Triangle Universities Nuclear Laboratory

Report to the US Nuclear Data Program

13 April 2000

I. TUNL Nuclear Data Evaluation Project

A. Personnel

Staff:	Jennifer Godwin	Dissemination Coordinator	Duke/TUNL
	Grace Sheu	Research Secretary	Duke/TUNL
	John Kelley	Research Assistant Professor	NCSU/TUNL
	Caroline Nesaraja	Research Associate (50% Data Project)	Duke/TUNL
	Ron Tilley	Professor of Physics, Emeritus	NCSU/TUNL
	Henry Weller	Professor of Physics	Duke/TUNL

Collaborators:	Gerry Hale	$A = 5$, 6, 7	LANL
	Hartmut Hofmann	$A = 6$, 7	Universität Erlangen-Nürnberg
	Jim Purcell	Update Lists	Georgia St. University

B. Publication Status

TUNL is responsible for data evaluations in the mass range $A = 3$–20. The current publication status of these evaluations is summarized below:

Nuclear Mass	Publication	Institution
$A = 3$	*Nucl. Phys.* *A*474 (1987) 1	TUNL
$A = 4$	*Nucl. Phys.* *A*541 (1992) 1	TUNL [a]
$A = 5$–10	*Nucl. Phys.* *A*490 (1988) 1	Penn [b]
$A = 11$–12	*Nucl. Phys.* *A*506 (1990) 1	Penn [b]
$A = 13$–15	*Nucl. Phys.* *A*523 (1988) 1	Penn [b]
$A = 16$–17	*Nucl. Phys.* *A*564 (1993) 1	TUNL
$A = 18$–19	*Nucl. Phys.* *A*595 (1995) 1	TUNL
$A = 20$	*Nucl. Phys.* *A*636 (1998) 247	TUNL [c]

[a] Co-authored with G.M. Hale, LANL.
[b] F. Ajzenberg-Selove, University of Pennsylvania.
[c] Co-authored with S. Raman, ORNL.

C. Evaluations in Progress

Nuclear Mass	Publication	Institution
$A = 5$	Preliminary version mailed February 1998	TUNL [a]
$A = 6$	Preliminary version mailed January 2000	TUNL [b]
$A = 7$	Preliminary version to be mailed April 2000	TUNL [b]

[a] Co-authored with G.M. Hale and C.M. Laymon.
[b] Co-authored with G.M. Hale and H. Hofmann.

An "Energy Levels of Light Nuclei, $A = 5$–7" review is planned for submission to *Nuclear Physics A* in 2000.

D. WWW Services

TUNL continues to develop new WWW services for the nuclear science and applications communities. In addition to the "Energy Levels of Light Nuclei" publications listed in the table below, Energy Level Diagrams

are provided for $A = 4$–20 nuclei, and ENSDF material appears in two forms. Update Lists have been added which provide brief descriptions of important research bearing on level information published since the last full evaluation. References for the Update Lists are given for each nuclide with experimental and theoretical subdivisions for each, and include links to the NSR database. The Update Lists for $A = 5$–12 nuclei are currently online; lists for other nuclei are being prepared. Our intentions for the Update Lists are to provide to the nuclear community via our WWW page a continuously updated guide to important new work. PDF documents for the most recent FAS evaluations $A = 5$–15 and TUNL evaluations $A = 3$–7, $A = 16$–20, $A = 5$–7 preliminary verisons are now available online. We are also in collaboration with Elsevier to provide PDF documents of all of FAS evaluations including years 1966–1987. Also, a preliminary posting of our new HTML project will be online late April 2000. HTML documents will be provided for individual nuclides ^{6}He, ^{7}Be, ^{7}Li, ^{8}Be, ^{8}Li, ^{9}Li, ^{10}Be, ^{10}Li, ^{11}He and ^{11}Li. We hope to provide HTML documents for each nuclide found in the FAS and TUNL evaluations since 1980.

Documents Available on the TUNL-NDEP Web Site [a]

$A = 3$	*Nucl. Phys.* *A*474 (1987) 1	TUNL
$A = 4$	*Nucl. Phys.* *A*541 (1992) 1	TUNL
$A = 5$–10	*Nucl. Phys.* *A*490 (1988) 1	Penn
$A = 5$	1998 Preliminary version	TUNL
$A = 6$	2000 Preliminary version	TUNL
$A = 7$	1999 Preliminary version	TUNL
$A = 11$–12	*Nucl. Phys.* *A*506 (1990) 1	Penn
$A = 13$–15	*Nucl. Phys.* *A*523 (1991) 1	Penn
$A = 16$–17	*Nucl. Phys.* *A*564 (1993) 1	TUNL
$A = 18$–19	*Nucl. Phys.* *A*595 (1995) 1	TUNL
$A = 20$	*Nucl. Phys.* *A*636 (1998) 247	TUNL

[a] Versions of the *Nucl. Phys. A* articles have been modified slightly from their original form.

E. ENSDF

Since TUNL has begun to produce evaluations of $A = 5$–20 nuclei, we have also been updating the corresponding ENSDF files. Earlier ENSDF files that contained adopted levels & gammas and β-decay data were produced by M. Martin (ORNL) and M. Bhat (BNL). The following table outlines the current status of the $A = 2$–20 ENSDF files which include updates of the specific reaction information.

Mass	Content	Publication Center	ENSDF Center
2	Levels	Unpublished	TUNL
3–4	Levels	TUNL	TUNL
5	Levels	TUNL	TUNL [a]
6	Levels & Gammas,Reactions	TUNL	TUNL [a]
7–10	Levels & Gammas,Reactions	Penn	TUNL
11–13	Levels & Gammas,Reactions	Penn	TUNL [b]
14–15	Levels & Gammas	Penn	ORNL
16–20	Levels & Gammas,Reactions	TUNL	TUNL

[a] Updates for $A = 5$–7 will be added after publication of the review in *Nucl. Phys. A*.
[b] Work completed in 1999–2000 and submitted in April 2000.

II. TUNL Program on Preequilibrium Phenomenology

A. Personnel

Constance Kalbach-Walker Senior Research Scientist (0.4 FTE) Duke/TUNL

B. Ongoing Program

This effort involves the development of preequilibrium reaction models embodied in the exciton model computer code PRECO and its associated global set of model input. The goal is to understand the basic physics and to create a reliable predictive tool to be used either independently or as a module in Hauser-Feshbach model codes. Both the energy spectra and angular distributions of particles emitted into the continuum can be calculated. The approach is phenomenological, and involves extensive benchmarking against literature data.

C. Work Accomplished

At last spring's meeting, early results were reported on two issues: the surface localization of the initial target-projectile interaction (which is more pronounced for incident neutrons than for protons) and the inclusion of strong collective state excitation. Over the last year, that work has been refined and verified. A table of input parameters for the strongest 2+, 3- and 4+ states for common target nuclides is now available.

Initial comparisons with the project database (currently comprising about 180 energy spectra from the literature) indicated that excitation of giant resonance (GR) states might play a helpful role in describing the energy spectra for inelastic scattering. Thus GR excitation was included in the calculations using the model employed for the spectroscopic collective states. Systematic values for the GR energies, widths, and strengths were chosen. The isoscaler GR states included are the low- and high-energy octopole resonances and the giant quadrupole resonance. The giant monopole is too weak to make a significant contribution.

After inclusion of the GR states, another comparison between calculation and experiment was performed for the project database. The GR cross sections are not large but tend to improve agreement between calculation and experiment. The model can now successfully account for all four (N,xN) reaction channels with a single set of global input for most reactions up to 100 MeV.

D. Progress Towards Deliverables

The work described above has been written up and was just submitted for publication. Preparation of a new users manual for the TUNL code system PRECO is just beginning, paving the way for a new formal release of the code.

E. Future Work

The users manual and a new release of the PRECO will be completed. Then work will begin on expanding the project database for reactions at 35 to 100 MeV so that open questions of physics in this energy domain can be addressed.