# WINEGROWING AREAS OF SOUTH AFRICA

**COASTAL REGION**
Districts:
- SWARTLAND
- STELLENBOSCH
- TYGERBERG
- CAPE POINT
- CONSTANTIA (Ward)
- TULBAGH
- PAARL
- DARLING

**KLEIN KAROO REGION**
Districts:
- CALITZDORP
- LANGEBERG-GARCIA

**DISTRICTS NOT PART OF A REGION**
- OVERBERG
- WALKER BAY
- DOUGLAS
- CAPE AGULHAS
- PLETTENBERG BAY

**OLIFANTS RIVER REGION**
Districts:
- LUTZVILLE VALLEY
- CITRUSDAL VALLEY
- CITRUSDAL MOUNTAIN

**BREEDE RIVER VALLEY REGION**
Districts:
- BREEDEKLOOF
- WORCESTER
- ROBERTSON
- SWELLENDAM

**WARDS NOT PART OF A REGION**
- CERES
- CEDERBERG
- PRINCE ALBERT VALLEY
- SWARTBERG
- LAMBERT'S BAY
- LOWER ORANGE

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Alex Brown[1] , A. Signoracci[1] and M. Wiescher[2]

1 Dept. of Physics and Astronomy, and NSCL,
Michigan State University
2 Dept. of Physics and Joint Institute for
Nuclear Astrophysics, Univ. of Notre Dame

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# ***OUTLINE***

*Introduction*

*The New Effective Interactions USDA and USDB*

*Comparison with Exp and the older USD*

*Application to the structure of Mg-26*

*Application to the structure of Si-26*

*Calculation of Al-25 (p,gamma) Si-26 reaction rates*

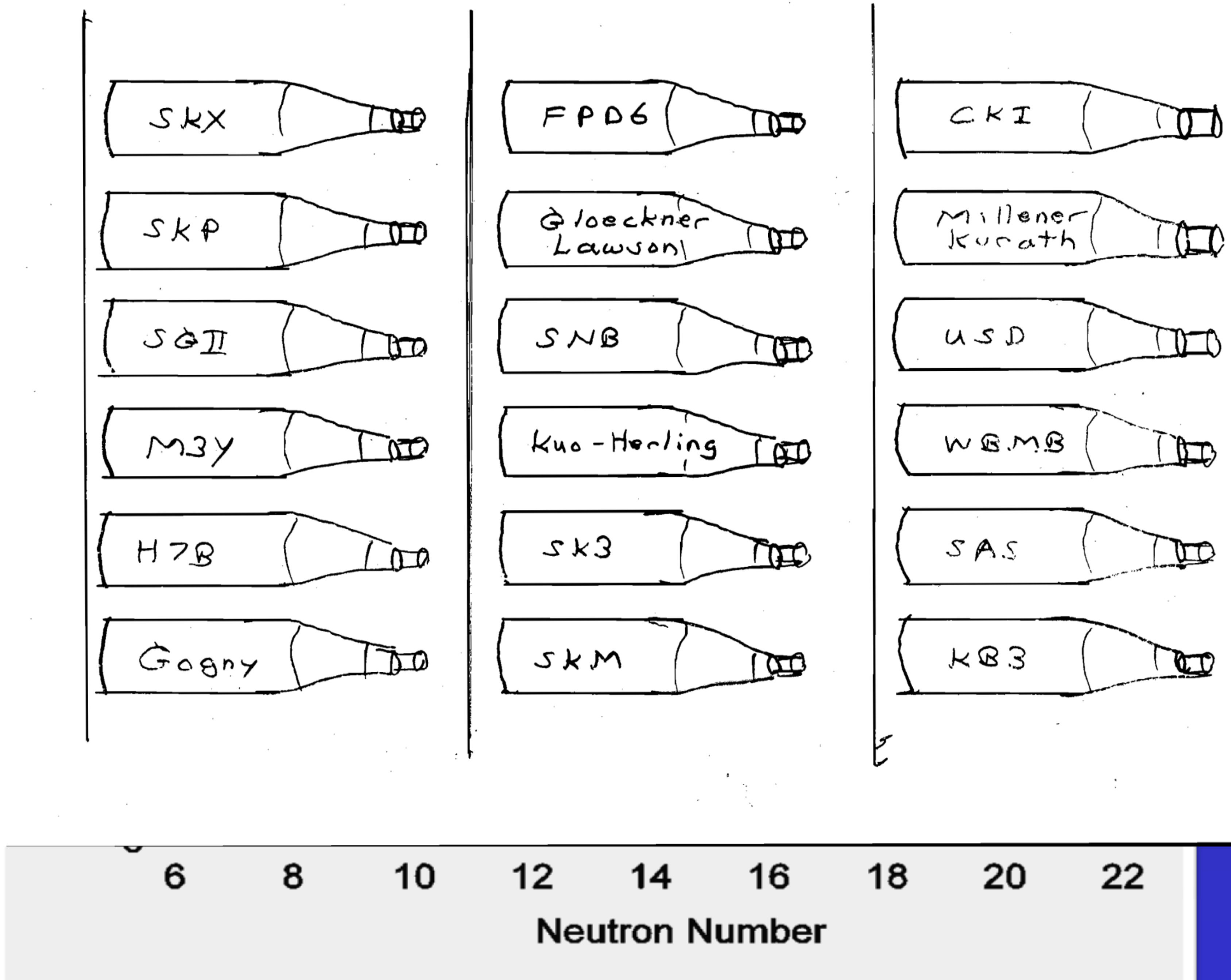
*Conclusions*

*The production mechanism and site for the long-lived radioactive isotope $^{26}$Al has been of interest since the first indications of $^{26}$Al enrichment in meteoritic inclusions was observed. Understanding its origin would serve as a unique signature for nucleosynthesis in novae and supernovae.*

*The main reaction sequence leading to $^{26}$Al is $^{24}Mg(p,\gamma)^{25}Al(\beta+\nu)^{25}Mg(p,\gamma)^{26}Al$. At the high-temperature conditions expected for shell carbon burning and explosive neon burning the $^{25}Al(p,\gamma)^{26}Si$ reaction becomes faster than the $^{25}$Al β decay. Since $^{26}$Si β decays to the short lived 0+ state of $^{26}$Al, the long-lived (5+) state becomes depleted.*

*Many levels in $^{26}$Si (mirror of $^{26}$Mg) are not well known, thus requiring theoretical input. The calculated gamma-decay lifetimes and $^{25}$Al to $^{26}$Si spectroscopic factors together with experimental information on the levels of excited states are used to determine the $^{26}$Al(p,γ)$^{26}$Si reaction rates. A theoretical error on this rate is based on the use of different interactions.*

*The total rp-process reaction rate depends on the partial gamma decay widths of $^{26}$Si levels above the proton-emission threshold as well as the proton decay widths to states in $^{25}$Al. We have calculated this for the USDA and USDB interactions, as well as with certain approximations for the gamma decay widths.*


SkX
SkP
SGII
M3Y
H7B
Gogny
FPD6
Gloeckner Lawson
SNB
Kuo-Herling
Sk3
SkM
CKI
Millener Kurath
USD
WBMB
SAS
KB3
6
8
10
12
14
16
18
20
22
Neutron Number

## EXPERIMENTAL DATA

- With neutron-rich nuclei and previously omitted nuclei we used 608 levels in 77 nuclei

## FITTING PROCEDURE

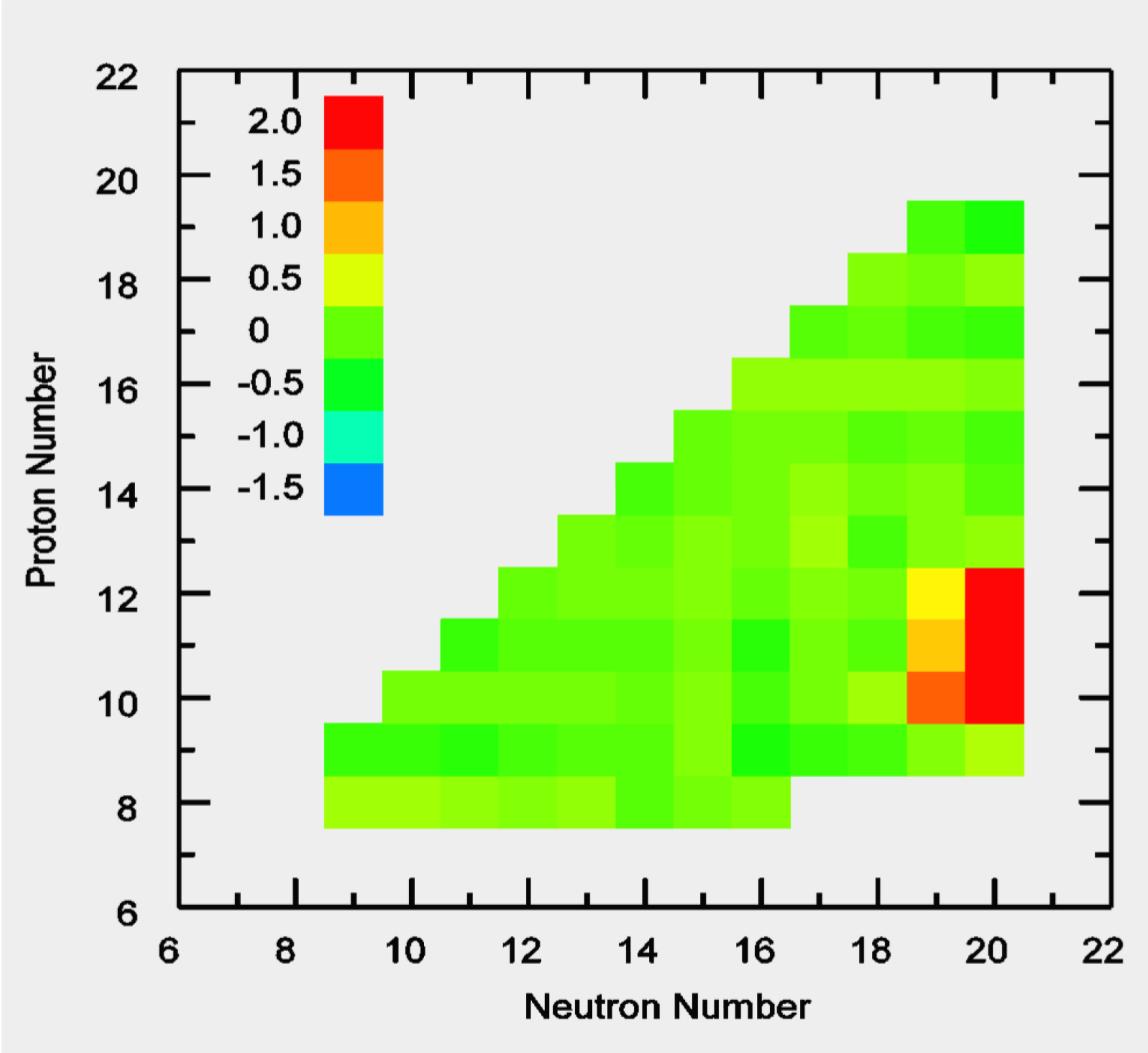
- Minimize deviations (chi-squared) between theor. and exp. energies in several iterations

For USDA, 30 well-determined LC's
(170 keV rms)

For USDB, 56 well-determined LC's
(130 keV rms)

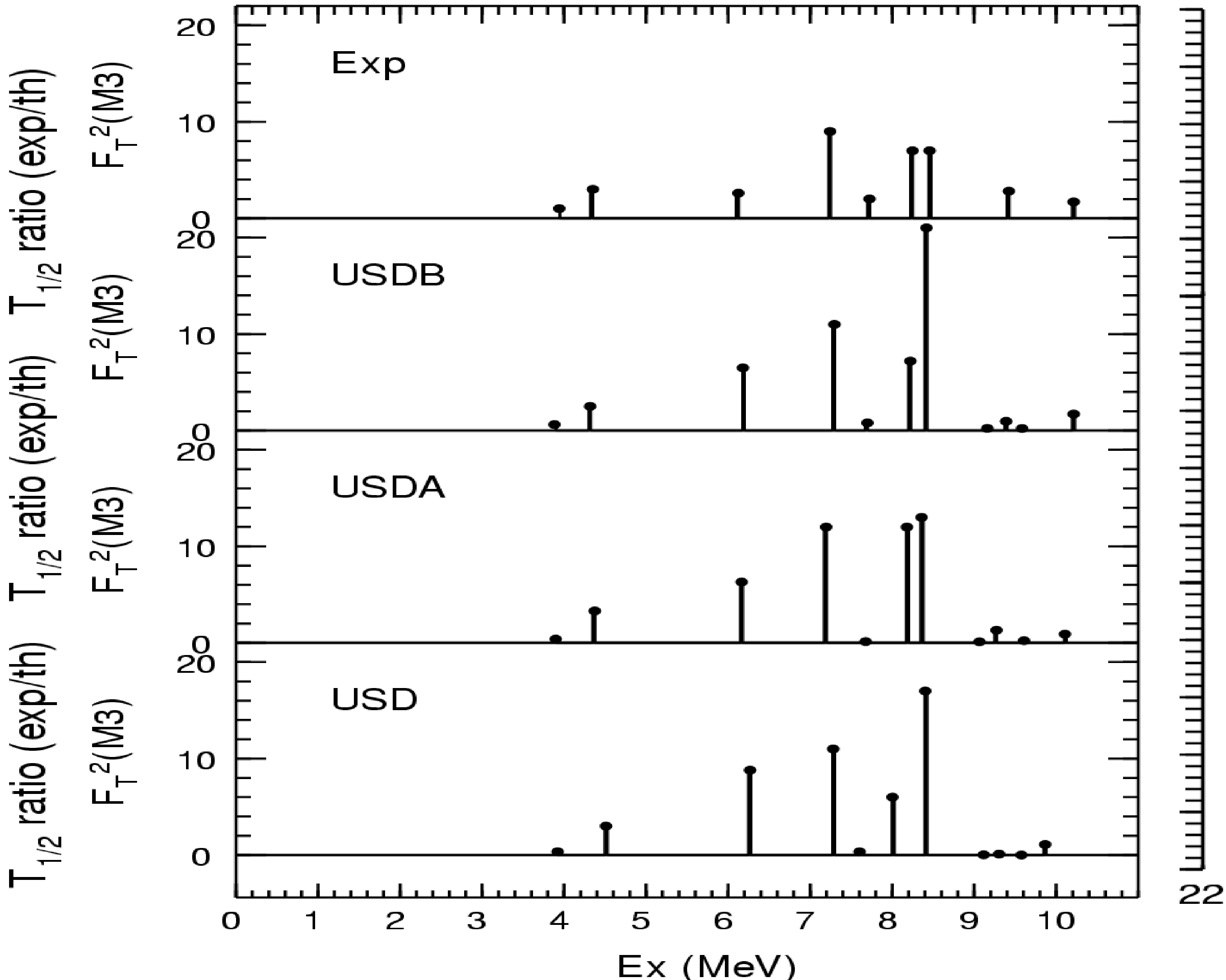
RE

ES

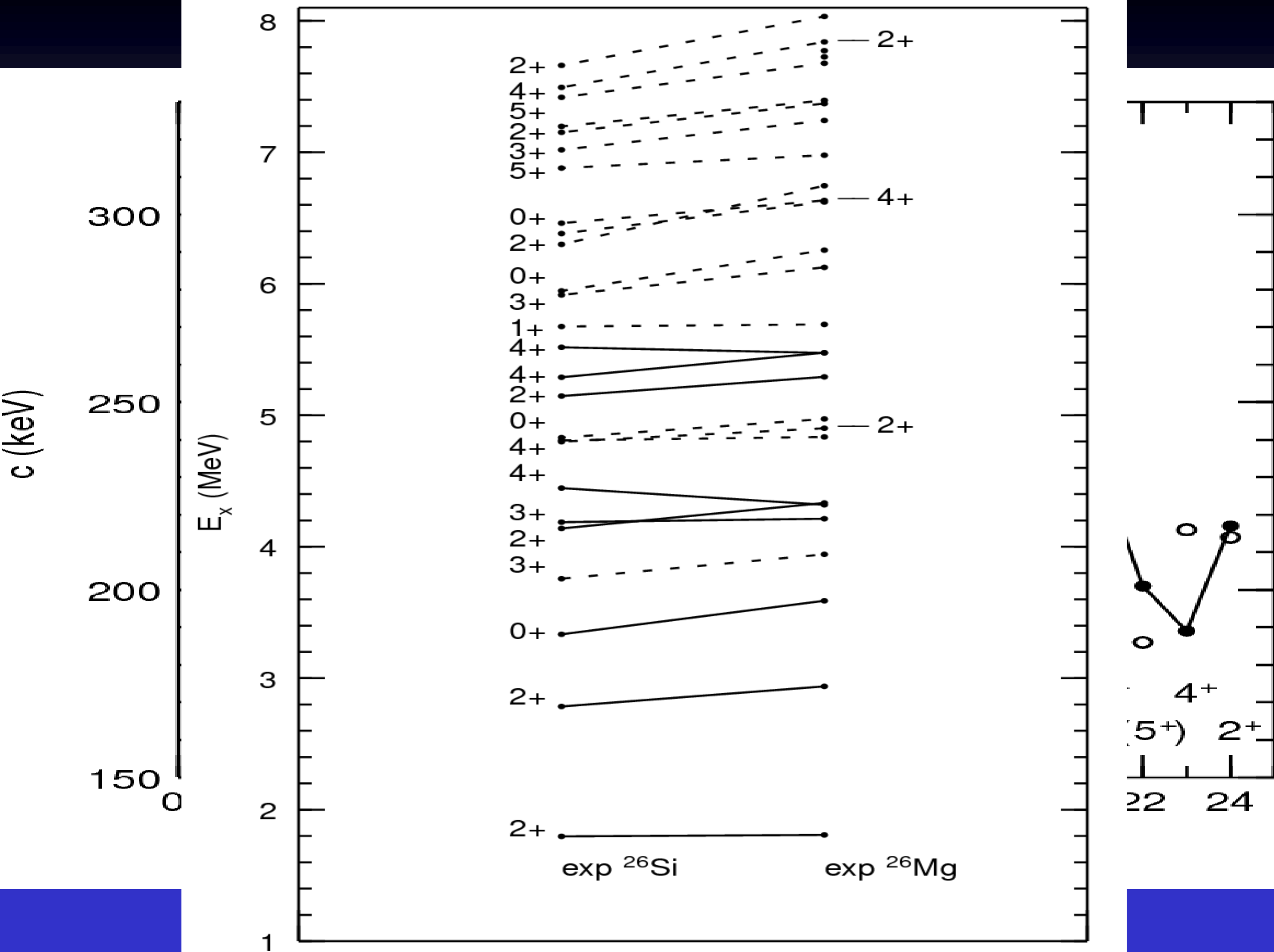

2.0
1.5
1.0
0.5
0
-0.5
-1.0
-1.5
Proton Number
22
20
18
16
14
12
10
8
6
6
8
10
12
14
16
18
20
22
Neutron Number

Generally good agreement with experiment for all sd-shell observables calculated with the effective interactions USDA and USDB [Richter,Mkhize, Brown, Phys. Rev. C 78, 064302 (2008) ]

For <u>level energies</u> USDB provided a superior agreement (130 keV rms fit deviations). Both USDB and USDA gave improved <u>binding energies</u> for neutron-rich nuclei compared to USD .

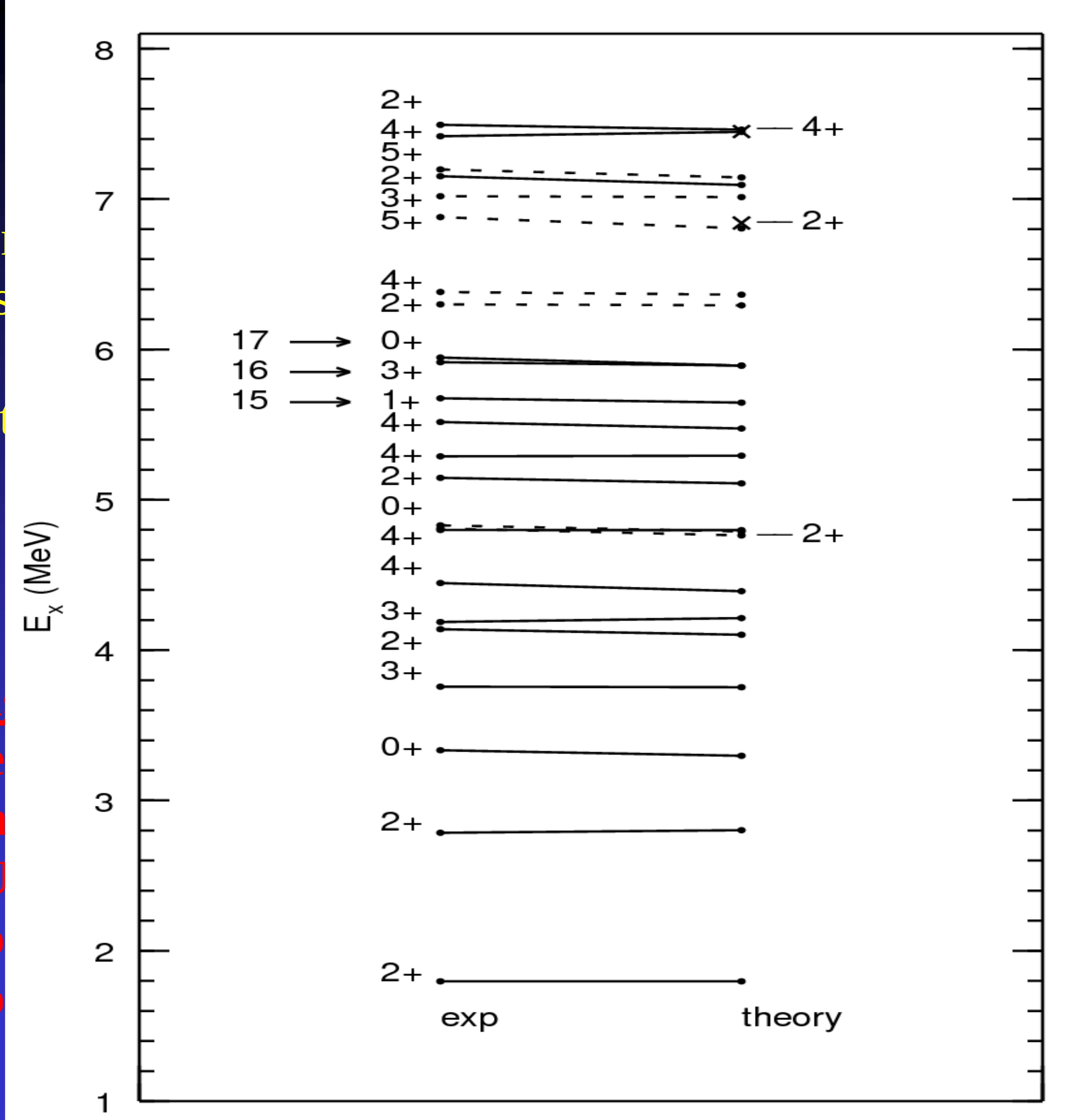


Exp
USDB
USDA
USD
$F_T^2$(M3)
$T_{1/2}$ ratio (exp/th)
20
10
0
0 1 2 3 4 5 6 7 8 9 10
Ex (MeV)
22



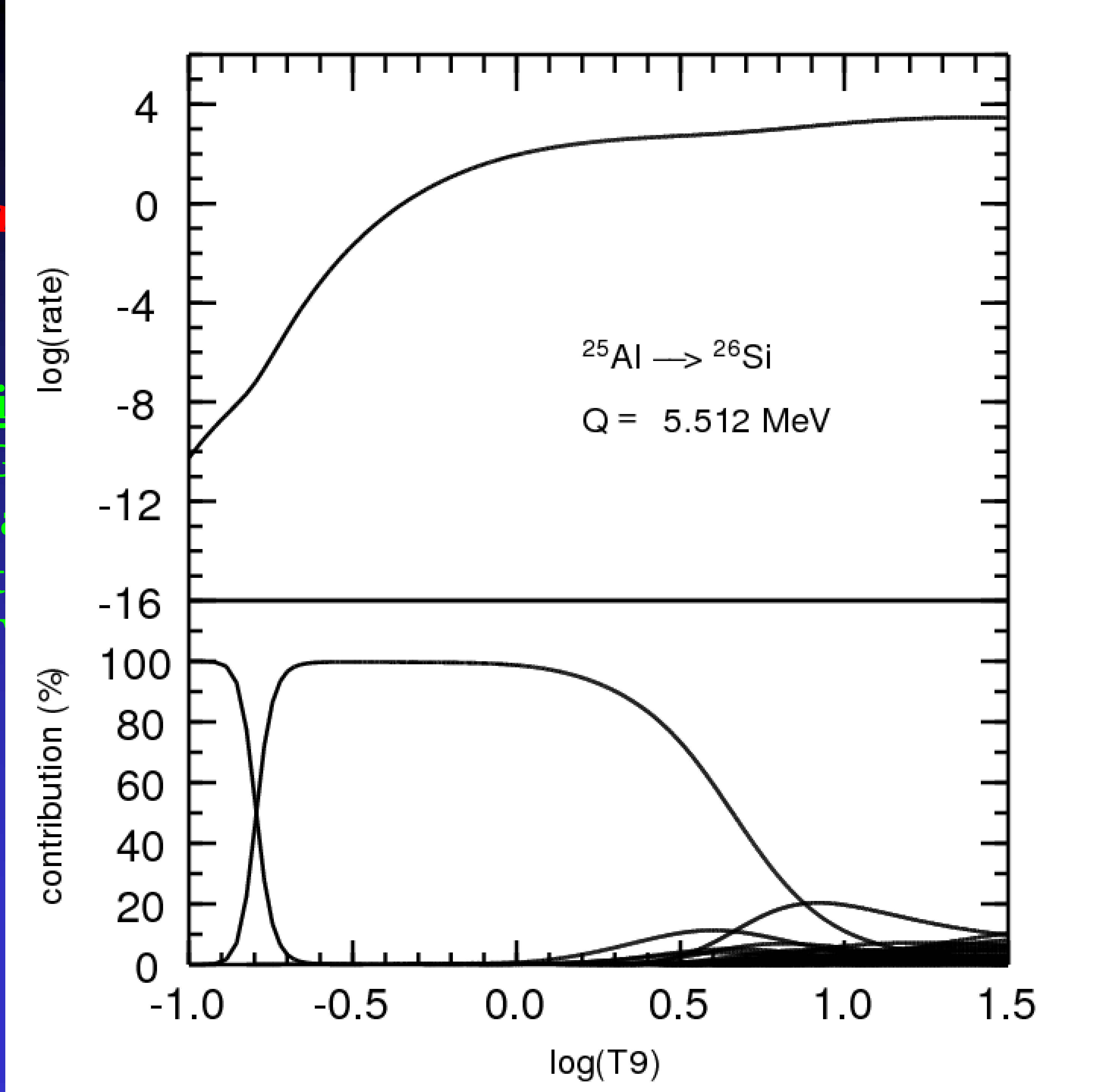
E$_x$ (MeV)
8
7
6
5
4
3
2
1
2+
4+
5+
2+
3+
5+
0+
2+
0+
3+
1+
4+
4+
2+
0+
4+
4+
3+
2+
3+
0+
2+
2+
2+
4+
2+
exp $^{26}$Si
exp $^{26}$Mg
c (keV)
300
250
200
150
0
22
24
4$^+$
(5$^+$)
2$^+$

A r … s in $^{26}$Si
bas … e states
in … efficient
of t




**Fi** … n $^{26}$Si
**ve** … **binding**
**en** … **cient**
**(U** … **rosses**
**co** … **al**
**co**

*Ca* ... *tes*




**Fi** ... **T9**
**(G** ... **final**
**st** ... **state**
**at**
**T**

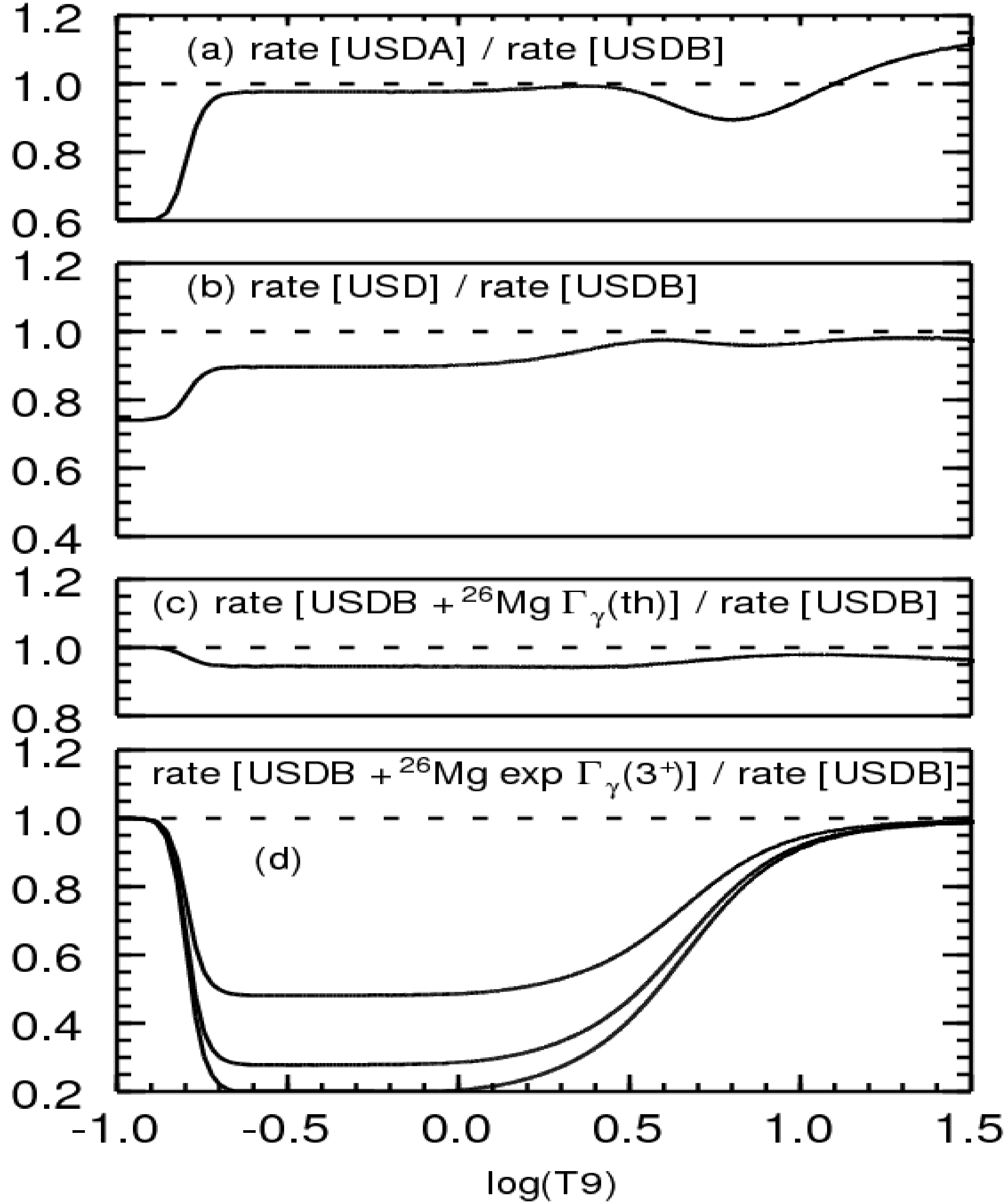
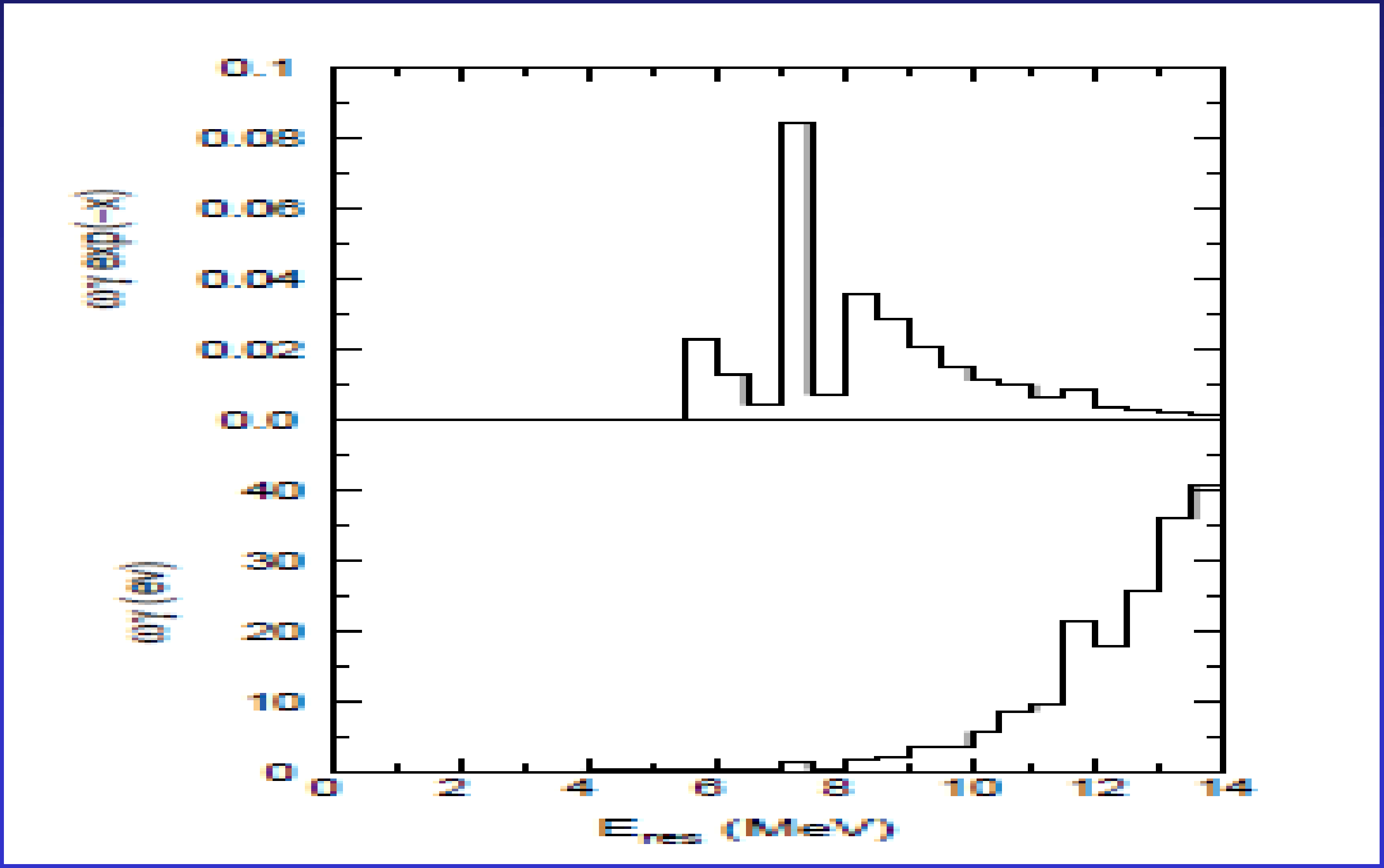

(a) rate [USDA] / rate [USDB]
(b) rate [USD] / rate [USDB]
(c) rate [USDB + 26Mg Γγ(th)] / rate [USDB]
rate [USDB + 26Mg exp Γγ(3+)] / rate [USDB]
(d)
1.2
1.0
0.8
0.6
0.4
0.2
-1.0
-0.5
0.0
0.5
1.0
1.5
log(T9)

***Figure 6. Relative contributions to the reaction rates for $x = -E_{res}/(kT)$ with $T9 = 10$. Resonant reaction rate $\alpha\ \Sigma_f\, \omega\gamma_{i\,f}\, e^{-Eres/(kT)}$.***



# *CONCLUSIONS*

- *Our new method for determining energies of states in $^{26}$Si , based on the IMME, with experimental energies for the T = 1 analogue states and the theoretical c-coefficients, should be extended to other cases in the sd shell.*

- *For the gamma decay lifetime calculations it is an adequate approximation to use the theoretical lifetimes of the mirror nucleus $^{26}$Mg.*

- *The use of different interactions and approximations gives an indication of the theoretical error in the rates.*