JANIS-2: An Improved Version of the NEA Java-based Nuclear Data Information System

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Abstract. JANIS (JAva-based Nuclear Information Software) is a display program designed to facilitate the visualisation and manipulation of nuclear data. Its objective is to allow the user of nuclear data to access numerical and graphical representations without prior knowledge of the storage format. It offers maximum flexibility for the comparison of different nuclear data sets. Features included in the latest release are described such as direct access to centralised databases through JAVA Servlet technology.

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INTRODUCTION

Nuclear data are fundamental to all applications involving radioactive materials and nuclear fuels. The data concerned cover both the properties of radioactive nuclei and the elementary laws of nuclear interactions. The data libraries are often very voluminous and the large variety of applications and end-users also result in a need for convenient storage and software for access. Efficient means to store and to retrieve the data are handled by the definition of standardised formats to allow their exchange among users and their treatment with specialised computer codes such as the Evaluated Nuclear Data File (ENDF) format [1]. Cross-platform compatibility requires the formats to be based on textual representation of the data. Formats such as these, however, become too complex for a non-specialised user. Both experienced and in-experienced users would thus benefit from an easy and efficient access to the data without a prior knowledge of the storage format.

BACKGROUND

The OECD Nuclear Energy Agency Data Bank is part of an international network of data centres in charge of the compilation and dissemination of basic nuclear data [2]. Through its activities in the nuclear data field, the NEA plays a role that involves the participation in the production of data and the dissemination of these data through the services provided to nuclear data users. The NEA thus provides an essential link between producers and users of nuclear data.

One of the main missions of the OECD/NEA Data Bank is to provide nuclear data services to research laboratories, universities and industry in member countries. The means used for providing these services have greatly evolved over the decades, from printed materials and continuing with a variety of electronic products based on the latest information technology. In the last decade, these services have developed along two parallel paths, namely, the use of the Internet and the distribution of dedicated software. Each approach has its advantages. For instance, the Internet option enables the user to access centralised (and thus up-to-date) databases. However, the display of the data is limited by the capabilities of Web pages. Likewise, software running on the user's personal computers can implement advanced, user-friendly interfaces enabling the display of complicated structures. Yet, the data

distributed in conjunction with a given release of the software cannot be updated easily.

JEF-PC was an example of such software [3], developed by the NEA in the early nineties through collaboration between the UK and France. Version 1.0 and 2.0 were released in 1994 and 1997, respectively, and were acquitted by more than 500 users. JEF-PC featured display of evaluated and experimental cross-sections, radioactive decay data and fission yields.

The NEA has been using relational databases since 1993 to provide a centralised repository of data and has used web-based technology to allow interactive retrieval of the data. The NEA web site (http://www.nea.fr) offers interfaces to the main nuclear databases: EVA for evaluated data, CINDA for bibliographical information and EXFOR for experimental data. This latter also includes on-line plotting capabilities. By accessing centralised information, web users can benefit from up-to-date data, the drawbacks being that the graphical interface is less sophisticated and the user may be limited by the amount of data transferred.

Investigations of different programming languages were carried out in 1998 and 1999 taking into account criteria such as cross-platform portability, performances in terms of execution time and the possibility of having a dual usage as discussed above (software and web-based). Java technology offered the optimum choice, and a project was launched by the NEA to develop a new software called JANIS (JAva Nuclear Information System). The first version of this software was released in conjunction with the nuclear data conference ND'2001 in Tsukuba, Japan, in October 2001 [4].

Users that have worked with these two kinds of services have contributed with feedback over the years. Since the release of JANIS-1, over 700 copies of the software have been distributed. Collected user feedback recently gave a basis for further development, and a new version was released in January 2004, containing several improvements that are going to be described below. A step forward has been accomplished in the integration effort by implementing a connection to local and remote relational databases. The adoption of Java programming language has proven to be a good choice, as both Java and computer performance has significantly improved with preserved cross-platform compatibility for Java-based programs.

The following section will describe the general features of JANIS, followed by a section on the new features in the latest release. The last section of this paper will discuss the foreseen developments, which include taking full advantage of the central server with data processing remotely and with all the flexibility of local applications.

GENERAL FEATURES OF JANIS

JANIS was implemented as application-like software with direct access to large databases. The software is free of charge and can be downloaded or launched from the JANIS home page: http://www.nea.fr/janis, where the complete manual can be found as well. JANIS accesses data contained in comprehensive databases. The formats supported are ENDF-6 (along with the linearised pointwise option PENDF and the group-wise option GENDF) and the computational format derived from EXFOR. Data originating from the major evaluation files ENDF/B, JEFF, JENDL, BROND etc. can be displayed and inter-compared.

Various navigation tools are available for helping the user identify the nucleus of interest. Figure 1 shows the main browser of JANIS and the “Chart of Nuclides”. The properties of the selected nuclide are displayed using textual, graphical or tabular formats. The following sub-sections describe general features in JANIS in examples and figures.

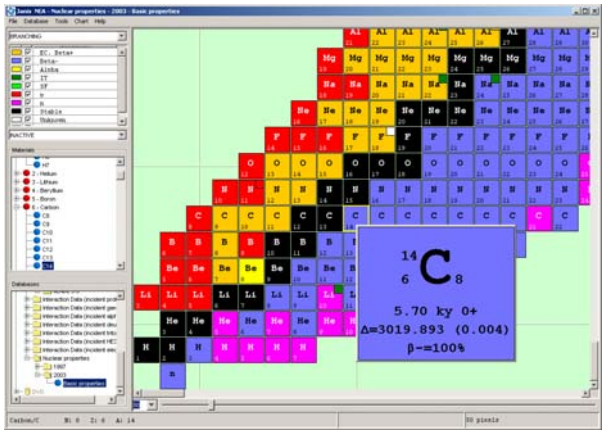

Fig. 1 JANIS browser window with the 'Chart of Nuclides'.

Radioactive Decay Data

A summary of the important properties of radioactive nuclides is provided with mass of the nuclide, excitation energy, spin and parity, half-life, mean decay energies and decay modes. For each decay

mode, the corresponding Q value, branching ratio and nuclide produced are given. The decay path followed by a particular nuclide toward the stability can be produced in tabular and graphical format.

Discrete and continuous spectra of emitted particles (gamma and X-rays, alpha particles, beta+ and beta-) are represented in JANIS using tabular and graphical formats. The information displayed includes the energy of the emitted particle and the corresponding uncertainty, relative and absolute line intensity and the associated errors.

Fission Yield Data

Data exist as independent fission yields (yield directly produced by fission prior to delayed neutron, beta decay, etc.) and cumulative yields (which account for all decay branches after fission). JANIS displays these yields using tabular and graphical formats.

Fission yields depend on the energy of the neutron causing fission. Independent and cumulative yields are thus given for typical neutron spectra (thermal neutron-induced, fast neutron-induced and high-energy neutron-induced fission). Spontaneous fission yields are provided as well.

Particle Interaction Data

Data displayed in this category include cross-sections (pointwise and multi-group forms) and associated uncertainties, resonance parameters, energy distributions, angular distributions and correlated energy-angle distributions. Experimental data can be plotted as well, with advanced search options combining reaction identifiers, projectile energy range, laboratory, and experiment date.

NEW FEATURES IN JANIS-2

The main improvements to JANIS-2 are presented below. Concerning the overall software, local data are now handled with a Java-based relational database management system. Furthermore, the access to centralised and optimised reference databases is available on the NEA server through the Java Servlet technology.

A variety of output formats exist in JANIS. For the graphical display, the PS/EPS and PNG formats are possible, and tabular data can be stored in CSV format (Comma Separated Values) for further use in other software (e.g. MS Excel).

All Experimental Data from EXFOR

The first version of JANIS accessed only the numerical EXFOR data, while in the new version, the user can access the full EXFOR work, including the first sub-work that contains descriptive information, such as experimental details and error analysis.

Bibliographical Data and Nuclear Properties

The latest version of JANIS includes bibliographical data from the CINDA (Computer Index of Neutron DAta) database, which contains references to measurements, calculations, reviews and evaluations of neutron cross-sections and other microscopic neutron data.

Search capabilities were included already in JANIS-1, to help the user identify nuclides that have specific characteristics. In the latest version it has been extended to also cover queries to the CINDA database, as shown in Fig. 2, where a search on ^{232}Th has been performed. The access to references in the CINDA database for neutron induced reaction data, permits to establish a link between CINDA and EXFOR.

Access to nuclear and decay properties in NUBASE-97 and NUBASE-2003 [5] has been added to the general summary of the properties of nuclides.

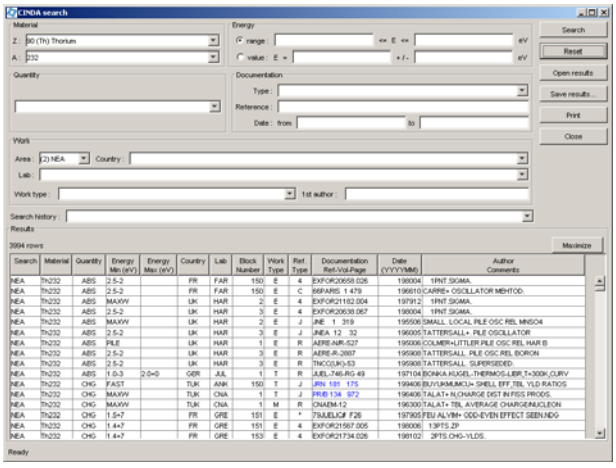

Fig. 2 CINDA search window.

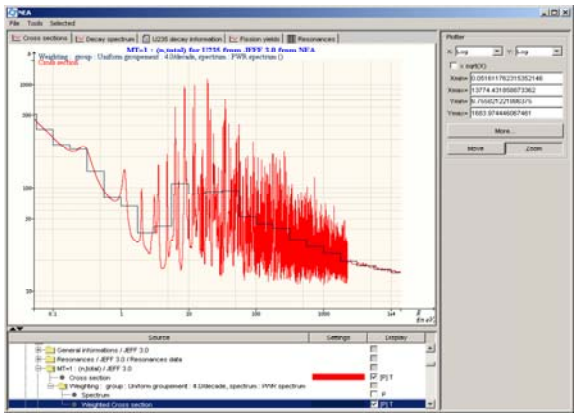

Fig. 3 Comparison of pointwise and weighted multi-group cross-sections.

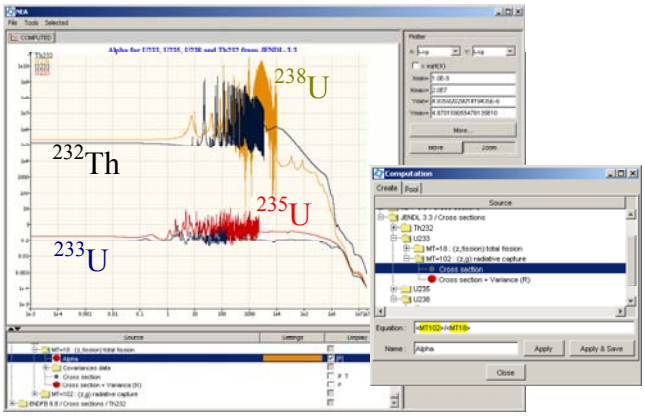

Fig. 4 Example of capture-to-fission-ratio manipulation, $\alpha = \sigma_{capture}/\sigma_{fission}$, plotted for four isotopes (^{233}U, ^{235}U, ^{238}U and ^{232}Th), with the equation editor window to the right.

Computational Flexibility

JANIS was specially designed to offer flexibility for the comparison and computation of different data sets. These features (such as linear combinations, ratios of data, flux weighting) were earlier restricted to cross-section data only. It is now possible to perform more advanced combinations such as a product of cross-sections with energy and angular distributions. Figure 3 illustrates some of the possibilities on pointwise cross-sections compared to weighted multi-group cross-sections.

Results from a calculation of $\alpha = \sigma_{capture}/\sigma_{fission}$ obtained from individual components in an ENDF formatted file is shown in Fig. 4. The results are easily plotted in the graphical window, and the equation editor window, also shown in Fig. 4 (right), offers a user-friendly interface and the possibility to store and reuse equations.

FUTURE DEVELOPMENTS

The current version of JANIS can access data from local or network drives and from the web. The same technology can be extended to provide the user with a package of services in integrated client/server architecture. For instance, the current EXFOR display on the web could be enhanced and extended when incorporated into JANIS. The user can choose the information to be transferred on his local computer. The client side could then be used only for the display and manipulation of data sets.

The output formats of JANIS will be extended to include vectorial graphics formats (such as Windows MetaFile, WMF) to improve quality.

CONCLUSIONS

JANIS is meant to provide an easy and efficient access to nuclear data. The software is free of charge and can be downloaded directly from the NEA web site at the address: http://www.nea.fr/janis. Updates of the software can be automatically downloaded through the live-update feature. JANIS runs on almost all operating systems and will enable users to access the latest versions of the data and associated tools through its integrated client/server architecture. Feedback is appreciated and can be posted on the NEA web site.

JANIS-1 was used by more than 700 users, originating from more than 20 different countries. Over 1000 copies have already been distributed of the latest release in August 2004. This indicates that JANIS has been established worldwide as a powerful tool for nuclear data display and manipulation. The software has proven to be useful to both experienced and inexperienced nuclear data users.

REFERENCES

1. ENDF-102, edited by McLane V., BNL-NCS-44945-01/04-Rev., 2001

2. Schwerer O., McLane V., Henriksson H., Maev S., these proceedings

3. Konieczny M., et al., Nuclear Data for Science and Technology, Conf. Proc. Vol. 59, 1997, pp. 1063-1065

4. Nouri A., et al., Journal of Nucl. Sci. & Techn., Suppl 2, 2002, pp. 1480-1483

5. Audi G., Bersillon O., Blachot J. and Wapstra A.H., Nucl. Phys. A 729, 2003, pp. 3-128