

Status Report: McMaster University

October 1, 2020 to September 30, 2021

Nuclear Structure and Decay Data

ENSDF, XUNDL, NSR, Topical Compilations / Evaluations

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ENSDF and related work:

Publications: Oct 2020 to Nov 2021

A=194: J. Chen, **B. Singh**, NDS **177**, **1-508** (Nov 2021). (Previous: April 2006)

A=219: **B. Singh**, G. Mukherjee et al., NDS **175**, 150-268 (July-Aug 2021). (Prev. May 2001)

A=100: **B. Singh**, J. Chen, NDS **172**, **1-542** (Feb 2021). (Prev. Dec 2007)

A=233: **B. Singh**, J.K. Tuli, E. Browne, NDS **170**, 499-705 (Dec 2020). (Prev. April 2005)

A=190: **B. Singh**, J. Chen, NDS **169**, **1-390** (Nov 2020). (Prev. April 2003)

Development of a Reference Database for Beta-Delayed Neutron Emission,

P. Dimitriou, I. Dillmann, **B. Singh**, V. Piksaikin, K.P. Rykaczewski et al. NDS **173**, 144-238 (March-April 2021): IAEA-CRP: 33 authors from 9 countries.

Compilation and Evaluation of Beta-Delayed Neutron Emission Probabilities and Half-Lives for $Z > 28$ Precursors, J. Liang, B. Singh, E.A. McCutchan, I. Dillmann, M. Birch et al., NDS 168, 1-116 (Sept-Oct 2020): IAEA-CRP: 16 authors from 6 countries.

IAEA-CRP for Beta-delayed neutrons: directed by Vivian Dimitriou at the IAEA from 2012 to 2019. Work continues under her guidance in updating B-n data for recent publications.

ENSDF work: submitted: FY-2021

A=167: B. Singh, J. Chen: submitted Sept 30, 2021. (Prev. July 2000)

A=71: B. Singh, J. Chen: submitted Sept 30, 2021. (Prev. Nov 2010)

A=31: J. Chen, B. Singh: submitted Sept 15, 2021. (Prev. Feb 2013)

A=231: B. Singh, J.K. Tuli, E. Browne: submitted July 31, 2021. (prev May 2013)

Individual nuclide updates for ENSDF: 67 spread over different mass regions.

ENSDF work: A chains in pipeline

A=64: B. Singh, J. Chen: final for NDS to be submitted this week.

A=130: S. Pascu, **B. Singh**, A. Rodionov and G. Shulyak: submitted Sept 18, 2018: post-review. Many new papers, more to come since 2018.

A=172: B. Singh and T. Kibedi: submitted May 2017: post-review.

A=57: A. Negret, **B. Singh** and R.B. Firestone: submitted April 2017: post-review.

A=76: B. Singh and A.R. Farhan: submitted April 2016: post-review. Many new papers and an unpublished thesis to include since 2016. NSCL-MSU is interested in A=70-80 mass region for research and data evaluation: invited Jun Chen to participate, which he has kindly agreed.

A=149: B. Singh and J. Chen: post-review

¹⁴⁷Pm nuclide update which included ¹⁴⁷Nd decay data evaluation and its half-life: Sept 2019: post review: **Nd-147** decay: still waiting for final results from experiments at Livermore and NPL, UK.

ENSDF work: on-going, and planned

A=132 (with A. Rodionov, PNPI)

A=226: with S. Singh, S. Kumar (India): **planned** : Jan 2022.

A=58 (with C. Nesaraja, ORNL)

ENSDF: planned for FY-2022, and on-wards..

A=165, 44: with Jun Chen: planned Sept 2022

A=62: with Xiaolong Huang (Beijing): planned Aug 2022

A=80: 2023

A=222: 2023

A=151: 2023

Individual Nuclide updates: perhaps.

XUNDL work: FY-2021

38 papers: including **21** for PRC-Data check.

176 datasets: includes 40 for PRC-Data check.

21 reports for PRC Data-check papers.

20 datasets from **11** papers were revised for published Errata or for response from authors to data-related queries.

7 PRC papers: second round data check: **17** datasets revised, and in a few cases second set of reports.

Mass measurements: **15** papers: Dec 1, 2020 to Nov 11, 2021: being compiled, to complete this month. Will soon be sent to Michael Smith for placement on www.nuclearmasses.org.

NSR work: FY-2021: PRC

August 2020 to July 2021, 12 issues:

Number of papers consulted: **989**.

Keyword abstract prepared for **713** papers (72% of total).

Since August 2007, **~14K** PRC papers consulted; Keyword abstract prepared for **~10K**. About 70% were theory papers and 30% experimental: nuclear structure and nuclear reactions. Feels weird, but true, that I turned each page of PRC for the last 14 years!

It surprises me that up until two days back, I have been made aware of only one mistake in keywords, where a nuclide of interest could not be retrieved online. John Kelley brought up 2 more in his Tuesday presentation, one of which I am not sure whether it is a mistake. It is possible Boris as NSR manager has been kind to me and has corrected some PRC keywords without letting me know.

I am glad to know that Dymtro Symochko will take over PRC keywording, and about the efforts at LBNL for automatizing NSR-keywording using AI.

NSR work: comment

2020Kr08: PRC **102**, 02616 (Aug 2020): Theory paper.

Keywords submitted Oct 2020:

NUCLEAR REACTIONS $^4\text{He}(n, n)^5\text{He}^*$, $E(\text{cm}) < 10.5$ MeV; calculated phase shifts from third to fifth order of the chiral expansion in comparison to the empirical phase shifts obtained from **R-matrix analysis of $A=5$ reaction data**, phase shifts from the Gaussian process model (GPM) with local/nonlocal 3N force, Bayesian posterior distributions of low-energy constants for the contact plus one-pion exchange using the binding energies of ^3H and ^4He and the charge radius of ^4He , positions and **widths of n - α resonances**. ^4He ; **calculated ground-state energy, point-proton radius and charge radius**, and associated chiral uncertainties using the chiral interaction models. Computation of structure and reaction observables for three-, four-, and five-nucleon systems within the ab initio frameworks of the no-core shell model and no-core shell model with continuum. Overall uncertainty budget of many-body calculations using Bayesian statistics. Comparison with experimental data.

Authors: *Page 4: “NCSMC calculations of n - α scattering require as input the NCSM eigenstates of the ^4He target and of the **composite ^5He system**. In this work we used up to the lowest ten states in each of the negative and positive parity sectors of the **$A = 5$ system**, covering an **excitation energy range of up to 25 MeV**”.*

Without my knowledge $^4\text{He}(n, n)^5\text{He}^*$ is now changed in NSR to $^4\text{He}(n, n)^4\text{He}^*$ which seems incorrect to me as composite system is ^5He not ^4He , and authors consistently discuss g.s. properties of ^4He . Perhaps $^4\text{He}(n, n), (n, X)^5\text{He}^*$?

^{147}Nd decay: update on continuing saga...

^{147}Nd : important fission product: 531.0-keV gamma from its decay is used to determine fission yields. Also used in world-wide monitoring of radiation from nuclear events by the CTBTO.

Presently available absolute I_γ of 531.0 γ -ray in evaluated databases:

ENSDF (2008, corrected 2013): **13.4(3)%**. **DDEP** (2012): **12.7(9)%**.

Difference and fairly large uncertainties prompted three new experiments. Alejandro in 2016 or so asked me to do an independent evaluation, first draft of which was completed in 2018: ~100 papers. Presented evaluation in 2019 (presented at CSWEG-2019): **13.00(34)%**

New experiments for measurement of absolute I_γ of 531.0 γ :

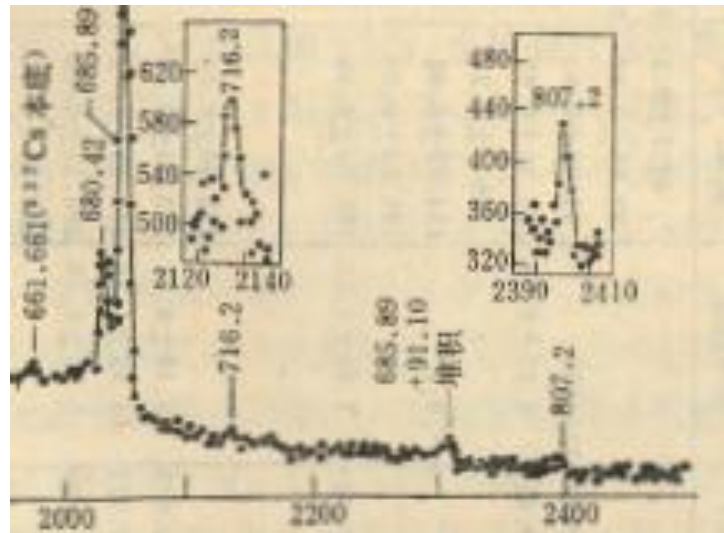
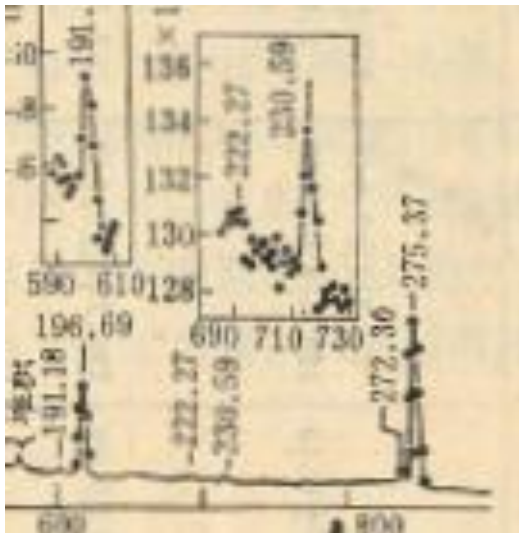
1. LNHB-CEA-Saclay (2020Ke08): **13.11(13)%**
2. LLNL-Texas A&M-ANL (2020KoZZ): **13.019(53)%** : preliminary result
3. NPL-UK: contacted Dr. Sean Collins Oct 20, 2021. Received preliminary results and some spectra. Result falls within the uncertainties of #1 and #2 values. Also measured precise half-life.

^{147}Nd decay

Half-life of ^{147}Nd decay:

11.26(1) d (2019Br01: ORNL); 10.98(1) d (1971Ba28); 11.02(5) d (1963Ho15); 11.14(6) d (1960Al33); 11.06(4) d (1957Wr37). NPL-UK measurement is highly precise, agrees with older values, not with the 2019Br01-ORNL value.

Gamma-spectrum details: 1983Li19: Chin. J. Nucl. Phys. 5, 312: not cited in present ENSDF or DDEP evaluations. Peaks at 230, 716, 807 keV ?



Review of Log ft values: S. Turkat, K. Zuber (Dresden), X. Mougeot (LNHB, CEA-Saclay), B. Singh (McMaster)

Update of 1998Si17 (NDS 84, 487) review by B. Singh et al.

Several queries received in the last 5 or so years for an updated version

2018-2019: Steffen developed computer codes to select well-established data, create systematic plots of log ft distributions, tables, etc.

2020: Xavier extracted all the beta-decay (B-, EC+B+) datasets from ENSDF. Updated all the Q values from AME 2016. Sent all the datasets to me.

2020-2021: I updated many relevant datasets for new data and recent mass chain evaluations, but not a complete update. Current version of BetaShape code requires absolute beta feedings. I looked through each dataset, and adjusted beta feedings in many datasets with relative beta feedings. Sent all the datasets to Xavier July 2021.

Aug-Oct 2021: Xavier updated all the Q values to AME 2020, and ran each dataset through **BetaShape** code. I have been sending him more updates to be up-to-date with the current **ENSDF version of Oct 13, 2021**. Xavier sent all the datasets to Steffen, Kai and me Oct 22, 2021.

Oct-Dec 2021: Steffen is now working on processing all the decay datasets through his codes. At the same time he is busy with finishing up his Ph.D. experimental projects.

Hopefully this project can be completed early in 2022, and submitted for publication.

Other topical compilations/evaluations

Atlas of nuclear isomers (≥ 10 ns): update of 2015Ja04 NDS publication: with A.K. Jain, S. Garg, B. Maheshwari in India: Table completed and up-to-date as of Nov 10, 2021. Paper in preparation: expected submission early 2022.

Many problematic cases for half-lives. Examples: half-lives of fission isomers in ^{236}U and ^{238}U , each has 17 measurements. ^{236}U : 1969-1991, 2020: **67-144 ns**. ^{238}U : 1970-1991: **110-300 ns**. Seems unresolved issues, whether two isomers possible for each nuclide ?

Magnetic-rotational (shears) bands: update of 2000Am02: ADNDT publication: with S. Singh, S. Kumar and A.K. Jain in India: Table updated to current date. Paper in preparation: expected submission mid 2022.

On-going:

B(E2) for the first 2+ and 4+ states in e-e nuclei: with Boris Pritychenko.

Systematics of gamma-transition strengths, RULs: with Jun Chen.

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