Progress Report on FY00 Nuclear Reaction Data Work at Los Alamos Group T-16

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Note to readers: This informal summary was prepared by editing our group's FY00 work summary for FY00.

Nuclear Physics ENDF Databases

General: Evaluated nuclear reaction data, for applications and for basic science needs, are stored in the ENDF database, which is maintained by BNL. As chair of the CSEWG evaluation committee, we have worked with BNL to insure quality control, particularly for new evaluations. We have also submitted new evaluations listed below (funded primarily from other sources) for archival in ENDF/B-VI.

Deliverables:

- Worked with BNL to issue Release-7 of ENDF/B-VI
- We have completed 14 new ENDF evaluations of neutron and proton reactions on mercury isotopes, up to 150 MeV. These will soon be submitted to CSEWG (once documentation is completed). This is particularly important for modeling neutron production at Oak Ridge's SNS project.
- We submitted our new bismuth neutron and proton ENDF evaluations up to 150 MeV to CSEWG, and these have been released in Rel-7 of ENDF/B-VI. These data are important for high-energy neutron spectrometry, and for accelerator-driven technologies (ATW, RIA)
- Submitted new 150 MeV n+28Si evaluation, guided by recent LANSCE measurements, to ENDF, important for detector design, and single-event-upset calculations in microelectronics. Published results in Phys. Rev. C.

Astrophysics Reaction Data

General: Participated in USNDP effort to develop high-quality data for astrophysics calculations of nucleosynthesis, making new calculated and evaluated results available to the wider astrophysics research community via the USNDP Dissemination Working Group.

Deliverables:

- We performed a number of consistency checks for our E1 12C(alpha,gamma) calculations, such as varying the channel radii, and found little change in the results. The next step is to include E2 capture information in the analysis.
- Worked on the N-N analysis, including n+p capture and deuteron photodisintegration data, is nearing completion. It should result in better-determined n+p capture cross sections in the range of BBN interest. We are also studying other reactions in the BBN set.

- We have begun with our postdoc S. Karataglidis an assessment of methods for extrapolating the 7Be(p,gamma) capture reaction. We plan to proceed with our own analysis later in the fiscal year.
- Collaboration with TUNL researchers on the light systems has continued with the release of preliminary articles for the A=5,6 level structures on the TUNL web site. We are currently working on A=7. Another collaboration resulted in a new analysis of n+12C cross sections and analyzing powers.
- Use Hauser-Feshbach methods to calculate photonuclear data important in nucleosynthesis: initial work completed – we have completed 12 photonuclear ENDF evaluations including the important silicon reactions for nucleosynthesis. This was done in collaboration with an IAEA CRP. A full suite of ENDF evaluations will soon be made available on CD, and will be submitted to CSEWG for eventual inclusion into ENDF/B-VI.
- Compute fission barriers using microscopic-macroscopic model for r-process termination: We have made significant improvements in our fission model calculations, using more sophisticated representation of the shapes of the fissioning system as it proceeds through scission. We are still refining the theoretical and computational methods, and have not yet begun our analysis for r-process nuclei due to lack of resources. Our new methods have been accepted for publication Phys Rev C.

Reaction Data for RIB target design

General: Radioactive Ion Beam facility design needs high-quality nuclear reaction data for target design, and facility design. We have worked with ORNL and ANL researchers to provide key reaction cross sections, using theory calculations and measurements to evaluate the data, and will continue to address their needs in the future.

Deliverables:

- Study theoretical and phenomenological methods for predicting production cross sections of neutron-rich products in fission reactions, for a future database of fission products in n+U RIB production experiments: Little progress so far due to lack of resources.
- Developed nuclear reaction model code tools for improved predictions of RIB cross sections (see 5 below), including isospin dependence in optical models for nuclei with large isospin, and improvements in fission theory for predicting neutron-rich nuclides. --We have made significant developments in our model prediction capabilities, see below
- Guide/support RIB researchers at ORNL, ANL, and LBNL, into the use of the Los Alamos CINDER/LAHET code for predictions of radioactive products in RIB facilities: We have continued to provide support to researchers in the RIA community on use of LANL simulation codes for target design.
- Additionally, at LANL we have begun a thrust to develop a proposal for LANL involvement in the national RIA project. McClelland, Vieira, and Chadwick are leading an effort on getting together a group of people who are focussed on RIA target design simulation capabilities (skills in nuclear modeling, running

simulation codes for ISOL targets, and developing diffusion models to calculate radionuclide production and emission). This work has been done under internal Los Alamos LDRD funds. We expect to submit a more formal FWP proposal to DOE within 1 year, as well as proposals for additional Los Alamos LDRD funds.

Model code development, and reaction theory studies at LANSCE and GEANIE

General: Nuclear reaction theory calculations have played a crucial role in the evaluation of nuclear data, and will continue to play an important part in future evaluations due to the decrease in operating experimental facilities throughout the world. The LANL GNASH code has proved to be an important tool, and we will develop a new version of this code to provide a state-of-the-art capability to predict reaction cross sections. This also involves a close collaboration with experimentalist at LANSCE (R.C. Haight, J.A. Becker, S.M. Grimes) to interpret new measurements using the GEANIE gamma-ray detector, as well as (n,charged-particle) data, resulting in advances in our understanding of nuclear reaction mechanisms, as well as improvements in our modeling codes.

Deliverables:

- Produce first working version *of McGNASH*, our improved version of the *GNASH* Hauser-Feshbach code, using Fortran90 and modern coding practices, with numerous improved physics packages, particularly: level densities, preequilbrium reactions, transmission coefficients, and gamma-ray strength functions. Include a Monte-Carlo option: Good progress has been made. The first McGNASH Hauser-Feshbach version is working. We are working hard to extend the code's capabilities, and are interacting with other researchers in this area (LLNL, and NEA modeling working group)
- Calculate and interpret gamma-ray reactions measured with GEANIE at LANSCE, including n+^{112}Sn reactions producing far-from-stability products, and reactions in competition with fission: Calculations have been completed and suppied to LLNL experimental collaborators
- Study level densities, a crucial input in nuclear model calculations, using (n,z) measurements by Haight at LANSCE, and publish work on isospin and level densities in n+Si reactions: We published a paper in PRC (Nov 1999) on our work on silicon and how the results are sensitive to level densities and isospin effects. We are beginning an analysis of data for calcium which provide useful insights into nuclear reaction mechanisms (collaboration with Grimes and Haight)

WWW Dissemination of nuclear data

General: Continue to develop our T-2 Online Nuclear Information Service, for convenient and wide access to our nuclear modeling research, data evaluations, and publications. Develop this WWW site in coordination with the USNDP Dissemination working Group.

Deliverables:

- Include access to new reaction and structure data evaluations, supported by DOE/Nuclear Physics, via the T-2 WWW site: This ongoing work is in progress. We are continuing to make new evaluations available. A new set of light charged-particle reaction cross sections, and Maxwellian-averaged rates, have been made available through the T-2 WWW site, together with numerous high-energy evaluations that extend up to 150 MeV (including new evaluations for Hg, Bi, Li isotopes).

- We included WWW access to ENDF/B-VI Release 6, which is now available

- Finish development of “interpreted ENDF” printout of reaction data: Much progress has been made here, including enhanced “help” capabilities. MacFarlane will report on this at the April’00 meeting.

- Include additional color-plot capabilities on T-2 WWW site: All ENDF evaluations now have enhanced plots that show the data