2012/13 Status Report of China Nuclear Data Center

Ge Zhigang

China Nuclear Data Center, China Committee of Nuclear Data, China Institute of Atomic Energy
P.O.Box 275-41, Beijing 102413, P.R.China, Fax:+86-10-69358119/69358798, E-mail: gezg@ciae.ac.cn

1. General information of China Nuclear Data Center

1-1 Manpower Information:

3 graduated students joined CNDC for their master degree in last year, and 2 will come in this autumn.

Evaluation Unit	Head: Dr. Huang Xiaolong	3 official staff
Theory Unit	Head: Dr. Ge Zhigang	6 official staff
Macroscopic Data Unit	Head: Dr. Liu Ping	4 official staff
Data Library Unit	Head: Dr. Shu Nengchuan	5 official staff
Secretary Office		2 official staff

Director: Ge Zhigang.
Deputy Directors: Dr.Chen Guochang and Dr.Wu Haicheng.

20 official staff + 5 technical support seniors (retired staff) + 5 graduated students.

1-2 Mainly Tasks of CNDC in 2012:

- New evaluations for CENDL new version.
- Neutron data library evaluations and data processing for Th-U fuel cycling studies(Chinese TMSR Project).
- Nuclear data evaluation and benchmark/validation for ADS needs.
- Nuclear structure and decay data evaluation for ENDSF.
- EXFOR compilation for NRDC.
- Nuclear data methodology studies.
- The benchmark/validation of nuclear data libraries (CENDL-3.1, ENDF/B-VII, JENDL-4. JEFF etc.).

1-3 Activities Information

- 2012 Conference on Nuclear Data Benchmark/Processing and Application was held in Hangzhou city on Nov. 4-9, 2012 and more than 69 participants from

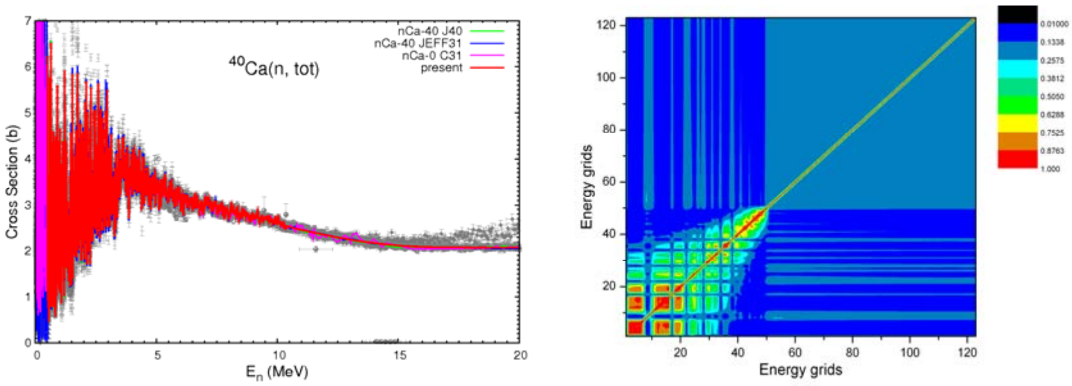
China attended this conference, more than 39 presentations received.

- Dr. Efrem Soukhovitski from JIPNR-“Sosny”, Minsk, Belarus visited CNDC on Aug. 29, 2012.
- For foreign scientists (Drs. M.Aikawa, K. Kato, Y.Lee and N.Otsuka) from Japan, Korea and IAEA/NDS visited CNDC on Oct. 30, 2012.
- The 2012 standing committee meeting of China Committee of Nuclear Data was hold in Beijing on 26, Dec. 2012.

2. Nuclear Data Evaluation and Methodological Studies.

2-1 CENDL Project

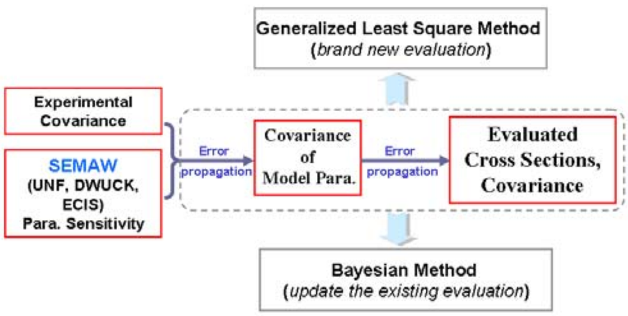
- The CENDL-3.2 is the next output results of CENDL project which consists of the neutron reaction sub-library, the activation sub-library, decay data sub-library and fission yield sub-library. CENDL-3.2 can be used for the nuclear engineering, nuclear medicine and nuclear science etc. fields.
- The evaluation activities (including the neutron file, fission product yield and activation sub-libraries) of CENDL-3.2 are performing according to the updated need from users, new nuclear data evaluation methodologies and experimental information. The mainly contribution of CENDL-3.2 are being carried out at CNDC, China Institute of Atomic Energy and China Nuclear Data Coordination Network(CNDCN) and international collaboration.



The new evaluation(preliminary) of the ^{40}Ca(n,tot) CS and its covariance file.

2-2 Neutron Cross Section Covariance Evaluation

A covariance evaluation system, COVAC, is being developed in CNDC to achieve the covariance files mainly for structure and fission nuclides in CENDL.



COVAC SYSTEM OF CNDC

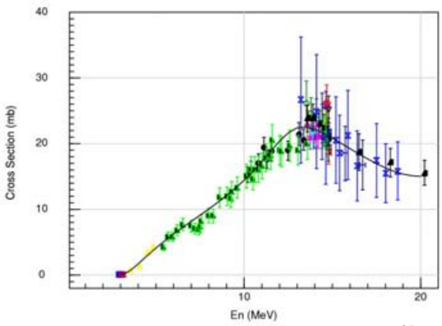
The sensitivity calculation of the model parameters can be done by the SEMAW code, and now we are focusing to establish a method to construct covariance from the experimental information for structure nuclei and actinides. Following items are studying;

1、to obtain the error information from different methods(TOF, Activation…) of measurements.

2、to derive the systematic errors and statistic errors from exp. data.

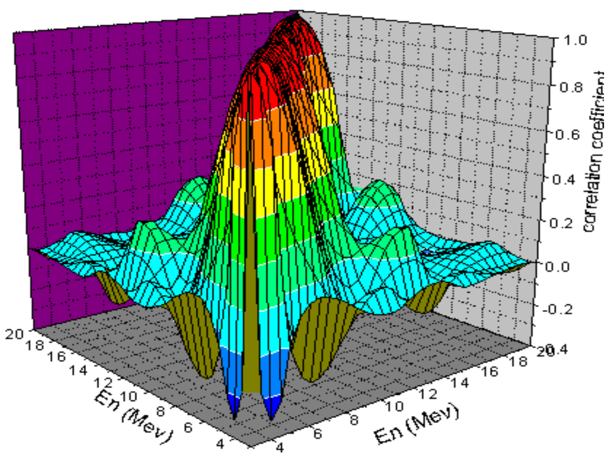
3、to determine the correlated errors in exp. data evaluation.

As an example, the covariance evaluation of experimental data for ^{65}Cu(n,p) measurements by activation has been performed. The errors of standard cross sections, detector efficiency, branching ratios of γ(or β) and uncertainties of target thickness etc. were considered and analysed as correlated elements.



Year	Author	Energy (MeV)	points	Sys. Error (%)	Sources of Sys errors(%)
2007	W.Mannhart+	10.2~14.0	10	1.72	Standard: 1.5，Percentage of isotopes
2004 2000	T.Shimizu+	2.90~3.09 3.00~3.20	2	6.29	Neutron flux: 0.4, sample mass: 0.1, thickness: 0.6, detection: 5.5, standard: 3
1999	A.A.Filatenkov+	13.6~14.8	7	2.6	Normalization
1994	N.I.Molla+	13.9~14.7	4	3.1	Sample mass: 1, flux: 1, others: 0.65, Norm.: 2.6
1980	P.N.Ngoc+	13.66~14.7	6	5.98	Sample mass, purity: 2, standard: 5, normalization: 2.5
1965	D.C.Santry+	5.45~13.6	31	3.12	Geometry: 1, BG: 0.5, flux: 0.5, breakup: 0.5, ^{65}Ni, ^{32}P correction: 2

The measurements of ^{65}Cu(n, p) cross sections in En≤20MeV(fig.) and exp. error evaluation of some measurements(table)



The present correlation coefficient of ^{65}Cu(n, p)

2.3 An Evaluated Nuclear Data Library(CENDL-TSMR, preliminary)

The CENDL-TSMR is used for Th-U experimental reactor design which contained 400 nuclei (take from CENDL-3.1, ENDF/B-VII.0, ENDF/B-VII.1, JENDL-4.0, JEFF-3.1, IAEA/ADS-2.0) which were selected by comparison with exp. data and benchmark/validation. CENDL-TSMR also contained 21 thermal neutron scattering evaluations, and electro-atomic evaluations for 100 materials (take from ENDF/B-VII.1). Below table shows the content of CENDL-TSMR.

	Material	

Light nuclei	^{1,2,3}H、^{3,4}He、^{6,7}Li、^{9}Be、^{10,11}B、^{12}C、^{14,15}N、^{16,17}O、^{19}F	16
Structure and FP	^{22,23}Na、^{24,25,26}Mg、^{27}Al、^{28,29,30}Si、^{31}P、^{0,32,33,34,36}S、^{35,37}Cl、^{36,38,40}Ar、^{39,40,41}K、^{40,42,43,44,46,48}Ca、^{45}Sc、^{46,47,48,49,50}Ti、^{0}V、^{50,52,53,54}Cr、^{55}Mn、^{54,56,57,58}Fe、^{59}Co、^{58,60,61,62,64}Ni、^{0,63,65}Cu、^{0}Zn、^{69,71}Ga、^{70,72,73,74,76}Ge、^{74,75,77,79}As、^{74,76,77,78,79,80,82}Se、^{79,81}Br、^{78,80,82,83,84,85,86}Kr、^{85,86,87}Rb、^{84,86,87,88,89,90}Sr、^{89,90,91}Y、^{90,91,92,93,94,95,96}Zr、^{93,94,95}Nb、^{92,94,95,96,97,98,99,100}Mo、^{99}Tc、^{96,98,99,100,101,102,103,104,105,106}Ru、^{103,105}Rh、^{102,104,105,106,107,108,110}Pd、^{107,109,110m,111}Ag、^{106,108,110,111,112,113,114,115m,116}Cd、^{113,115}In、$^{112,113,114,115,116,117, 118,119,120,122,123,124,125,126}$Sn、^{121,123,124,125,126}Sb、$^{120,122,123,124,125,126,127m,128,129m, 130,132}$Te、^{127,129,130,131,135}I、^{123,124,126,128,129,130,131,132,133,134,135,136}Xe、$^{133,134,135, 136,137}$Cs、^{130,132,133,134,135,136,137,138,140}Ba、^{138,139,140}La、$^{136,138,139,140,141,142, 143,144}$Ce、^{141,142,143}Pr、^{142,143,144,145,146,147,148,150}Nd、^{147,148,148m,149,151}Pm、^{144,147,148,149,150,151,152,153,154}Sm、^{151,152,153,154,155,156,157}Eu、$^{152,153,154,155,156,157,158, 160}$Gd、^{159,160}Tb、^{156,158,160,161,162,163,164}Dy、^{165,Ho166m}Ho、^{162,164,166,167,168,170}Er、^{175,176}Lu、^{174,176,177,178,179,180}Hf、^{181,182}Ta、^{180,182,183,184,186}W、^{185,187}Re、^{191,193}Ir、^{197}Au、^{196,198,199,200,201,202,204}Hg、^{204,206,207,208}Pb、^{209}Bi	310
Heavy nuclei	^{223,224,225,226}Ra、^{225,226,227}Ac、^{227,228,229,230,231,232,233,234}Th、^{230,231,232,233}Pa、^{232,233,234,235,236,237,238,239,240,241}U、^{235,236,237,238,239}Np、$^{236,237,238,239,240,241,242,243, 244,246}$Pu、^{240,241,242,242m,243,244,244m}Am、^{240,241,242,243,244,245,246,247,248,249,250}Cm、^{249,250}Bk、^{249,250,251,252,253,254}Cf、^{253,254,255}Es、^{255}Fm	74
Total		400

2-4 Evaluation Method for Light Nuclei Based on R-Matrix Theory

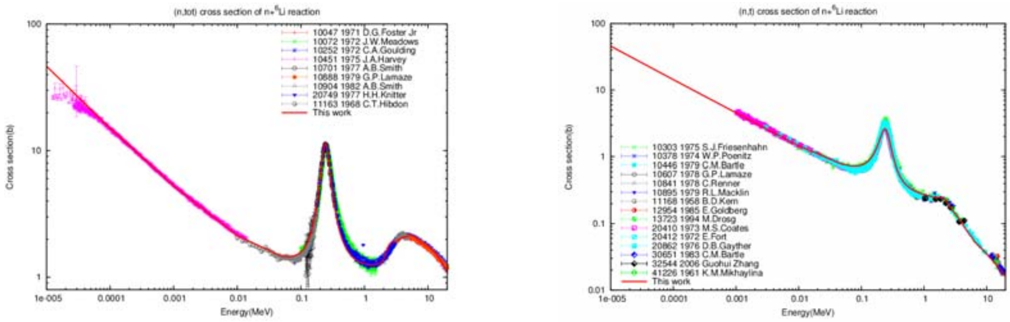
A Full and Diagonal Reduced R-matrix(FDRR) code is developed at CNDC and Nankai Uni. This code can be used for the experimental data evaluation for light nuclei reactions introduced by n,p,t,α,d,^{3}He and ^{5}He et al. Four kinds of R-matrix formalism are included in FDRR code:

1) Full (un-approximated) R-matrix formalism including un-diagonal elements (the general R-matrix theory);
2) The un-diagonal elements are keeping for retained channels but only diagonal elements are keeping for eliminated channels;
3) The reduced R-matrix theory(similar with the method used in RAC code);
4) Reich-Moore R-matrix theory.

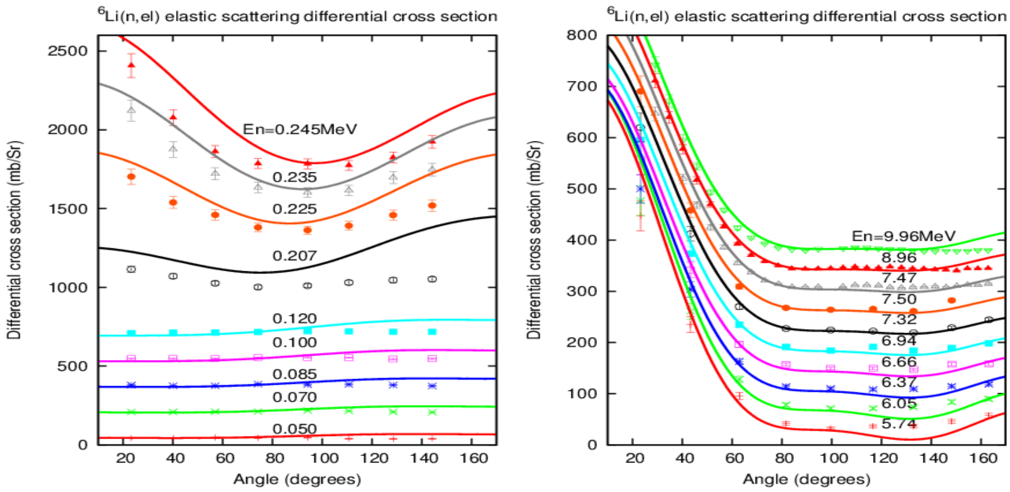
The S-L coupling S-matrix theory is used in FDRR code. The same compound nuclei uses one set of parameters and auto adjusting the resonance width parameters.

All reaction channels(Cross sections, angular distributions, analyzing power) which have the same compound nucleus are considered simultaneously including 3-body channels and those channels which has no experimental data.

As an example, following figures show the calculating and fitting results used FDRR code for n+^{6}Li reactions below 20 MeV.



The comparisons of the preliminary calculation and exp. data of
the total CS (left) and (n,t)(right) for n+^{6}Li.

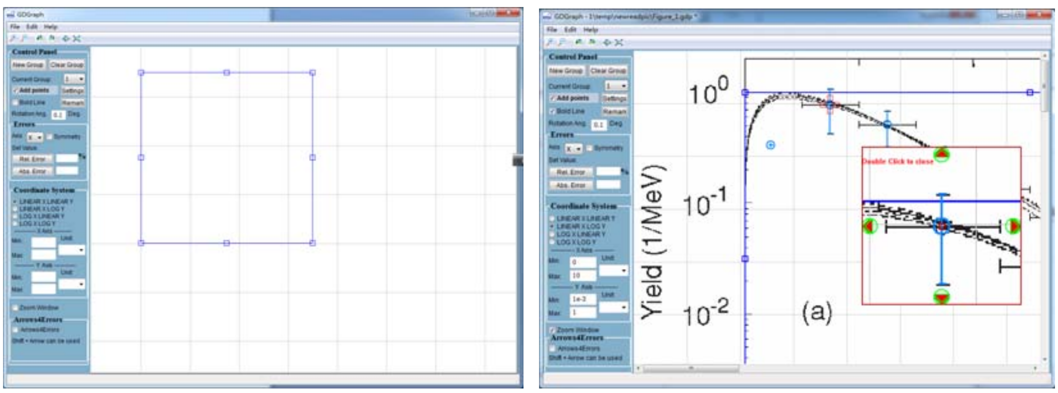


The comparisons of the preliminary calculation and exp. of
the angular distributions of ^{6}Li(n,el)

3. EXFOR Software and Database Compilation Progress

3-1 GDgraph Software

A series of digitization software(GDgraph) have been developed by CNDC, and GDgraph-v4.4 was participated in the Benchmarking of the Digitization Software organized by IAEA/NDS last year, and which showed a good ability and high accuracy. After then a new vision of the GDgraph-v5.0 has been developed, and some new functions ware added. The user's manual of GDgraph-v5.0 is preparing. GDgraph-v5.0 will be available for EXFOR compilers soon.



The working windows of GDgraph (partial)

3-2 EXFOR Compilation.

During the 2012-2013 EXFOR compile group at CNDC have finished Neutron: 14, Charge particle: 3 and Include in X4 database: 14. The: 11(Neutron: 3 and Charge particle: 8) are Compiling. All these experiments were finished by Chinese and published in the following journals and proceedings:

(1) Chinese Physics C(ENG/2007;HEN)
(2) Atom. Energy Sci. & Tech.(CHN/1959)
(3) J. of Nucl. & Radiochemistry(CHN/1979)
(4) Nuclear Physics Review(CHN/1984)
(5) Nuclear Techniques(CHN/1978;+ENG/1989)
(6) Com. of Nucl. Data Prog.(ENG/1989)
(7) Nuclear Science and Techniques(ENG/1989)
(8) Chinese Physics Letters(ENG/1984)
(9) Chinese Physics B (ENG)
(10) Acta Physica Sinica(ENG/1933)
(11) Proceedings of Conference, Workshop etc.