McMaster University Nuclear Data Project

Report of completed work from May 2015-May 2017, and on-going work
(IAEA-NSDD meeting, Berkeley, California, USA. May 22-26, 2017)

ENSDF: evaluations; training, computer codes, network coordination.
XUNDL: compilation of current papers, coordination.
NSR: writing key-word abstracts of papers in PRC journal.
Horizontal evaluations and compilations:
B(E2) for first 2+ and first 4+ states in e-e nuclei.
Beta-delayed neutron (BD-N) emitters: %Pn, $T_{1/2}$ for all potential B-n emitters.
Compilation of nuclear isomers of $T_{1/2} \geq 10$ ns
Update of Akovali's 1998 table of r0 for e-e alpha-decaying nuclei.

ENSDF evaluation work

Mass Chain publications in NDS (May 2015 to May 2017):
A=189: T.D. Johnson and B. Singh, NDS 142, 1-330 (2017)
A=256: B. Singh, NDS 141, 327-364 (2017)
A=139: P. Joshi, B. Singh, S. Singh, and A.K. Jain, 138, 1-292 (2016)
A=42: J. Chen and B. Singh, NDS 135, 1-192 (2016)
A=79: B. Singh, NDS 135, 193-382 (2016)
A=227: F.G. Kondev, E.A. McCutchan, B. Singh, and J.K. Tuli, NDS 132, 257-354 (2016): IAEA-ICTP workshop, mass chain coordinated by B. Singh.
A=224: S. Singh and B. Singh, NDS 130, 127-182 (2015)
A=182: B. Singh, NDS 130, 21-126 (2015)
A=43: B. Singh and J. Chen, NDS 126, 1-150 (2015)

Nuclide updates for ENSDF: 160 additional nuclide updates for ENSDF.
Review work for ENSDF: A=158 mass chain.
Submitted for publication (May 2015-May 2017)
A=76: B. Singh and A.R. Farhan (review stage)
A=172: B. Singh and T. Kibedi (review stage)
A=57: A. Negret, B. Singh and R.B. Firestone (review stage)
A=258: B. Singh (post-review stage)
A=217: F.G. Kondev, E.A. McCutchan, B. Singh (IAEA-ICTP workshop, review stage)

Mass chains in Progress:
A=164 (with J. Chen, post-review stage)
A=130 (with S. Pascu and A. Rodionov)
A=219 (with group in India)
A=266-300 even-A
A=58 (with C. Nesaraja)
A=73 (with J. Chen)
A=218, 190, 165, 98

XUNDL compilation work:

May 2015-Sept 30, 2015: continued coordination with different data centers.

Compiled: 450 datsets from about 210 papers.

May 2015 to Sept 2015: reviewed 175 datasets from other centers.

Coordinated: XUNDL compilation work at the 2016 IAEA-ICTP workshop.

Compilation of papers on Atomic Mass measurements (since 2008):

1. **Oct 29, 2015: 17 papers with 83 data points, compared to AME-2012 data.**
2. **May 15, 2017: 22 papers with 133 data points, compared to AME-2016 data.**

Both files are available on Michael Smith's nuclearmasses.org webpage at ORNL.

Work continues on XUNDL compilations and fairly frequent communications with authors.

NSR key-wording of papers in PRC:

May 2015-May 2017: about 2250 papers consulted, keyword abstracts written for about 1530 papers and submitted for the NSR database.

Horizontal evaluations and compilations:

1. **B(E2) for the first 2+ states in e-e nuclei (NNDC, BNL; McMaster, Central Michigan, IIT, Roorkee : Publications:**
   i) B. Pritychenko, M. Birch, B. Singh, and M. Horoi, **ADNDT 107**, 1- 139 (2016)
   ii) B. Pritychenko, M. Birch, and B. Singh: *Revisiting Grodzins systematics of B(E2) values,* **Nucl. Phys. A 962**, 73-102 (2017)
   iii) M. Birch, B. Pritychenko, and B. Singh: *On the equivalence of experimental B(E2) values determined by various techniques*, **Nucl. Phys. A 955**, 145-155 (2016)
   iv) B. Maheshwari, A.K. Jain, and B. Singh: *Asymmetric behavior of the B(E2↑; $0^+ \rightarrow 2^+$) values in $^{104-130}$Sn and generalized seniority*, **Nucl. Phys. A 952**, 62-69 (2016).

   NNDC+McMaster collaborative continues for a first compilation and evaluation of B(E2) for the first 4+ states in e-e nuclei, systematic of BE2(4+ to 2+)/BE2(2+ to 0+) and

E(4+)/E(2+), etc. Also update of B(E2) values continues for the first 2+ states, as this topic is of very active current experimental work.

2. **Beta-delayed neutron emission probabilities (Pn) and half-lives for n-rich nuclei: (McMaster, TRIUMF, NNDC-BNL, CIAE-Beijing, VECC-Kolkata, Valencia, CNEA-Argentina, Warsaw): Part of the IAEA-CRP 2012-2017:**
Publication: M. Birch, B. Singh, I. Dillmann, D. Abriola, T.D. Johnson, E.A. McCutchan, and A.A. Sonzogni, *Evaluation of Beta-Delayed Neutron Emission Probabilities and Half-Lives for Z = 2-28* , **NDS 128, 131-184** (2015). This paper dealt with about 220 B-n emiiters.

For Z>28 nuclides (total of about 410 nuclides), semi-final draft of Pn and half-life tables with bibliographic file has been prepared and sent to the IAEA-NDS for setting up a reference database for beta-delayed neutron precursors, first of its kind. The **systematic** of experimental data are being prepared using Kratz-Herrmann (1973Kr15) formalism, McCutchan et al. (2012Mc04,2014Mc07) noval approach, and Miernik's level-density parameterization method (2013Mi23,2014Mi23) Results will be presented at the upcoming 3rd and final RCM of the CRP June 12-16, 2017. A paper based on this work is in preparation and is expected to be submitted to NDS by Fall 2017.

3. **Atlas of nuclear isomers of half-life 10 ns or greater: (IIT-Roorkee, McMaster):**
Publication: A.K. Jain, B. Maheshwari, S. Garg, M. Patial, and B. Singh, *Atlas of Nuclear Isomers,* **NDS 128, 1-130** (2015). As the search for isomers is another vigorously pursued experimental research, an addendum to include new values and revise previous half-lives and isomer energies has been prepared. (See presentation by A.K. Jain).

4. **Update of Akovali's 1998 radius (r0) parameters for alpha-decay hindrance factors (Akal Univ., India, McMaster, IIT-Roorkee):** radius parameters have been deduced for all the known e-e alpha emitters (about 190 systems) with revised half-lives and alpha branching ratios by a thorough search of the NSR database after the mass chain literature cutoff dates, and using Q(alpha) values from AME-2016. Systematics have been studied, and a detailed paper is under preparation for submission to the NDS. (See presentation by B. Singh for New-ALPHAD code and incorporation of the updated 2017 r0 table.

5. **Possible new project: Update of 1998 logft review by B. Singh et al. (1998Si17):** Prof. Kai Zuber at Dresden is interested in the update of this table. He visited McMaster for a week in summer 2016 and is also visiting this summer. Hopefully, in collaboration with Dr. Xavier Mougeot from Saclay, this project can be planned as Dresden-McMaster-Saclay collaboration.

Network Coordination and participation in workshops for computer codes:

1. Participated in May 2015 ENSDF one-week workshop at the IAEA: lectures and discussed formats for ENSDF.
2. Participated in July-August 2016 IAEA-ICTP ENSDF two-week workshop in Trieste: lectures and hands-on training in ENSDF formats through XUNDL compilations and ENSDF evaluations.
3. Participated in IAEA-ENSDF codes meeting Oct 5-8, 2015: B. Singh presented JAVA-NDS; M. Birch presented J-GAMUT and V-AVELIB converted to JAVA and a revised method (based on Barlow's approach) to handle asymmetric uncertainties in the averaging procedure. B. Singh also collaborated with S. Singh on the new ALPHAD and Rad-d codes.
4. Participated in JAVA-NDS workshop Oct 5-8, 2015 at TUNL, USA to go over fine details of the .pdf output from JAVA-NDS code.

Analysis of experimental data for Y-94 decay to Zr-94:

The experiment was performed in 2011 at TRIUMF with S. Yates as the spokesperson. B. Singh participated in the experiment run for a week. The data are currently being analyzed by Dr. Anagha Chakraborty at Visva Bharati University in India, in consultation with B. Singh. We hope to bring analysis to completion by the end of 2017, which should be a major improvement in the knowledge of the decay characteristics of Y-94 isotope, a fission fragment, last studied by B. Singh et al., Jour. Phys. G 2, 397 (1976). It may also be possible to extract an independent Pn value for Rb-94 decay, grand-parent of Y-94 isotope.

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