
   SD-1 band (95HABB)
   SD-2 band (95HAAA)
   SD-3 band (95HAAA)
   133Pr (Z=59):4
   SD-1 band (95WIAA)
   SD-2 band (95WIAA)
   SD-3 band (95WIAA)
   SD-4 band (95WIAA)
   ....
   END CHART
   Contains the body of the chart with nuclide identification followed by data. The first line of data immediately follows the nuclide ID, and subsequent lines of data are preceded by tabs.

The user can begin with a blank chart and use the menu to customize the chart. Once the chart is constructed, it can be saved for later use with **File, Save as...** However, the design of the menu is not yet complete, and some of the commands must be edited manually into the Build section. The following section gives a summary of the available commands.

X. The Script Language

This section describes the script language used in the Build process. The information is needed only if you wish to produce custom charts.

General Rules

- Any text between ***//*** and the end of a line is treated as a comment.
- Case is ignored.

Command Language

BandOut

Output band labels for all selected data sets.

ColorAccordingTo(*parameter*)

Define which parameter should be used for color coding the chart.

Database(*database.dat*)

The name of *database* can be TOI, Moller, or *databasename*.

1. The TOI and Moller databases contain experimental and theoretical ground state properties of the nuclides, respectively; TOI is the default database.

2. The user can supply a simple text file database (see toi.dat for an example). The file extension must be .dat and the user file name appears in place of *databasename*.

Def(param=...)

See the section on predefined parameter functions below.

Display(Draw or Table or Plot)

A left click on a nuclide box shows the list of the data types. If the list includes *datasets* or *bands*, the user can select a band or a data set to display by clicking. The display type selected by this command will be opened.

DSOut

Output data set names for selected datasets.

EnsdfDB(ENSDF or PENSDF or SENSDF or EHSDF or EDDF)

To search on level or gamma properties, the user must select an ENSDF format database. The default database is ENSDF, but there are five databases to choose from:

1. ENSDF is the Evaluated Nuclear Structure Data File. It contains complete level and transition information for each nuclide.

2. PENSDF database is a version of ENSDF derived by grouping together decay datasets from the same parent nuclide.

3. SENSDF database contains data for nuclides with superdeformed bands.

4. EHSDF database contains only adopted datasets from ENSDF with most of the comments removed to make the files smaller; some high-spin data not in ENSDF has been added to this database.

5. EDDF database contains only decay datasets from ENSDF.

FindGamma(...)

Find gammas with selected properties. For example,

FindGamma(e=250-260) means find gammas with energy from 250–260 keV.

Note: An accompanying GammaOut(quantity) command is required to generate output to the chart.

FindLevel(...)

Find levels with selected properties. Examples:

FindLevel(e=300-350) means find levels with an excitation energy between 300-350 keV
FindLevel(t=1-1.e5) means find levels with half-life between 1 and 10^5 seconds
FindLevel(spin={0+,2+,1-}) means find the lowest energy 1^- level which lies above a 2^+ that in turn lies above a 0^+ level
FindLevel(e=0,t=1-1e7) means find ground states with half lives between 1 and 10^7 seconds
Note: An accompanying LevelOut(quantity) command is needed to generate output

FindOut(*quantity*)

Extract *quantity* from a chart database (database.dat file) and store it in the chart. If the command OutToFile(*filename*) is given, the datum is also stored in the file *filename*.

GammaOut(E,ELI,ELF,JPII,JPIF,RI)

Output the given quantities to the chart, where
E is the gamma-ray energy
ELI, ELF are the initial and final level energies
JPII, JPIF are the initial and final level spin/parities
RI is the relative intensity; If uncertainty is required, add D to the key, e.g. ED, RID

KeepLines

Not implemented

LevelOut(E,JPI,J(J+1),T)

Output the given quantities to the chart, where
E is the level energy
JPI is the spin/parity of the level
J(J+1) is the spin squared
T is the half life; if uncertainty is required, add D to the key, e.g. ED, TD

Nucleus(filter1,filter2...)

A, Z, N, or isomer filter. For example a=50-, a=50-100, a=-50, z=102, even-a, odd-z, etc. For the isomer filter (isomer=n), n=0 (ground state), n=1, first excited state, etc. If this command is absent, all nuclides in the Chart section (or Data file) will be processed.

OutToFile(FileName)

When a chart is built, the output can be redirected to a file with the name given in brackets. If this command is missing, the output will be stored in the chart (memory) and can be saved to a disk file by selecting **Chart, Save as...**.

SelectBand(All or Yrast or GS or SD)

The default database is ENSDF; the default data set is the first data set for the nuclide.

SelectDS(All or Decay or B-Decay or EC-Decay or NGThermal)

Select data sets of the specified type; this command must be followed by a DSOut command.

Examples

1. For A=100-200, and the ENSDF database find, gammas with energy in the range 1200-1250 keV. Output the gamma-ray energy, initial level energy, and spin/parity of the initial and final levels to the chart and to the file test.out.

```
nucleus(a=100-200)
database(ensdf)
outtofile(test.out)
findgamma(e=1200-1250)
gammaout(e,eli,jpii,jpif)
```

Result – first few lines from the file test.out.

```
100Y  (Z=39): 2
    1241.66     1340.74
    1240.12     1412.14                (3+)
100Zr (Z=40): 1
    1228.99     1441.44      (1,2+)        2+
.
.
```

2. For the SENSDF database with A=80-200, select superdeformed bands and output the band labels to the chart. When a band is selected, a band plot is shown:

```
DataBase(SEnsdf)
Nucleus(A=80-200)
SelectBand(sd)
BandOut
Display(Plot)
```

Predefined Functions

Even(*argument*), Odd(*argument*)

Returns 1 if *argument* is an even integer, odd integer. Otherwise returns 0

Sqrt(*argument*), Exp(*argument*), Log(*argument*), Log10(*argument*)

Returns values of the corresponding Fortran functions

Sin(*argument*), Cos(*argument*), Tan(*argument*)

Returns values of the corresponding Fortran functions

Asin(*argument*), Acos(*argument*), Atan(*argument*), Atan2(*argument1*,*argument2*)

Returns values of the corresponding Fortran functions

Pi()

Returns 3.141592653

NuclA(), NuclZ(), NuclN()

Returns A, Z, N for the nuclide

If(*condition*,YesValue,NoValue)

Returns YesValue if *condition* is not equal to 0. Otherwise returns NoValue

Val(*parameter*):

Returns value of *parameter* if it is defined. Otherwise returns 0

IsQM(*parameter*)

Returns 1 if value of *parameter* contains a '?'. Otherwise returns 0

IsGT(*parameter*), IsLT(*Parameter*), IsAP(*Parameter*), IsEQ(*Parameter*)

Returns 1 if value of *parameter* defined as '>', '<', '~', '='. Otherwise returns 0

IsDef(*Parameter*)

Returns 1 if *parameter* is defined for this nuclide. Otherwise returns 0

EQ(*argument1,argument2*)

If *argument1* is equal to *argument2,* returns 1. Otherwise returns 0

GE(*argument1,argument2*)

If *argument1* is greater than or equal to *argument2* returns 1. Otherwise returns 0

LE(*argument1,argument2*)

If *argument1* is smaller than or equal to *argument2* returns 1. Otherwise returns 0

GT(*argument1,argument2*)

If *argument1* is greater than *argument2* returns 1. Otherwise returns 0

LT(*argument1,argument2*)

If *argument1* is smaller than *argument2* returns 1. Otherwise returns 0

Rules

1. If a parameter's name contains nonalphanumeric characters it must be contained in double quotes ("a parameter name","qb-").
2. Optionally the parameter can be preceded by an N, Z offset or a database name so that the value of the parameter is taken from a neighboring nuclide or another database. For example, if the parameter *mass* is defined in the database Moller,

   "[[moller]][-1,0]mass"

   the result is the mass for the N-1,Z neighboring nuclide from the Moller database.
3. Spaces between operators are ignored.
4. If a line ends with the character '\', the line will be merged with the following line.

Examples

1. If %A is uncertain, set it to 500:

```
Def(myvar1=if(isqm("%A"),500,"%a"))
FindOut(myvar1)
```

2. Calculate the nuclide mass (mass0) from the Weizäcker mass formula. Get the experimental mass (mass) from the TOI database:

```
def(Z=nuclZ())
def(A=nuclA())
def(N=nuclN())
def(av=14.1)
def(as=13)
def(ac=0.595)
def(aa=19)
def(ap=33.5)
def(Delta=ap/A^(3/4)*If(Even(A),If(Even(Z),-1,1),0))
def(mass0=Z*938.767+N*939.549-av*A +as*A^(2/3)+ac*Z^2/A^(1/3)+aa*(A-
  2*Z)^2/A+Delta)
FindOut(mass0)
FindOut(mass)
```

Chart User-Interface
The chart mode can be used as a user interface to select the data to be displayed. To activate the chart user-interface, a section like the following should be included in the build section of the chart file (comments after //):

```
BUILD:
DataBase(Ensdf)      //define database
SelectDS(decay)      //select decay data sets
dsout                //output list of data sets to chart
Display(level)       //display level plot of selected data set
END BUILD
```

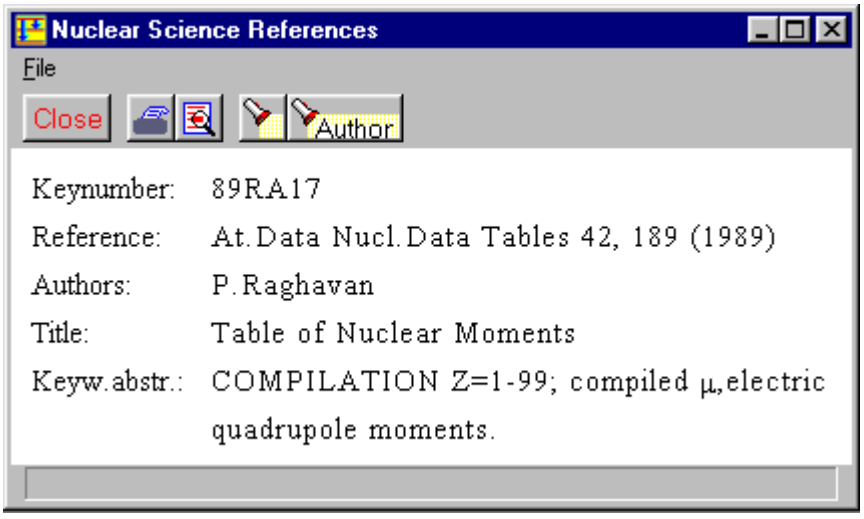
The Data Files
Chart data can also be made available to Isotope Explorer as data files with the extension .DAT. See the file **toi.dat** for the required format.

XI. Literature References

Provided the NSR files are available to Isotope Explorer on disk or via the Internet, Isotope Explorer can decode the NSR keynumbers in the ENSDF file.

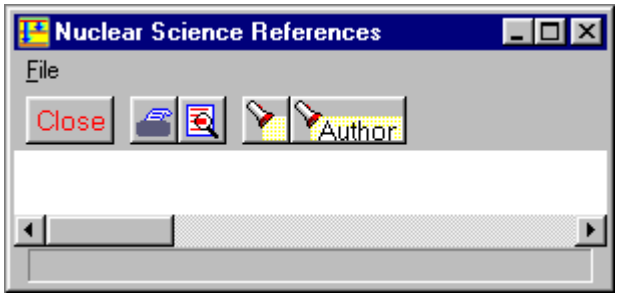
Some data sets contain keynumbers on the ID card (identification card or the first card of a data set). The references corresponding to these keynumbers are the main references for data in the data set. Reference keynumbers may also be contained in data comments. Isotope Explorer scans each data set, and makes a list of all keynumbers. These keynumbers can be decoded into complete references by clicking the “Ref” button on the tool bar.
Keynumbers with an asterisk (*) correspond to the main references of the data set.

Selecting a Keynumber from the list in the panel will yield a display similar to the following:



The source (local or Internet) for the reference data can be changed with the main menu item **Configuration, Reference data source.**

By instead clicking **User Select**, a panel like this one will appear.



The first three icons enable the user to close the panel, print preview, and print references. With the next icon (torch), the user can enter any valid NSR Keynumber to be decoded. The last icon (torch with Author) provides access to the NSR references by author name provided that the NSR files are available on the local disk or Internet.

NSR Data
Isotope Explorer can access NSR data in two ways: from local files or by transfer via the Internet.

Local files

The files AUTHORS.LIS, AUTHORS.DIC (for the author index), and NSRxx.DIC, NSRxx.REF (for the reference data where xx is the year between 10 and 96) are required for decoding the key numbers.

These files are available on the TOI CD-ROM or by downloading them from the Internet address

http://isotopes.lbl.gov/isotopes/install.html.

Internet transfer

Individual key numbers can be decoded directly via the Internet. For searching the Author index, the files AUTHORS0.LIS, AUTHORS0.DIC are required (see Section XIII).

XII. Preview and Printing

Plots, tables, and drawings can be previewed and printed by choosing **File, Print Preview** and **File, Print**, respectively. The font size for printing is determined from the viewing mode, and can be changed under **Options.**

XIII. Technical Issues

This section deals with issues that are of most concern to the advanced user.

Data Transfer
When the Internet database is selected with the **Configuration menu**, Isotope Explorer transfers the data with TCP/IP from a server.

Nuclear data

The transfer of a data set is performed with a GET command in HTTP from 128.3.253.100 (csa5.lbl.gov) or 130.235.92.5 (outis.lucas.lu.se).

The file CATALOG0.LOG contains a list of the available data sets. This file should be deleted at regular intervals. It is automatically replaced by a new file provided by the server.

Reference data

Reference keynumbers are decoded with a database program running on 128.3.252.64 (nsdssr.lbl.gov).

For author searches, the file AUTHORS0.DIC is required. This file is created when it is needed from the file AUTHORS0.LIS, which is transferred from the server. These files should be deleted at regular intervals. They are automatically replaced by new files provided by the server.

Security

Since Isotope Explorer can transfer files via the Internet, it is prudent to ask whether viruses can be transferred this way. Although nothing can be absolutely certain, the Isotope Explorer is as safe as most Web browsers. Here are some facts that may allow you to judge the security.

- All files are transferred as ASCII files which cannot carry viruses.
- No hidden information is sent from the client to a server.
- All hardware/software information sent with a bug report (**Help, Report problem**) is visible to the user, and can be edited if the user desires.

The ISOEXPL.INI File

Most program parameters can be changed in Isotope Explorer with the **Configuration** menu. If requested, these values are saved for the next Isotope Explorer session in the ISOEXPL.INI file in the program directory. This file consists of several named sections which contain a parameter name and its value separated by an = (equals sign). The following is a partial parameter table.

Section	Parameter name	Value	Meaning
[General]	Debug	0/1	Debug mode off/on
	CWD	C:/ISOEXPL	Program directory
[ENSDF database]	UseInternetDB	yes/no	Internet/local ENSDF data
	CatalogDir	E:/PCENSDF	ENSDF data directory
[NSR DATABASE]	UseInternetNSR	yes/no	Internet/local NSR data
	NSRDir	E:/NSR	NSR data directory
[Setup Window]	Maximized	yes/no	
	XYHW	1,1,429,624	
[Recent Files]	NumberOfFiles	0-6	Number of recently used files
	File1	filename	Name of recently used file
	...	...	

XIV. Acknowledgements

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