

Recent Activities & Initiatives in the ORNL Nuclear Data Program – USNDP 2009

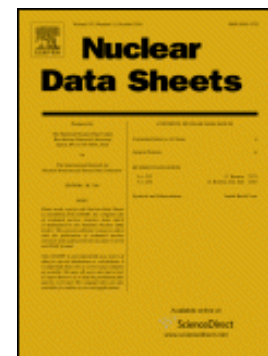


Caroline D. Nesaraja,
Michael S. Smith
ORNL
Physics Division



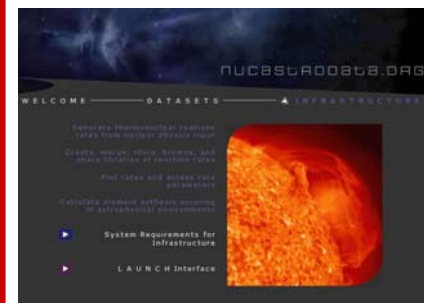
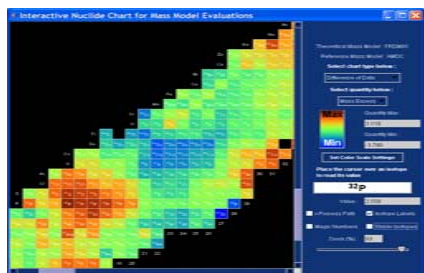
Nuclear Structure Data

- 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
- Software to facilitate a proposed new effort in nuclear mass evaluations



Nuclear Structure Data

EVALUATIONS

Responsibility: Actinide
Evaluations A=241 – 249

A=152 evaluation in progress
(Murray Martin)

A=69 evaluation in progress
(Caroline Nesaraja)

A=121 review
(Caroline Nesaraja trained by Murray Martin)

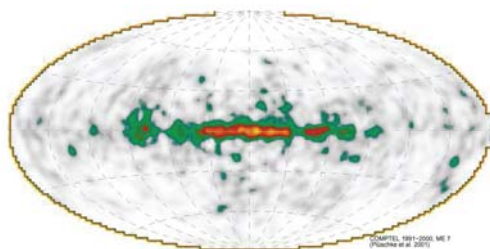
243Cf 10.7 M	244Cf 19.4 M	245Cf 45.0 M	246Cf 35.7 H	247Cf 3.11 H	248Cf 933.5 D	249Cf 551 Y	250Cf 13.0 Y
ε	α	ε	α	ε	α	α	α
242Bk 7.0 M	243Bk 4.5 H	244Bk 4.35 H	245Bk 4.94 D	246Bk 1.80 D	247Bk 1380 Y	248Bk >9 Y	249Bk 330 Y
ε	ε	ε	ε	ε	α	α	β-
241Cm 32.8 D	242Cm 162.8 D	243Cm 29.1 Y	244Cm 18.1 Y	245Cm 8500 Y	246Cm 4780 Y	247Cm 1.56E+7 Y	248Cm 3.48E+7 Y
ε	α	α	α	α	α	α	α
240Am 50.8 H	241Am 432.6 Y	242Am 16.02 H	243Am 7370 Y	244Am 10.1 H	245Am 2.05 H	246Am 39 M	247Am 23.0 D
ε	α	β-	α	β-	β-	β-	β-
239Pu 24110 Y	240Pu 6561 Y	241Pu 14.290 Y	242Pu 3.75E+5 Y	243Pu 4.956 H	244Pu 8.00E+7 Y	245Pu 10.5 H	246Pu 10.8 Y
α	α	β-	α	β-	α	β-	β-

[illegible]

Nuclear Astrophysics Data

^{27}Si

Motivation: Properties of ^{27}Si above the proton threshold energy needed for the $^{26}\text{Al}(p,\gamma)^{27}\text{Si}$ reaction rates



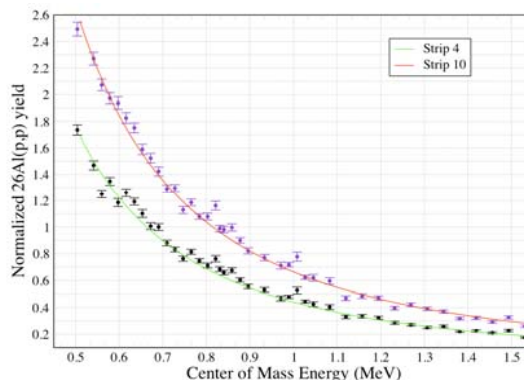
Detection of γ rays from decay of ^{26}Al is evidence of continuing nucleosynthesis in the Milky Way Galaxy

$^{26}\text{Al}(p,\gamma)^{27}\text{Si}$ reaction in novae, affects the interpretation of Galactic ^{26}Al observations

Many levels in the relevant energy range (7.5 – 8.5 MeV) have unknown **J^π and proton widths**

Measurement of **elastic and inelastic $^{26}\text{Al}+p$ scattering** reaction using radioactive ^{26}Al beam at ORNL's **HRIBF**

PhD. Thesis of Stephen Pittman
University of Tennessee, Knoxville



NNDC- NUDAT based on ENSDF

—	8777	16 KeV
—	8671	5.4 KeV
—	8545	4.8 KeV
(1/2,3/2)+	8451	
(3/2+ TO 9/2+)	8358	< 0.5 KeV
(7/2+ TO 13/2+)	8289	< 1.0 KeV
—	8207	
—	8140	
?	8036	
—	7911	
(9/2,11/2+)	7831	< 1.0 KeV
(9/2,11/2+)	7740.8	< 0.3 KeV
—	7652	
—	7532	
—	7428	
—	7324	
—	7223	
—	7080	
—	7005	

^{27}Si

Data analysis and level assessments in progress

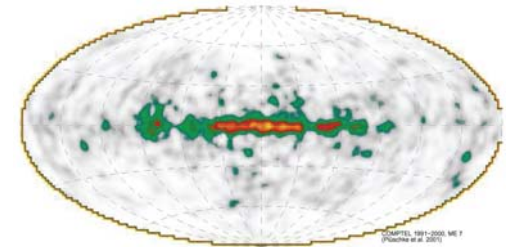
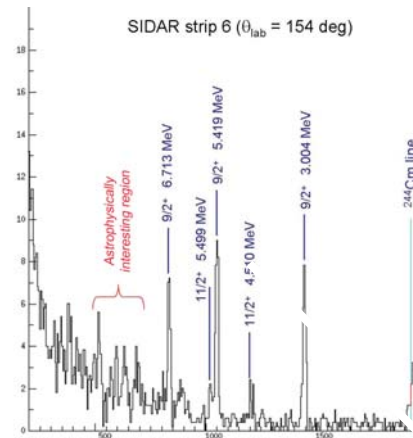
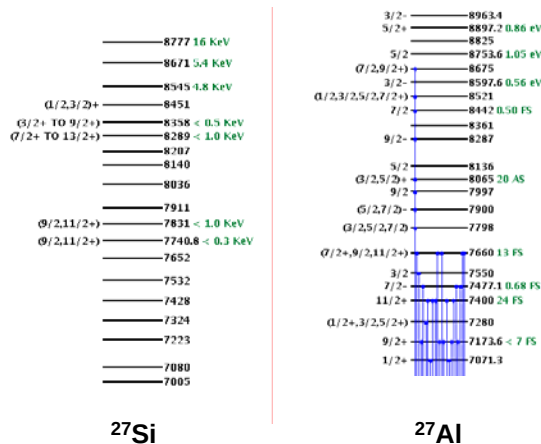
Nuclear Astrophysics Data

^{27}Si

Motivation: Properties of ^{27}Si above the proton threshold energy needed for the $^{26}\text{Al}(p,\gamma)^{27}\text{Si}$ reaction rates

Measurement of $^{26}\text{Al}(d,p)^{27}\text{Al}$ reaction in inverse kinematic was studied to search for mirrors states in ^{27}Al to inform the ^{27}Si structure

NNDC- NUDAT based on ENSDF



Online spectrum from a single strip of SIDAR for a subset of the data taken during the experiment

Data under analysis by PhD student Stephanie Brien from the University of West Scotland

Data analysis and **level assessments** in progress

Nuclear Astrophysics Data

^{18}Ne

Motivation: Properties of ^{18}Ne to understand the directly measured $^{14}\text{O}(\alpha, p)^{17}\text{F}$

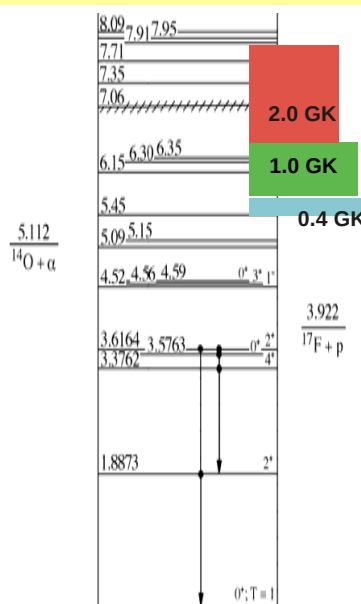
Previous measurements:

$^{17}\text{F}(p, \alpha)^{14}\text{O}$ (J.C. Blackmon *et al.* 2001)

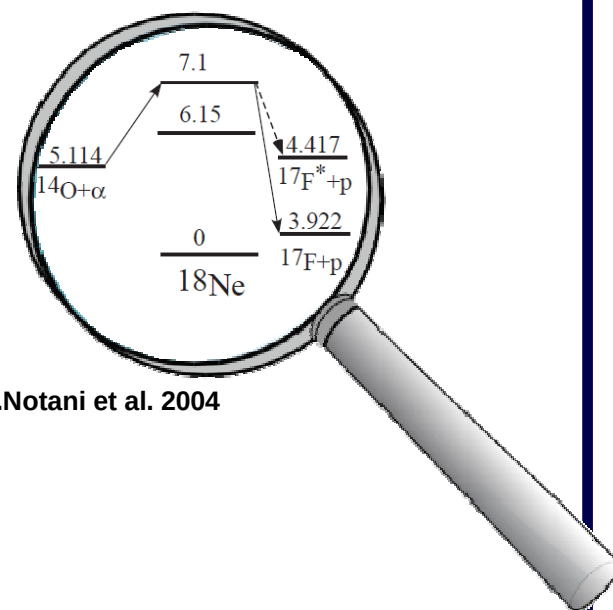
$^{17}\text{F}(p, p')^{17}\text{F}^*$ (B. Harss *et al.* 2002)

$^{14}\text{O}(\alpha, p)^{17}\text{F}$ (M. Notani *et al.* 2004). New resonance was suggested indicating proton decay from ^{18}Ne to $1^{\text{st}} E_x$ in ^{17}F .

- Implication that this branch can increase the $^{14}\text{O}(\alpha, p)^{17}\text{F}$ reaction rate by 50 %
- Investigate this anomaly via inelastic scattering in the **$^{17}\text{F} + p$ system**



TUNL Nuclear Data Evaluation Project, "Energy Level Diagram, ^{18}Ne ".



M. Notani *et al.* 2004

Data analysis and **level assessments** in progress

D. W. Bardayan,
ORNL

Nuclear Astrophysics Data

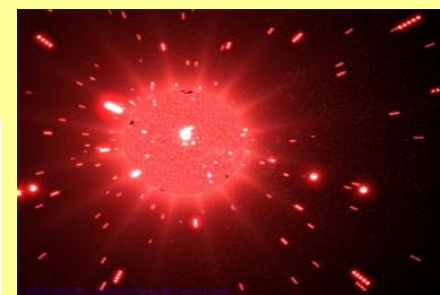
^{125}Sn , ^{131}Sn , ^{133}Sn

R.L. Kozub, TTU & K. L. Jones, UTK

Motivation: Provide nuclear structure information important for simulating r process nucleosynthesis in supernova explosions

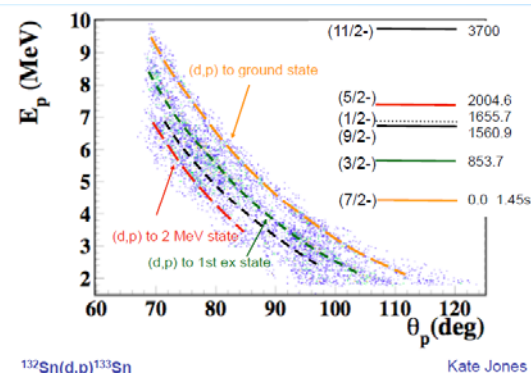
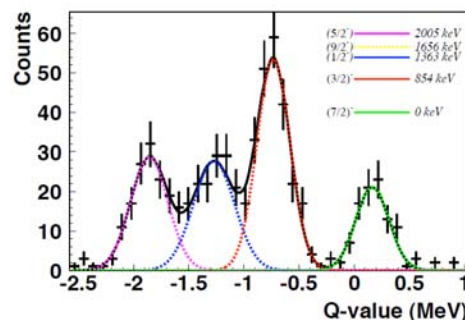
123Te	124Te	125Te	126Te	127Te	128Te	129Te	130Te	131Te	132Te	133Te	134Te	135Te	136Te	137Te	138Te
122Sb	123Sb	124Sb	125Sb	126Sb	127Sb	128Sb	129Sb	130Sb	131Sb	132Sb	133Sb	134Sb	135Sb	136Sb	137Sb
121Sn	122Sn	123Sn	124Sn	125Sn	126Sn	127Sn	128Sn	129Sn	130Sn	131Sn	132Sn	133Sn	134Sn	135Sn	136Sn
120In	121In	122In	123In	124In	125In	126In	127In	128In	129In	130In	131In	132In	133In	134In	135In

Evaluations of selected nuclei related to ongoing research at ORNL



NNDC-NUDAT

- (d,p) transfer experiments made with unique radioactive ^{130}Sn and ^{132}Sn beams and stable ^{124}Sn
- selectively populates single-neutron states in the recoiling nucleus



Level assessments in progress and papers being drafted

Computational Infrastructure for Nuclear Astrophysics

New Features since USNDP-2008 meeting

- New reaction rate calculator ----- in progress
- simplified interface for element synthesis animator
- made six new profiles of X-ray bursts available for simulations
- simplification of tools for sensitivity studies----- in progress

Computational Infrastructure for Nuclear Astrophysics

Rate Evaluations

☐ Element Synthesis Simulator

Repository

☐ Element Synthesis Manager

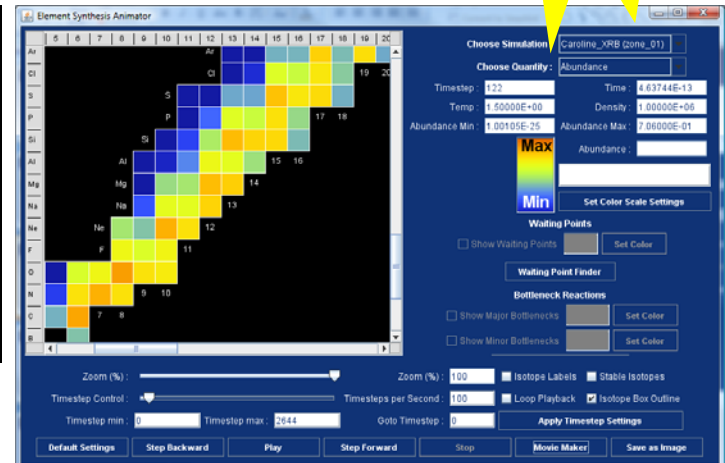
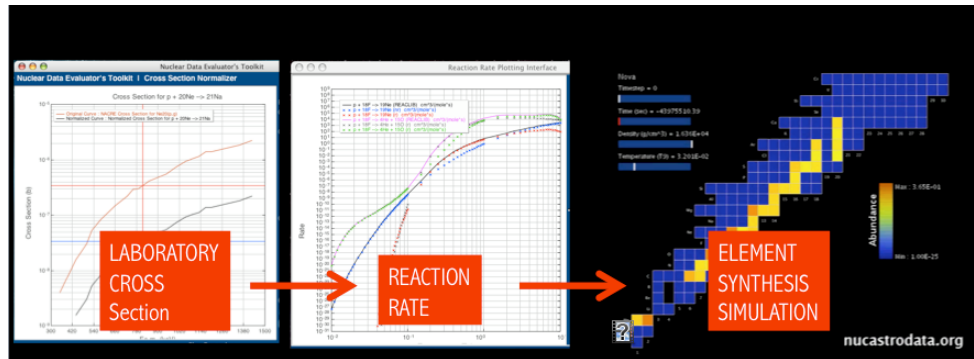
Nuclear Data

☒ Element Synthesis Visualizer

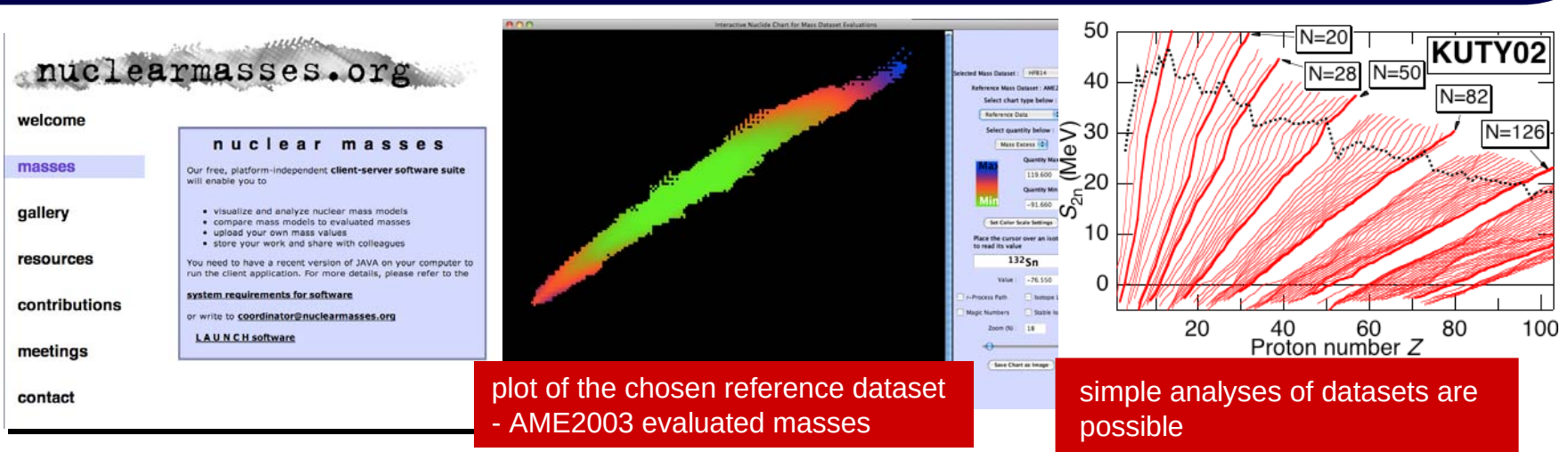
Reaction Rates and Rate Libraries

Element Synthesis

users in 85
institutions
in 22
countries



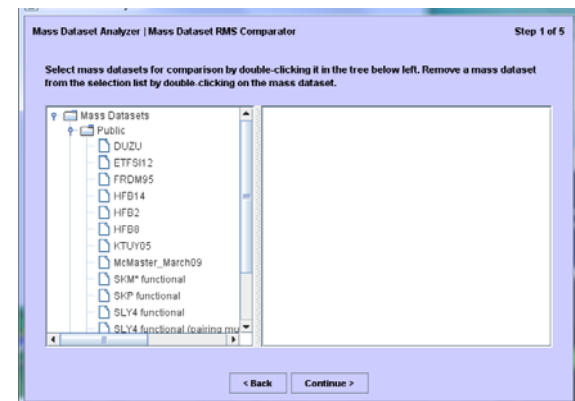
Nuclear Masses



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-2008 meeting

- added capabilities to plot δV_{pn} values
- uploaded 6 new theoretical mass model data sets



Nuclear Masses

- uploaded new experimental mass compilation dataset from **B. Singh, McMaster**

The screenshot shows the website **nuclearmasses.org** with a sidebar on the left containing links: **welcome**, **masses**, **gallery**, **resources**, **contributions**, **meetings**, and **contact**. The main content area displays the **McMaster Mass Compilation 03** page, which includes the compiler's name (Balraj Singh, Allison MacDonald, McMaster Univ., Canada), contact information, date (October 30, 2009), and a list of references. The references are presented in a table with four columns: NSR Key#, Citation, Author, and Title.

NSR Key#	Citation	Author	Title
2009NE03	PRL 102, 112501	D. Neidherr et al.	"Discovery of 229Rn and the Structure of the Heaviest Rn and Ra Isotopes from Penning-Trap Mass Measurements"
2009ER02	PRC 79, 032802	T. Eronen et al.	"Mass and QEC value of 26Si"
2009SA12	PRL 102, 132501	J. Savory et al.	"rp Process and Masses of N=Z=34 Nuclides"
2009EL08	EPJ A34, 341	V.-V. Elomaa et al.	"Light-ion-induced reactions in mass measurements of neutron-deficient nuclides close to A=100"
2009IR03	PLB 675, 170	R. Ringle et al.	"High-precision Penning trap measurements of 9,10Be and the one-neutron halo nuclide 11Be"
2009RO04	PRC 79, 031603	T. Roger et al.	"Mass of 11Li from the 1H(11Li,9Li)3H reaction"
2009GA24	NP A826, 1-23	C. Gaulard et al.	"Mass measurements of the exotic nuclides 11Li and 11,12Be performed with the MISTRAL spectrometer"
2009RE07	PRL 102, 212502	M. Redshaw et al.	"Masses of 130Te and 130Xe and Double-beta-decay Q Value of 130Te"
2009EL07	PRL 102, 252501	V.-V. Elomaa et al.	"Quenching of the SnSbTe Cycle in the rp Process"
2009K0AA	EPJ A, JULY 09	M. Kowalska et al.	"Preparing a journey to the east of 208Pb with ISOLTRAP: Isobaric purification at A=209 and new masses for 211-213Fr and 211Ra"
2009BR09	PRC 80, 035805	M. Breitenfeldt et al.	"Penning trap mass measurements of 99-109Cd with

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)
- Reaction and structure evaluation for ^{27}Si , ^{18}Ne and $^{125,131,133}\text{Sn}$

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