Oak Ridge National Laboratory
Nuclear Data Project
Activity Report

November 2003

Activities at the Nuclear Data Project (NDP) at Oak Ridge National Laboratory (ORNL) include: the evaluation of nuclear structure and decay data information needed for nuclear structure and nuclear astrophysics studies; the compilation, evaluation, and dissemination of nuclear reaction information relevant for nuclear astrophysics studies; the development of a computational infrastructure to facilitate the incorporation of nuclear data into astrophysical models; and the development and maintenance of computational tools expanding the utility of the ENSDF and XUNDL nuclear structure databases. This report discusses the recent progress and future plans in these areas.

ORNL Nuclear Data Project Personnel

ORNL Staff (part time): M. S. Smith (project leader), J.C. Blackmon, D. Radford
Subcontractor (part time): Y. Akovali
Graduate Students (Univ. Tennessee Knoxville): K. Chae, Z. Ma
Programmers: E. Lingerfelt, J. P. Scott
Consultant: R. A. Meyer

Nuclear Structure and Decay Evaluations of Mass Chains - Y. A. Akovali

The ORNL NDP has responsibility for the evaluation of 46 A-chains, all above mass 213. In the last three years, eight A-chains have been completed and published. One additional A-chain has been completed and submitted for review. Additionally, two A-chains have been reviewed during that period and one evaluation is in progress.

Published evaluations:

In the past year, evaluations of nuclear structure data pertaining to all nuclei with mass numbers 242, 238, 244, and 217 were completed, and adopted data, levels, spin, parity and configuration assignments are presented in the following publications:

A=242: Y. A. Akovali, Nucl. Data Sheets 96, 177 (2002)
A=238: F. E. Chukreev, V. E. Makarenko, M. J. Martin, Nucl. Data Sheets 97, 129 (2002)
A=244: Y. A. Akovali, Nucl. Data Sheets 98, 1009 (2003)
A=217: Y. A. Akovali, Nucl. Data Sheets 100, 141 (2003)

Submitted evaluation:

A=247: Y. A. Akovali; These evaluations are completed and submitted, but have not yet been reviewed.

Evaluations in progress:

A=243: Evaluations of A=243 nuclei have been started. It is estimated that they will be finalized in Spring 2004.

Reviewed evaluations:

A=235, 239: these two A-chain evaluations were reviewed.

Plans for future evaluations:

Evaluations of nuclear structure and decay data for A=241 and 237 nuclei are planned to be started after the evaluations of A=243 nuclei are submitted for publication. A=241 and A=237 evaluations are expected to be completed in 2004.

Nuclear Structure Databases – D. Radford

An FTP site **radware.phy.ornl.gov** and a suite of programs have been developed to facilitate nuclear structure data analyses and evaluations. This effort provides a modern and efficient user access – via the RADWARE program - to the ENSDF and XUNDL data libraries. Users can rapidly combine their own measured gamma-ray energies with those in the libraries to generate dynamic level schemes with publication-quality output options. The semi-automatic conversion of journal articles and other data sources into ENSDF-format databases is also featured on this site, as well as a utility to search the databases for coincident gamma rays. These programs and the databases are continuously developed and maintained. Future plans include making a number of improvements on the graphical level schemes.

Nuclear Structure & Reaction Evaluations Relevant for Astrophysics – M. S. Smith, J. C. Blackmon, Z. Ma, N. Shu

Some important nuclear reactions that occur in stars can be directly measured in the laboratory. For others, an indirect technique is utilized whereby stellar thermonuclear reaction rates are determined from laboratory measurements and theoretical estimates of the masses, lifetimes, and excited state properties (spin, parity, total and partial decay widths, energy, spectroscopic factors) of the interacting nuclei. For the latter studies, an evaluation of the available, relevant structure information on the interacting nuclei is very important. For both types of studies, calculations of the cross sections, astrophysical S-factors, and rates of the reactions are necessary. The ORNL NDP is currently involved in these structure and reaction evaluations, and subsequent reaction rate calculations, for a number of reactions important in stellar explosions. Each of these projects is closely

coupled to recent or planned measurements at ORNL's Holifield Radioactive Ion Beam Facility.

The $^{18}F(p,\gamma)^{15}O$ and $^{18}F(p,\alpha)^{19}Ne$ Reactions: N. Shu et al.

The properties of 19 levels in the ^{19}Ne nucleus above the ^{18}F + p threshold are being evaluated to determine new ^{18}F + p reaction rates in nova explosions and X-ray bursts. One Ph.D. Thesis [N. Shu, Chinese Institute of Atomic Energy] and one paper [N. Shu et al., Chin. Phys. Lett. **20** (2003) 1470] have been written on this work, and a longer paper is in preparation for Phys. Rev. C. New preliminary reaction rates were calculated and used to determine the impact of a recent ORNL measurement on element synthesis in novae [D. Bardayan et al., Phys. Rev. Lett. **89** (2002) 262501].

The $^{14}O(\alpha,p)^{17}F$ Reaction: J.C. Blackmon et al.

The properties of six levels in the ^{18}Ne nucleus above the ^{14}O + α and ^{17}F + p thresholds are being evaluated to determine a new reaction rate in nova explosions and X-ray bursts. This work also involves an analysis of the reactions, via R-matrix fits with the EDA (LANL) and SAMMY (ORNL) codes using data from four different reaction channels: $^{17}F(p,p_0)^{17}F_{gs}$, $^{17}F(p,p_1)^{17}F^*$, ^{17}F + p thick target, and $^{17}F(p,\alpha)^{14}O$. One short paper has been published [J.C. Blackmon et al., Nucl. Phys. **A718** (2003) 127] and a longer paper on this work is in preparation.

The $^{30}P(p,\gamma)^{31}S$ Reaction: Z. Ma et al.

The properties of ten levels in the ^{31}S nucleus above the ^{30}P + p threshold are being evaluated to determine a new reaction rate relevant for nova explosions.

The $^{33,34}Cl(p,\gamma)^{34,35}Ar$ Reactions: Z. Ma et al.

The properties of eight levels in the ^{34}Ar nucleus above the ^{33}Cl + p threshold, and seven levels in the ^{35}Ar nucleus above the ^{34}Cl + p threshold, are being evaluated to determine new reaction rates relevant for nova explosions and X-ray bursts.

Computational Infrastructure for Nuclear Astrophysics Data – M. S. Smith, K. Chae, E. Lingerfelt, R. A. Meyer, J. P. Scott

A suite of computer programs is being developed to facilitate the incorporation of nuclear physics information into astrophysical models. This **computational infrastructure** will take nuclear structure and reaction information - the products of evaluation activities - as input and, with a point-and-click interface, generate thermonuclear reaction rates in formats readily inserted into libraries used by astrophysics modelers. It will be accessible through the **www.nucastrodata.org** site that links together all datasets relevant for nuclear astrophysics studies.

Long-Term Planning – M. S. Smith, R. A. Meyer

The **Mentoring in Nuclear Information Technology (MINIT) Program** has been developed and proposed as a mechanism to rebuild and revitalize the evaluation capabilities of the US Nuclear Data Program. The goal is to reverse the current shrinking and aging manpower pool involved in nuclear data evaluations. MINIT may also have features that may provide useful to other international evaluation centers as they address their manpower issues. Hopefully, MINIT will spur some community-wide discussions of ways to proactively resolve the manpower crisis in nuclear data evaluations.