Nuclear Data Project

McMaster University

Status Report: Oct. 1, 2011-Sept. 30, 2012

Balraj Singh (McMaster)

USNDP meeting: Nov 5-6, 2012

Nuclear Structure and Decay Data (85%)

Balraj Singh, John Cameron, Jun Chen, Michael Birch, Ervin Thiagalingam

- ENSDF
- XUNDL (includes papers on Atomic masses)
- NSR (includes papers on nuclear reactions)
- Topical Evaluations: B(E2); Beta-delayed neutron emitters
- ENSDF training workshops
- Collaborative research projects

ENSDF

- Published A-chains in NDS
- A=36, 37, 62, 77, 34: NDS **113:** 1-155; 365-514; 973-1114; 1115-1314; 1563-1733 (2012): all shared with other groups in US-NDP
- Submitted A-chains/nuclides FY-12
- A=42, 164 + 20 individual nuclides (total of 48 nuclides)
- Final versions of A-chains for NDS with NNDC: A=31, 89
- Post-review versions, near final versions: A=85, 75, 129
- A=42, 43, 164: at pre- or post-review stage.
- In progress: A=76, 130, 139, 189, 190 + individual nuclides

- Collaborators from other centers: N. Nica (Texas A&M), J.K. Tuli and T. Johnson (NNDC), N. Negret (Bucharest), J. Timar and Z. Elekes (ATOMKI), A. Rodionov and Yu. Khazov (PNPI), P.K. Joshi (TIFR), A. Farhan (Kuwait)

ENSDF cont.

- A working version of JAVA-NDS code developed primarily at McMaster given to NNDC in Oct 2011. For several years it has been used routinely to produce ‘band drawings in color’ for NDS publication. In August 2012, on request the code was given to Dr. Marco Verpelli. He plans using this code to produce drawings for decay schemes, and perhaps also for XUNDL datasets.

- M. Birch has developed a general purpose code which has a library of different averaging procedures, including outliers. This code also handles asymmetric uncertainties, not handled by AVETOOLS.

  (Presentation by M. Birch at this meeting)

XUNDL Oct 7, 2011 to Oct 31, 2012

- 508 new datasets (includes 42 with D. Kulp)
- 18 datasets updated for new papers
- 84 (63 from TUNL, 21 from ANL) checked/edited
- Represent about 280 papers.
- At McMaster: undergraduate students: M. Birch since March 2011; E. Thiagalingam since March 2012
- M. Birch wrote a new code to replace temporary key-numbers to permanent ones.
- Active communication with authors continued to resolve data-related inconsistencies and/or to request additional data details. Excellent response to such requests. Benefits both the data compilers/evaluators and researchers
- Mass compilations: 19 papers: 195 data points; sent to ORNL.

XUNDL work will continue in 2012-13

NSR

- PRC articles:

  In FY-12 about 820 keyword abstract were prepared from about 1250 articles (13 months of PRC).

  M. Birch and E. Thiagalingam prepared first drafts.

  B. Singh provided training for the key-wording process. Draft of keywords checked and edited for technical content, wording, and run through NSR-PREP code to resolve formatting errors, prior to sending to NNDC.

Topical Evaluations

- B. Pritychenko, **J. Choquette**, M. Horoi, **B. Karamy** and **B. Singh**, An update of B(E2) evaluation for 0_1^+ to 2_1^+ transitions in even-even nuclei near N~Z~28, ADNDT 98, 798-811 (2012).
- B(E2) data for 0_1^+ to 2_1^+ transitions in even-even nuclei for Z=2-22, Z>32 have been evaluated. Article for Z=2-22 region is being prepared for submission to ADNDT.
- In October 2011, B. Singh participated in Consultants' meeting at IAEA for a reference database of %P(n) values for beta-delayed neutron emitters. Summary report was published by D. Abriola, **B. Singh** and I. Dillmann: INDC(NDS)-0599 (Dec 2011)
- In May 2012, a follow-up meeting was hosted at McMaster with 15 participants from different countries with interest in experimental and evaluation work of beta-delayed neutron emitters.
- A first draft of evaluation of %P(n) and $T_{1/2}$ for A<72 nuclei has been prepared (talk by M. Birch at this meeting).

ENSDF training workshops

- August 6-17, 2012: IAEA-ICTP-Trieste: B. Singh participated as lecturer.

  Coordinated evaluation of A=211 mass chain, which has since been submitted for NDS/ENSDF.

- November 26-29, 2012: workshop is planned at Variable Energy Cyclotron Center (VECC) in Kolkata, India.

  B. Singh plans to participate, lecture and coordinate A=215 evaluation. Hope for strengthening ENSDF evaluation work in India.

Collaborative research projects

- In connection with ongoing work on A=139 with P.K. Joshi at TIFR in India, long-standing issue of discrepant half-life of ^{139}Ba has been settled by an experiment at BARC reactor facility in India. Also level-scheme study of N=82, 139La

  L.S. Danu, **P.K. Joshi**, D.C. Biswas, S. Mukhopadhyay, A. Goswami, P.N. Prashanth, L.A. Kinage, R.K. Choudhury, **B. Singh**:

  Eur. Phys. Jour. A (accepted, 2012)

- McMaster plans participation in IAEA-CRP approved in September 2012 for beta-delayed neutron emitters

- Deformed Structures and Shape Coexistence in ^{98}Zr: experiment approved at TRIUMF August 2012. Spokespersons: S.W. Yates, P.E. Garrett, J.L. Wood. B. Singh plans to participate in this experiment which is expected sometime in spring 2013.

Nuclear Astrophysics Data Evaluation

Jun Chen, Alan Chen

- Astrophysical reaction rate evaluated and updated for reactions:

  $^{17}F(p,\gamma)^{18}Ne$

  ➢ an important reaction for understanding nova explosions and x-ray bursts.

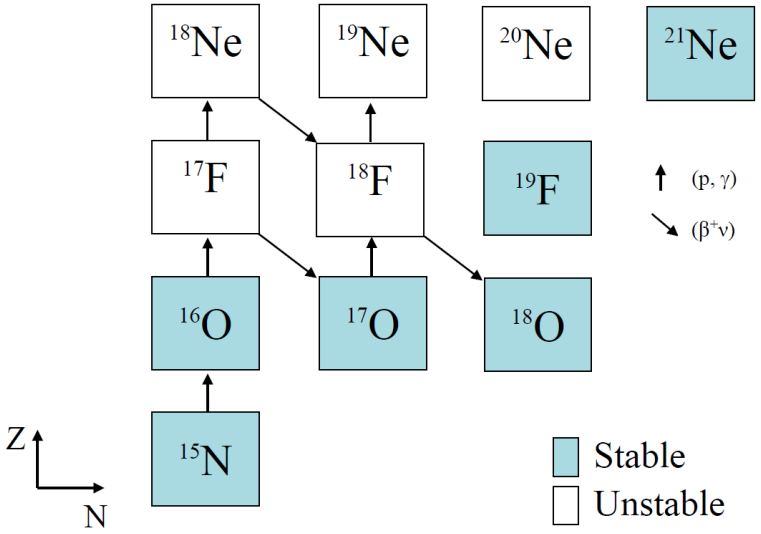
  $^{55}Co(p,\gamma)^{56}Ni$

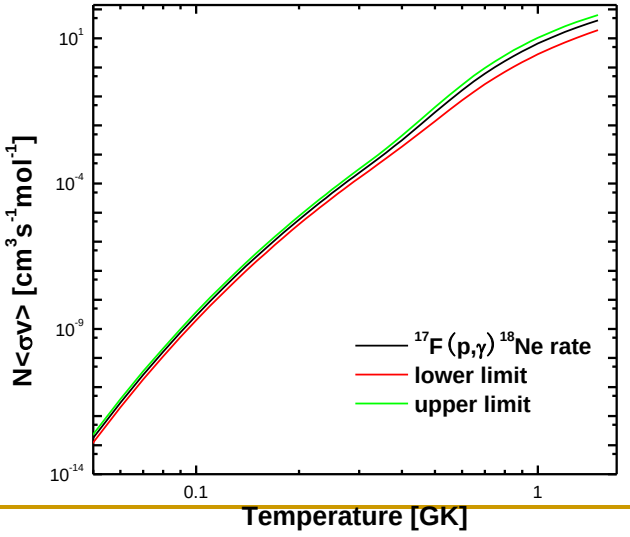
  ➢ have the largest effect on the yield of ^{55}Fe in supernovae

- Rates submitted using the Computational Infrastructure for Nuclear Astrophysics at www.nucastrodata.org at ORNL

$^{17}F(p,\gamma)^{18}Ne$ Rate

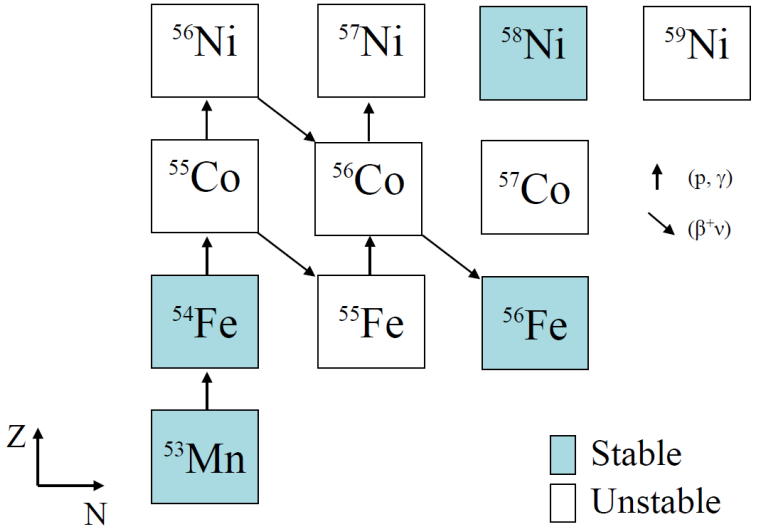
- It significantly affects the final isotopic abundances in novae and x-ray bursts.
- The rate is uncertain because the level structure above the proton threshold is not well understood.
- Rate is dominated at Nova temperatures (0.1-0.4 GK) by a broad proton resonance at 600 keV with a large uncertainty in its resonance strength.
- S(p)=3923.05(44) keV from recent mass evaluation by Audi et al. (2011AuZZ)

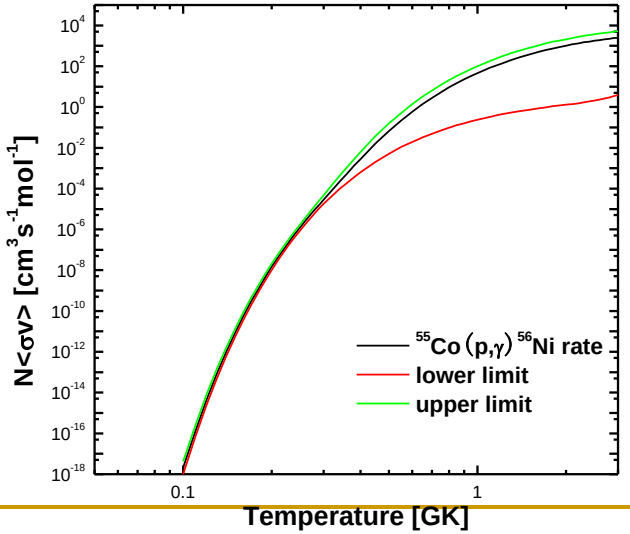




$^{55}Co(p,\gamma)^{56}Ni$ Rate

- Main reaction influencing the yield of 55Fe gamma-rays from supernovae at T=1-3 GK.
- Proton resonant states in ER=700 – 1500 keV region are important for the rate.
- Spins and parities of relevant resonant states are unknown. Only theoretical resonance strengths are available.
- Large uncertainties still remain in the resonance energies of important states.
- S(p)=7166.62(34) keV from recent mass evaluation by Audi et al. (2011AuZZ)





Division of effort

- TOTAL: 1.5 FTE + 1 volunteer
- ENSDF: 0.85 FTE + 1 volunteer (John Cameron)
- Nuclear Astrophysics data (evaluation): 0.2 FTE
- XUNDL, Mass compilation: 0.25 FTE
- NSR key-wording, training of students, etc. : 0.20 FTE

Current collaborations (Data evaluation-related work):

- 1. National Nuclear Data Center, Brookhaven National Lab.: Drs. B. Pritychenko, T. Johnson, J.K. Tuli, E.A. McCutchan, A.A. Sonzogni
- 2. Physics Department, Kuwait University, Kuwait: Prof. A. Farhan
- 3. Petersburg Nuclear Physics Institute, Gatchina, Russia: Drs. A.A. Rodionov, Y. Khazov
- 4. Nuclear Research Institute (ATOMKI), Debrecen, Hungary: Drs. J. Timar, Z. Elekes
- 5. Institute of Nuclear Physics (IFJ-PAN), Krakow, Poland: Dr. K. Zuber
- 6. National Institute of Physics and Nuclear Engineering , Bucharest, Romania: Dr. A. Negret
- 7. Tata Institute of Fundamental Research (TIFR), Mumbai, India: Dr. P.K. Joshi
- 8. International Atomic Energy Agency (IAEA-NDS): Dr. D. Abriola

Personnel and Funding

- A.A. Chen: Assoc. Professor, PI of Data Project.
- J. C. Waddington: Emeritus-Professor, Co-PI of Data Project.
- J. A. Cameron: Emeritus-Professor: Volunteer work since 1999:
  ENSDF evaluation of A=31-44 region (region completed 2012)
- B. Singh: Senior Research Scientist/Nuclear Data Evaluator.
- J. Chen: Post-doctoral Fellow: until March 2012

Undergraduate students:

- J. Choquette: until Dec 2011
- M. Birch: since March 2011
- E. Thiagalingam: since March 2012

- Financial support: Office of Nuclear Physics, Office of Science, DOE, USA

Staff data for 2011-2012

- Scientific Permanent staff: 4
  US-NDP funded: 1.0 FTE (DOE)
- Scientific Temporary staff: 1; US-NDP funded: 0.5 FTE (DOE)
- Scientific External collaborators: 14; US-NDP funded: 5
  (Partial coverage of expenses for visiting scientists to McMaster)
- Technical/Support staff: none
- New Hires: none
- Resignations/Retired: none