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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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

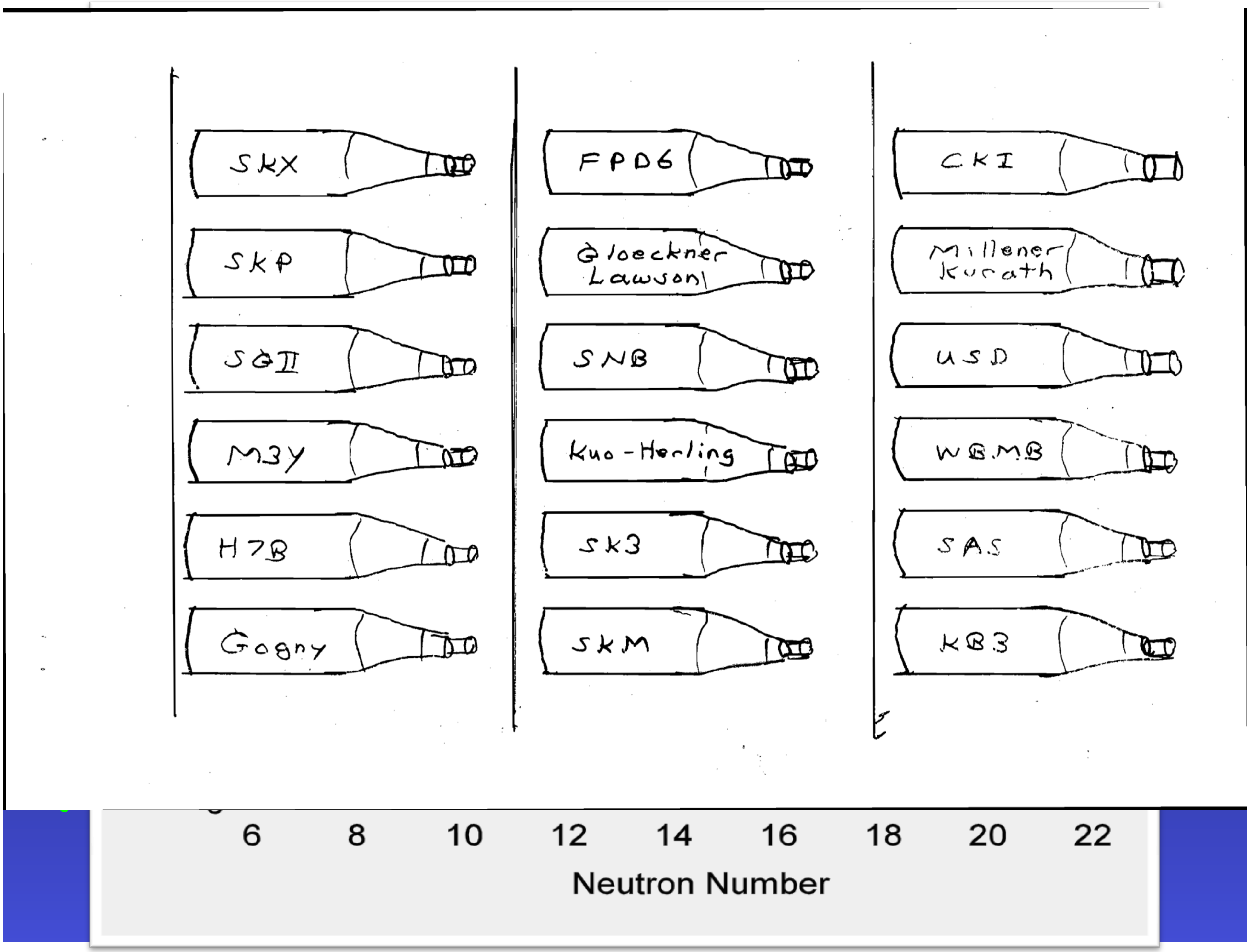
Conclusions

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 $^{26}Al(p,\gamma)^{26}Si$ 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)

RESU … GIES

Co

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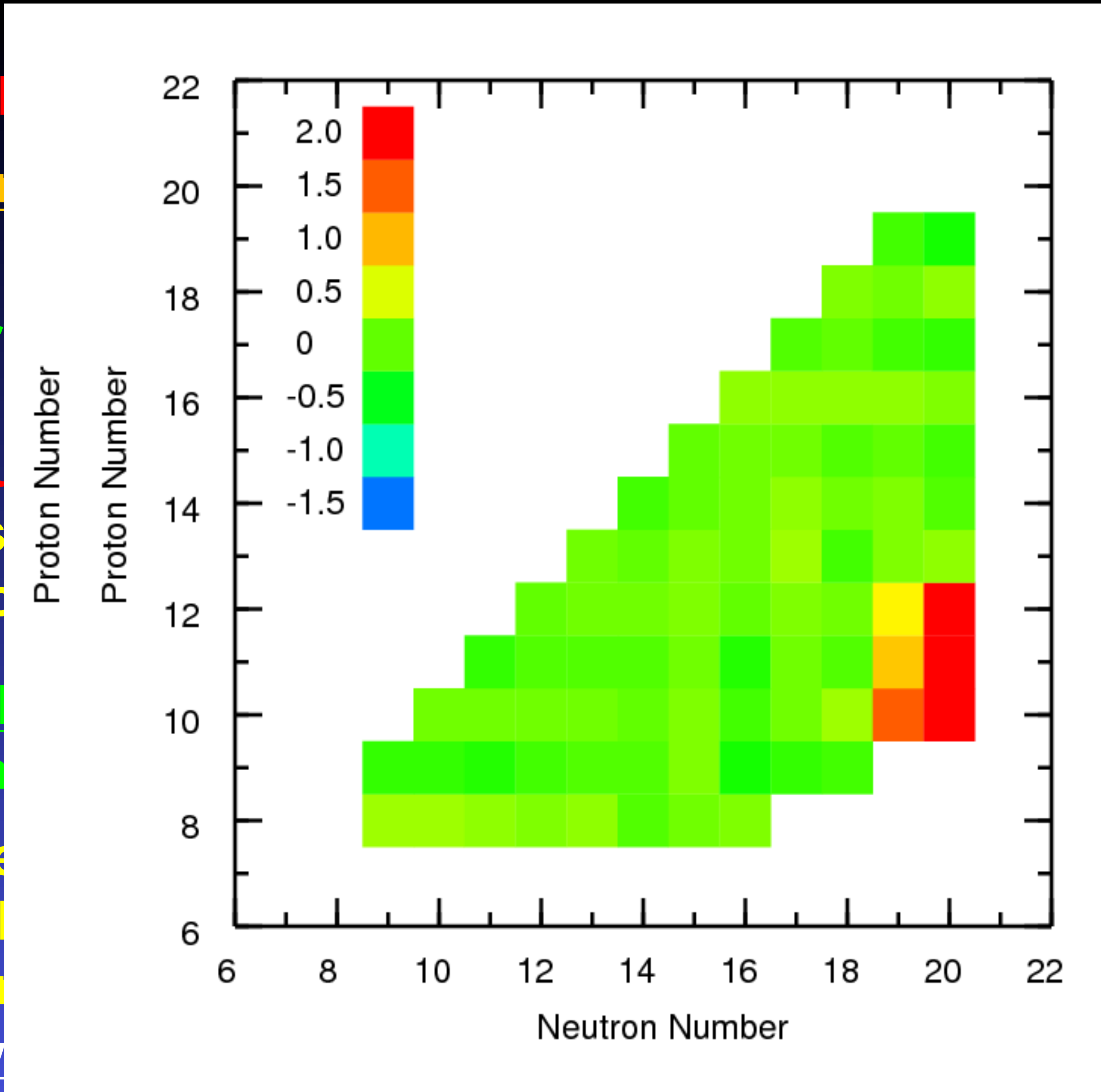
- US … Thu
- Als … by abo

USI … O a

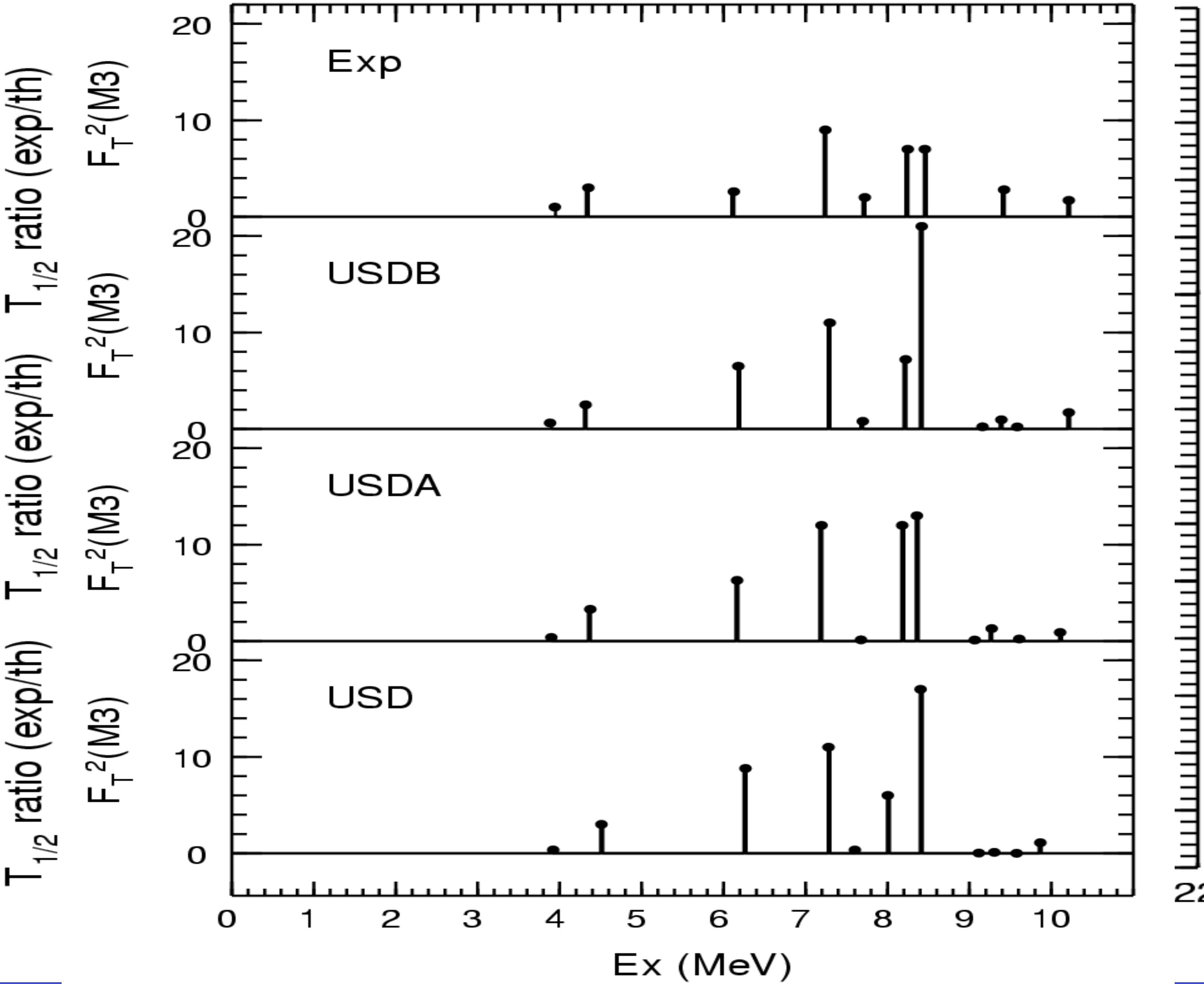
Spe … th USI … Co … :

ww

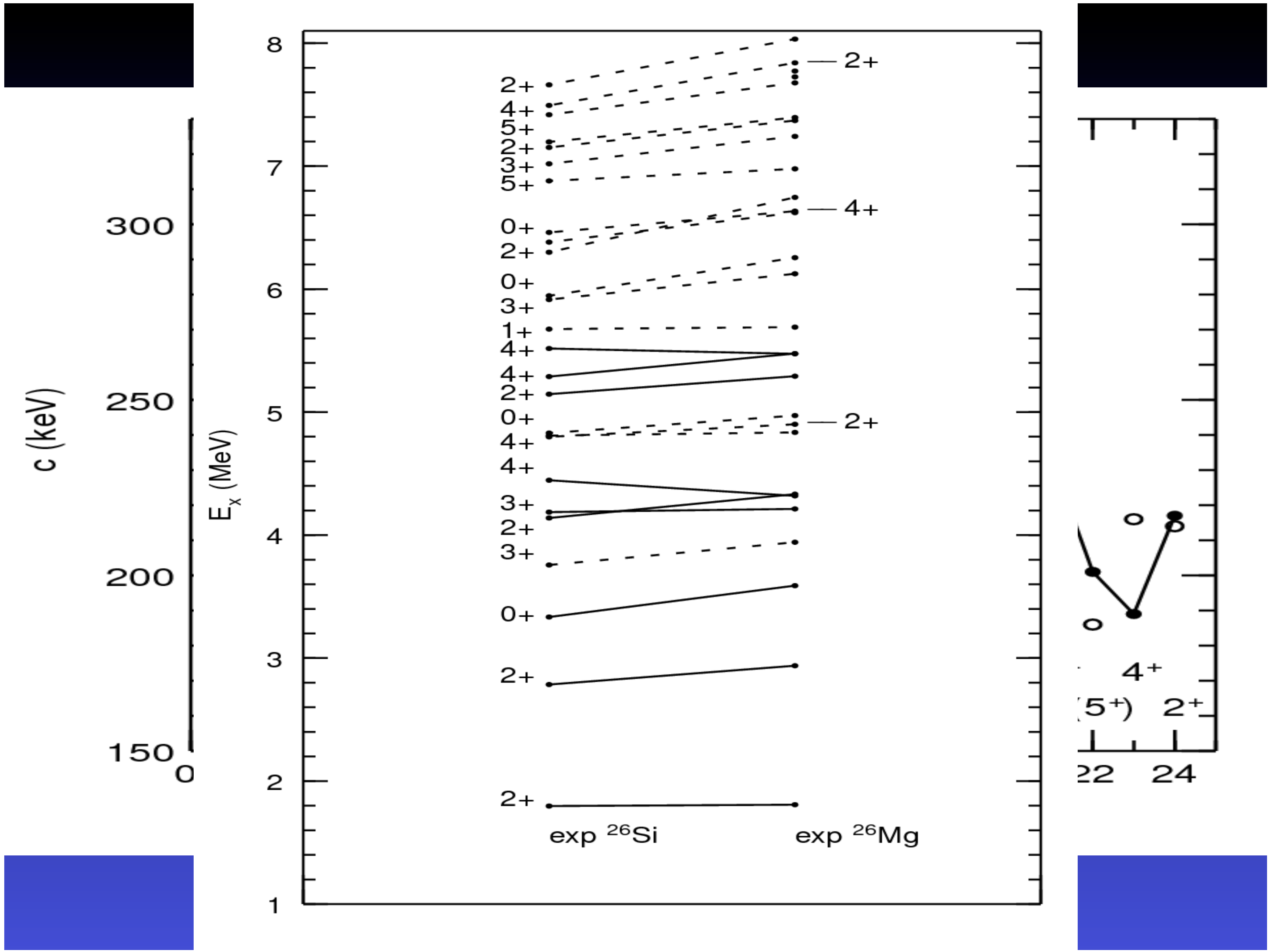


Generally good agreement with experiment for all sd-shell observables calculated with the effective interactions USDA and USDB [Richter,Mkhize, Brown, Phys. Rev. C 78, 064302 (2008)]

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



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



c (keV)
300
250
200
150
0
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
4$^+$
(5$^+$)
2$^+$
22
24

A nove ... ^{26}Si
based u ... ates
in ^{26}Al ... ient
of the is

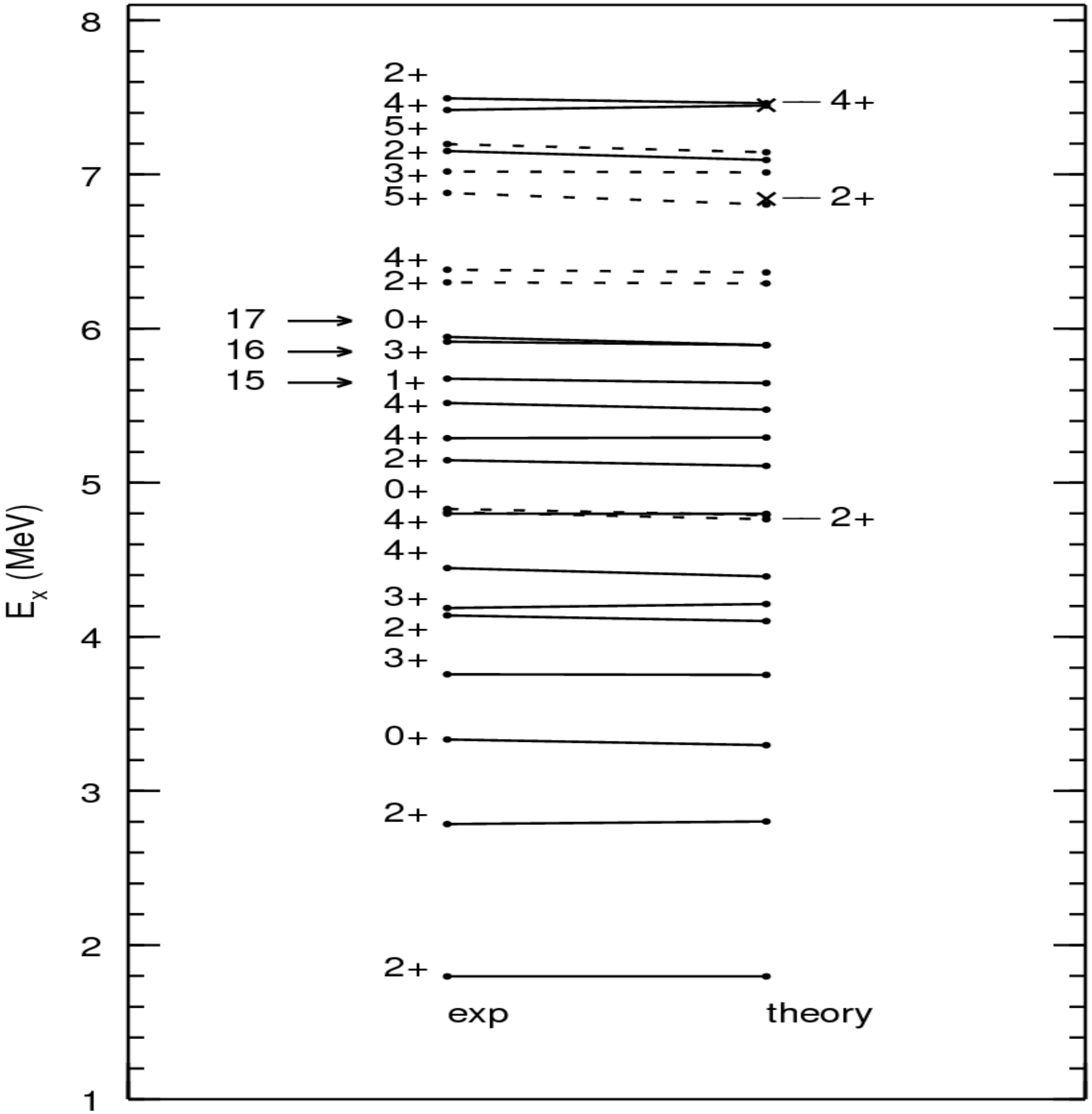
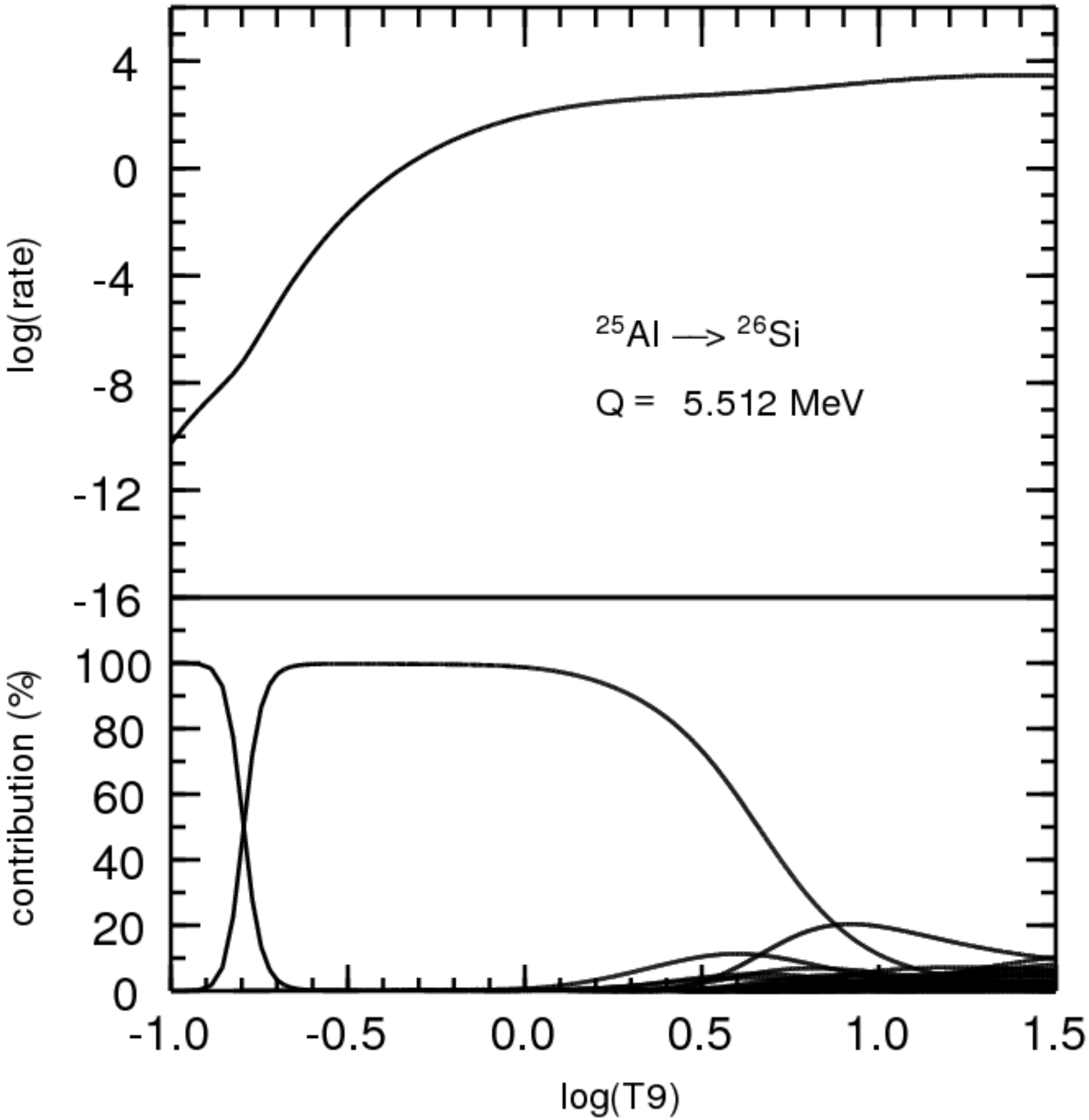
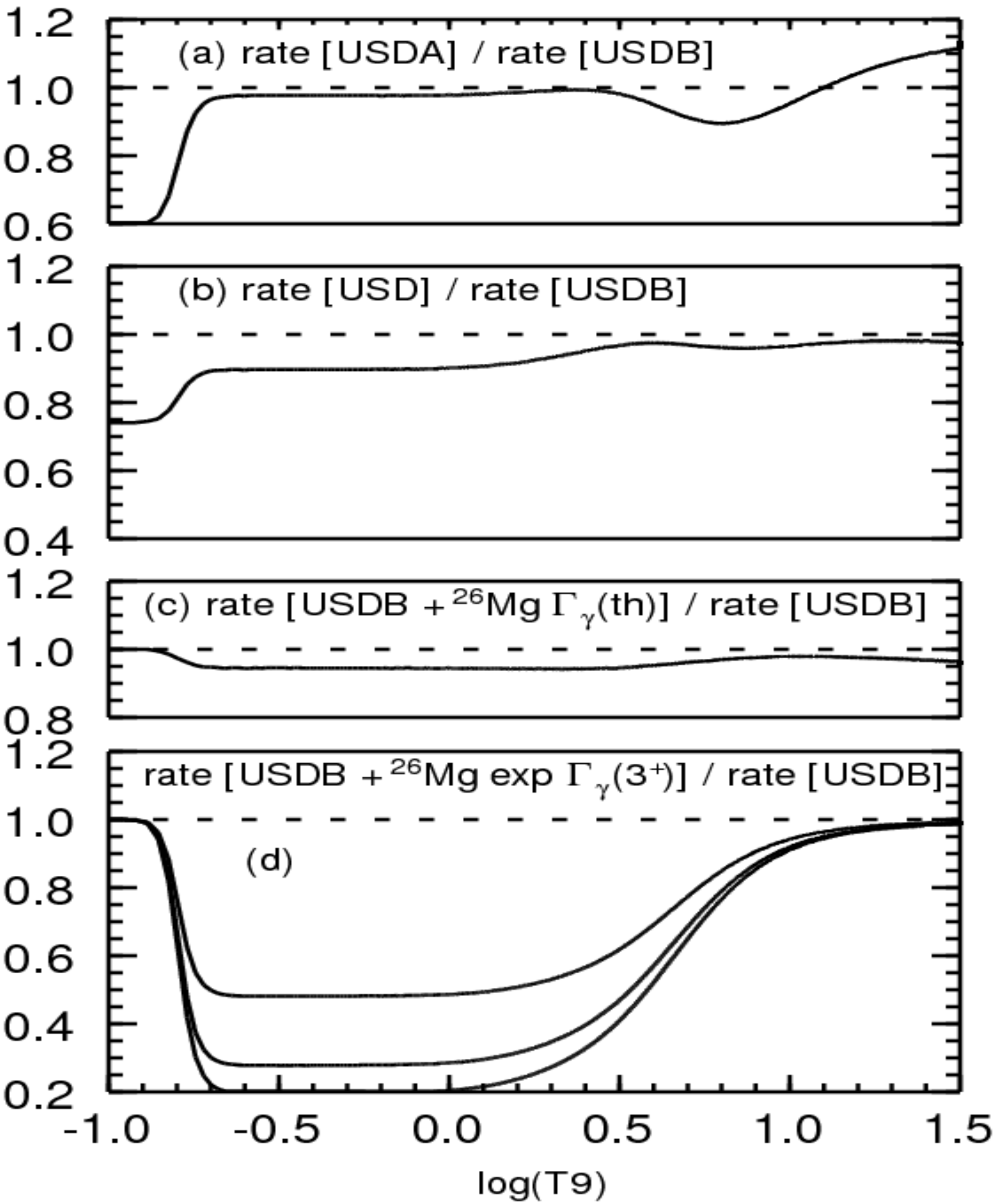


Figure ... i
versus ... ing
energi
(USDB ... es
corres
counte

Ca ... *tes*

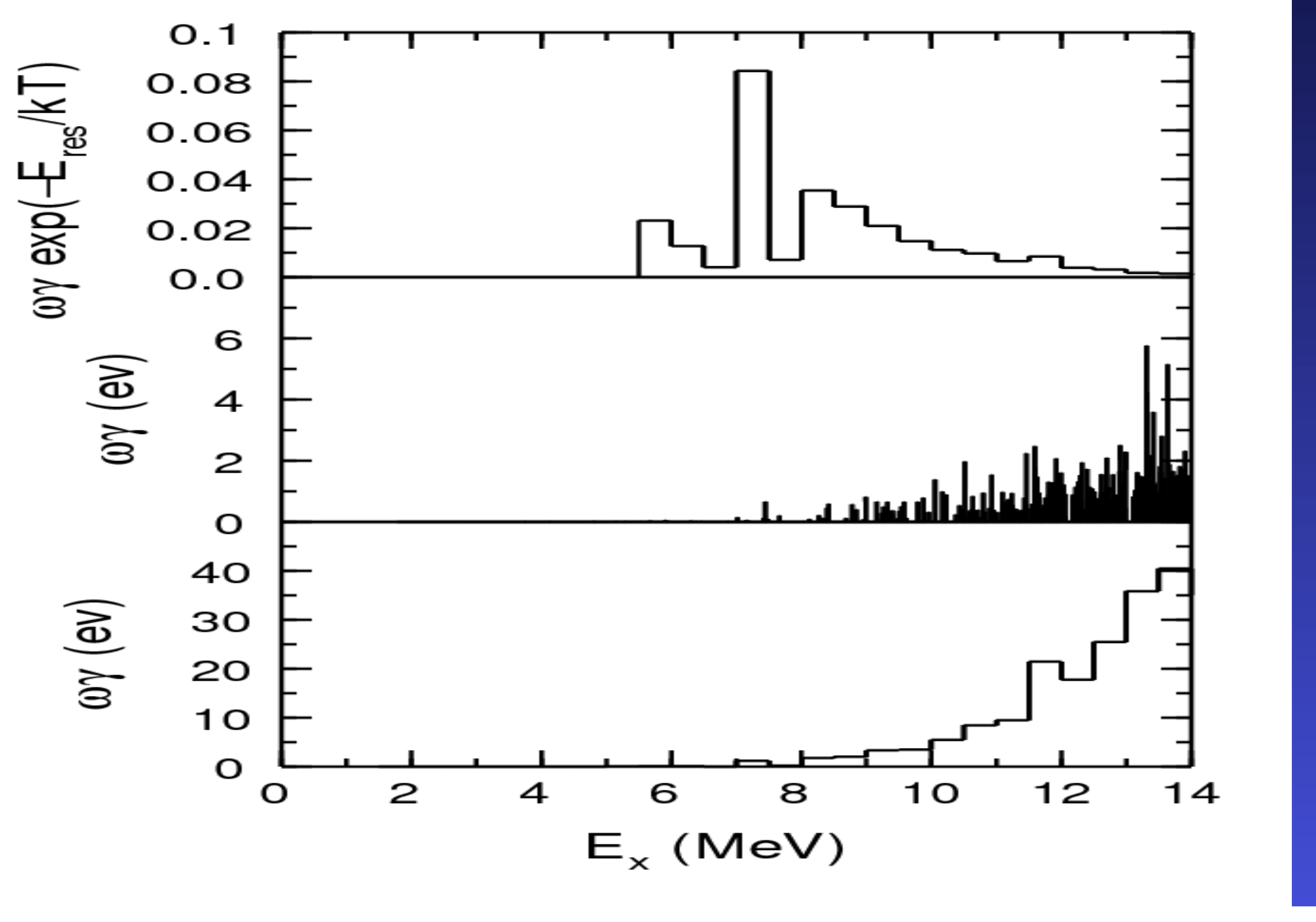
Fi ... T9
(G ... final
st ... state
at
T





(a) rate [USDA] / rate [USDB]
(b) rate [USD] / rate [USDB]
(c) rate [USDB + ^{26}Mg Γ_γ(th)] / rate [USDB]
rate [USDB + ^{26}Mg exp $\Gamma_\gamma(3^+)$] / 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 α $\Sigma_f \omega\gamma_{if} e^{-E_{res}/(kT)}$.



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*

- *Some estimate of the contribution of negative parity states must still be made.*