

Nuclear Data Project McMaster University

Status Report: Oct. 1, 2005-Sept. 30, 2006

November 1, 2006

USNDP: Nov. 7-9, 2006

Part 1: Nuclear Structure and Decay Data

Prepared by: B. Singh

ENSDF Work

- **Permanent Responsibility:**

A=1 (2005), 31-36 (1999),
37 (1999,w), 38 (1999,s)
39 (2006), 40 (2004),
41 (2001), 42 (2000),
43 (2001), 44 (1999),
64 (1996,s), 89 (1998),
98 (2003), 100 (1997,s),
149 (2004), 151 (1997,w),
164 (2001), 188 (2002),
190 (2003), 194 (2006)

- Note: The number in parentheses gives the year of last revision in ENSDF database
- w: work in progress
- s: revision submitted

- During FY-2006, work was also done on other A-chains and nuclides, which are outside McMaster's A-chain responsibility

Mass-chain Evaluations Published or Submitted Since October 1, 2005

- **A=38:** J.A. Cameron and B. Singh, NDS (submitted September 2006, at pre-review stage)
- **A=135:** B. Singh, Yu. Khazov and A. Rodionov, NDS (submitted September 2006, at pre-review stage)
- **A=100:** B. Singh (submitted September 2006, at pre-review stage)
- **A=64:** B. Singh, NDS (submitted March 2006, final galley version)
- **A=199:** B. Singh, NDS (submitted September 2005, in ENSDF, to appear in NDS in early 2007).
- **A=74:** B. Singh and A.R. Farhan, NDS **107**, 1923-2102 (2006)
- **A=194:** B. Singh, NDS **107**, 1531-1746 (2006)
- **A=165:** A.K. Jain, A. Ghosh and B. Singh, NDS **107**, 1075-1346 (2006)
- **A=218:** A.K. Jain and B. Singh, NDS **107**, 1027-1074 (2006)
- **A=39:** B. Singh and J.A. Cameron, NDS **107**, 225-354 (2006)
- **A=1:** B. Singh, NDS **106**, 601-618 (2005)

Nuclide & Superdeformed Structure updates

The following nuclides have been updated for ENSDF:

^{32}Si , ^{58}Ni (*), ^{84}Zr (*), ^{161}Lu (*), ^{249}No , ^{250}No (by B. Singh)

(*) : also SD band update

- SD Data from primary publications during 2005-2006 included in ENSDF (by B. Singh) for the following nuclides:

^{88}Mo , ^{133}Nd , ^{167}Lu , ^{170}Hf , ^{173}Hf , ^{196}Pb

- As of November 1, 2006, we are current on the coverage of SD band data in ENSDF. Continuous updates are planned as new papers appear
- Review work: $A=122$ for ENSDF, ^{241}Pu decay for DDEP (B. Singh)

XUNDL work

Compilation of Data from Current Literature

- Between October 1, 2005 and September 30, 2006, 380 compiled (checked for internal level-scheme and data consistency) datasets prepared by McMaster group have been included in the XUNDL database.
- 28 datasets in XUNDL were revised/updated to incorporate newer related papers from the same groups
- Frequently scan web pages of primary nuclear physics journals:
(PR-C, PRL, NP-A, PL-B, EPJ-A, JP-G)
- As of Nov 1 we are almost up-to-date on the coverage of data from current papers, with the exception of about 10 papers which have appeared in journal web pages in the last 3-4 weeks.
- Quite a lot of compilation work since October 2005 performed by undergraduate student, Joel Roediger until April 2006, and a new undergraduate student Maxim Mitchell since April 2006. Maxim has been receiving training since April in the XUNDL compilation work and basics of nuclear physics and spectroscopy.
- Datasets checked thoroughly by B. Singh, before submission to NNDC for inclusion in XUNDL
- Communication with authors actively pursued to resolve data-related inconsistencies and/or to request additional data details. Copies of about 40 communications between 2004-2006 sent to NNDC.

Work in Progress

(as of October 1, 2006)

A=37. Complete all ENSDF style datasets for all reactions and adopted properties. Work has just started.

A=151. Work has just started to update all nuclides in these A-chains. The previous evaluation was published in 1997.

A=182. Work started in late summer 2005 to update all nuclides of this mass chain. It involves major updating and editing of earlier full evaluation in 1982.

Mentoring and Training of New Data Evaluators through Collaborative work

- **A=165, 218:** Work in collaboration with new team of evaluators at Department of Physics, Indian Institute of Technology, Roorkee, India. Both these A-chains have now appeared in NDS and incorporated in ENSDF. Dr. Jain and two of his Ph.D. students have now independently published or submitted evaluations of other A chains.
- **A=135:** This collaborative work is continuing with the team of evaluators at Petersburg Nuclear Physics Institute, Russia. Dr. Alexander Rodionov from this center visited McMaster for three weeks during June-July 2006. This group is now back in active and independent work. They have published A=131 and are near finishing A=133.

Other Related Activities

- **Three-quasiparticle structures in deformed region:**

A compilation of all the known 3-quasiparticle structures in the deformed region has been prepared, covering all the literature up to July 2005. This work is a collaboration between B. Singh and Dr. A.K. Jain's theory group in India. The paper containing data for 168 3-qp bands is now published:

S. Singh, S.S. Malik, A.K. Jain and B. Singh:

Atomic Data and Nuclear Data Tables 92, 1-46 (2006).

- **Magnetic-dipole rotational (MR) bands:**

Compilation of magnetic-dipole rotational structures is continuing in collaboration with Dr. Jain's theory group in India. A complete update of our previous publication in the year 2000 has been prepared and is expected to be submitted for publication to the Atomic Data and Nuclear Data Tables. A preprint of the table covering data up to October 2006 will soon be made available on NNDC website.

Personnel and Funding

- A. Chen: Professor, Principal Investigator, data group at McMaster.
 - J. C. Waddington: Emeritus-Professor, Co-PI, data group.
 - J. A. Cameron: Emeritus-Professor, A=31-44 mass region.
 - B. Singh: Research Scientist/Nuclear Data Evaluator.
 - J. Roediger: Undergraduate Student; until April 2006.
 - M. Mitchell: Undergraduate Student; since April 2006.
-
- 1/2 FTE support from DOE, USA + 1/2 FTE from NSERC, Canada.
 - Partial support for undergraduate student.

Part 2: Astrophysics Data

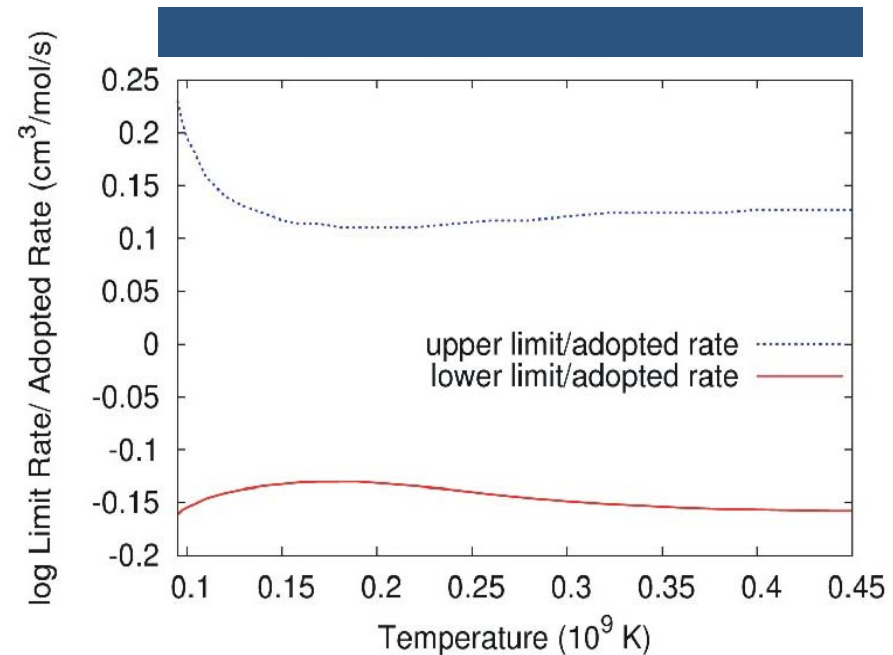
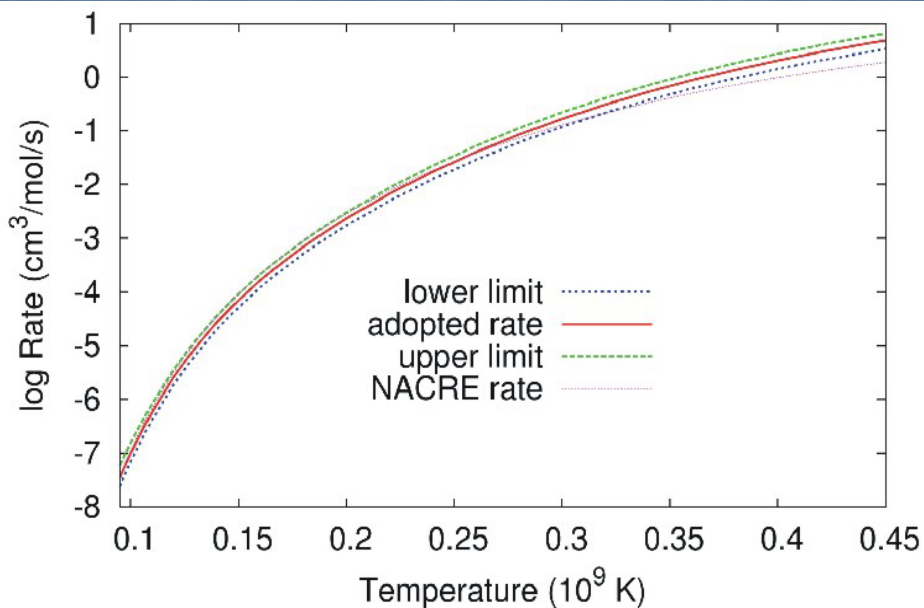
Prepared by: A. Chen

Evaluation of Data for Astrophysics

- Personnel: A. Chen (McMaster faculty)
J. Pearson (postdoc, part-time)
- Evaluation closely coupled to experimental program of McMaster team (e.g., TRIUMF)
- Reactions evaluated: $^{26}\text{Al}(p,\gamma)^{27}\text{Si}$ and $^{40}\text{Ca}(\alpha,\gamma)^{44}\text{Ti}$ (ongoing)
 - New data for both reactions from TRIUMF-ISAC
 - Additional updated rates (ongoing as more new data arrive):
 - $^{21}\text{Na}(p,\gamma)^{22}\text{Mg}$, $^{18}\text{Ne}(\alpha,p)^{21}\text{Na}$, $^{25}\text{Al}(p,\gamma)^{26}\text{Si}$, $^{13}\text{N}(p,\gamma)^{14}\text{O}$

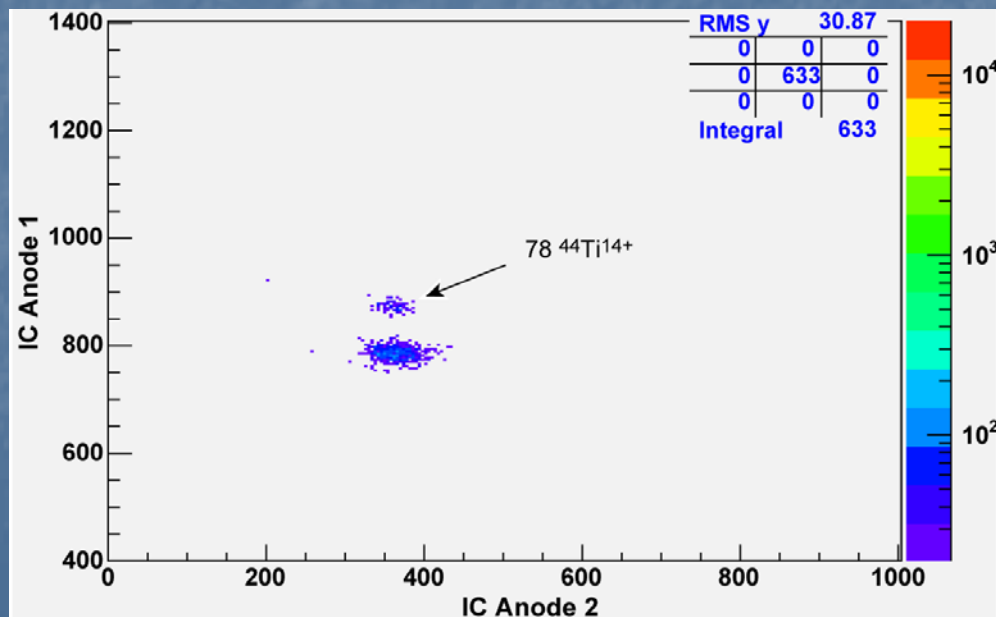
Evaluation of the $^{26}\text{Al}(p,\gamma)^{27}\text{Si}$ reaction rate

- Critical rate in the destruction of galactic ^{26}Al in explosive nucleosynthesis – 1.8 MeV γ -ray from ^{26}Al decay has been observed with telescopes
- Incorporated new data from recent measurement of key resonance for the reaction rate at TRIUMF-ISAC using DRAGON (Ruiz et al. PRL (2006))



Evaluation of the $^{40}\text{Ca}(\alpha,\gamma)^{44}\text{Ti}$ reaction rate

- Important in production of the observed gamma emitter ^{44}Ti in supernova explosions ($E_\gamma = 1.16 \text{ MeV}$)
- New measurement of the cross section has been carried out at TRIUMF-ISAC in 2005-06.
- Data analysis and rate evaluation in progress
(Ph.D. thesis, C. Ouellet, McMaster University)



E- Δ E spectrum
from ionization
chamber

(energy in a.u.)