Triangle Universities Nuclear Laboratory
Report to the US Nuclear Data Program
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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	Duke/TUNL
	Ron Tilley	Professor of Physics, Emeritus	NCSU/TUNL
	Henry Weller	Professor of Physics	Duke/TUNL
Collaborators:	Gerry Hale	LANL	
	Hartmut Hofmann	Universitat Erlangen-Nurnberg	
	Jim Purcell	Georgia State University	

B. Publication Status

TUNL is responsible for data evaluation in the mass range from A = 3 – 20, and for continuing the "Energy Levels of Light Nuclei" series that was carried on by Fay Ajzenberg-Selove. The current publication status of these evaluations is summarized below:

Nuclear Mass	*Publication*	*Reviewers*	*ENSDF Status*
A = 3	*Nucl. Phys*. A474 (1987) 1	TUNL	Adopted Levels
A = 4	*Nucl. Phys*. A541 (1992) 1	TUNL[a]	Adopted Levels
A = 5-10	*Nucl. Phys*. A490 (1988) 1	Penn[c]	Adopted Levels
A = 11-12	*Nucl. Phys*. A506 (1990) 1	Penn	Adptd Lvls, γ-rays, decay & rx data
A = 13-15	*Nucl. Phys*. A523 (1991) 1	Penn	Adopted Levels
A = 16-17	*Nucl. Phys*. A564 (1993) 1	TUNL	Adptd Lvls, γ-rays, decay & rx data
A = 18-19	*Nucl. Phys.* A595 (1995) 1	TUNL	Adptd Lvls, γ-rays, decay & rx data
A = 20	*Nucl. Phys*. A636 (1998) 247	TUNL[b]	Adptd Lvls, γ-rays, decay & rx data

a) With G.M. Hale, b) with S. Raman
c) See Evaluations in progress

C. Evaluations in Progress

Nuclear Mass	*Status*
A = 5-7[a]	In preparation for submission to Nuclear Physics A[b]
A = 8-10	Evaluations of A=8 & 9 nuclides are in progress

a) With Gerry Hale and Hartmut Hofmann
b) Prepublication version is available online

D. Online Services

TUNL continues to develop new online services for the nuclear science and applications communities. In addition to the "Energy Levels of Light Nuclei" publications listed in the table above, a prepublication TUNL version for the A = 5-7 review is also available online. PDF documents for earlier Fay Ajzenberg-Selove evaluations are being made available. We are also in collaboration with Elsevier to provide PDF documents of all of FAS evaluations. Our new HTML project is online with HTML documents for individual nuclides that provide dynamic links to tables, diagrams, reaction discussion and NSR references.

Energy Level Diagrams are provided for A = 4-20 nuclei, and ENSDF material appears in two forms. Update Lists are available 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 = 5-13 nuclei are currently online; lists for other nuclei are being prepared.

E. ENSDF Files

ENSDF files are consistent with the most recent publications for A = 3-13 and 16-20. We are presently updating the A = 14 file; after the A = 15 file is updated, ENSDF files will be updated as new evaluations are published in Nuclear Physics.

II. TUNL Program on Preequilibrium Reaction Phenomenology

A. Personnel

Staff:	Constance Kalbach Walker	Sr. Research Scientist	Duke/TUNL

B. Work Status

Work since April 2000 has involved preparing the TUNL preequilibrium reaction code PRECO-2000 for formal release. The plan was to submit it to code distribution centers by the end of FY-2000. A "final" draft of the users manual was sent to LANL for review in the Fall, but further checking of the output showed that much work was needed on the complex particle channels, which had not been looked at in over 10 years.

A revised description of these channels was developed, providing indications of the following physics:

- Nucleon transfer reactions can involve excitation of particle-hole pairs in the target nucleus along with the transfer process.

- The mean square matrix elements for the residual interactions producing energy equilibration seem to depend on the excitation energy per projectile nucleon rather than on just the energy itself.
- Isospin is mixed for targets with small neutron excesses even at incident energies as low as 18 MeV. This points to a condition for isospin conservation during energy equilibration based on the relative sizes of the excitation and symmetry energies.

A study was made to see how much of the elastic cross sections could be described by the collective state excitation model and to provide a rough estimate of elastic scattering. This work yielded the following results:

- The elastic scattering cross section has one part which can be described using the collective state excitation model with simple systematics for the deformation parameter, and a Coulomb part which varies with $(Z_a Z_A / E_{inc})^2$.
- For each part, the smooth trend of the angular distributions can be described using two components, one following the same systematics as the collective states and the other with a slope parameter 18 units higher. The division into the two component follows simple systematics.
- While the angular distribution slope parameter for collective state excitation by nucleons was known to follow the main systematics, the slope parameters for complex particles are larger by a factor which depends on the projectile.

Finally, at the request of users, the program was revised to generate arrays of cross section populating different residual nucleus excitation energies following direct and preequilibrium emission. These are used as input to Hauser-Feshbach model evaporation calculations in larger codes which use PRECO for the preequilibrium part.

The code PRECO and its extensive users manual are now almost ready for distribution to the code centers. During the second half of FY-2001, the work on the complex particle channels may be written up for publication, and then the project data base for (N,N) reactions will be extended to excitation energies up to 100 MeV.