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US Nuclear Data Activity Report

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INTRODUCTION

The United States nuclear data effort supports both basic physics research and applied nuclear technologies. At the present time, nuclear data support from the DOE Office of Science is largely directed to three areas: design of targets for radioactive ion-beam facilities, compilation and evaluation of high-spin nuclear physics data, and measurement and evaluation of nuclear data needed for astrophysics calculations. Other data activities in the intermediate energy are being carried out in support the development of spallation neutron sources for basic research, of accelerator transmutation of nuclear waste, for the study of the effects of cosmic-ray produced neutrons on electronics and for nuclear medicine.

US NUCLEAR DATA PROGRAM

The activities supported by the DOE Office of Science are coordinated through a newly created organization named the US Nuclear Data Program. This organization promotes this coordination through working groups, one for nuclear structure data, one for nuclear reaction data and one for data dissemination. Although largely devoted to supporting basic nuclear physics research, there is close coordination (and overlapping membership) with the Cross Section Evaluation Working Group which is responsible for the ENDF/B data library. The present chairman is Charles Dunford (BNL). Walter Henning (ANL) chairs a Steering Committee that provides independent oversight.

NUCLEAR REACTION DATA MEASUREMENTS

Progress in nuclear data experiments includes total cross sections, gamma-ray and charged-particle production, standards, activation and charged-particle-induced reactions. Neutron total cross section data from 5 to 600 MeV with statistical accuracy of better than 1% in 1% energy bins have been measured for 37 materials at the Los Alamos Neutron Science Center (LANSCE) spallation neutron source by a collaboration of Lawrence Livermore and Los Alamos National Laboratories and Ohio University scientists. These data serve as tight constraints on optical models of neutron-nucleus interactions. Also at LANSCE, gamma-ray production for neutrons on oxygen from threshold to 200 MeV and charged-particle production for neutron on silicon and ^{58,60}Ni from threshold to 60 MeV has been investigated. Significant differences were found in

these data from the current ENDF/B-VI evaluations up to 20 MeV, although for the gamma-ray data for oxygen, the ENDF/B-VI is much closer than ENDF/B-V to the new results.

Activation cross sections in the 16-20 MeV range are being measured by Argonne National Laboratory in collaboration with IRMM and JAERI. Recent materials studied include isotopes of F, Na, Mg, Al, Si, P, Cl, Ti, Mn, Fe, Nb, Sn, and Ba..

CHARGED PARTICLE DATA for NUCLEAR ASTROPHYSICS

A comprehensive program for supporting the data needs of nuclear astrophysics is under consideration by DOE. Some preliminary activities have already been started.

Charged-particle-induced reaction data, principally for astrophysics, have been compiled or evaluated (or both) for protons on ^{17}O (ORNL) and isotopes of S (ANL). R-matrix analyses of the compound systems ^5He , ^{16}O and ^{17}O have been completed and give new evaluated cross sections for $^3\text{He}(d,p)^4\text{He}$, $^{12}\text{C}(,)^{16}\text{O}$ and $^{13}\text{C}(,n)^{16}\text{O}$ (LANL). A lengthy review of Hauser-Feshbach calculations has been completed by Woolsey et al. (University of California at Santa Cruz, Livermore and others) for nucleosynthesis of element of mass 28 – 80. It turns out that the calculations of nucleosynthesis in supernovae for this mass region are relatively insensitive to uncertainties in the reaction rates although they are sensitive to the stellar models employed. Weak interaction rates are being investigated (Livermore and UC Santa Cruz).

Charged particle data back to 1980 are being compiled at Brookhaven. Presently there are more than 3,400 references and 600,000 data points. The NACRE collection of reaction rates is being entered into the NNDC databases.

NUCLEAR STRUCTURE and DECAY DATA

The evaluation of nuclear structure and decay data for the Evaluated Nuclear Structure Data File (ENSDF) continues to a major US activity. This data file is the starting point for application-oriented nuclear radiation data files. The continued worldwide reduction in the number of scientists contributing to the maintenance of this data file is of special concern. A new database of experimental nuclear structure and decay data has been established. At present the database contains mostly experimental high-spin data sets which have been compiled but not evaluated.

EVALUATIONS

Two new releases of the ENDF/B-VI evaluated nuclear data library have been issued since the last INDC meeting. A new release planned for this summer will contain an improved ^{235}U evaluation, which was developed at ORNL as a part of a NEA sponsored international collaboration. The library will contain many new neutron and charged particle evaluations from LANL which extend up to 150 MeV.

Evaluations of data up to 150 MeV for protons and neutrons on a wide range of materials have been completed and are described in Nucl. Sci. Eng. 131, 293 (1999) (Los Alamos). These data will be useful for simulations and design of new RIB facilities, accelerator-driven technologies, and simulations of proton and neutron therapy. A new effort is underway to evaluate photonuclear data, for use in astrophysics, and for quantifying photoneutron production in medical linacs. This is coordinated through an IAEA CRP. Numerous evaluations have been developed at laboratories in the US, Europe, Japan, China, Korea, Brazil, etc., and an IAEA-file combining these evaluations is under development.

An international effort to re-evaluate the ENDF neutron cross section standards is underway. The US head is A. Carlson (NIST). JAERI and other laboratories are participating. Additional co-workers would be welcome in this project.

The development and improvement of nuclear model codes is an important feature of the US nuclear data activity. An important use of the nuclear data measurement activity results is to provide reference data with which model codes can be tested. A comprehensive evaluation of nuclear level densities in the mass region $20 \leq A \leq 41$ has been submitted for publication. (Ohio University). A systematic review of level density models and available experimental data has been completed at BNL.

A successful workshop entitled “Covariance Matrices: Generation, Formats and Applications in Nuclear Energy Technologies” was organized by Don Smith (ANL) and Luiz Leal (ORNL) on behalf of the Cross Section Evaluation Working Group.

DISSEMINATION

Dissemination of nuclear data takes place increasingly through the World Wide Web. The central site for dissemination in the US is the National Nuclear Data Center in Brookhaven: <http://www.nndc.bnl.gov>. This site contains the nuclear data collection of the NNDC and links to members of the US Nuclear Data program and to many other international nuclear data resources. CDROM collections of nuclear data are available for the Table of Isotopes and Gamma Spectrum Catalogue (INEL). The use of this service continues to grow. In cooperation with the IAEA Nuclear Data Section, NNDC is developing and improving WWW interfaces to our common nuclear databases. Specialized data for astrophysics can be found at <http://www.phy.ornl.gov/astrophysics/data/data.html> and includes over 1200 references.