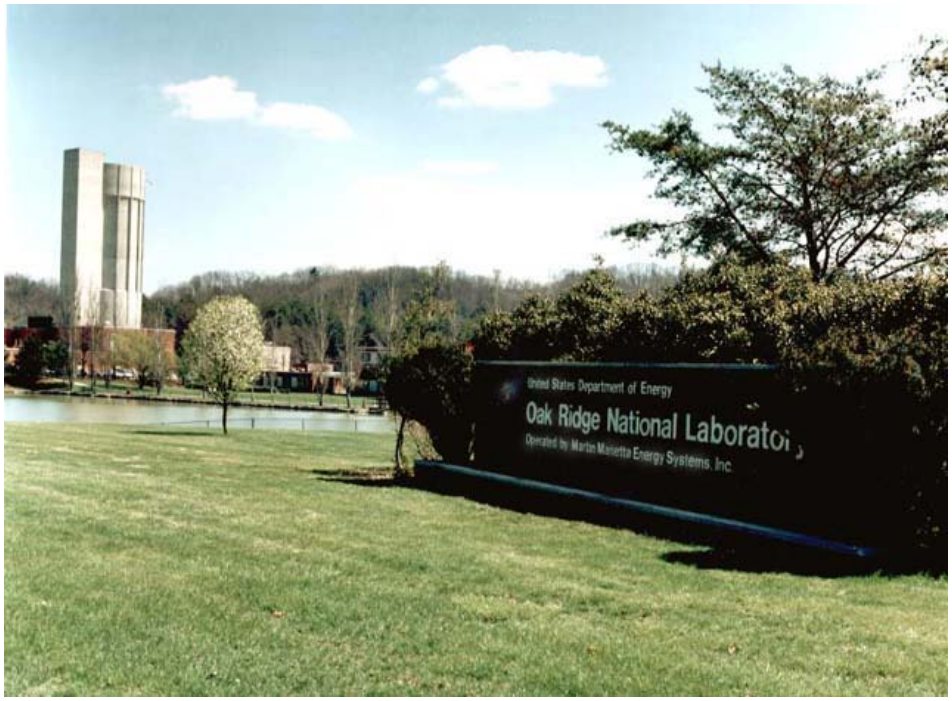
Recent Activities & Initiatives in the ORNL Nuclear Data Program – USNDP 2010

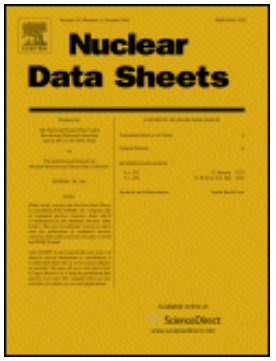


Caroline D. Nesaraja,
Michael S. Smith
ORNL
Physics Division

Activities

Nuclear Structure Data

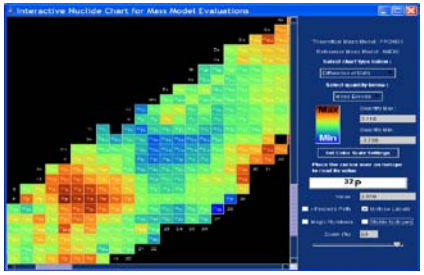
- A-chain Evaluations



Nuclear Astrophysics Data

- Evaluation and assessments of reactions critical for stellar explosion studies
(closely coupling research and data activities)

- Improve and expand functionality of the Computational Infrastructure for Nuclear Astrophysics and the Nuclear Masses software system



Nuclear Structure Data

EVALUATIONS

Responsibility: Actinide
Evaluations A=241 – 249

A=152 evaluation in progress
(Murray Martin)

A=69 evaluation in progress
(Caroline Nesaraja) * also for astrophysics

A=121 follow up on review
(Murray Martin & Caroline Nesaraja)

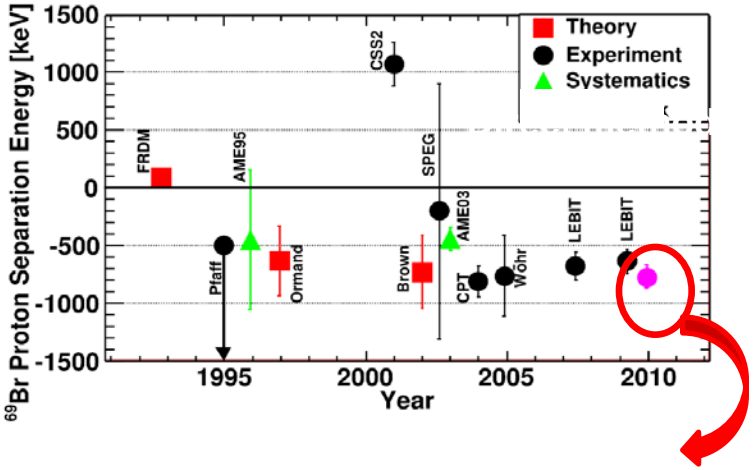
A=125 reviewed
(Murray Martin)

Close Coupling of Data Evaluation and Processing with Astrophysics Research at ORNL

^{69}Br Astrophysics Motivation: Properties of ^{69}Br essential for studying the rp-process waiting point nucleus ^{68}Se in X–ray burst

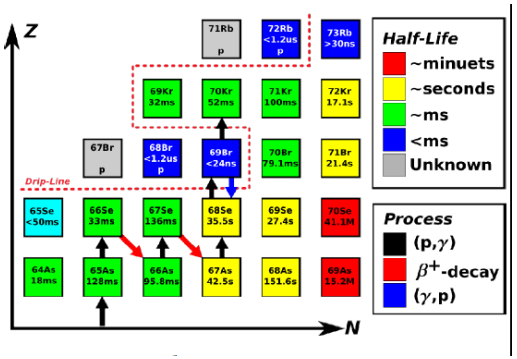
Waiting point nuclei:
Nuclides along the rp process path that hinder or delay the abundance flow to heavier masses are called waiting point nuclei (^{64}Ge, ^{68}Se, ^{72}Kr …)

Andrew M. Rogers. PhD Thesis, MSU. 2009



$S_p = -785^{+34}_{-40}$ keV

Direct method with lower uncertainties and model independent.



Level structure of ^{69}Br can be constrained from:

- Experimental Data
- Known structure information of the mirror nuclei ^{69}Se
- Theoretical shell Model Calculation

Work in progress:

- include in **ENSDF**
- generate statistical model cross section for ^{68}Se(p,γ)^{69}Br
- convert to reaction rate with CINA
- perform post processing element synthesis X-Ray bursts calculations with new CINA rate

Nuclear Astrophysics Data

^{26}Si

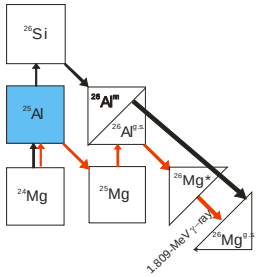
Motivation: **Properties of ^{26}Si** levels important for the ^{25}Al(p,γ)^{26}Si reaction rate which affect the production of galatic ^{26}Al

D.W.Bardayan
et al., 2002 & 2006

E_x	E_x,	J^π
5914 ± 2^a	5927 ± 4	3^+
6300 ± 4^b	6317 ± 7	$(2^+)^c$
6380 ± 4^b	6386 ± 3	$(2^+)^c$
6787 ± 4	6784 ± 3	3^-
7019 ± 10	7031 ± 5	$(0^+, 1^-)^d$
7160 ± 5	7157 ± 4	2^+
7425 ± 7^b	7439 ± 6	$(2^+)^c$
7498 ± 4^b	7512 ± 8	$(2^+)^c$
7687 ± 22	7672 ± 2	3^-
7900 ± 22	7875 ± 2	1^-
8120 ± 20^e		$(1^-, 2^+)^e$
–	$(8166) \pm 7$	
8570 ± 30^e		$(1^-, 2^+)^e$
8700 ± 30^e	8682 ± 5	$(1^-, 2^+)^e$
–	$(9124) \pm 8$	
9170 ± 30^e		$(1^-, 2^+)^e$
–	$(9952) \pm 17$	

^{24}Mg(p,γ)^{25}Al → (p, γ)^{26}Si(β$^+$ν)^{26m}Al(β$^+$ν)^{26}Mg$_{GS}$

^{24}Mg(p,γ)^{25}Al → (β$^+$ν)^{25}Mg(p,γ)^{26}Al(β$^+$ν)^{26*}Mg(γ)^{26}Mg$_{GS}$



The ^{28}Si(p,t)^{26}Si*(p) Reaction and Implications for the Astrophysical ^{25}Al(p,γ)^{26}Si Reaction Rate
K.A. Chipps et al., Phys. Rev. C 82, 045803 (2010)

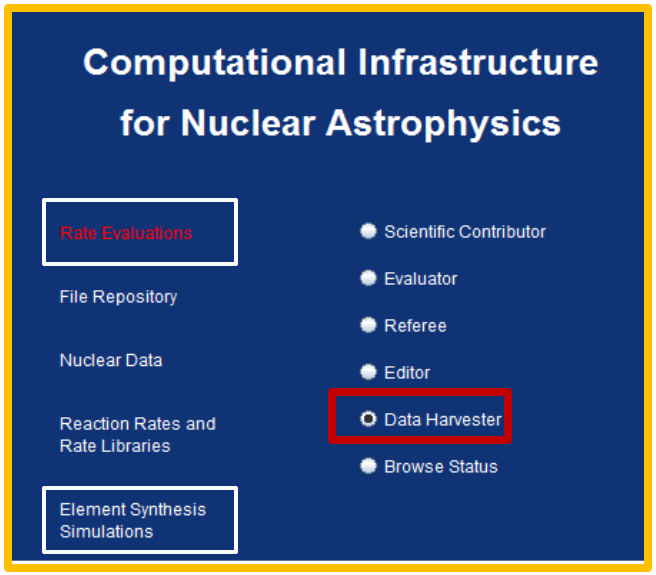
E_x (keV)	J^π	$B_p = \Gamma_p/(\Gamma_p + \Gamma_\gamma)$
5927	3^+	0.91 ± 0.10
$6317 + 6386$	2^+	0.88 ± 0.20
6784	3^-	1.21 ± 0.24^a
$7031 + 7157$	2^+	1.04 ± 0.25
$7439 + 7512$	2^+	1.31 ± 0.27^b
7672	3^-	1.18 ± 0.23^a
7875	1^-	1.11 ± 0.22^a

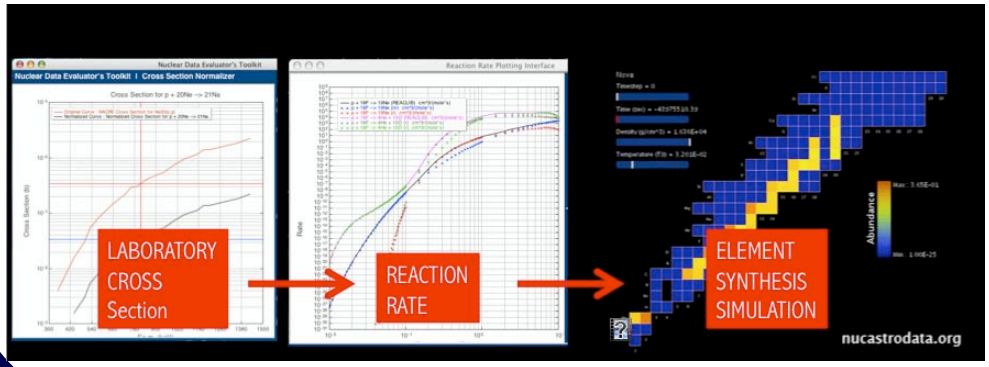
First measurement of proton decay branching ratios for unbound ^{26}Si

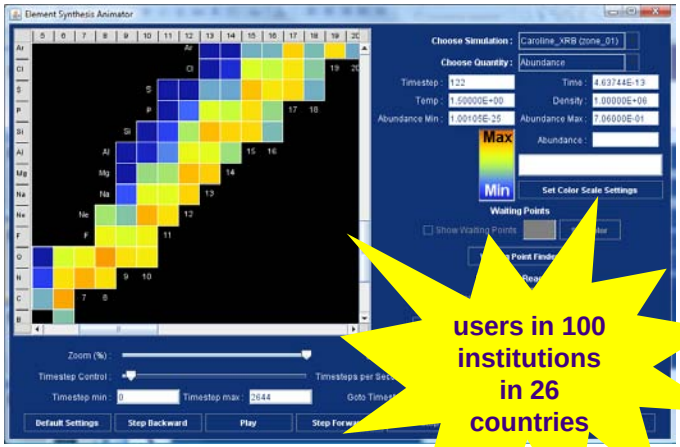
Computational Infrastructure for Nuclear Astrophysics

New Features since USNDP-2009 meeting

- Rate Evaluation
  - – Data Harvester : collect information from a number of major international databases
- Element Synthesis Simulations
  - – Element Synthesis Simulator: reaction rate sensitivity studies
  - – Element Synthesis Manager: report information, copy and erase simulations
  - – Element Synthesis Visualizer: sensitivity studies plotting interface of final abundance vs. rate

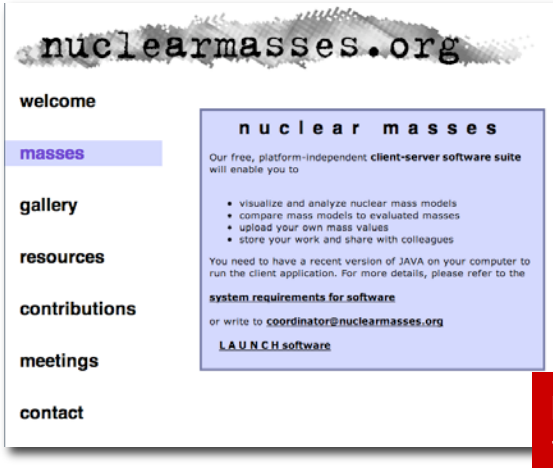




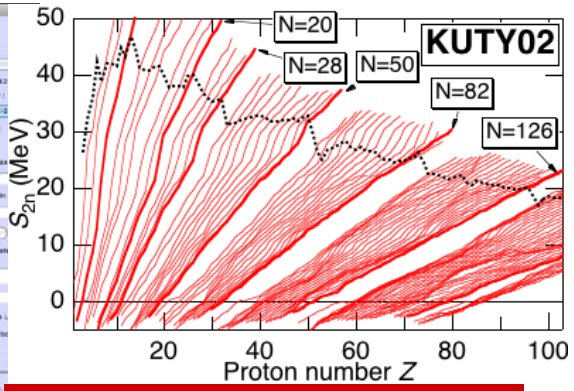


users in 100 institutions in 26 countries

Nuclear Masses



plot of the chosen reference dataset - AME2003 evaluated masses

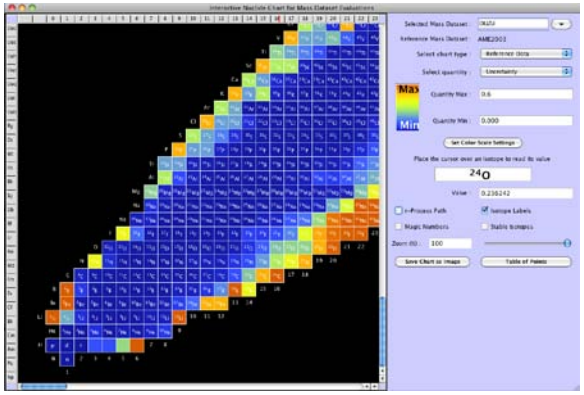


simple analyses of datasets are possible

nuclearmasses.org launched to aid research in nuclear masses and to help facilitate a proposed new effort in nuclear mass evaluations

New Features since USNDP-2009 meeting

- new mass compilation from Balraj Singh / McMaster Univ .
- generate table of data points
- uncertainty in masses can be entered , modified and visualized



Publications

Nucl. Data Sheets **111**, 897 (2010)
C.D.Nesaraja, S.D.Geraedts, B.Singh.
Nuclear Data Sheets for A = 58

Phys.Rev. C **82**, 045803 (2010)
K.A.Chipps et al.
The ^{28}Si(p,t)^{26}Si(p) Reaction and Implications for the Astrophysical ^{25}Al(p,g)^{26}Si Reaction Rate*

Phys.Rev. C **82**, 047302 (2010)
K.Y. Chae et al.
Spin assignments to excited states in ^{22}Na through a ^{24}Mg(p,^{3}He)^{22}Na reaction measurement

Phys.Rev. C **81**, 065802 (2010)
D. W. Bardayan et al.
Inelastic ^{17}F(p, p)^{17}F scattering at Ec.m.=3 MeV and the ^{14}O(α, p)^{17}F reaction rate

Nature (London) **465**, 454 (2010)
K.L. Jones et al.
The magic nature of ^{132}Sn explored through the single-particle states of ^{133}Sn

Selected Presentations

10th Int. Symp. Origins of Matter Evolution of Galaxies, Osaka, Japan, March 2010

"ORNL Radioactive Beams for Stellar Explosion Studies", M.S. Smith (invited)

"Bottlenecks and Waiting Points in Nucleosynthesis in X-ray bursts and Novae", M.S. Smith, T. Sunayama, W.R. Hix, E.J. Lingerfelt, C.D. Nesaraja (contributed)

"Nuclear Mass Visualization and Analysis at nuclearmasses.org", M.S. Smith, E.J. Lingerfelt, C.D. Nesaraja, H. Koura, and F.G. Kondev (contributed)

APS April Meeting 2010, Washington DC

Oral:
Structure of 69Br and the rp process in X-ray bursts
Caroline Nesaraja & Michael Smith

Oral:
Nuclear Masses : Sharing, Visualization, and Analysis Tool at nuclearmasses.org
M.S. Smith, E.J. Lingerfelt, C. D. Nesaraja , H.Koura & F. G. Kondev

Selected Presentations

ND 2010 International Conference on Nuclear Data for Science & Technology, Jeju Island, Korea

Invited Speaker (Plenary Session)
Nuclear Data for Astrophysics Research: A new Online Paradigm
Michael Smith

Poster:
Close Coupling of Data Evaluation and Processing with Astrophysics Reseach at ORNL
Caroline Nesaraja, Michael Smith, Eric Lingerfelt & Kelly Chipps

Seminars

"Recent Progress in Nuclear Astrophysics at ORNL", M.S. Smith, Chinese Inst. Atomic Energy, Beijing, PR China, Sept. 2010 (invited)

"Impact of Nuclear Structure Physics in Nuclear Astrophysics", M.S. Smith, Liaoning Normal University, Dalian, PR China, Sept. 2010 (Invited)

Summary/ Future Work

Nuclear Structure/ Nuclear Astrophysics Data Evaluation and Assessments

- Mass chain evaluation A=152 & A=69 (properties of ^{69}Br important for astrophysics)

Computational Infrastructure for Nuclear Astrophysics

- Implement a set of workflow tool for international collaboration in Nuclear Astrophysics
- Explore how work flow tools can be utilized in the broader Nuclear Data Community

Nuclear Masses

- Explore role of nuclearmasses.org in future mass evaluation efforts

Personnel & Funding

Scientific Permanent staff: 2 heads, USNDP funded 1.2 FTE

Scientific Temporary staff (Postdocs, long term visitors): 1 head, USNDP funded 0.15 FTE

Scientific External collaborators: many but none funded by USNDP

Technical/Support staff: 1 head, USNDP funded 0.5 FTE

New hires:
- none

Resigned/Retired:
- none