

Astrophysics Task Force

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Numerous USNDP institutions are pursuing projects needed to improve studies in nuclear astrophysics

These activities often involve a focus on both nuclear reactions *and* nuclear structure

Recent Activities in

Compilations & Evaluations

BNL, LANL, McMaster,
ORNL, TUNL

Development of Evaluation,
Processing, & Dissemination
Tools

ORNL

Nuclear Theory

LANL

Compilations & Evaluations

BNL

- **Compiled** all available data for **α -induced reactions** on ^{20}Ne , ^{24}Mg , ^{28}Si , ^{32}S , ^{36}Ar , ^{40}Ca [VNIIEF collaboration, ND2004 poster]
- Collaborated with VNIIEF on use of **Empire** code

LANL

- **R-matrix calculations** of light mass nuclei important in **stellar explosions** (e.g., ^{18}Ne) and other astrophysics scenarios

McMaster

Focus on reactions involving **radioactive nuclei** important for **stellar explosions** - coupled to ISAC measurements

Reaction evaluations in progress: $^{21}\text{Na}(p,\gamma)^{22}\text{Mg}$, $^{18}\text{Ne}(\alpha,p)^{21}\text{Na}$, & $^{25}\text{Al}(p,\gamma)^{26}\text{Si}$

All evaluations incorporating the very **latest experimental results**

Results will be disseminated through **nucastrodata.org** & NNDC

Compilations & Evaluations

ORNL

Focus on reactions involving **radioactive nuclei** important for **stellar explosions** - coupled to HRIBF measurements

Reaction evaluations in progress: $^{18}\text{F}(p,\gamma)^{19}\text{Ne}$, $^{18}\text{F}(p,\alpha)^{15}\text{O}$, $^{30}\text{P}(p,\gamma)^{31}\text{S}$, $^{33}\text{Cl}(p,\gamma)^{34}\text{Ar}$, $^{17}\text{O}(p,\gamma)^{18}\text{F}$, $^{17}\text{O}(p,\alpha)^{14}\text{N}$

All evaluations incorporating the **very latest experimental results**

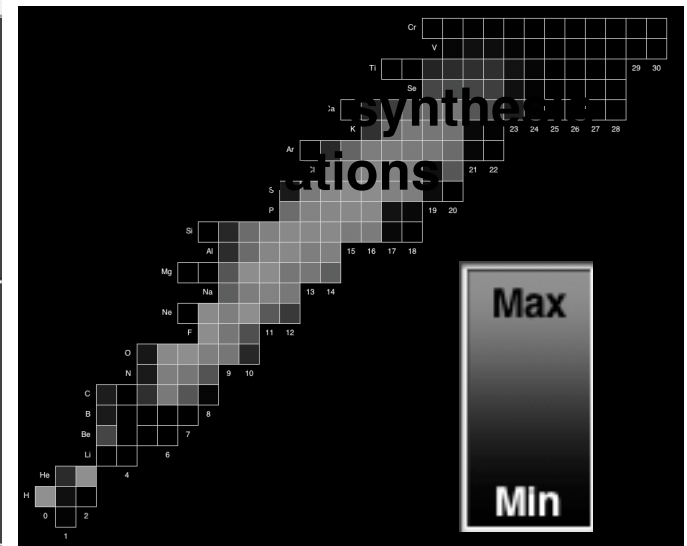
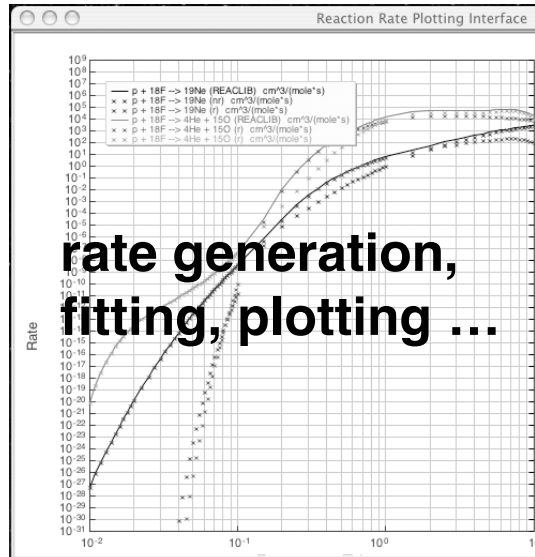
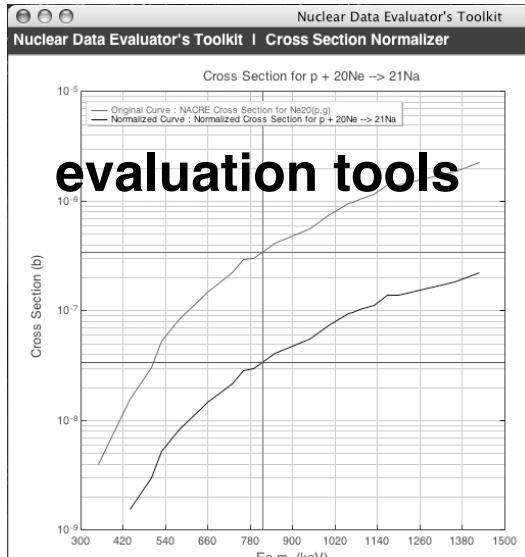
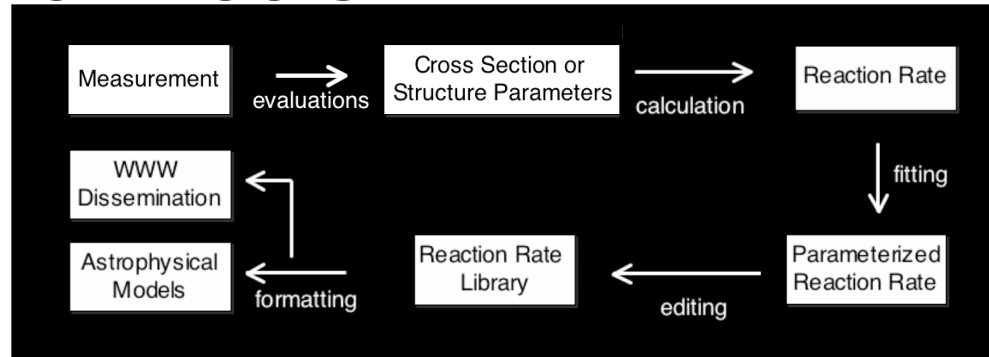
Results will be disseminated through **nuastrodata.org** & NNDC

TUNL

Completion of $A = 8 - 10$ evaluation, important in **early universe element synthesis**, for **solar thermonuclear fusion reactions**, & some **explosive astrophysical events**

Development of Evaluation, Processing, & Dissemination Tools

ORNL



Development of **new computational infrastructure** at nucastrodata.org to speed incorporation of nuclear evaluations into astro models

Development of **Monte Carlo element synthesis techniques** to quantitatively determine influence of nuclear reaction rate uncertainties (from data evaluations) on astro predictions [with ANL]

Nuclear Theory

LANL

Calculate **decay rates & log(ft) values** for beta decay from parent nuclei states to **all different states** in daughter nuclei

Include contribution of decay of **excited states** in parent nuclei to account for high-temperature astrophysical processes (supernovae...)

Datasets generated for **thousands** of nuclei

Calculations of **capture cross sections on unstable nuclei** at low energies

Hauser-Feshbach model with width fluctuation correction

Important for **s-process element synthesis in red giant stars**

PLOT NO 1 IS BETA MINUS TRANSITION FROM ^{78}Ni TO ^{78}Cu

PAIRING MODEL: LIPKIN-NOGAMI
SINGLE-PARTICLE MODEL: FOLDED-YUKAWA

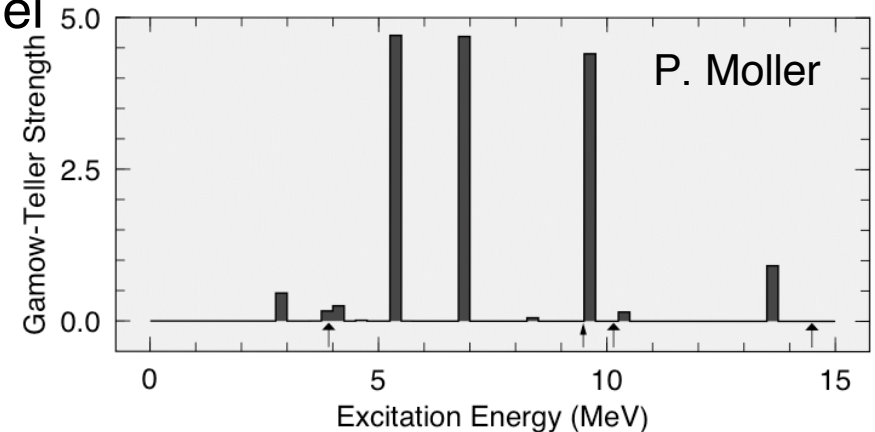
BIN BETA-STRENGTH (1/MEV) P. Moller

2.75 - 3.00	0.4607051E+00
3.50 - 3.75	0.8800582E-03
3.75 - 4.00	0.1655856E+00
4.00 - 4.25	0.2507653E+00
4.50 - 4.75	0.1250124E-01
5.25 - 5.50	0.4706103E+01
5.50 - 5.75	0.9565681E-03
6.75 - 7.00	0.4688719E+01
8.25 - 8.50	0.5553497E-01
9.50 - 9.75	0.4404953E+01
10.25 - 10.50	0.1502496E+00
13.50 - 13.75	0.9146936E+00

T-1/2 (SECS) = 0.371386E+00 EQBET = 9.4830 MeV

Ener	Beta Strength	IP	IN	SIG	OMP	OMN	DV	Int. (%)	log(ft)
2.76	0.1151763E+00	16	20	1	1/2-	1/2-	2	40.4129	4.5547
3.95	0.4139639E-01	14	19	1	1/2-	1/2-	2	5.9869	4.9991

Folded-Yukawa potential $\epsilon_2 = 0.000$ $\Delta_n = 0.64$ MeV $\lambda_n = 32.96$ MeV
 $P_n = 59.55\%$ $T_{1/2} = 371.39$ (ms) $\epsilon_4 = 0.000$ $\Delta_p = 1.08$ MeV $\lambda_p = 29.95$ MeV
 $^{78}_{28}\text{Ni} \rightarrow ^{78}_{29}\text{Cu} + e^-$ $\epsilon_6 = 0.000$ (L-N) $a = 0.80$ fm



Summary

- Progress in understanding many **astrophysical phenomena requires improved nuclear data**
- Interesting, Important Astrophysics Projects involving
 - Structure & Reaction work
 - **Compilations, Evaluations, Disseminations, Tool development, Theory**
 - Multiple laboratories ANL, BNL, LANL, McMaster, ORNL, & TUNL
- **New computational infrastructure at nucastrodata.org** now online to pull this information into astro models