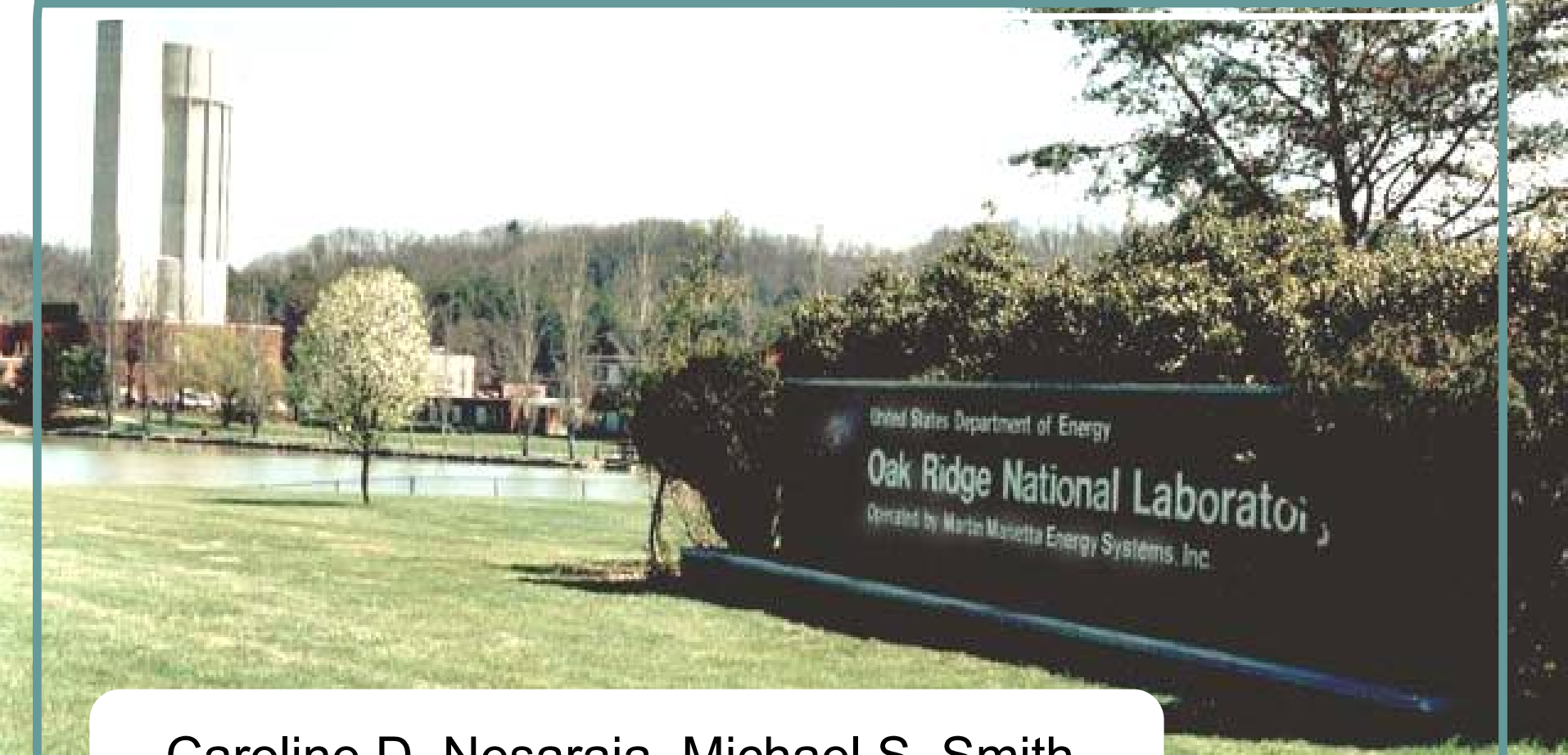
Recent Activities & Initiatives in the ORNL Nuclear Data Program



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

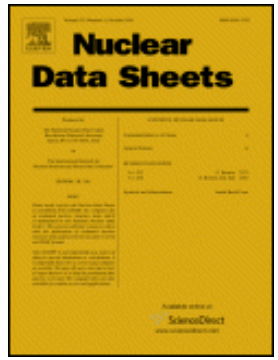
Activities

OAK RIDGE National Laboratory

NNDC

Nuclear Structure Data

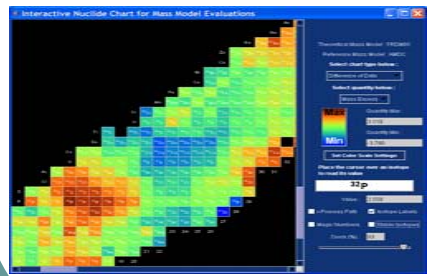
- Actinide A-chain Evaluations



Nuclear Astrophysics Data

- Evaluation of reactions critical for stellar explosion studies (couple research and data activities)

- Activities are portions of PhD theses of 5 graduate students



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

Nuclear Structure Data

EVALUATIONS

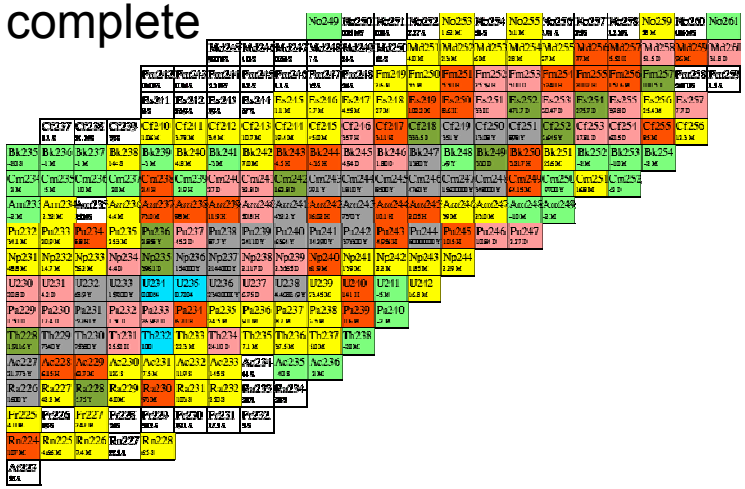
Actinides

Responsibility: Actinide Evaluations A=241 – 249

A=208 to be submitted by mid- November (Murray Martin)

A=201 reviewed (Murray Martin)

A=245 preliminary work done and expected to complete in March 2007 (Murray Martin*)



Light Nuclei

A=58 in progress (Caroline Nesaraja*)

Levels in ^{19}Ne, ^{31}S, ^{18}F (Caroline Nesaraja)

(see Nuclear Astrophysics Data below for details)

TRAINING

* Murray Martin working closely with Caroline Nesaraja on evaluation techniques of heavy nuclei (includes A= 245, A =58)

Nuclear Astrophysics Data

^{19}Ne

Motivation: Knowledge of proton induced reactions on ^{18}F is important for novae and X-ray burst

Publication: Paper has been submitted to Phys. Rev.C

Nuclear structure properties of astrophysical importance for ^{19}Ne above the proton threshold energy

C. D. Nesaraja[1,2], N. Shu[1,3], D. W. Bardayan[1], J. C. Blackmon[1], Y.S. Chen[3], R. L. Kozub[4], P. D. Parker[5], M. S. Smith[1]

Portion of Ph.D. thesis for N. Shu, CIAE, Beijing , 2004
& K.Chae, University of Tennessee Knoxville, 2006

Evaluation of **30 levels** (E_x=6.411 -8.100 MeV)

- new level found at E_x=7.420 MeV via **^{18}F(p,p)^{18}F**
- new values for Γ_p widths from spectroscopic measurements in **^{18}F(d,p)^{19}F**
- new upper limit for Γ_p widths from interference effects among the **J^π=3/2$^+$** from **^{18}F(p,α)^{15}O** measurements
- preparing into ENSDF format and will be submitted to TUNL & XUNDL

Nuclear Astrophysics Data

^{31}S

Motivation: ^{30}P(p,γ)^{31}S reaction plays a crucial role in the synthesis of heavier nuclear species in nova outburst on ONe White dwarfs

Publication: Paper has been submitted to Phys. Rev.C

Astrophysically important ^{31}S states studied with the ^{32}S$(p,d)^{31}$S reaction

Z. Ma,[1] D. W. Bardayan,[2] J. C. Blackmon,[2] R. P. Fitzgerald,[3] M. W. Guidry,[1] W. R. Hix,[2] K. L. Jones,[4] R. L. Kozub,[5] R. J. Livesay,[6] M. S. Smith,[2] J. S. Thomas,[4] and D. W. Visser[3]

Portion of Ph.D. thesis for Z. Ma, University of Tennessee Knoxville, 2006

Evaluation of **44 levels** (4.085-10.577 MeV)

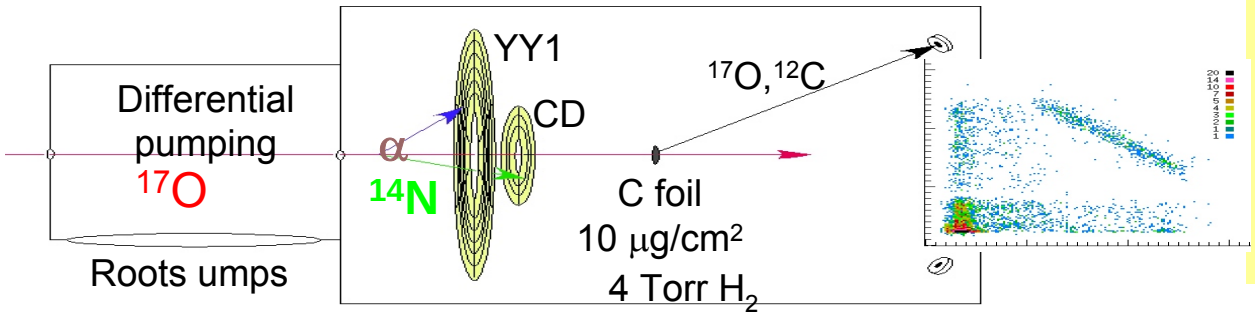
- 5 new states were observed from **^{32}S(p,d)^{31}S** measurement
- new values for Γ_p widths from spectroscopic measurements
- spin and parity were determined or constrained by the DWBA analysis of the angular distributions

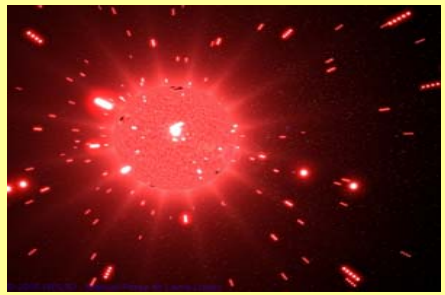
- preparing into ENSDF format and will be submitted to XUNDL

Nuclear Astrophysics Data

^{18}F

Motivation: Structure properties of ^{18}F are important to determine the ^{17}O(p,γ)^{18}F and ^{17}O(p,α)^{14}N rates in Red Giant Stars





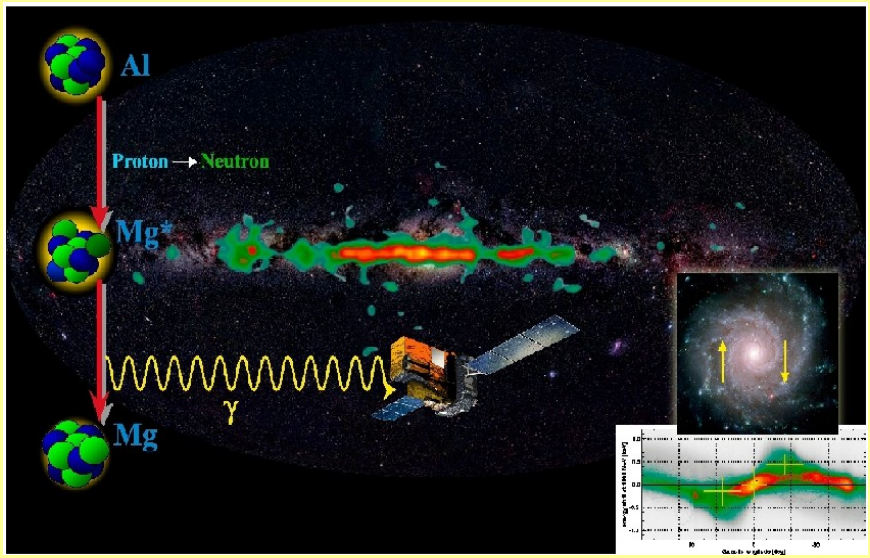
Portion of Ph.D. thesis for B. Moazen, University of Tennessee Knoxville

- a novel technique using a hydrogen gas target and the ^{17}O beam from HRIBF
- this approach allows a high sensitivity for narrow resonances to be measured at resonance 183 keV via **^{17}O(p,α)^{14}N** $\omega\gamma = 1.70 \pm 0.9_{stat} \pm 0.12_{sys}$
- resolved serious discrepancy in literature
- **status – level assessments in progress**

Nuclear Astrophysics Data

^{26}Si

Motivation: ^{25}Al(p,γ)^{26}Si reaction in novae affects the interpretation of Galactic ^{26}Al observations

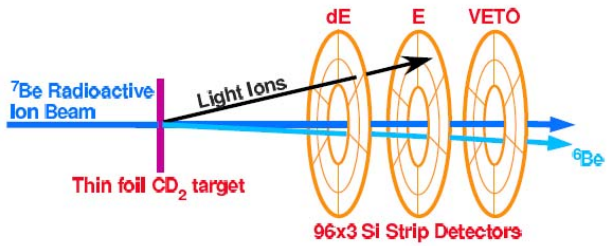


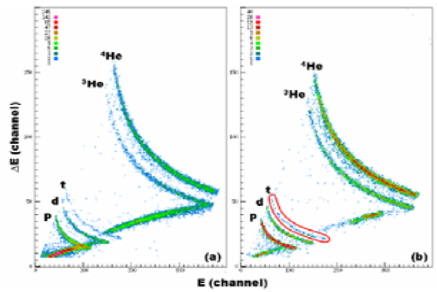
- a crucial **3$^+$** state at **E_x=5.914 MeV** observed via the **^{28}Si(p,t)^{26}Si** measurement
- resolve serious discrepancy in literature
- **status – level assessments in progress (Dan Bardayan)**

Nuclear Astrophysics Data

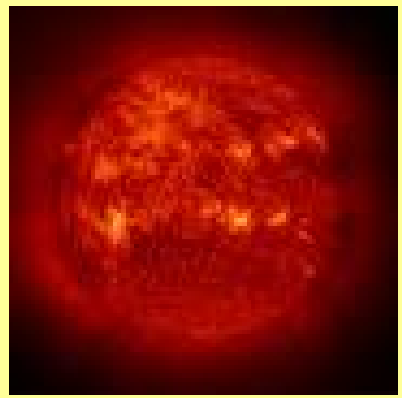
^{6}Be

Motivation: Structure properties of ^{6}Be is needed for the ^{3}He(^{3}He,2p)^{4}He reaction which is important for the destruction of ^{3}He in stars and strongly affects the calculated neutrino luminosity from the sun





Portion of Ph.D. thesis for K.Chae, University of Tennessee Knoxville, 2006

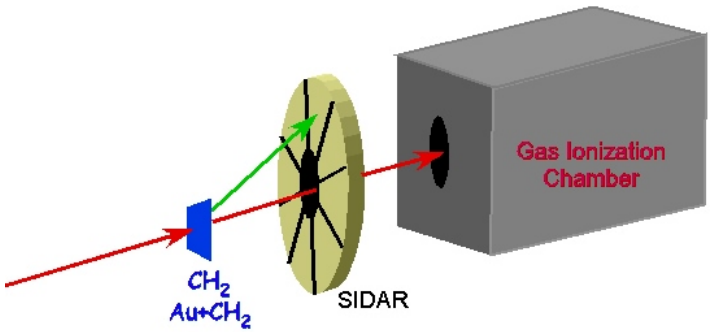


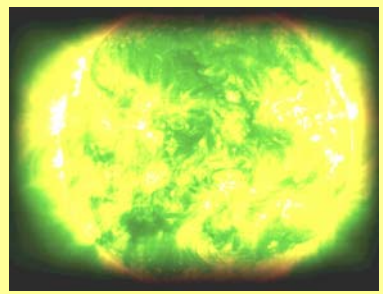
- A search for the missing **^{6}Be levels** was performed via the ***d*(^{7}Be,*t*)^{6}Be** reaction with radioactive ^{7}Be beam from the HRIBF
- Upper limits were set on the cross section to populate such levels
- analysis complete, paper being drafted

Nuclear Astrophysics Data

^{8}B

Motivation: To search for unobserved states in ^{8}B which will influence the extrapolation of the ^{7}Be(p,γ)^{8}B astrophysical S factor to stellar energies, and which is crucial for interpreting observations of the solar neutrino flux





Portion of Ph.D. thesis for R.J. Livesay, Colorado School of Mines

- A search for the **^{8}B levels** was performed via the elastic and inelastic ^{7}Be+ p scattering
- measurement done with radioactive ^{7}Be beam from the HRIBF
- status – data analysis in progress

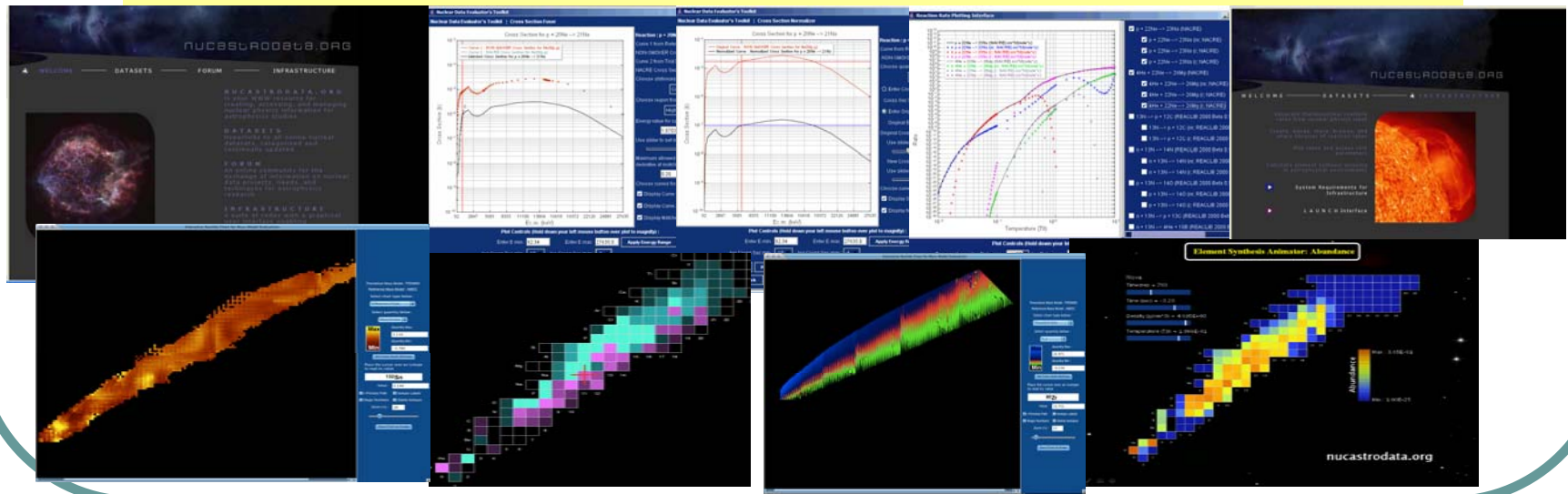
Computational Infrastructure for Nuclear Astrophysics

Overview

Computational Infrastructure for Nuclear Astrophysics is available free online at **nucastrodata.org**

With a few mouse clicks, one can

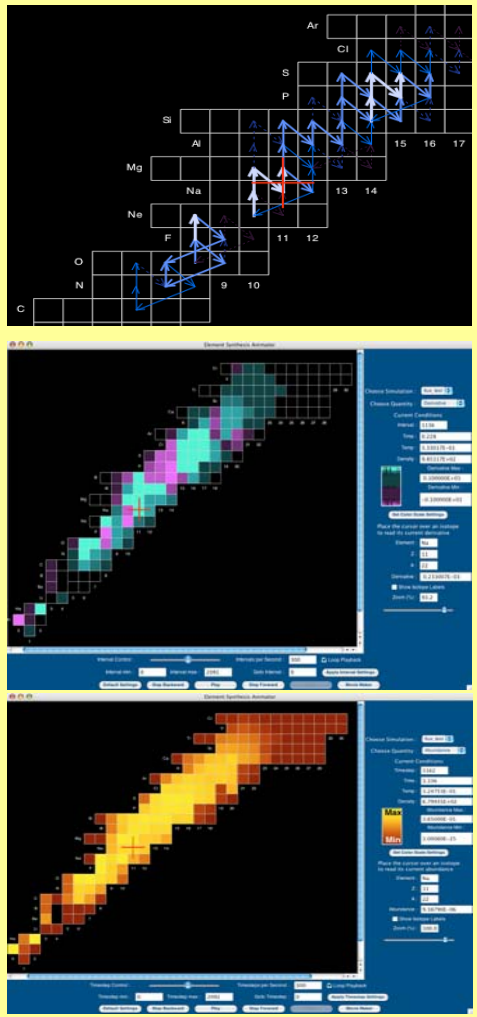
- Rapidly incorporate nuclear results into element burning models
- Run models and visualize results
- Share results and comments with online community



Computational Infrastructure for Nuclear Astrophysics

New Features since last USNDP meeting

- Rate locater – quickly generate list of all rates for a given reaction and plots them out
- Improved control over reaction rates fitting routines
- Reaction flux visualization (static & animated)
- Multiple zone post-processing element synthesis calculations
- nova and X-ray bursts simulations can be run
- movies can be created from one's own simulation code
- faster animation rendering & export
- quick comparison of simulations using different rate libraries



Future Work

Evaluations:

- Actinide A-chain A=241 – 249
- Reactions critical for Stellar Explosions studies and compilation & evaluation of the light nuclei

Computational Infrastructure for Nuclear Astrophysics:

- Add new evaluation tools, processing techniques, and visualization tools
- rates uncertainty propagation – cross sections --> reaction --> abundance predictions