OAK RIDGE National Laboratory

Status Report on Nuclear Data Activities at Oak Ridge National Laboratory

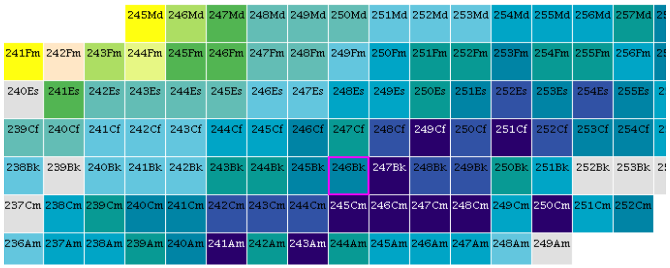
USNDP 2019

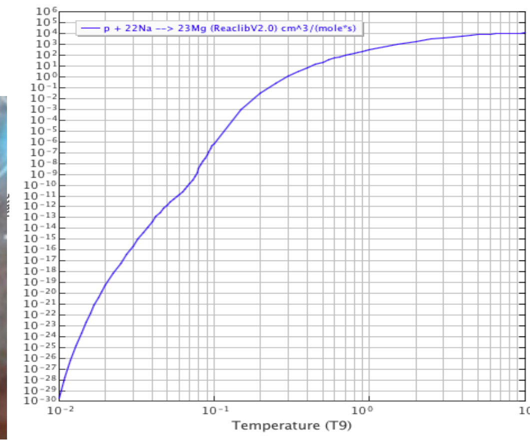
Michael Smith, Caroline Nesaraja, Murray Martin, Larry Zhang

ORNL is managed by UT-Battelle, LLC for the US Department of Energy

U.S. DEPARTMENT OF ENERGY

Members and Scope of Activities

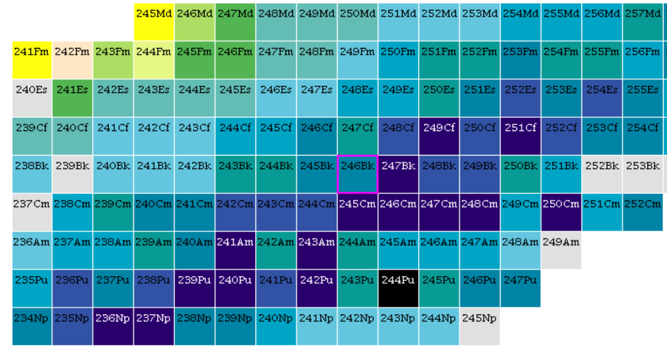




- **Members:**
  - **Michael Smith**: Group Leader for Experimental Astrophysics & Nuclear Data - nuclear astrophysics data, online software systems
  - **Caroline Nesaraja**: Research Staff Member - ENSDF evaluator
  - **Murray Martin**: Subcontractor - ENSDF evaluator and consultant
  - **Larry Zhang** : Student - nuclear astrophysics data

- **Activities:**
  - Nuclear Structure Data (ENSDF)
  - Nuclear Astrophysics Data

Nuclear Structure Data – Mass Chain Evaluations

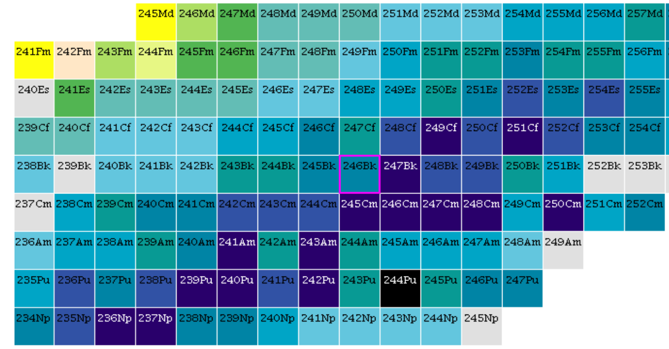


- **ORNL responsibility: A=241-249**

Mass Chain	**Current ENSDF Database (from NNDC website)**	
241	C.D. Nesaraja. NDS 130, 183 (2015)	(Lit cut-off Sept, 2015)
242*	Y. A. Akovali. NDS 96, 177 (2002)	(Lit cut-off Sept., 2001)
243	C.D. Nesaraja & E.A. McCutchan. NDS 121, 695 (2014)	(Lit cut-off Sept., 2013)
244	C.D. Nesaraja : NDS 146, 387 (2017)	(Lit cut-off August, 2017)
245	E. Browne & J.K. Tuli. NDS 112,447 (2011)	(Lit. cut-off June, 2010)
246	E. Browne & J.K. Tuli. NDS 112,1833 (2011)	(Lit. cut-off Jan., 2011)
247	C. D. Nesaraja :NDS 125, 395 (2015)	(Lit. cut-off March, 2014)
248	M.J. Martin :NDS 122, 377 (2014)	(Lit. cut-off Sept., 2014)
249	K. Abusaleem: NDS 112, 2129 (2011)	(Lit. cut-off Dec. 2010)

* Will be updated soon (under post-review stage)

Nuclear Structure Data – Mass Chain Evaluations



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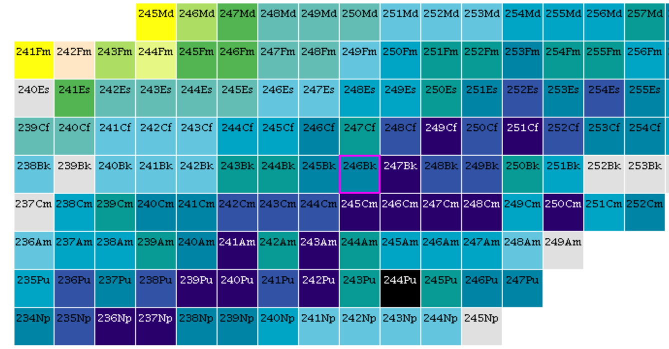
OAK RIDGE National Laboratory

Nuclear Structure Data – Mass Chain Evaluations

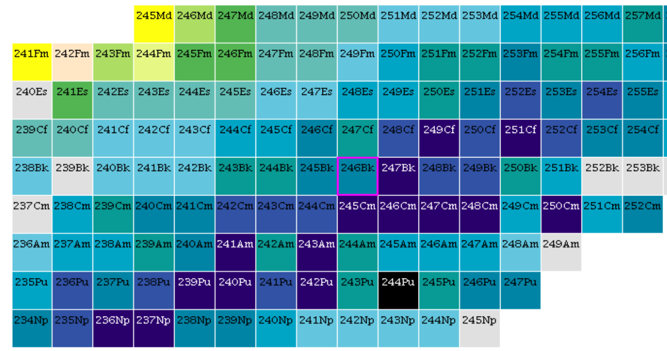


- ENSDF Evaluations

Mass Chain	Evaluator	#Nuclides	Status
66	Nesaraja	13	Submitted
218	Martin/Trieste Group	^{218}Ra/11	Complete
242	Martin	9	Post Review-In Progress
216	Nandi/Martin	11	Preliminary Version

Caroline Nesaraja 1.0 FTE
Murray Martin 0.15 FTE

Nuclear Structure Data – Mass Chain Evaluations



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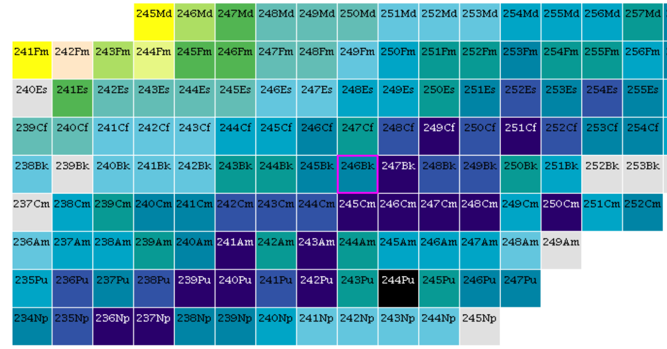
- ENSDF Reviews

C. Nesaraja: A=98 – submitted Nov. 4

M. Martin: Paper on "Radius Parameter in Alpha Decay "

Nuclear Structure Data – Mass Chain Evaluations



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Guidelines for Evaluators

with Appendices

M. J. Martin
Oak Ridge National Laboratory, Oak Ridge, Tennessee

October, 2019

- Guidelines for Evaluators: Murray Martin
- Future Work – next A-chain Evaluations & Reviews to be determined

Nuclear Structure Data – Issue Resolution

- Resolution of Issue in A=137 Evaluation (submitted FY2018)

Nuclear Data Sheets for A=137*

C.D. Nesaraja

Physics Division,
Oak Ridge National Laboratory,
Oak Ridge, Tennessee 37831-6354, USA

Abstract: Available information pertaining to the nuclear structure of ground and excited states for all known nuclei with mass numbers A=137 have been compiled and evaluated. The adopted level and decay schemes, as well as the detailed nuclear properties and configuration assignments based on experimental data, are presented for these nuclides. When there are insufficient data, expected values from systematics of nuclear properties and/or theoretical calculations are utilized. Unexpected or discrepant experimental results are also noted.

Cutoff Date: All literature available up to August 31, 2018 have been considered. The NSR database (2014Pr09) (www.nndc.bnl.gov/nsr/) is the primary source for the bibliography.

General Policies and Organization of Material: See the January issue of the *Nuclear Data Sheets* or http://www.nndc.bnl.gov/nds/NDSPolicies.pdf.

Resolution of a discrepancy in the γ-ray emission probability from the beta decay of $^{137}Ce^{g}$

M.S. Basunia[1], J.T. Morrell[2], M.S. Uddin[3], A.S. Voyles[1,2], C.D. Nesaraja[4], L.A. Bernstein[1,2], E. Browne[1], M.J. Martin[4], and S.M. Qaim[5]

[1]*Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, California 94720, USA*
[2]*Department of Nuclear Engineering, UC Berkeley, Berkeley, California 94720, USA*
[3]*Tandem Accelerator Facilities, INST, Atomic Energy Research Establishment, Savar, Dhaka, Bangladesh*
[4]*Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831, USA*
[5]*Institut für Neurowissenschaften und Medizin, INM-5:Nuklearchemie, Forschungszentrum Jülich, D-52425 Jülich, Germany*

Sept 11, 2019

During the evaluation of A=137, an issue to determine the normalization factor for decay involving transient equilibrium (137Ce ε decay) was presented at the 2019 meeting of the NSDD Evaluators' network by C. Nesaraja

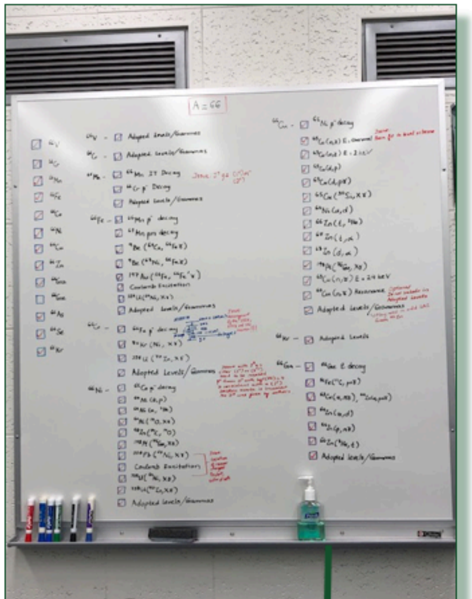
OAK RIDGE National Laboratory — It's a bit of a sticky wicket to determine the NR

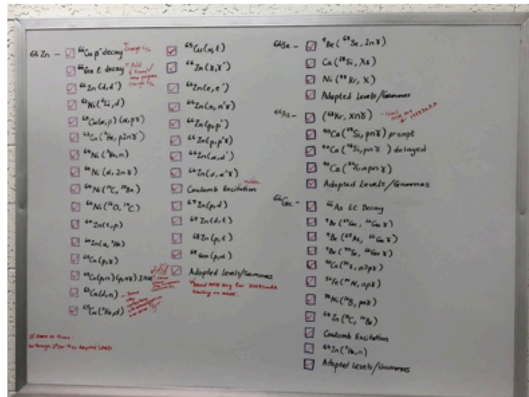
Experiment: 1975He20	Evaluation: ENSDF	Experiment: 2012To09
• Henry et.al (1975)	• Current ENSDF database	• Torrel & Krane (2012)
• Measured γ and conversion electron	• Determined normalization factor NR using activity Equilibrium correction factor	• Measured γ
• Hslcc	• Brlcc	• Authors used normalization factor from ENSDF
• At equilibrium, the total ε+β+ decay from the ^{137}Ce g.s (9 hr) is the total intensity of the isomeric 254γ.	• NR= 0.0168 (8)	• NR= 0.0168 (8)
• In transient equilibrium spectra		
I(254γ)/I(477γ)= 4.91 (15)		
• NR= 0.0224 (10)		

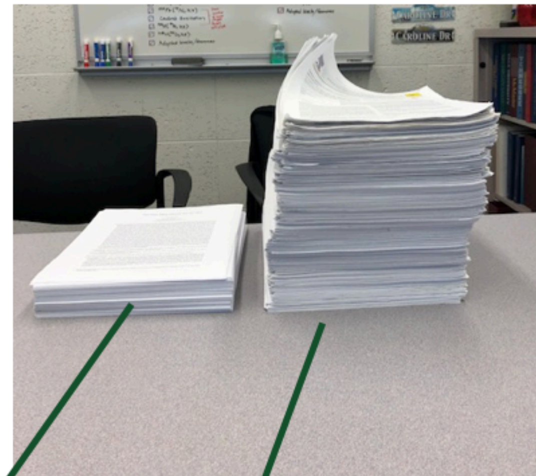
This issue led to measurements by S. Basunia et al. to determine the absolute value of the 447g relative to 254g

Refer to Shamsu's talk: Gamma-ray emission probability in transient equilibrium: Cases of ^{137g}Ce and ^{85g}Y on Thursday morning on how this issue was resolved!

Nuclear Structure Data – Supplemental

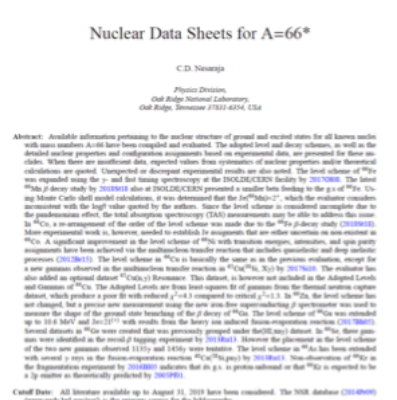






Number of References: 366

Number of pages in manuscript: 364


Nuclear Data Sheets for A=66*

C.D. Nesaraja

Physics Division,
Oak Ridge National Laboratory,
Oak Ridge, Tennessee 37831-6354, USA

Number of Nuclides: 13

Number of datasets including Adopted: 100

Number of lines in ENSDF text: 12486

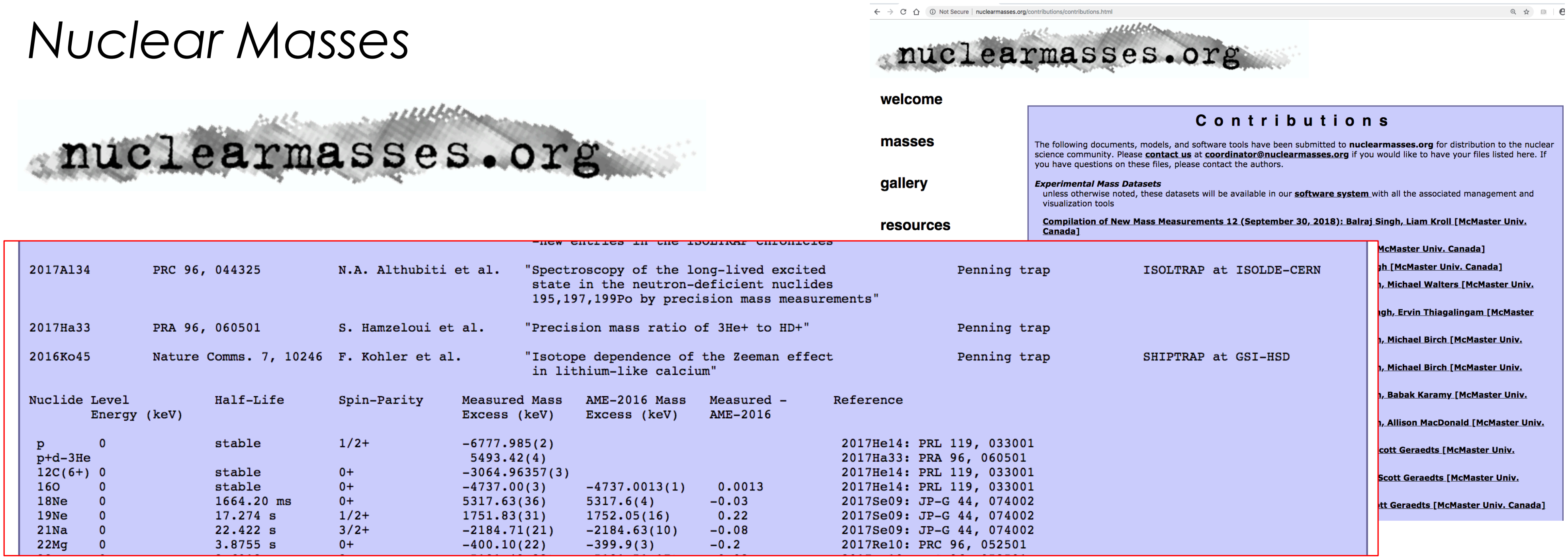
A=66 statistics using Jun Chen's Consistency Check Code

Nuclear Structure Data – Publications & Presentations

- Publications
  - Phys.Rev. C 99, 045807 (2019)
    S.N.Paneru, C.R.Brune, R.Giri, R.J.Livesay, U.Greife, J.C.Blackmon, D.W.Bardayan, K.A.Chipps, B.Davids, D.S.Connolly, K.Y.Chae, A.E.Champagne, C.Deibel, K.L.Jones, M.S.Johnson, R.L.Kozub, Z.Ma, C.D.Nesaraja, S.D.Pain, F.Sarazin, J.F.Shriner, D.W.Stracener, M.S.Smith, J.S.Thomas, D.W.Visser, C.Wrede, "s-wave scattering lengths for the ^{7}Be + p system from an R-matrix analysis"
  - Phys.Rev. C 99, 041302 (2019); Erratum Phys.Rev. C 99, 069901 (2019)
    B.Manning, G.Arbanas, J.A.Cizewski, R.L.Kozub, S.Ahn, J.M.Allmond, D.W.Bardayan, K.Y.Chae, K.A.Chipps, M.E.Howard, K.L.Jones, J.F.Liang, M.Matos, C.D.Nesaraja, F.M.Nunes, P.D.O'Malley, S.D.Pain, W.A.Peters, S.T.Pittman, A.Ratkiewicz, K.T.Schmitt, D.Shapira, M.S.Smith, L.Titus, "Informing direct neutron capture on tin isotopes near the N=82 shell closure"
- Presentations
  - Center Report: Status Report of Nuclear Data Activities at Oak Ridge National Laboratory at the 2019 meeting of the NSDD Evaluators' network
  - Technical Report: Determining normalization factor for decay involving transient equilibrium at the 2019 meeting of the NSDD Evaluators' network

Nuclear Masses

nuclearmasses.org



- ***nuclearmasses.org***
  - *contributed mass measurement compilations from Balraj Singh – 13 sets since 2008, most recent was November 2019*

Nuclear Masses

nuclearmasses.org

welcome

masses

gallery

resources

C o n t r i b u t i o n s

The following documents, models, and software tools have been submitted to **nuclearmasses.org** for distribution to the nuclear science community. Please **contact us** at **coordinator@nuclearmasses.org** if you would like to have your files listed here. If you have questions on these files, please contact the authors.

Experimental Mass Datasets

unless otherwise noted, these datasets will be available in our **software system** with all the associated management and visualization tools

Compilation of New Mass Measurements 12 (September 30, 2018): Balraj Singh, Liam Kroll [McMaster Univ. Canada]

McMaster Univ. Canada]

gh [McMaster Univ. Canada]

, Michael Walters [McMaster Univ.

gh, Ervin Thiagalingam [McMaster

, Michael Birch [McMaster Univ.

, Michael Birch [McMaster Univ.

, Babak Karamy [McMaster Univ.

, Allison MacDonald [McMaster Univ.

cott Geraedts [McMaster Univ.

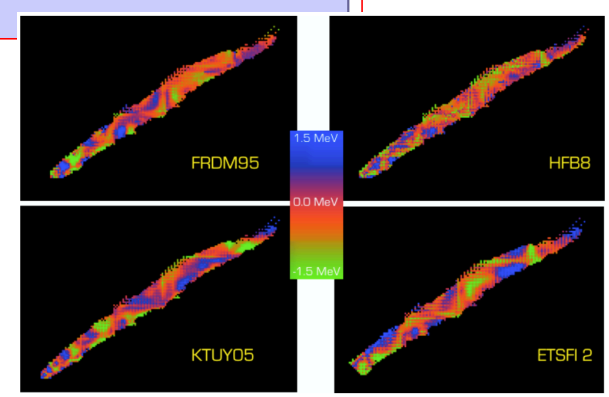
Scott Geraedts [McMaster Univ.

tt Geraedts [McMaster Univ. Canada]

-new entries in the ISOLTRAP chronicles

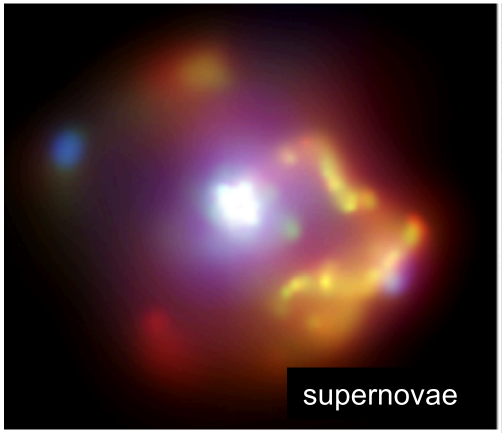
2017Al34	PRC 96, 044325	N.A. Althubiti et al.	"Spectroscopy of the long-lived excited state in the neutron-deficient nuclides 195,197,199Po by precision mass measurements"	Penning trap	ISOLTRAP at ISOLDE-CERN
2017Ha33	PRA 96, 060501	S. Hamzeloui et al.	"Precision mass ratio of 3He+ to HD+"	Penning trap	
2016Ko45	Nature Comms. 7, 10246	F. Kohler et al.	"Isotope dependence of the Zeeman effect in lithium-like calcium"	Penning trap	SHIPTRAP at GSI-HSD

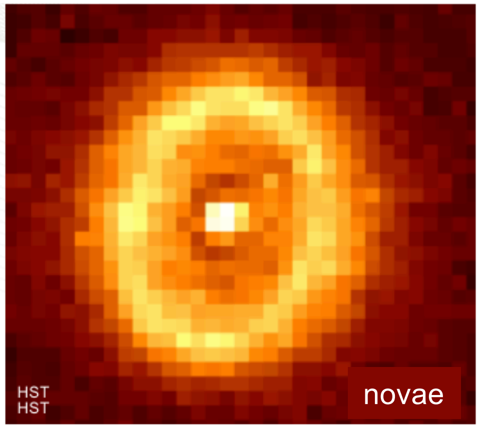
Nuclide	Level Energy (keV)	Half-Life	Spin-Parity	Measured Mass Excess (keV)	AME-2016 Mass Excess (keV)	Measured - AME-2016	Reference
p	0	stable	1/2+	-6777.985(2)			2017He14: PRL 119, 033001
p+d-3He				5493.42(4)			2017Ha33: PRA 96, 060501
12C(6+)	0	stable	0+	-3064.96357(3)			2017He14: PRL 119, 033001
16O	0	stable	0+	-4737.00(3)	-4737.0013(1)	0.0013	2017He14: PRL 119, 033001
18Ne	0	1664.20 ms	0+	5317.63(36)	5317.6(4)	-0.03	2017Se09: JP-G 44, 074002
19Ne	0	17.274 s	1/2+	1751.83(31)	1752.05(16)	0.22	2017Se09: JP-G 44, 074002
21Na	0	22.422 s	3/2+	-2184.71(21)	-2184.63(10)	-0.08	2017Se09: JP-G 44, 074002
22Mg	0	3.8755 s	0+	-400.10(22)	-399.9(3)	-0.2	2017Re10: PRC 96, 052501

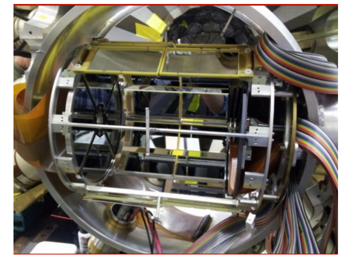


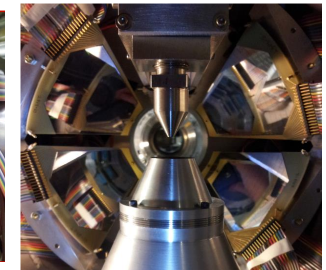
- ***nuclearmasses.org***
  - *contributed mass measurement compilations from Balraj Singh – 13 sets since 2008, most recent was November 2019*
  - *evaluated masses from AMDC*
  - *theoretical mass predictions from 14 models*
  - *Nuclear Mass Toolkit with customized visualizations, comparisons*

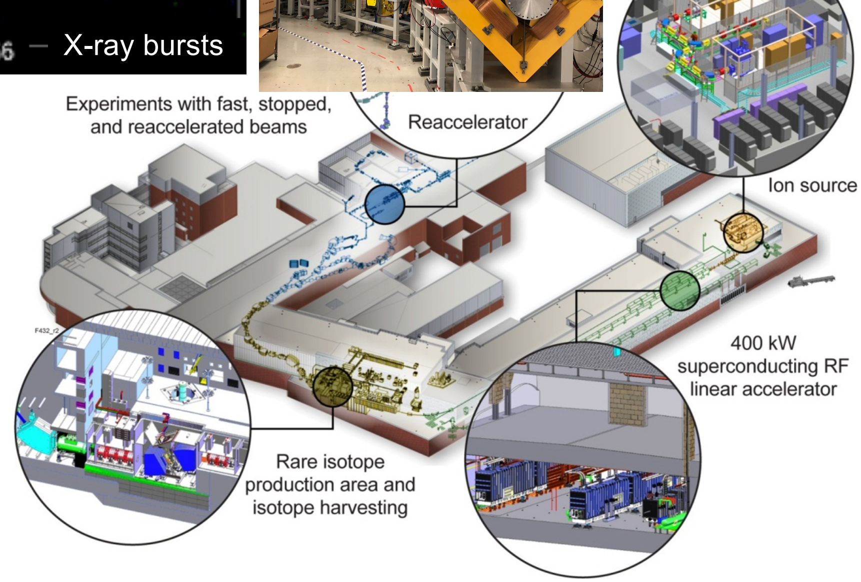
Nuclear Astrophysics Data

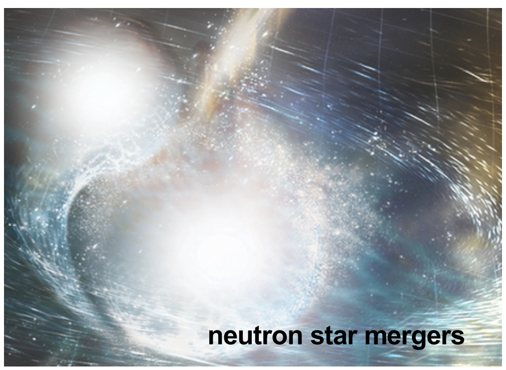


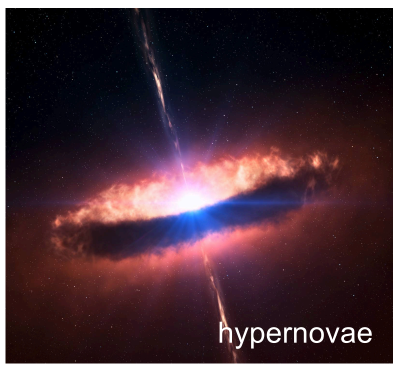












- *Focus on Stellar Explosions*
- *Closely couple data activities to FRIB measurements*

Nuclear Astrophysics Data

STARLIB rates

14C(a,g)18O	25Al(p,g)26Si	18O(p,g)19F	31P(p,a)28Si
14C(p,g)15N	25Mg(p,g)26Al	19Ne(p,g)20Na	31P(p,a)28Si
14N(a,g)18F	26Al(p,g)27Si	20Ne(a,g)24Mg	31P(p,g)32S
15N(a,g)19F	26Mg(p,g)27Al	20Ne(p,g)21Na	31S(p,g)32Cl
15O(a,g)19Ne	26Si(p,g)27P	21Na(p,g)22Mg	32Cl(p,g)33Ar
16O(a,g)20Ne	27Al(p,a)24Mg	21Ne(p,g)22Na	32S(p,g)33Cl
16O(p,g)17F	27Al(p,g)28Si	22Mg(p,g)23Al	34Ar(p,g)35K
17F(p,g)18Ne	27P(p,g)28S	22Na(p,g)23Mg	35Ar(p,g)36K
17O(p,a)14N	27Si(p,g)28P	22Ne(p,g)23Na	35Cl(p,a)32S
17O(p,g)18F	28Si(p,g)29P	23Al(p,g)24Si	35Cl(p,g)36Ar
18F(p,a)15O	29P(p,g)30S	23Mg(p,g)24Al	35K(p,g)36Ca
18F(p,a)15O	29Si(p,g)30P	23Na(p,a)20Ne	36Ar(p,g)37K
18F(p,g)19Ne	30S(p,g)31Cl	23Na(p,g)24Mg	38Ar(p,g)39K
18O(a,g)22Ne	30Si(p,g)31P	24Al(p,g)25Si	39Ca(p,g)40Sc
18O(p,a)15N	31Cl(p,g)32Ar	24Mg(a,g)28Si	40Ca(p,g)41Sc
		24Mg(p,g)25Al	

NACRE II rates

2H(p,g)3He	9Be(p,g)10B
2H(d,g)4He	9Be(p,d)8Be(
2H(d,n)3He	9Be(p,a)6Li
2H(d,p)3H	9Be(a,n)12C
2H(a,g)6Li	10B(p,g)11C
3H(d,n)4He	10B(p,a)7Be
3H(a,g)7Li	11B(p,g)12C
3He(d,p)4He	11B(p,a)8Be(
3He(τ,2p)4He	11B(a,n)14N
3He(a,g)7Be	12C(p,g)13N
6Li(p,g)7Be	12C(a,g)16O
6Li(p,a)3He	13C(p,g)14N
7Li(p,g)8Be(	13C(a,n)16O
7Li(p,g)4He	13N(p,g)14O
7Li(α,g)11B	14N(p,g)15O
7Be(p,g)8B	15N(p,g)16O
7Be(α,g)11C	15N(p,a)12C

NACRE II: an update of the NACRE compilation of charged-particle-induced thermonuclear reaction rates for nuclei with mass number $A < 16$

Y. Xu[a,1], K. Takahashi[a,b], S. Goriely[a], M. Arnould[a,*]
[a] Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, Belgium
[b] GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany
M. Ohta[c,d], H. Utsunomiya[d]
[c] Hirao School of Management, Konan University, Kobe, Japan
[d] Department of Physics, Konan University, Kobe, Japan

Abstract

An update of the NACRE compilation [Angulo et al., Nucl. Phys. A 656 (1999) 3] is presented. This new compilation, referred to as NACRE II, reports thermonuclear reaction rates for 34 charged-particle induced, two-body exoergic reactions on nuclides with mass number $A < 16$, of which fifteen are particle-transfer reactions and the rest radiative capture reactions. When compared with NACRE, NACRE II features in particular (1) the addition to the experimental data collected in NACRE of those reported later, preferentially in the major journals of the field by early 2013, and (2) the adoption of potential models as the primary tool for extrapolation to very low energies of astrophysical S-factors, with a systematic evaluation of uncertainties.

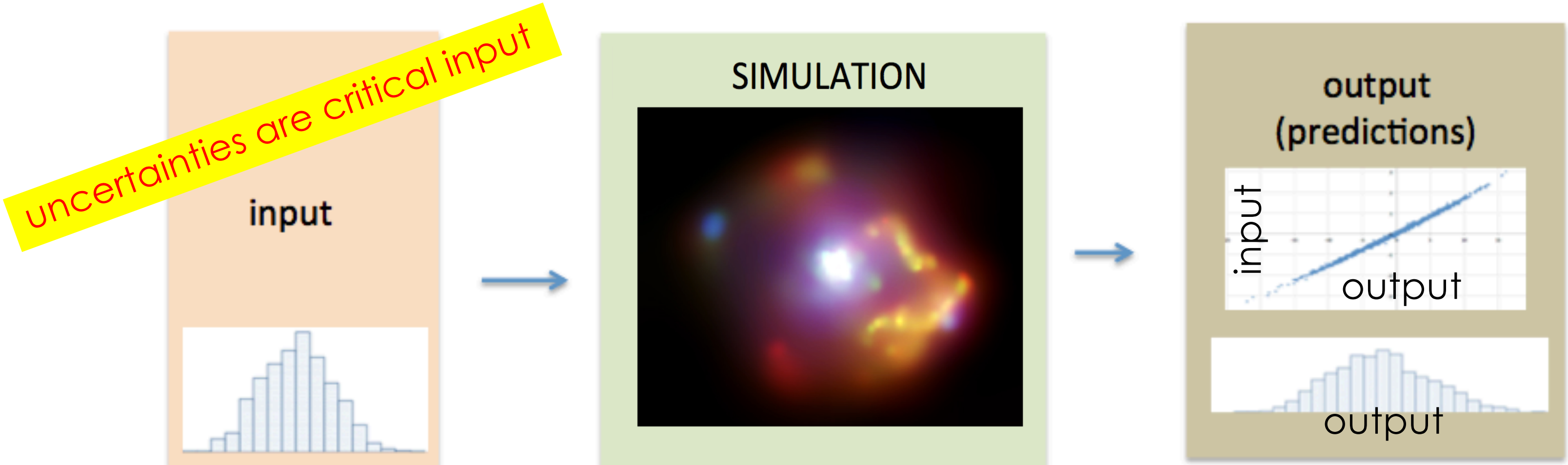
As in NACRE, the rates are presented in tabular form for temperatures in the $10^6 \lesssim T \leq 10^{10}$ K range. Along with the 'adopted' rates, their low and high limits are provided. The new rates are available in electronic form as part of the Brussels Library (BRUSLIB) of nuclear data. The NACRE II rates also supersede the previous NACRE rates in the Nuclear Network Generator (NETGEN) for astrophysics. [http://www.astro.ulb.ac.be/databases.html]

Keywords: thermonuclear reaction rates, nuclear astrophysics, potential model, dwba model

Rate			Uncertainty
n +	n15 →	n16	1.0860
p	n15	o16	1.3333
he4	n15	f19	1.0330
p	o15	f16	0.5000
he4	o15	ne19	2.3100
n	o16	o17	1.1050
p	o16	f17	1.0430
he4	o16	ne20	1.0600
p	o17	f18	1.0490
he4	o17	ne21	0.2000
n	o18	o19	1.0900
p	o18	f19	1.2100
he4	o18	ne22	1.1210
he4	o18	ne22	1.1210
n	o19	o20	0.5000
p	o19	f20	0.5000

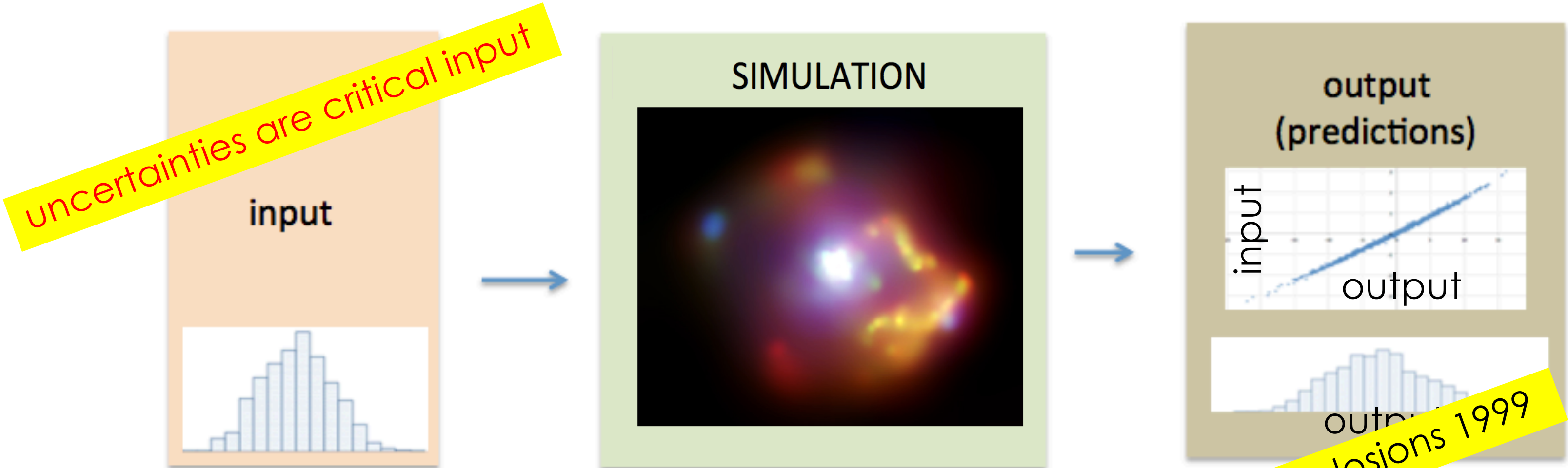
- *Personnel:*
  - *Michael Smith – Staff 0.1 FTE*
  - *Larry Zhang – subcontractor/student 0.2 FTE*
- *Activities*
  - *improved determination of uncertainties*
  - *conversion of uncertainties for use in modeling codes*

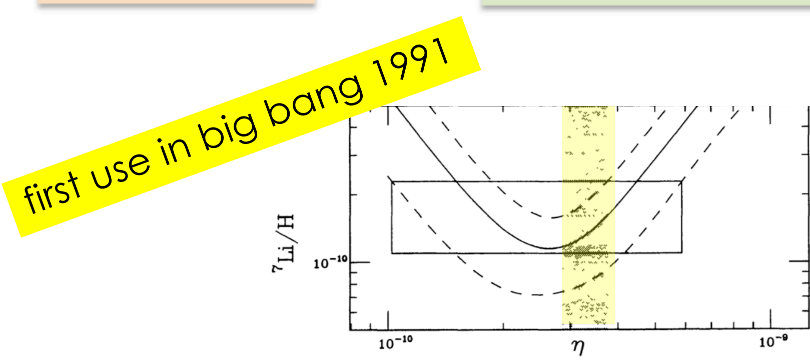
Nuclear Astrophysics Data

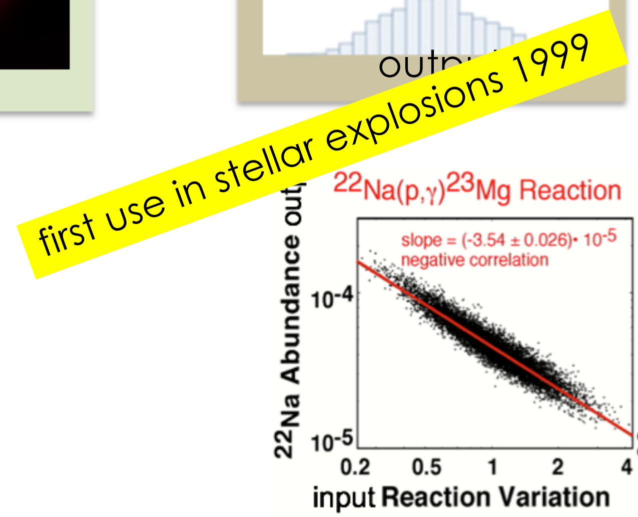


- *Monte Carlo Nucleosynthesis Calculations*

Nuclear Astrophysics Data







- *Monte Carlo Nucleosynthesis Calculations*

Nuclear Astrophysics Data

STARLIB rates

14C(a,g)18O	25Al(p,g)26Si
14C(p,g)15N	25Mg(p,g)26Al
14N(a,g)18F	26Al(p,g)27Si
15N(a,g)19F	26Mg(p,g)27Al
15O(a,g)19Ne	26Si(p,g)27P
16O(a,g)20Ne	27Al(p,a)24Mg
16O(p,g)17F	27Al(p,g)28Si
17F(p,g)18Ne	27P(p,g)28S
17O(p,a)14N	27Si(p,g)28P
17O(p,g)18F	28Si(p,g)29P
18F(p,a)15O	29P(p,g)30S
18F(p,a)15O	29Si(p,g)30P
18F(p,g)19Ne	30S(p,g)31Cl
18O(a,g)22Ne	30Si(p,g)31P
18O(p,a)15N	31Cl(p,g)32Ar

18O(p,g)19F	31P(p,a)28Si
19Ne(p,g)20Na	31P(p,a)28Si
20Ne(a,g)24Mg	31P(p,g)32S
20Ne(p,g)21Na	31S(p,g)32Cl
21Na(p,g)22Mg	32Cl(p,g)33Ar
21Ne(p,g)22Na	32S(p,g)33Cl
22Mg(p,g)23Al	34Ar(p,g)35K
22Na(p,g)23Mg	35Ar(p,g)36K
22Ne(p,g)23Na	35Cl(p,a)32S
23Al(p,g)24Si	35Cl(p,g)36Ar
23Mg(p,g)24Al	35K(p,g)36Ca
23Na(p,a)20Ne	36Ar(p,g)37K
23Na(p,g)24Mg	38Ar(p,g)39K
24Al(p,g)25Si	39Ca(p,g)40Sc
24Mg(a,g)28Si	40Ca(p,g)41Sc
24Mg(p,g)25Al	

NACRE II rates

2H(p,g)3He	9Be(p,g)10B
2H(d,g)4He	9Be(p,d)8Be(
2H(d,n)3He	9Be(p,a)6Li
2H(d,p)3H	9Be(a,n)12C
2H(a,g)6Li	10B(p,g)11C
3H(d,n)4He	10B(p,a)7Be
3H(a,g)7Li	11B(p,g)12C
3He(d,p)4He	11B(p,a)8Be(
3He(τ,2p)4He	11B(a,n)14N
3He(a,g)7Be	12C(p,g)13N
6Li(p,g)7Be	12C(a,g)16O
6Li(p,a)3He	13C(p,g)14N
7Li(p,g)8Be(	13C(a,n)16O
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NACRE II: an update of the NACRE compilation of charged-particle-induced thermonuclear reaction rates for nuclei with mass number $A < 16$

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[a] Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, Belgium
[b] GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany
M. Ohta[c,d], H. Utsunomiya[d]
[c] Hirao School of Management, Konan University, Kobe, Japan
[d] Department of Physics, Konan University, Kobe, Japan

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As in NACRE, the rates are presented in tabular form for temperatures in the $10^6 \lesssim T \leq 10^{10}$ K range. Along with the 'adopted' rates, their low and high limits are provided. The new rates are available in electronic form as part of the Brussels Library (BRUSLIB) of nuclear data. The NACRE II rates also supersede the previous NACRE rates in the Nuclear Network Generator (NETGEN) for astrophysics. [http://www.astro.ulb.ac.be/databases.html.]

Keywords: thermonuclear reaction rates, nuclear astrophysics, potential model, dwba model

Rate			Uncertainty
n	+ n15	→ n16	1.0860
p	n15	o16	1.3333
he4	n15	f19	1.0330
p	o15	f16	0.5000
he4	o15	ne19	2.3100
n	o16	o17	1.1050
p	o16	f17	1.0430
he4	o16	ne20	1.0600
p	o17	f18	1.0490
he4	o17	ne21	0.2000
n	o18	o19	1.0900
p	o18	f19	1.2100
he4	o18	ne22	1.1210
he4	o18	ne22	1.1210
n	o19	o20	0.5000
p	o19	f20	0.5000

- *Personnel:*
  - *Michael Smith – Staff 0.1 FTE*
  - *Larry Zhang – subcontractor/student 0.2 FTE*
- *Activities*
  - *improved determination of uncertainties*
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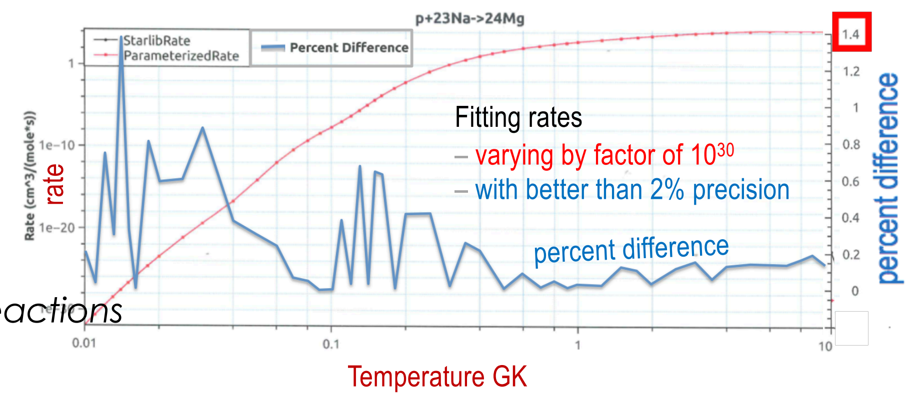

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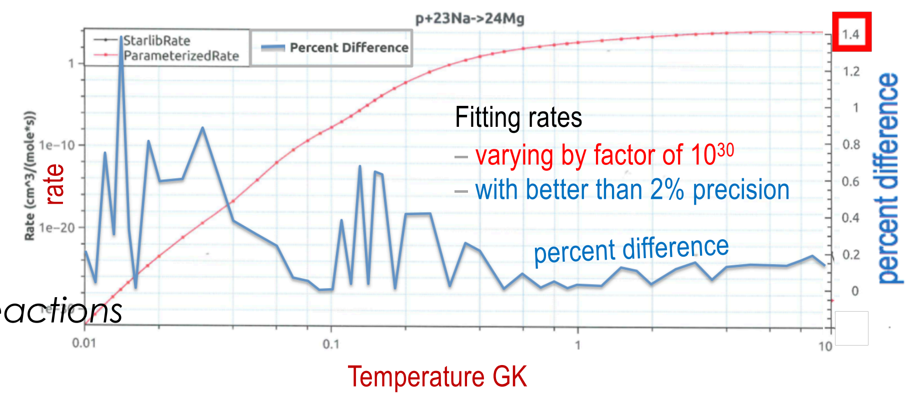
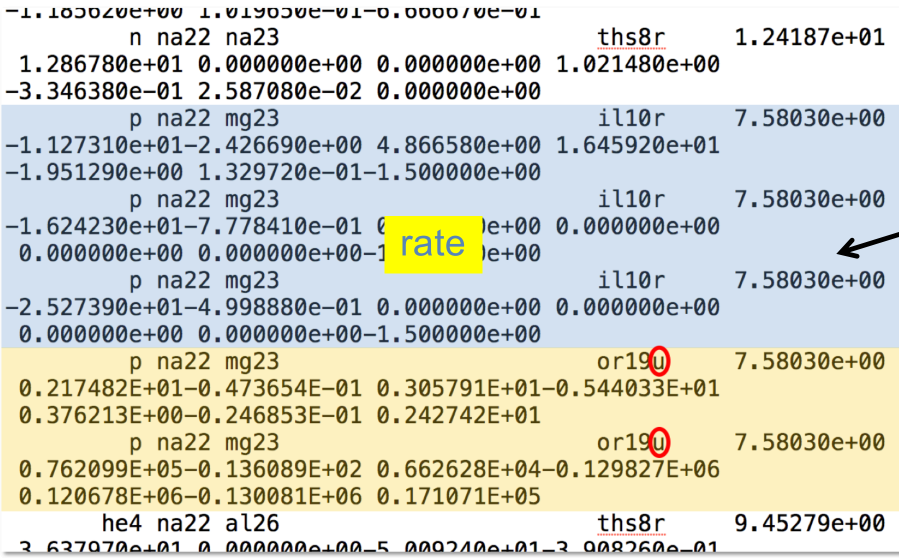
- *Critical Issues*
  - ***REACLIB community database needs updating** – but no funding to do this (needs ½ postdoc)*
  - *Funding for ORNL effort in this area subcritical*



Nuclear Astrophysics Data – Uncertainties in REACLIB

REACLIB



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-3.346380e-01 2.587080e-02 0.000000e+00
         p  na22  mg23                        il10r     7.58030e+00
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         p  na22  mg23                        il10r     7.58030e+00
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 0.376213E+00-0.246853E-01 0.242742E+01
         p  na22  mg23                        or19u     7.58030e+00
 0.762099E+05-0.136089E+02 0.662628E+04-0.129827E+06
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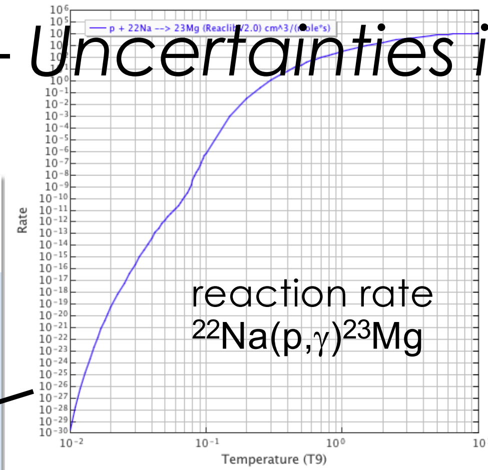

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Nuclear Astrophysics Data – Uncertainties in REACLIB

REACLIB

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 1.286780e+01 0.000000e+00 0.000000e+00 1.021480e+00
-3.346380e-01 2.587080e-02 0.000000e+00
        p na22 mg23                     il10r    7.58030e+00
-1.127310e+01-2.426690e+00 4.866580e+00 1.645920e+01
-1.951290e+00 1.329720e-01-1.500000e+00
        p na22 mg23                     il10r    7.58030e+00
-1.624230e+01-7.778410e-01 0       e+00 0.000000e+00
 0.000000e+00 0.000000e+00-1       e+00
        p na22 mg23                     il10r    7.58030e+00
-2.527390e+01-4.998880e-01 0.000000e+00 0.000000e+00
 0.000000e+00 0.000000e+00-1.500000e+00
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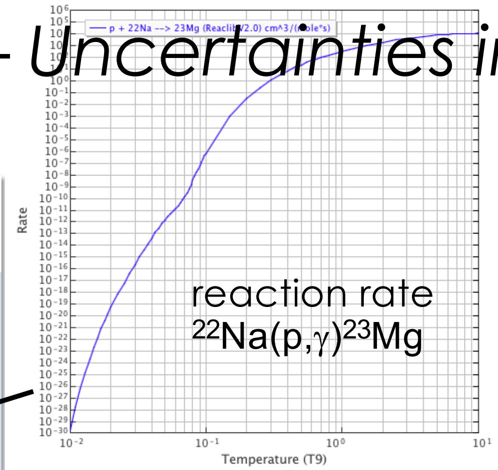
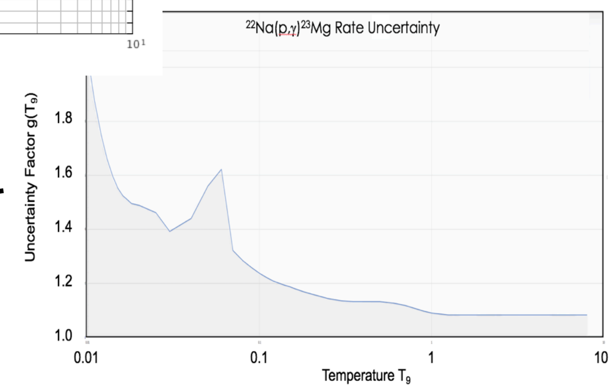
        p na22 mg23                     or19u    7.58030e+00
 0.762099E+05-0.136089E+02 0.662628E+04-0.129827E+06
 0.120678E+06-0.130081E+06 0.171071E+05
      he4 na22 al26                     ths8r    9.45279e+00
 3.637970e+01 0.000000e+00-5.009240e+01-3.908260e-01
```

rate

uncertainty





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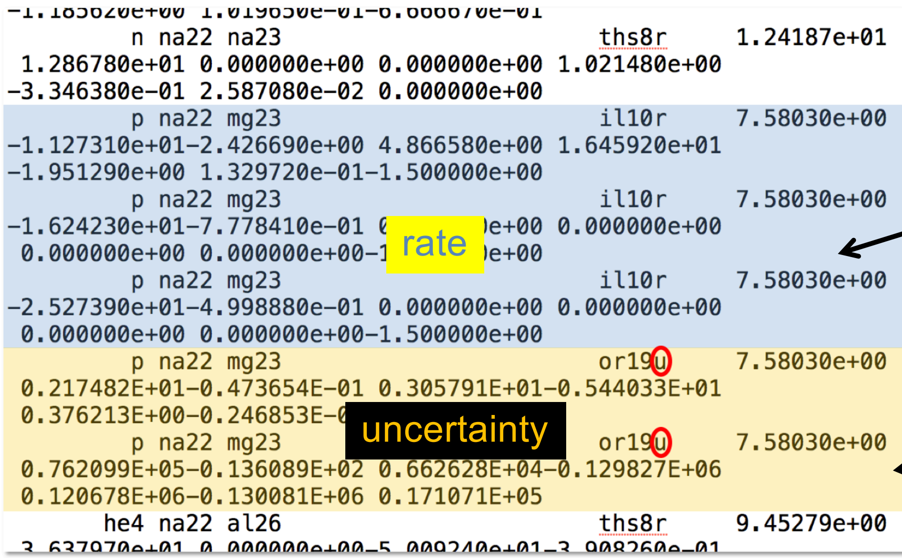

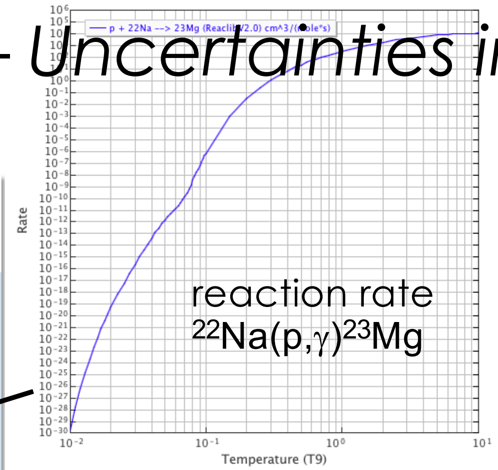

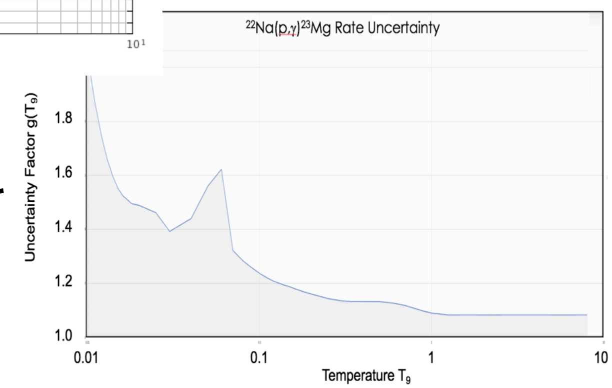

- proposed a simple inclusion of **parameterized multiplicative rate uncertainty factors** in the **REACLIB** database to enable UQ studies in astrophysics
- provides a **path forward** for REACLIB to be used in UQ and other sophisticated studies
- will require **adjustments** of **code systems** using REACLIB (e.g., *nucastrodata.org* tools)

Growing the USNDP Effort

- ***Strongly suggest brainstorming session at USNDP Meeting to grow effort***
- *Suggest **bold** proposal to expand effort at DOE NP Budget Briefing*
  - ***double effort** in 10 years by 2030*
  - *recruit & train new generation of evaluators*
  - *raise profile of data program within DOE NP activities*
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