STATE DENSITY FORMALISM OF THE IWAMOTO-HARADA MODEL: A SUITABLE TOOL TO TREAT CLUSTER EMISSION FROM HEAVY-ION COLLISIONS WITH ACCOUNT FOR SPIN VARIABLES

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Exotic nuclear shapes (super and hyperdeformed) expected also for some (light) 4-α nuclei, like ^{36}Ar etc. Their formation possible (with probably higher cross section – higher angular momenta) in heavy ion induced reactions, obviously dependent on the way of production. This is a practical stimulation for our effort.

Iwamoto & Harada (1982); Betak & Dobes (1977)

classical coalescence

$$\lambda_c(x,n,\varepsilon) \propto \gamma_x \frac{\omega(p-p_x,h,U)}{\omega(p,h,E)} \frac{\omega(p_x,0,\varepsilon_x+B_x)}{g_x}$$

IH coalescence (pickup + knockout + coalescence

$$\sum_{p^*=1}^{p_x} \omega(p-p^*,h,E-\varepsilon_1)\omega(p^*,0,\varepsilon_1)\omega(0,p_x-p^*,\varepsilon_2)d\varepsilon_1$$

Heavy ions "translated" into the language of the pre-equilibrium exciton model mean replacing the initial exciton number by another value.

Similarly as in the beginning of the exciton (systematics of n_0), we use similar approach for heavy ions. Both very rough derivation and analyses of data (Cindro *et al.*, Ma *et al.*) give similar results.

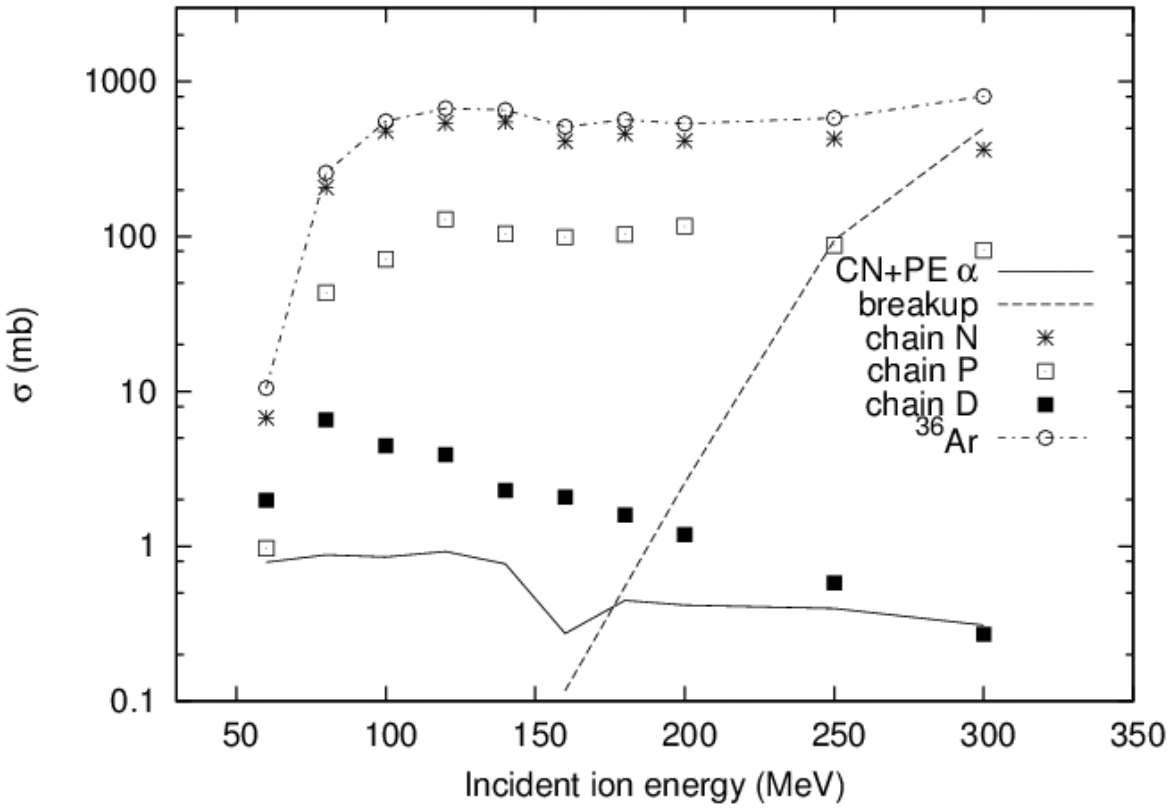
For low energies

$$\frac{n_0}{A_{proj}} = 0.09 + (0.38 - 0.08\frac{A_{t\,\mathrm{arg}} - A_{proj}}{A_{t\,\mathrm{arg}} + A_{proj}})\sqrt{\frac{E_{cm} - V_C}{A_{proj}}}$$

For higher ones

$$\frac{n_0}{E_{exc}} = 4.6 + 0.54\sqrt{\frac{E_{cm} - V_C}{A_{proj}}}$$

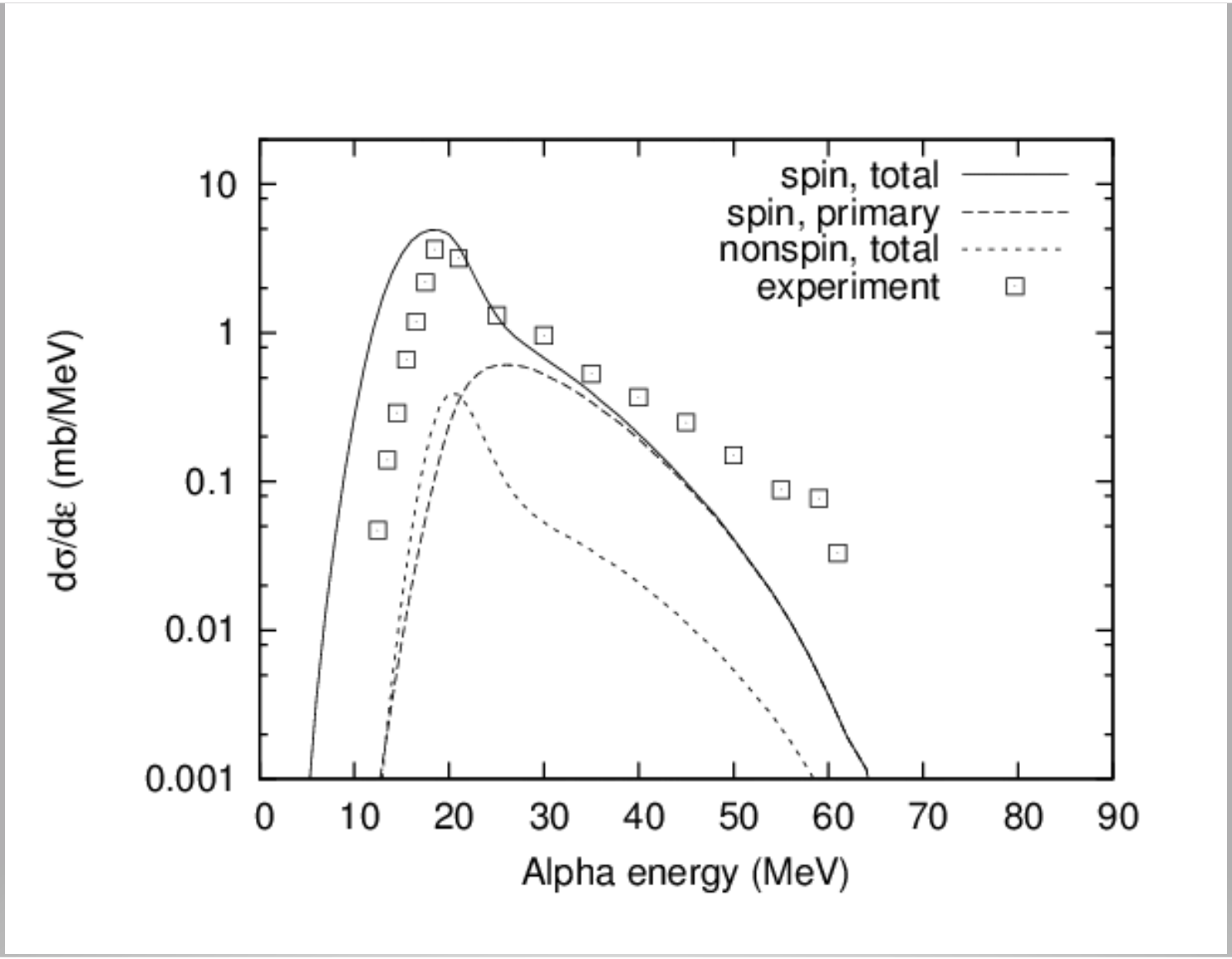
(or replacing 4.6 by 6.6 for “pure systematics”)

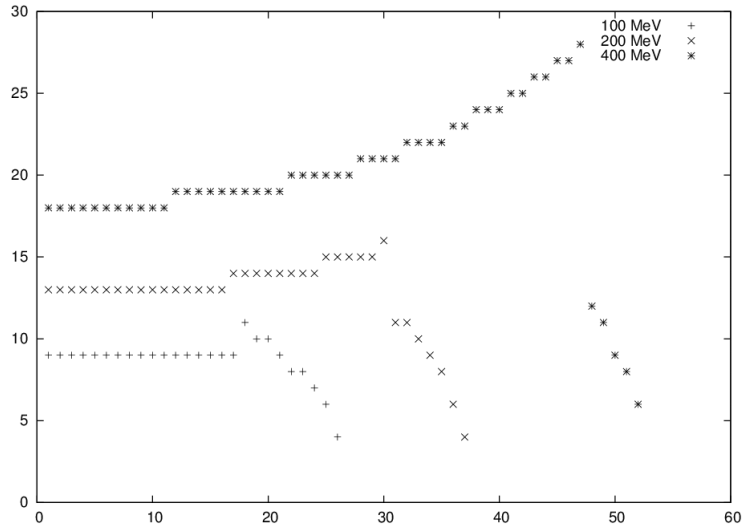

1000
100
10
1
0.1
σ (mb)
50
100
150
200
250
300
350
Incident ion energy (MeV)
CN+PE α
breakup
chain N
chain P
chain D
36Ar

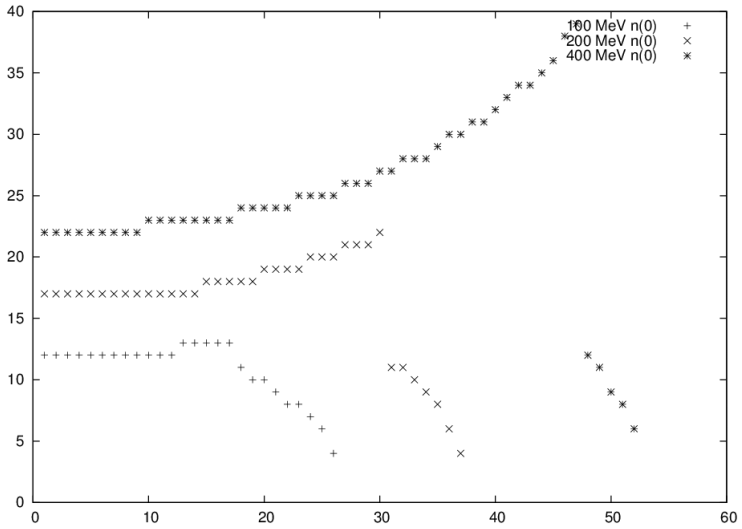
Inclusion of spin by deducting rotational energy from the excitation one

$$E_{exc}(l) = E_{cm} + B - E_{rot}(l)$$

where $E_{rot}(l)$ is calculated with inertia moment of two touching spheres, at least for incident energies ca 5 – 20 MeV/A (*see time-dependent calculations of initial phase of heavy-ion collisions*)


spin, total
spin, primary
nonspin, total
experiment
dσ/dε (mb/MeV)
10
1
0.1
0.01
0.001
0
10
20
30
40
50
60
70
80
90
Alpha energy (MeV)


100 MeV
200 MeV
400 MeV
0
5
10
15
20
25
30
0
10
20
30
40
50
60


100 MeV n(0)
200 MeV n(0)
400 MeV n(0)
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60

Thank you for your attention