WEB-BASED NUCLEAR DATA INFORMATION FOR ASTROPHYSICS

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Capture reactions play an integral role in the origin of the chemical elements, the structure of our sun, and the evolution of stars. Simulations of these astrophysical phenomena require knowledge of the capture reaction rates on both stable and unstable nuclei. To ensure that the latest experimental and theoretical advances in capture reactions are effectively incorporated in astrophysics models, dedicated efforts in data compilation, evaluation, dissemination, and coordination are needed. A number of strategies to improve the utilization of nuclear data for astrophysics studies, including web-based dissemination tools, are presented. Two new developements are a new web site to aid in locating available nuclear data sets, **www.nucastrodata.org**, and a visualization program with an easy-to-use graphical user interface to over 8000 reaction rates.

1. Nuclear Physics Information for Cosmic Studies

This conference featured presentations on the latest advances in our understanding of capture reactions. These reactions are not only important in nuclear physics, but they also play an integral role in understanding the origin of the chemical elements, the structure of our sun, and the evolution of stars. For example, most of the normal (baryonic) matter in the universe is hydrogen and helium, and capture reactions involving these nuclei occur throughout the cosmos. Also, the capture of neutrons is responsible for the production of the elements heavier than Fe, and these reactions occur in red giant stars, supernovae, and other cosmic environments. Measurements and theoretical descriptions of capture reactions provide a crucial part of the foundation of sophisticated astrophysical models. In many instances, the ability of these models to accurately describe the latest, spectacular

observations of the cosmos strongly depends on the input nuclear data. More extensive and precise nuclear data is required for many advances in astrophysics.

It is not enough, however, to perform state-of-the-art nuclear measurements or theoretical calculations. To be utilized in astrophysical studies, this information has to be appropriately prepared for input into astrophysics simulation codes. This requires *dedicated efforts* in data compilation, evaluation, dissemination, and coordination. Unfortunately, the results of many of the latest nuclear measurements or model calculations are not used in studies of the very astrophysical puzzles that - in some cases - motivated their production. The situation is getting worse as more nuclear measurements and calculations are being made but not folded into reaction rate libraries or other astrophysical datasets.

2. Nuclear Data Strategies for Astrophysics

It is recognized, at the international level [1], that the current effort in nuclear astrophysics data is insufficient to meet the needs of the community. While some efforts in recent years have yielded important progress [2,3], a number of strategies can improve the situation. First and foremost, more manpower is needed for evaluations. It is also important to exploit the overlap between the nuclear data and nuclear astrophysics communities [4], as well as to coordinate plans to evaluate nuclear reactions or structure properties in order to share expertise and avoid duplications. Such cooperation would be greatly facilitated by the establishment of a Nuclear Astrophysics Data Coordinator [5,6] whose duties would be to:

- Establish, maintain, and update a central WWW listing of datasets;
- Modify existing datasets for compatibility with astrophysical codes;
- Improve the user interface of datasets via the creation of indices, search capabilities, graphical interfaces, bibliographies, error checking, plotting tools, and other enhancements;
- Other activities such as: help coordinate international data activities; establishing and maintaining a nuclear astrophysics email distribution list; publicize new nuclear astrophysics meetings, experimental results, and publications; and establish and maintain a priority list of important nuclear reactions and properties for further study.
- Maintain an active research program using nuclear data to ensure the data activities truly fulfill the needs of data users.

These data activities can make a significant positive impact on nuclear astrophysics research efforts worldwide with only a modest investment. The following section describes some recent initiatives to improve nuclear data for nuclear astrophysics.

3. Web-based Tools for Nuclear Astrophysics Data

The modern mechanism for information dissemination is electronically via the World Wide Web (WWW). The development of web-based tools such as web sites, datasets, and data viewers is essential to ensure that the latest nuclear data is effectively utilized in astrophysics studies. Two new web tools are discussed below.

3.1. *New Website for Nuclear Astrophysics Data*

Nuclear data users are now able to search, browse, display, and download a wide variety of information via the WWW. This includes data sets specialized for nuclear astrophysics studies (e.g., reaction rates), as well as those for general nuclear physics studies. The first website dedicated to disseminating nuclear data relevant for astrophysics [7] was launched in 1996, and now there are roughly ten such sites based at institutes around the world. Many of these sites feature datasets developed at the host institute and links to other sites of interest. There has, however, been no site linking *all available nuclear datasets* relevant for astrophysics studies, and there has been little synergy between the existing nuclear astrophysics data websites.

To rectify this situation, a new website has been launched: **www.nucastrodata.org**. This site features an extensive list of nuclear datasets (over 60 so far) important for nuclear astrophysics studies available from around the world. It is designed to help users navigate through these datasets, as well as to publicize them to the research community. The site is independent of any host institution and does not compete with any existing nuclear astrophysics data site. With community support, this website will grow into a very valuable resource for astrophysics research.

3.2. *New Interactive Reaction Rate Viewer*

Much of the existing information for nuclear astrophysics studies posted on the WWW is posted in the form of tables, which usually require effort by the user (downloading, writing a program, plotting results) to visualize. While some sites feature pre-made plots of reaction rates [8,9], there are no sites that have user-friendly, interactive reaction rate plotting packages

online. To address this need, a new visualization tool [10] has been developed which provides an easy-to-use, interactive, platform-independent, graphical user interface to the rates of over 8000 nuclear reactions - many of them capture reactions - included in the widely-used REACLIB library [11]. This program, viewable through a web browser, enables users to plot multiple rates, access rate parameters, add new rates and plot them, and create rate vs. temperature tables, all through a point-and-click graphical user interface based on the chart of the nuclides.

4. Summary

Information on capture reactions, as well as other nuclear data, is crucial for the understanding of many phenomena in astrophysics. Dedicated effort is, however, needed to ensure that the latest nuclear datasets are incorporated into astrophysics models. A number of strategies to improve the utilization of nuclear data for astrophysics studies are presented, and some new initiatives - a web site **www.nucastrodata.org** and a new interactive reaction rate plotting program, are already helping to reach these goals.

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