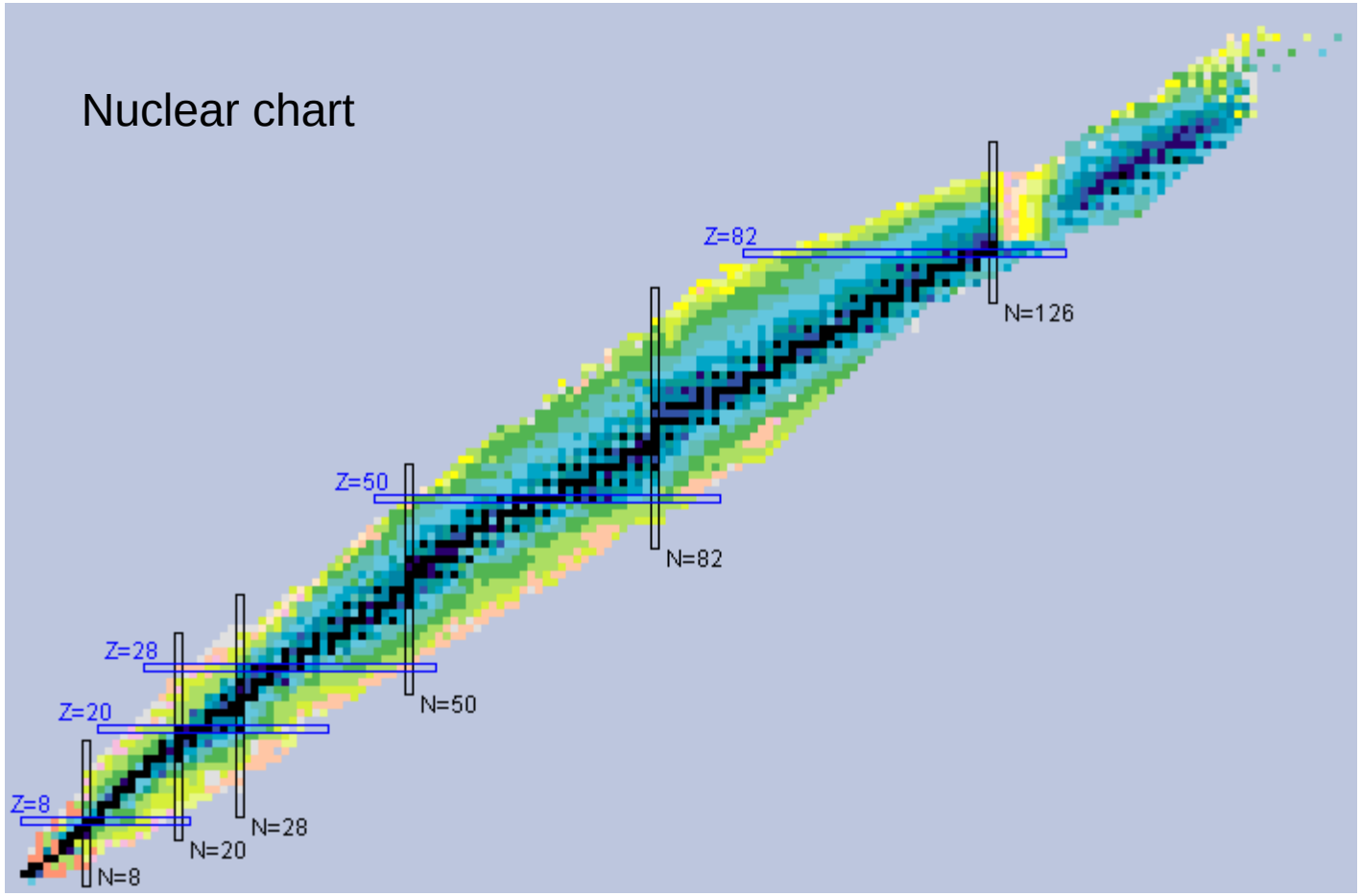
Self-consistent description of multipole strength in exotic nuclei

J. Terasaki, J. Engel, M. Bender, J. Dobaczewski,
W. Nazarewicz, and M. Stoitsov

Mar. 31, 2005



Z

N

http://www.nndc.bnl.gov/nudat2/

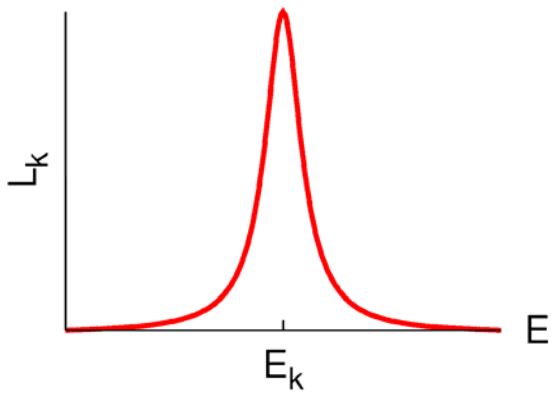
Strength function

$$S_J(E) = \sum_k \sum_{M=-J}^{J} \left| \langle \Psi_k | \hat{F}_{JM} | \Psi_0 \rangle \right|^2 L_k(E)$$

$|\Psi_k\rangle$: excited state
$|\Psi_0\rangle$: ground state
$\Big\}$ ← quasiparticle random phase approximation,
Skyrme and volume - type pairing forces

$\hat{F}_{JM}$: transition operator
$\propto r^n Y_{JM}(\Omega)$
isoscalar and isovector

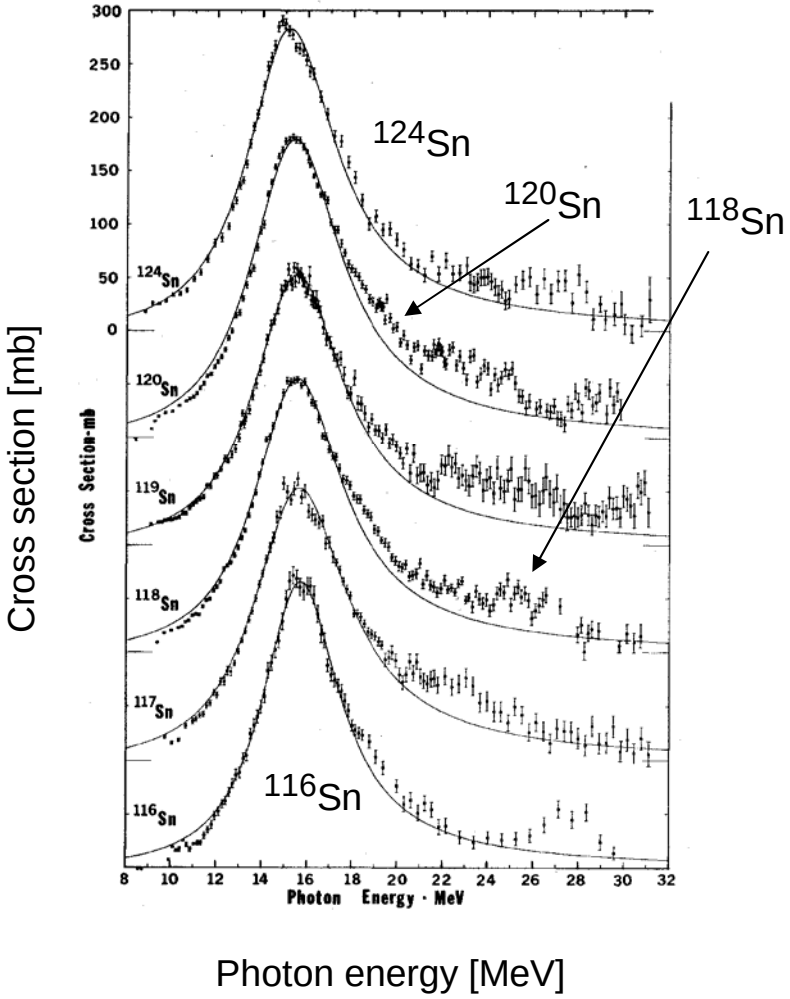
$L_k(E)$: Lorenzian



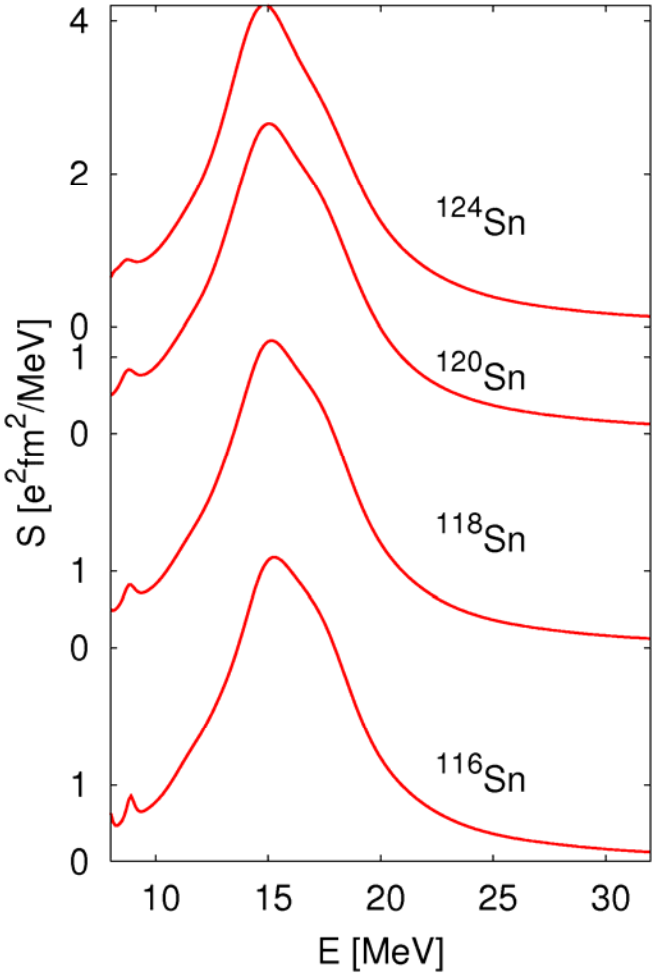
PRC **71**, 034310 (2005)

Isovector 1^-

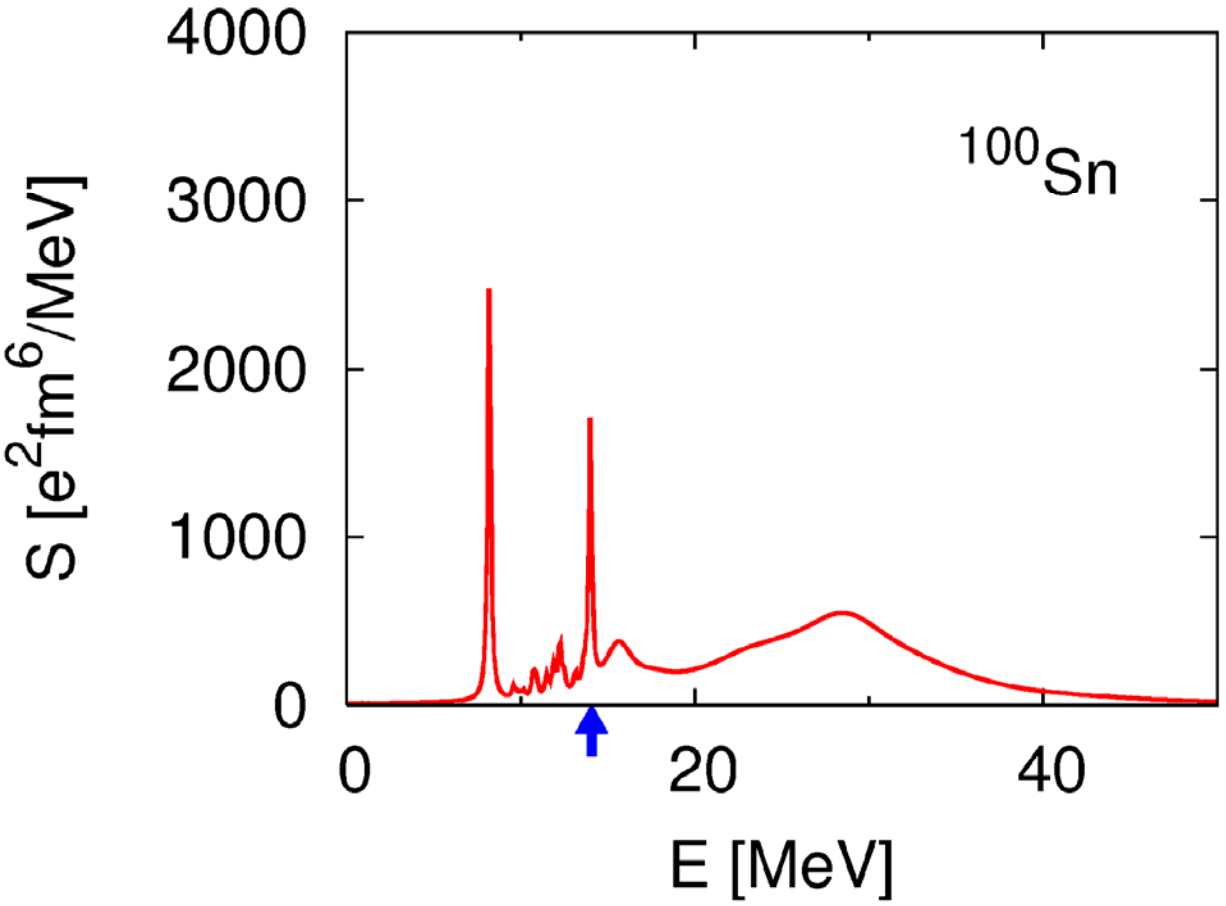
B.L. Berman and S.C Fultz,
Rev.Mod.Phys. **47** (1975) 713

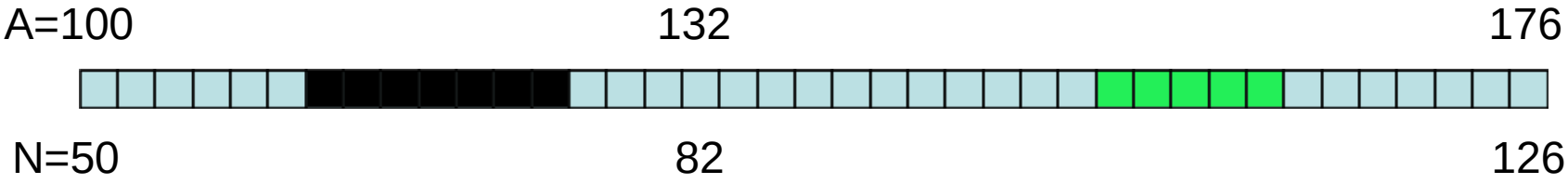


Our calculation (SkM*)



Isoscalar 1^- strength functions





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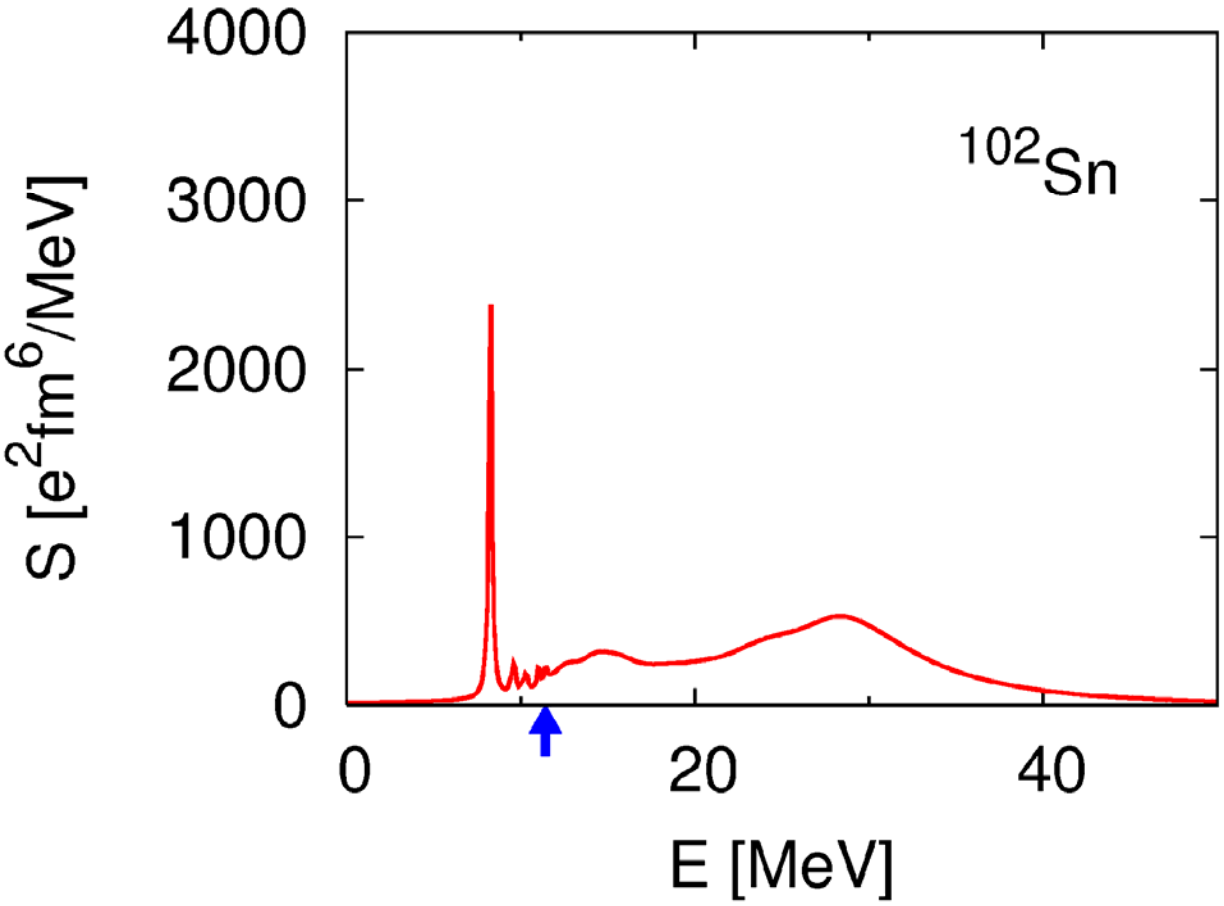

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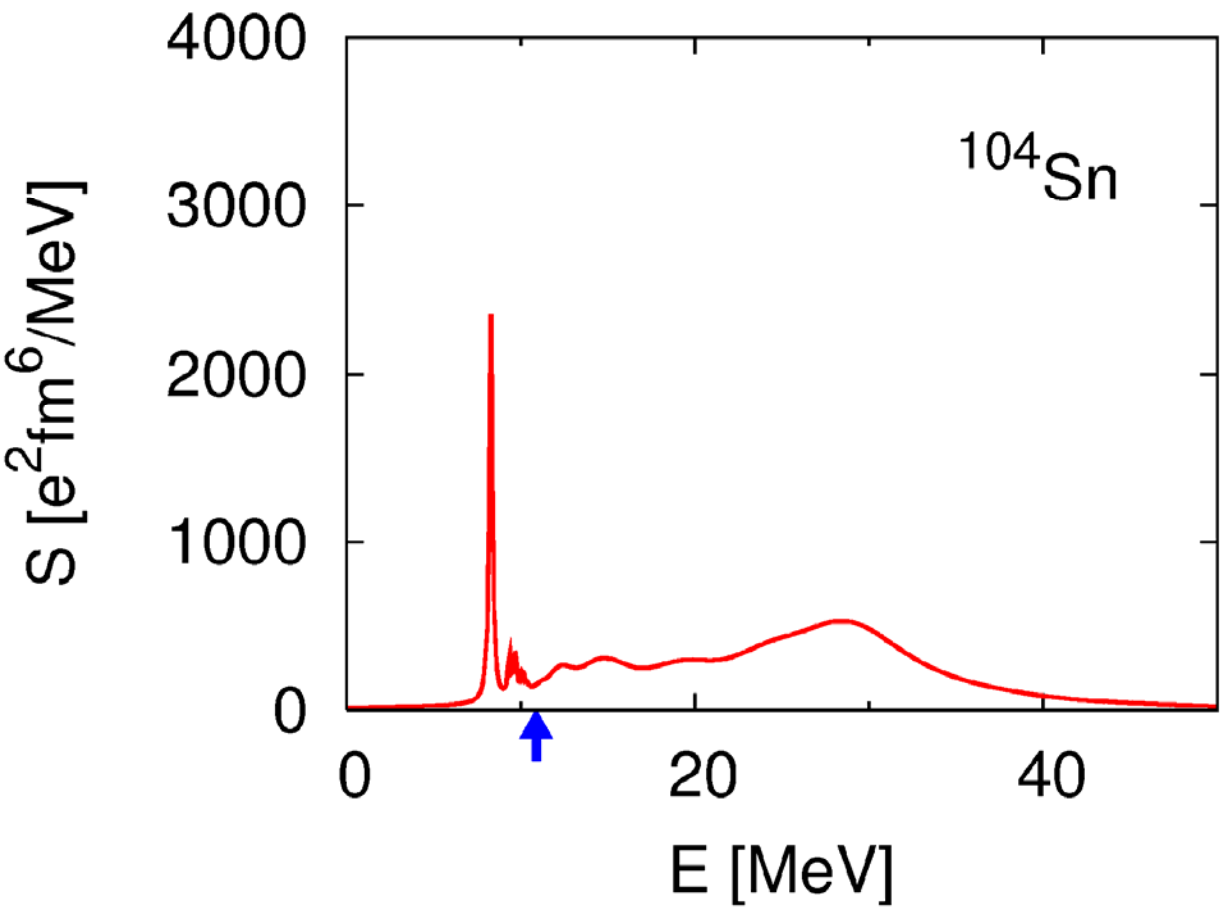

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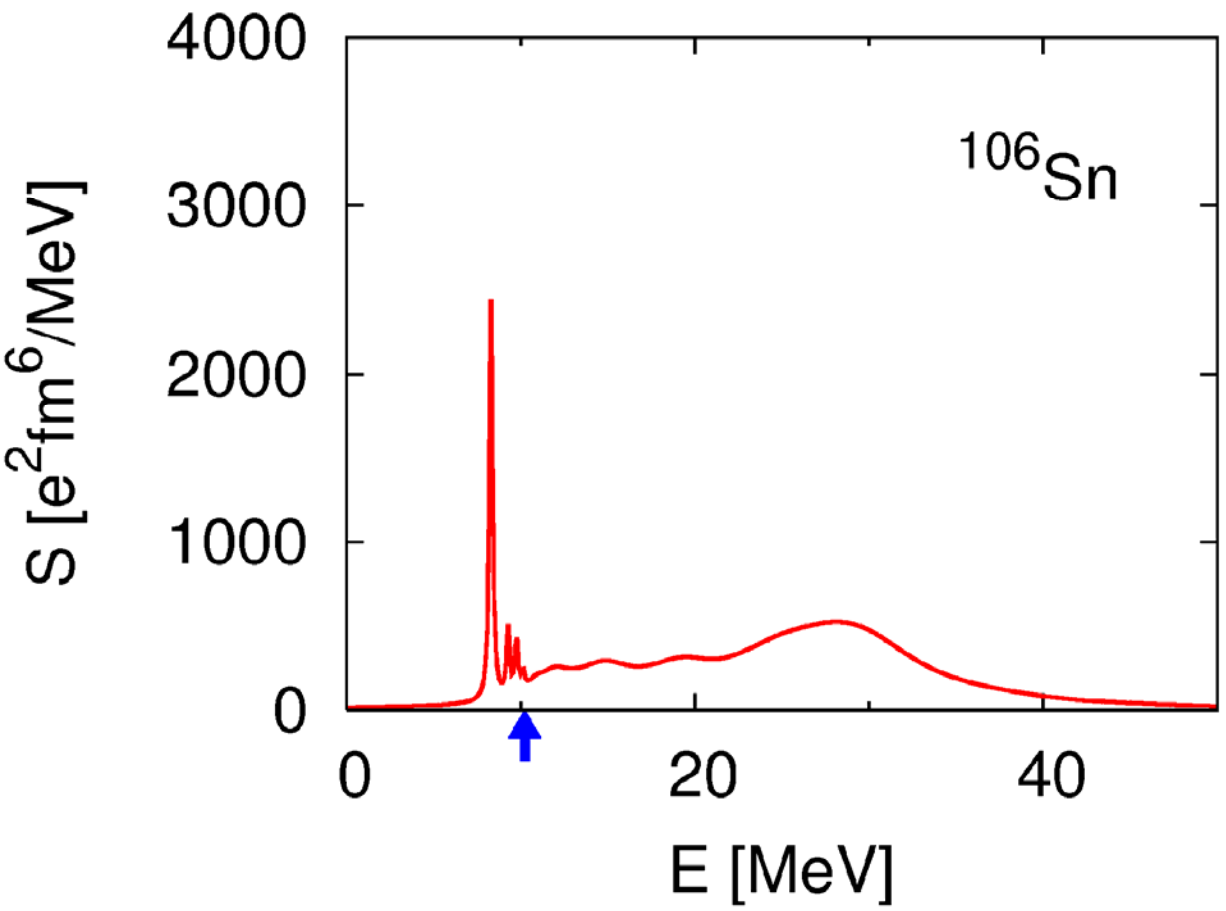

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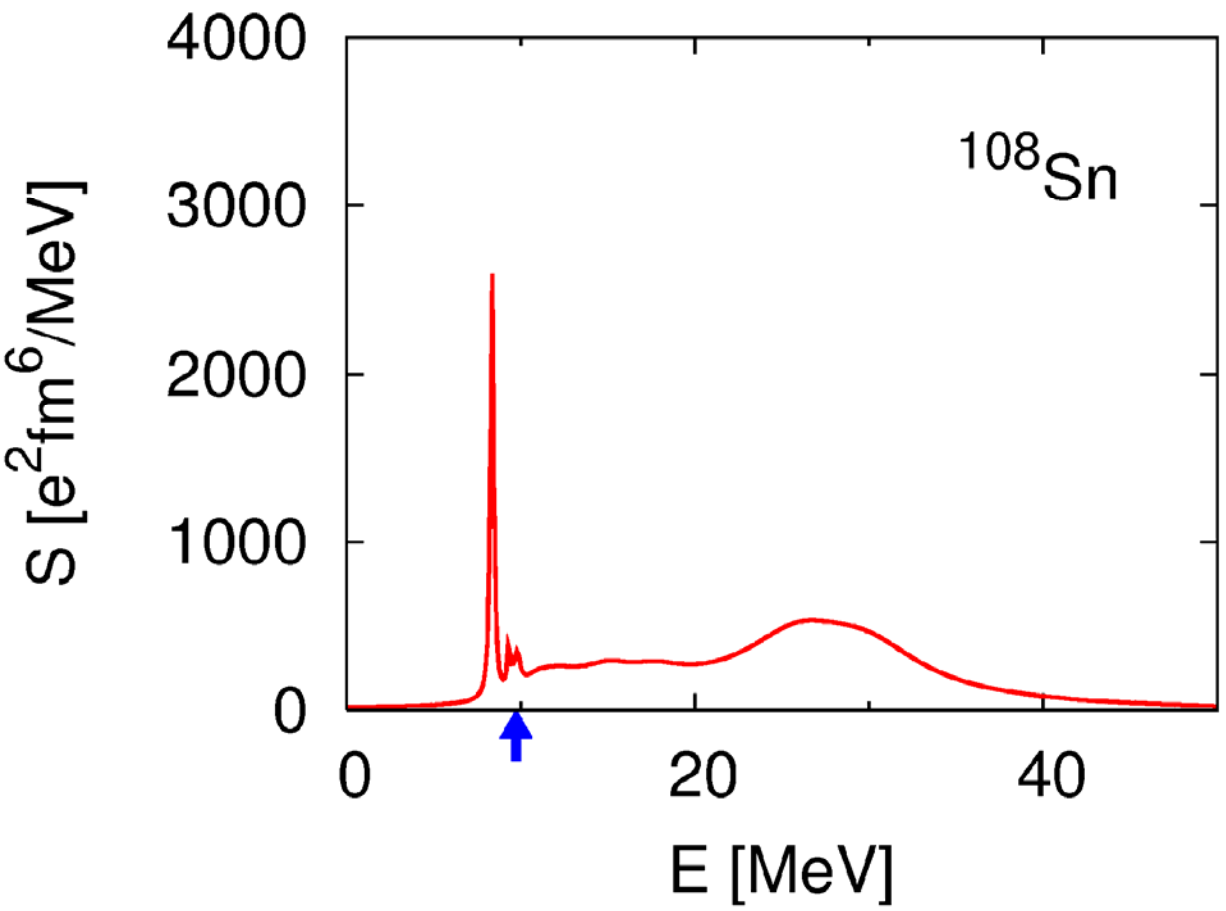

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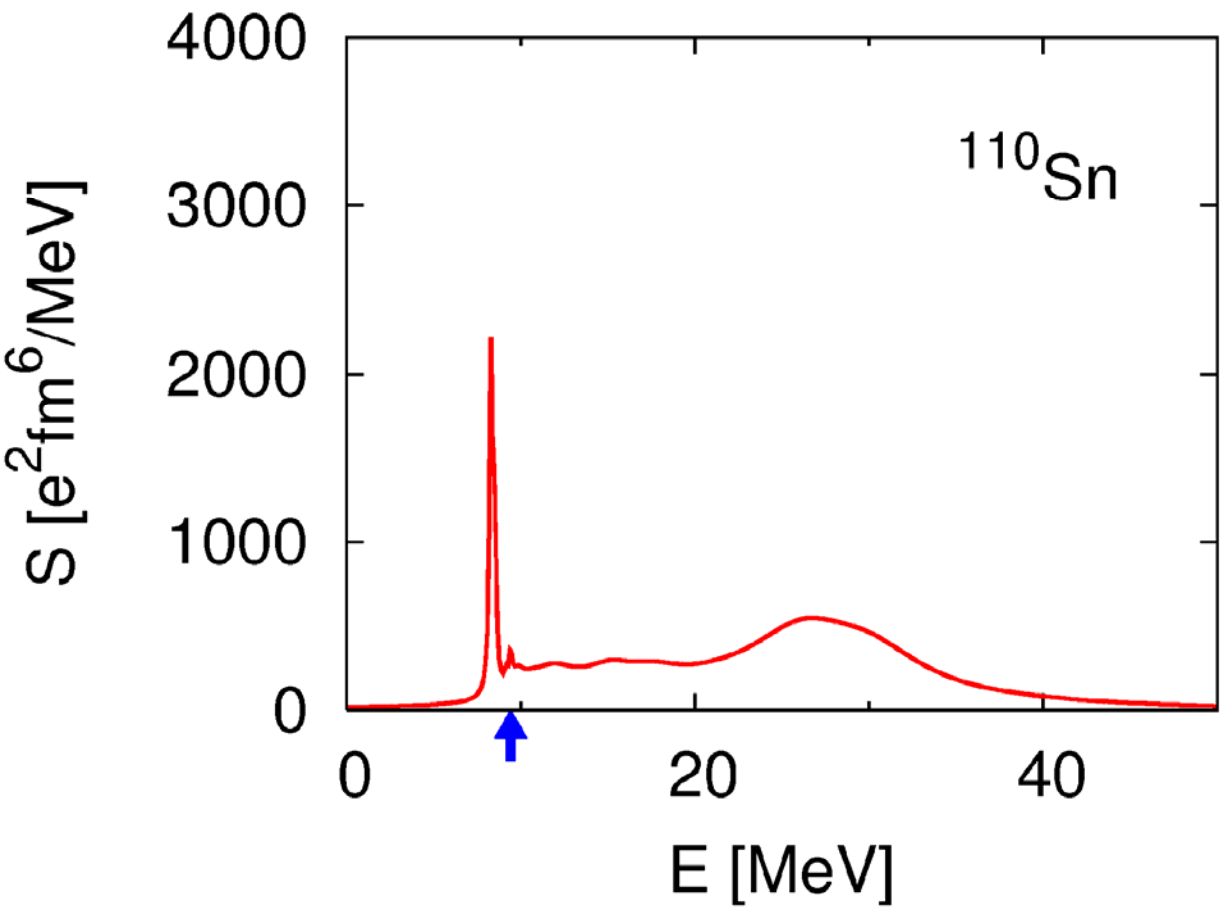

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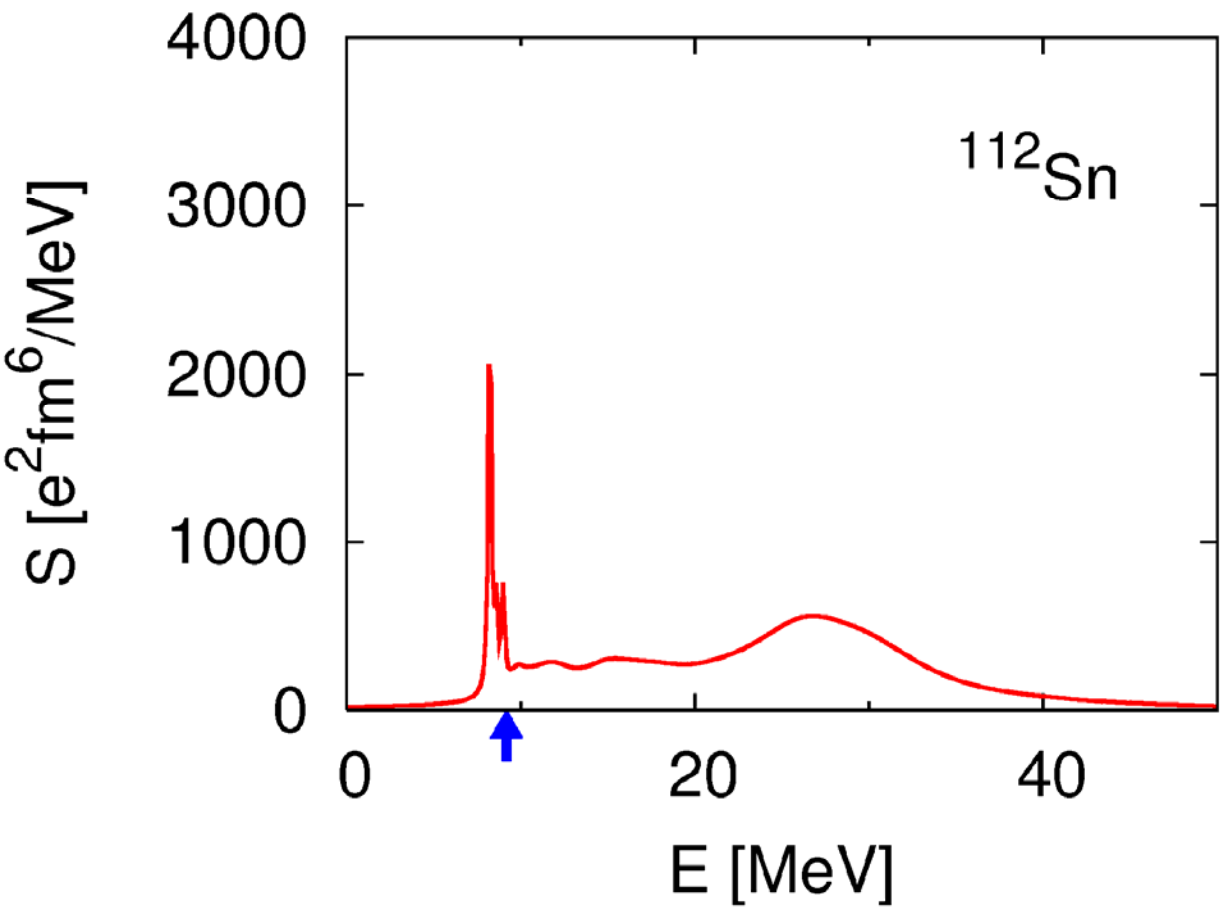

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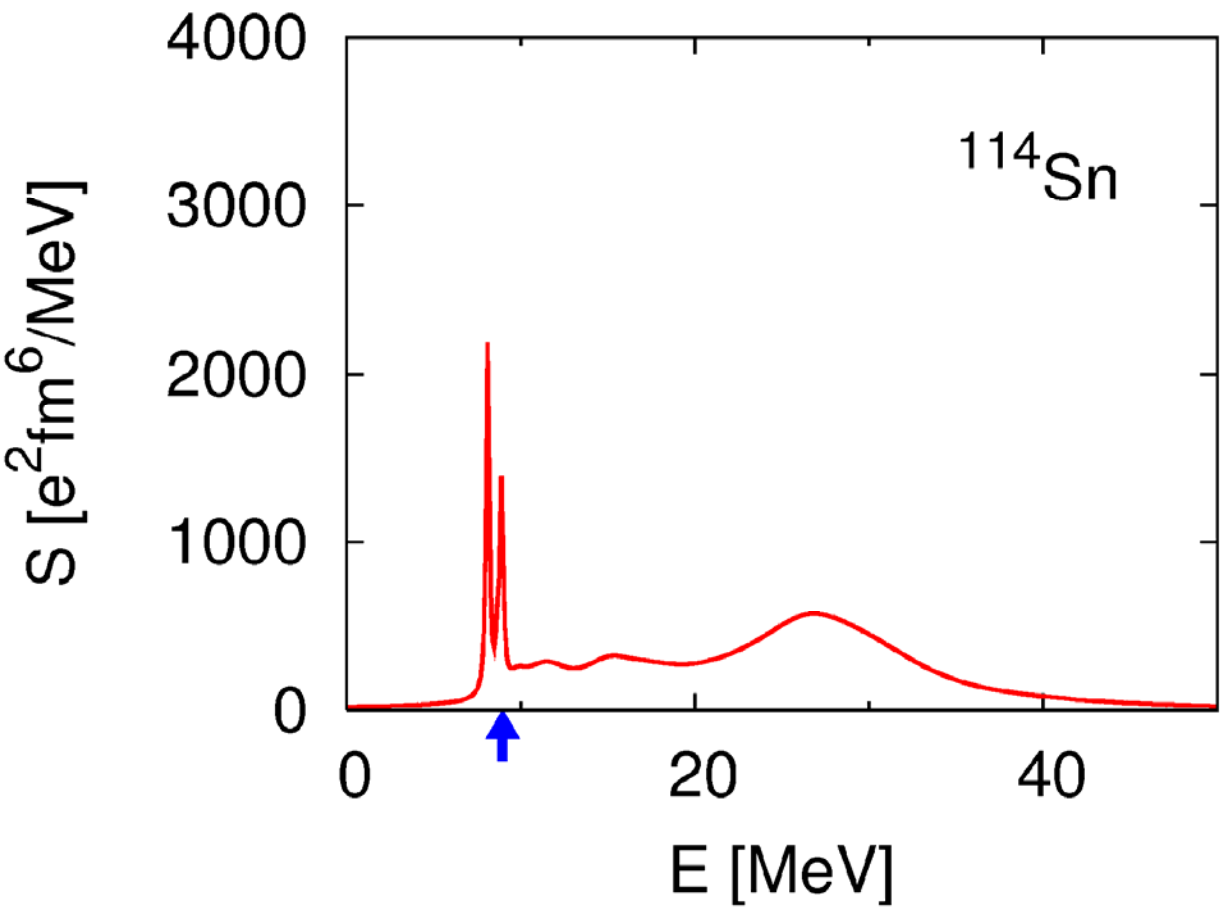

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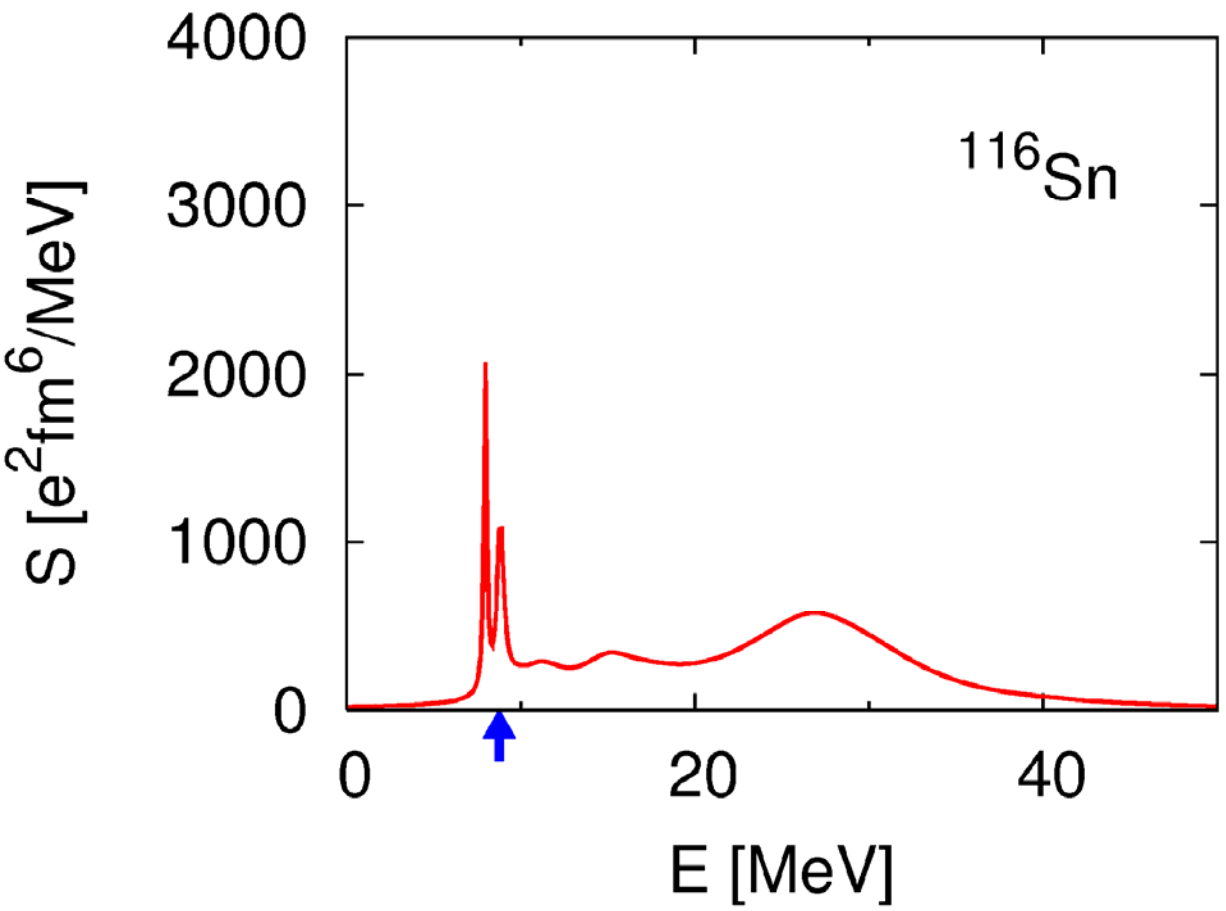

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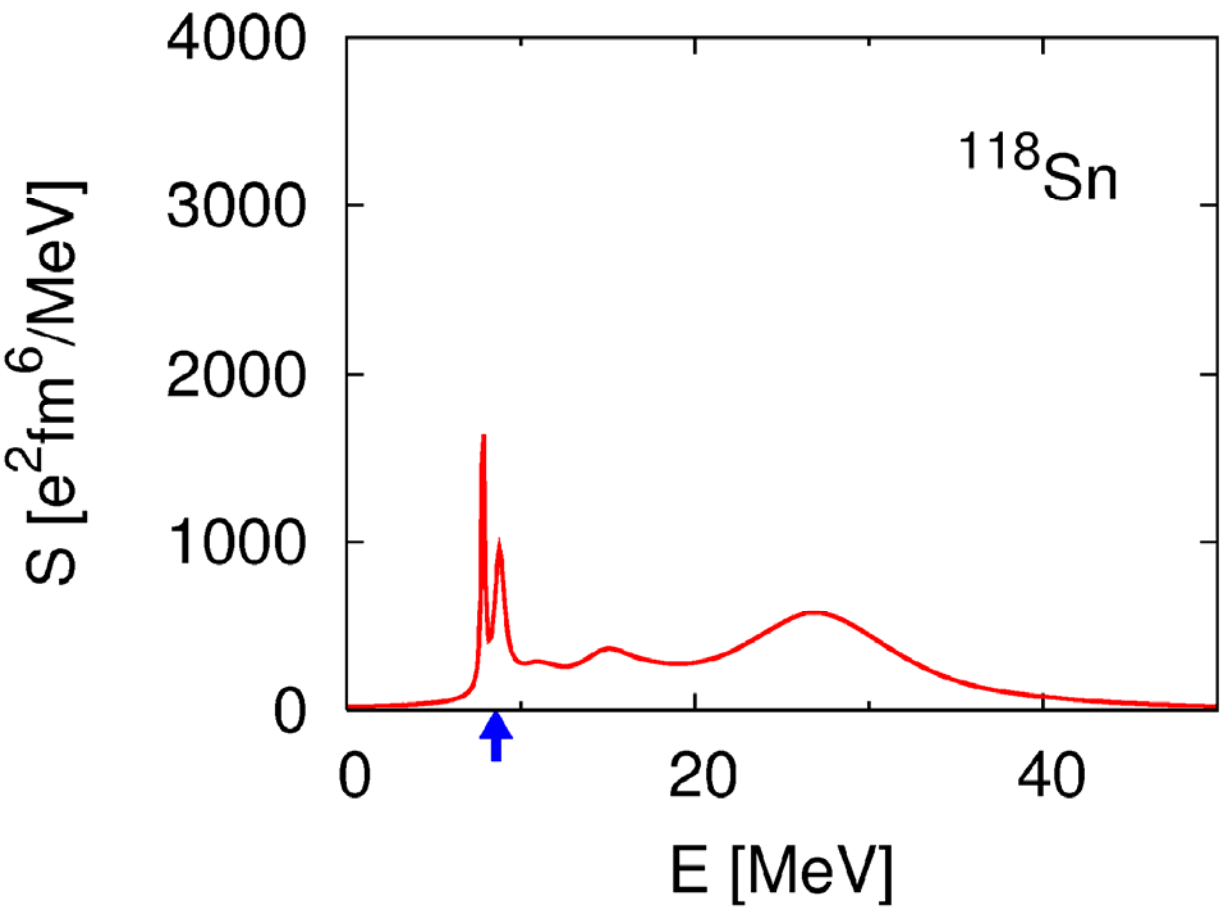

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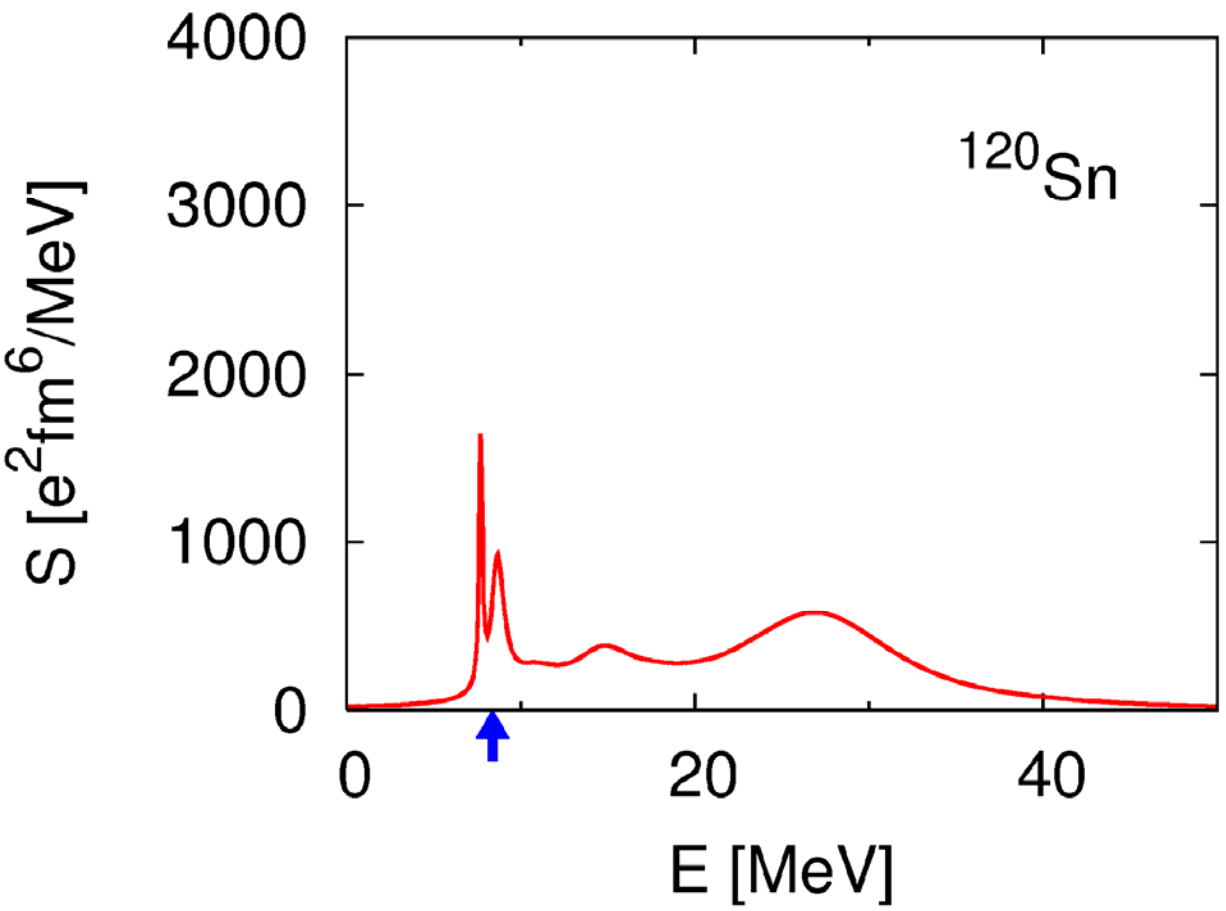

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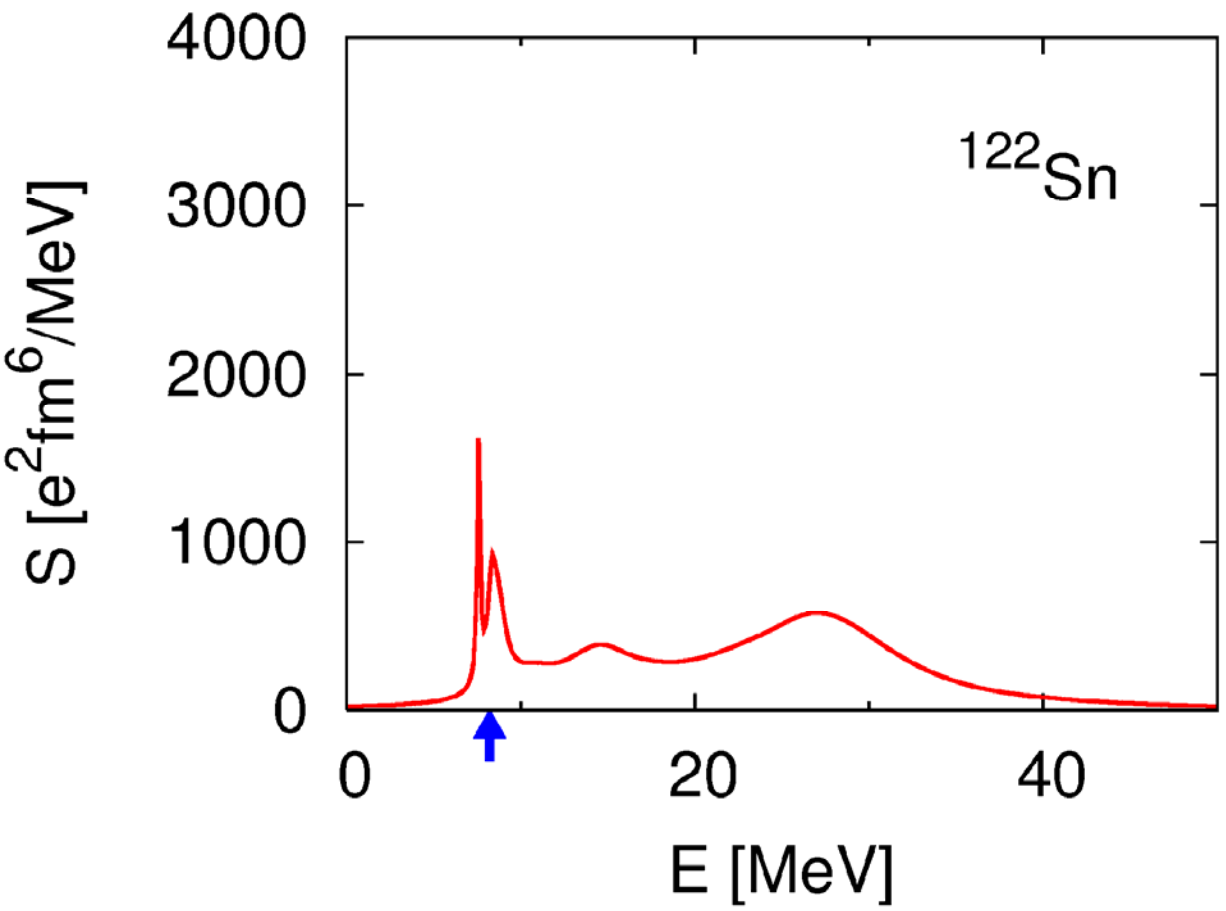

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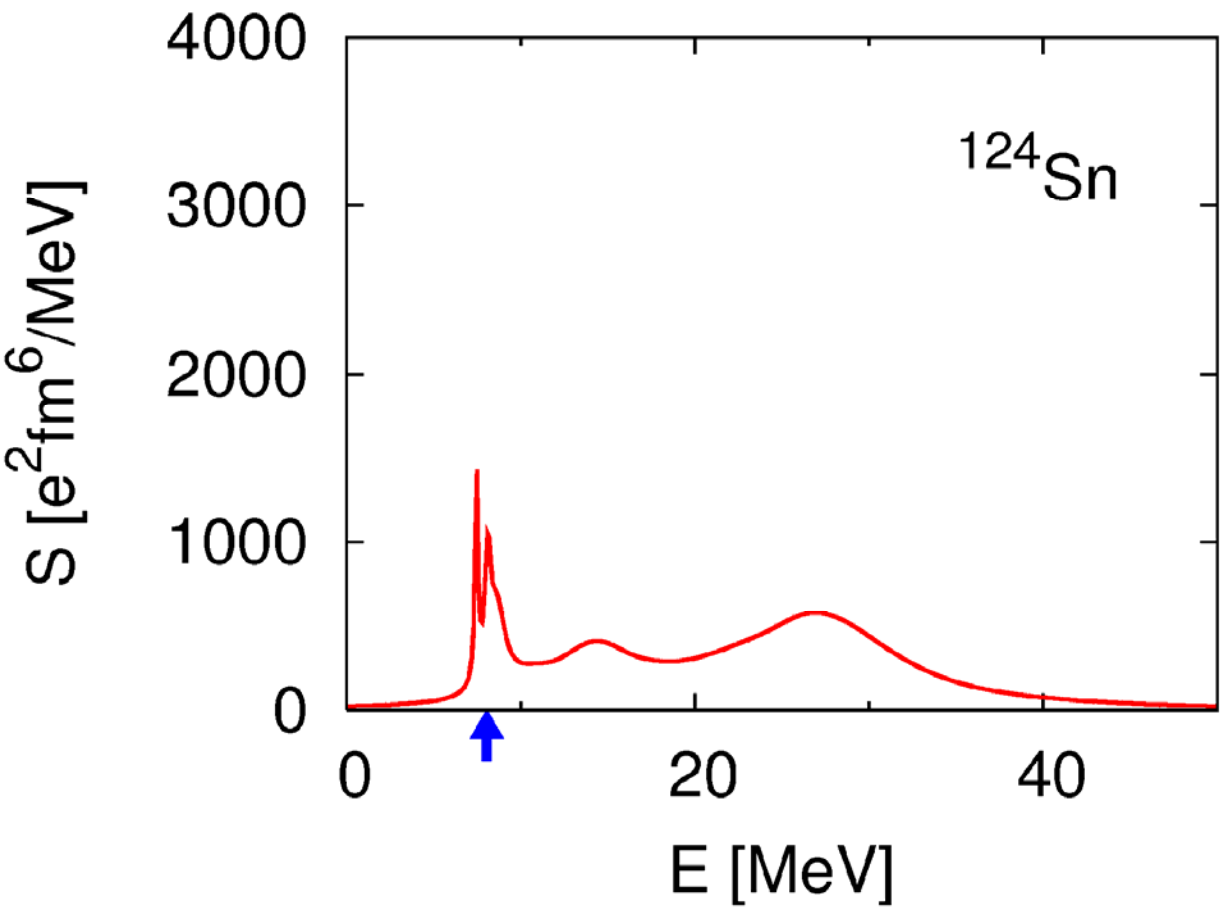

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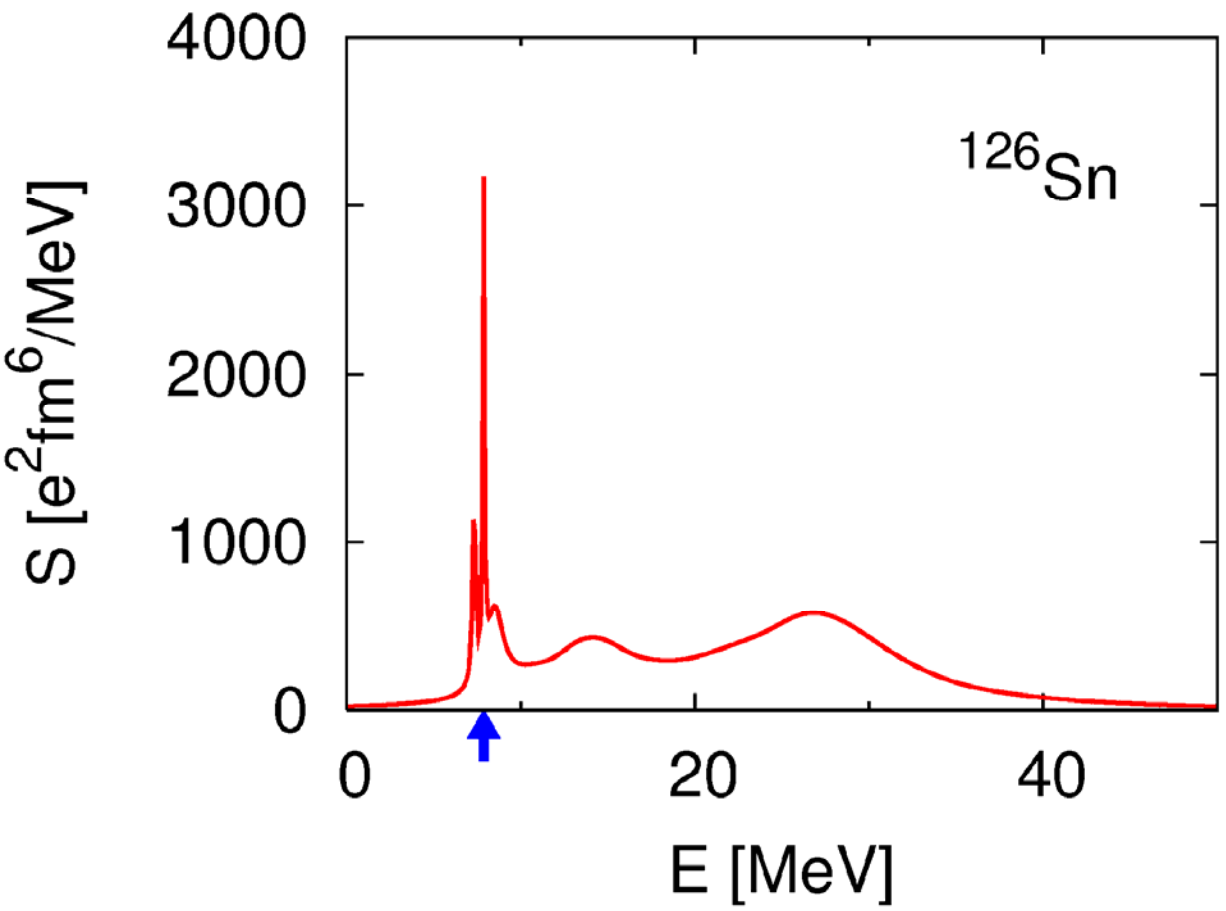

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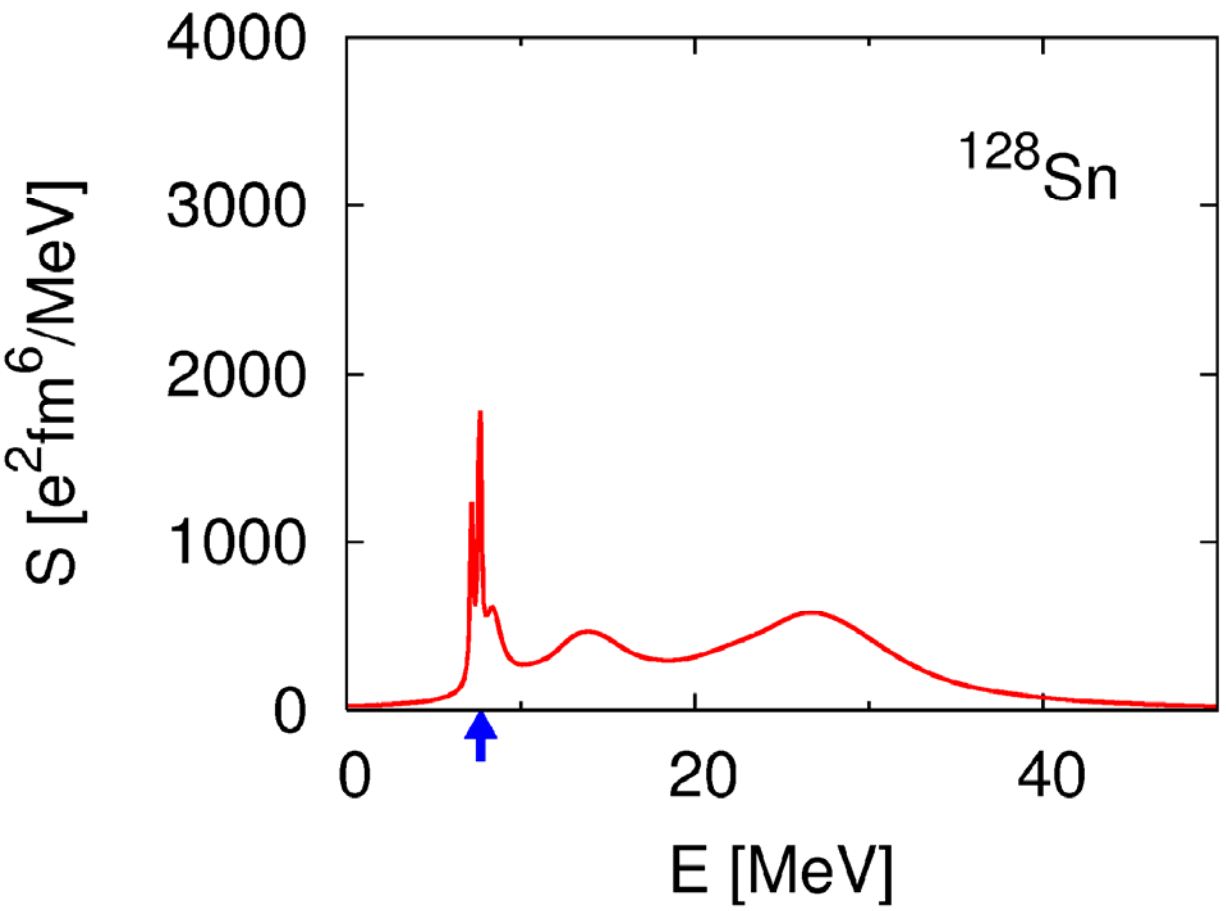

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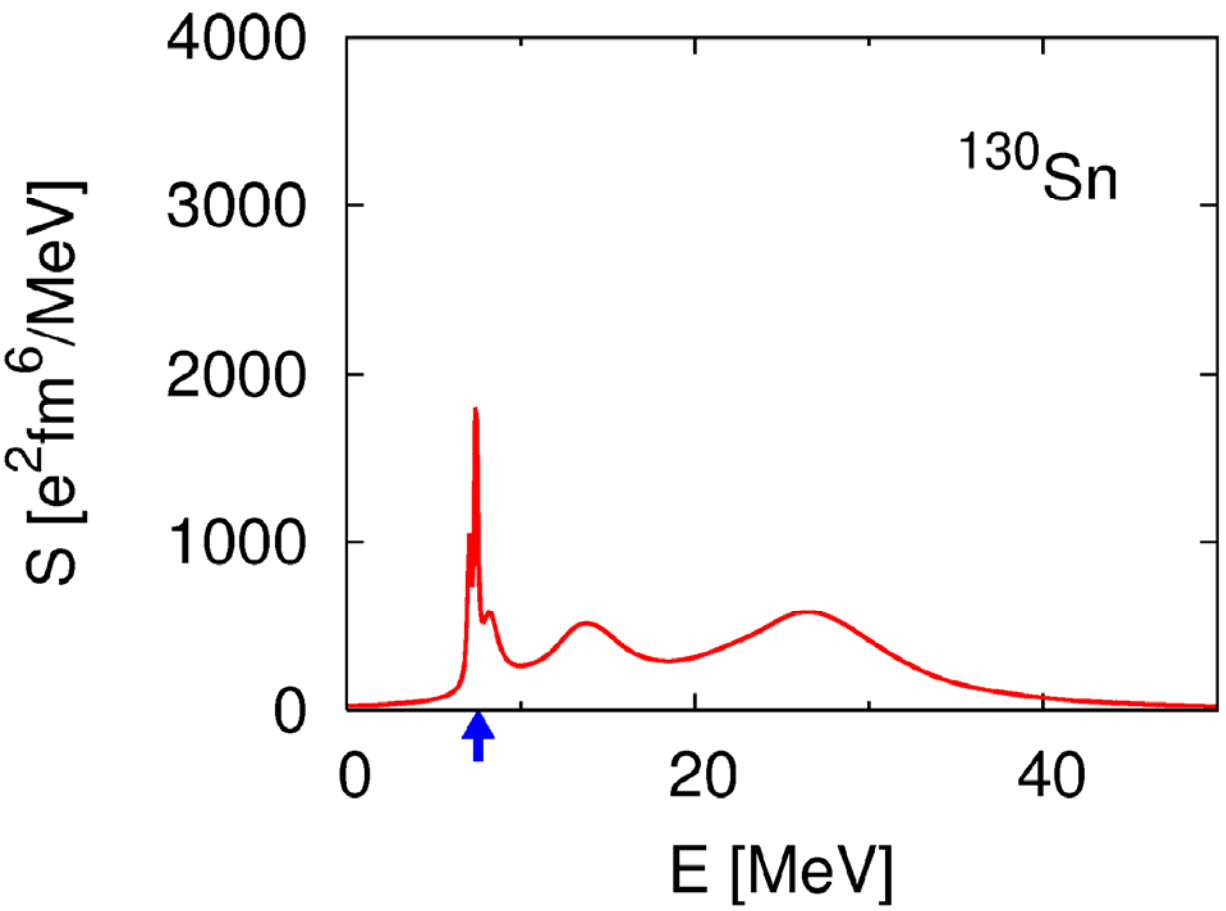

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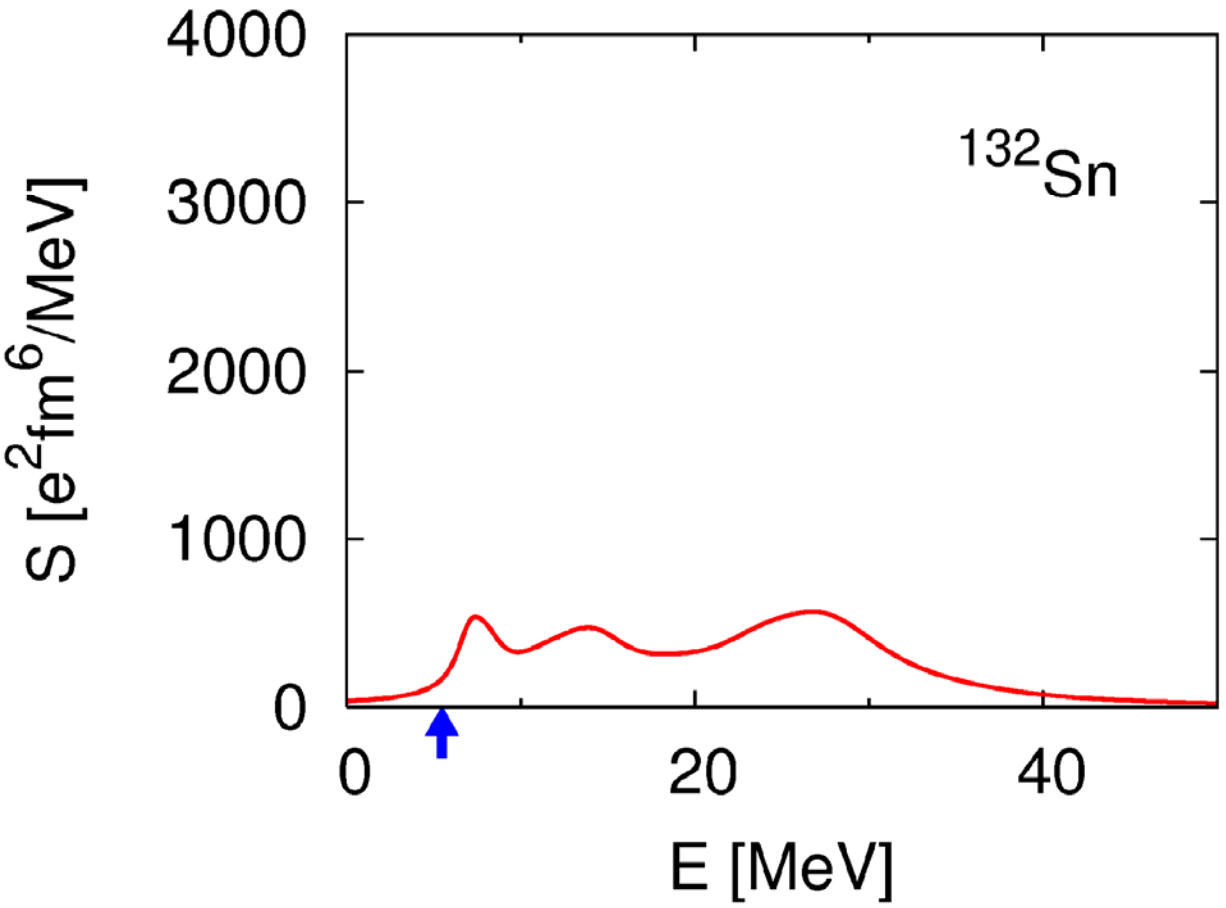

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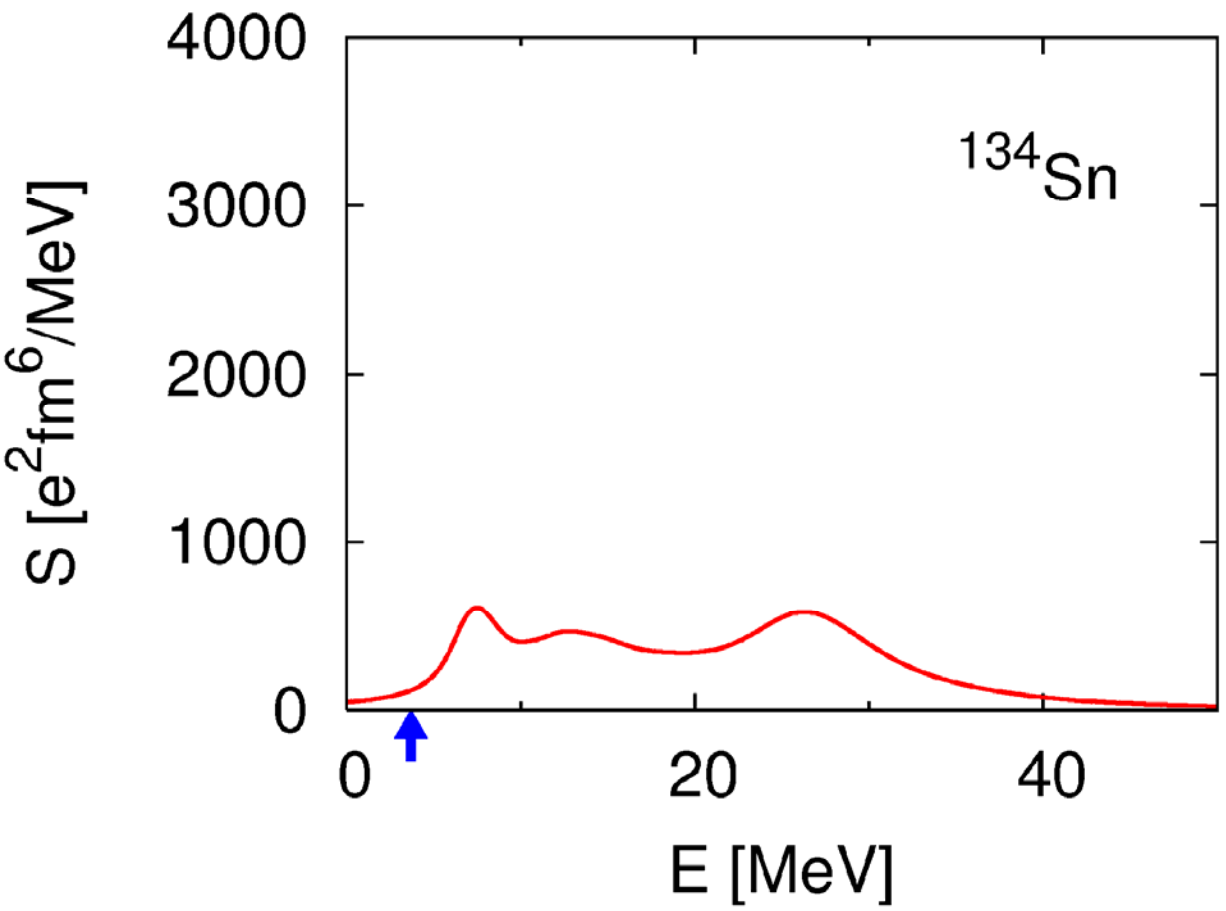

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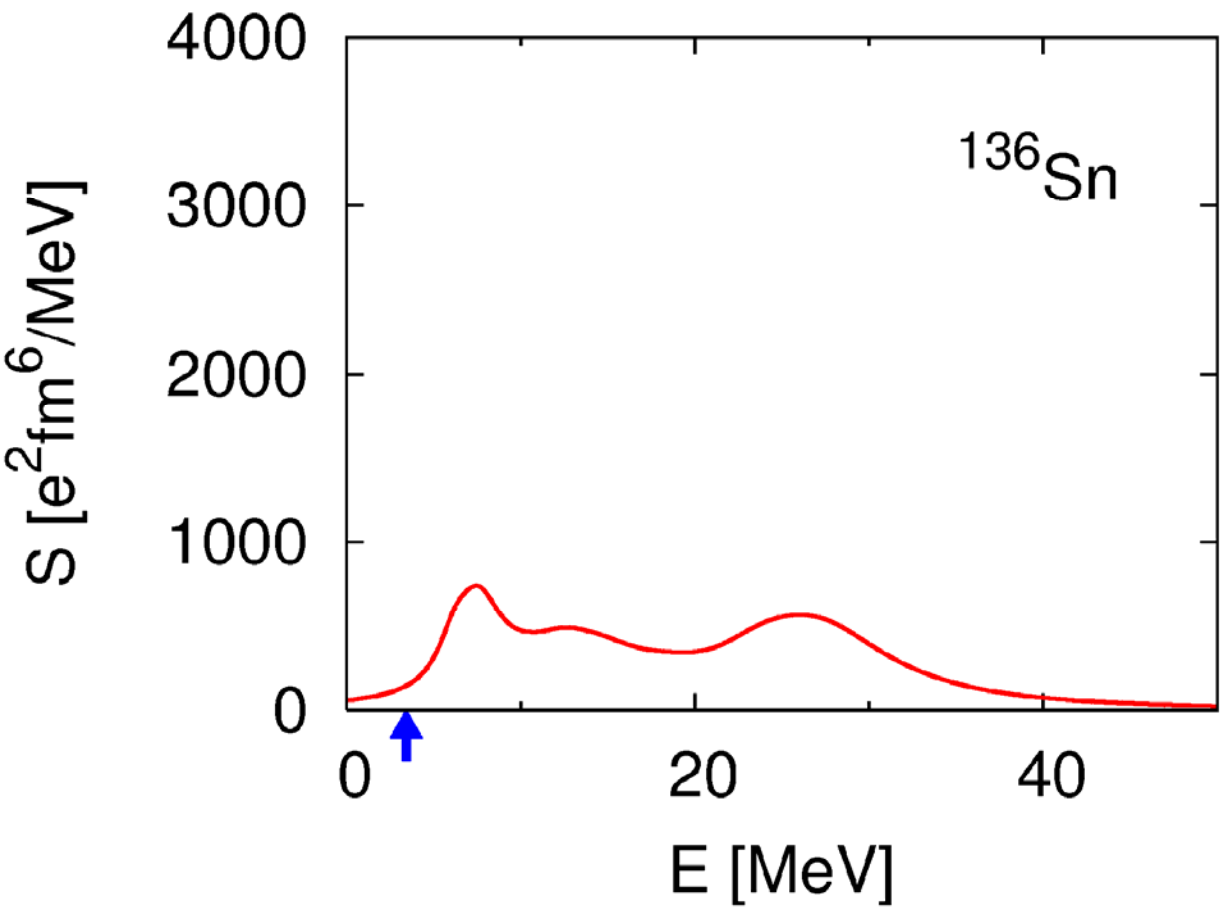

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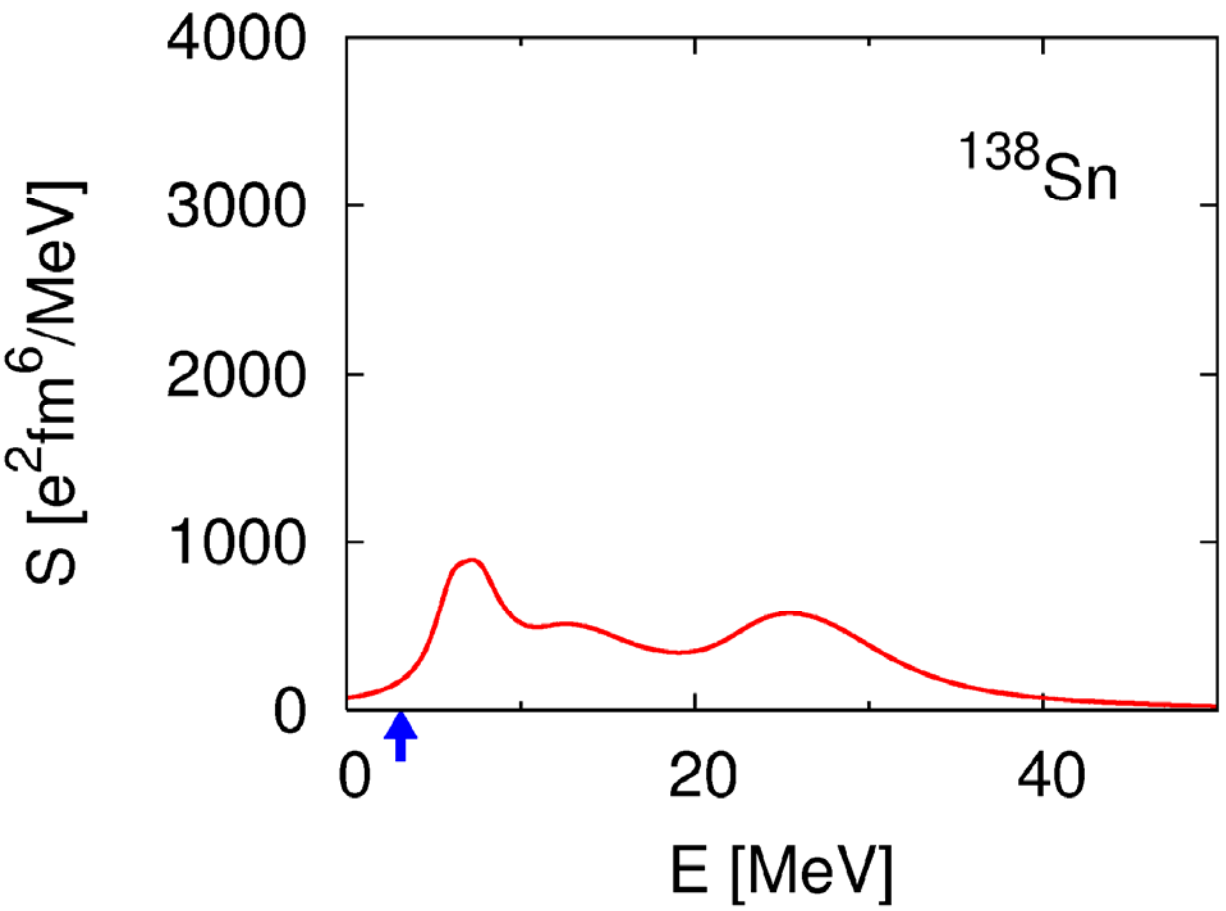

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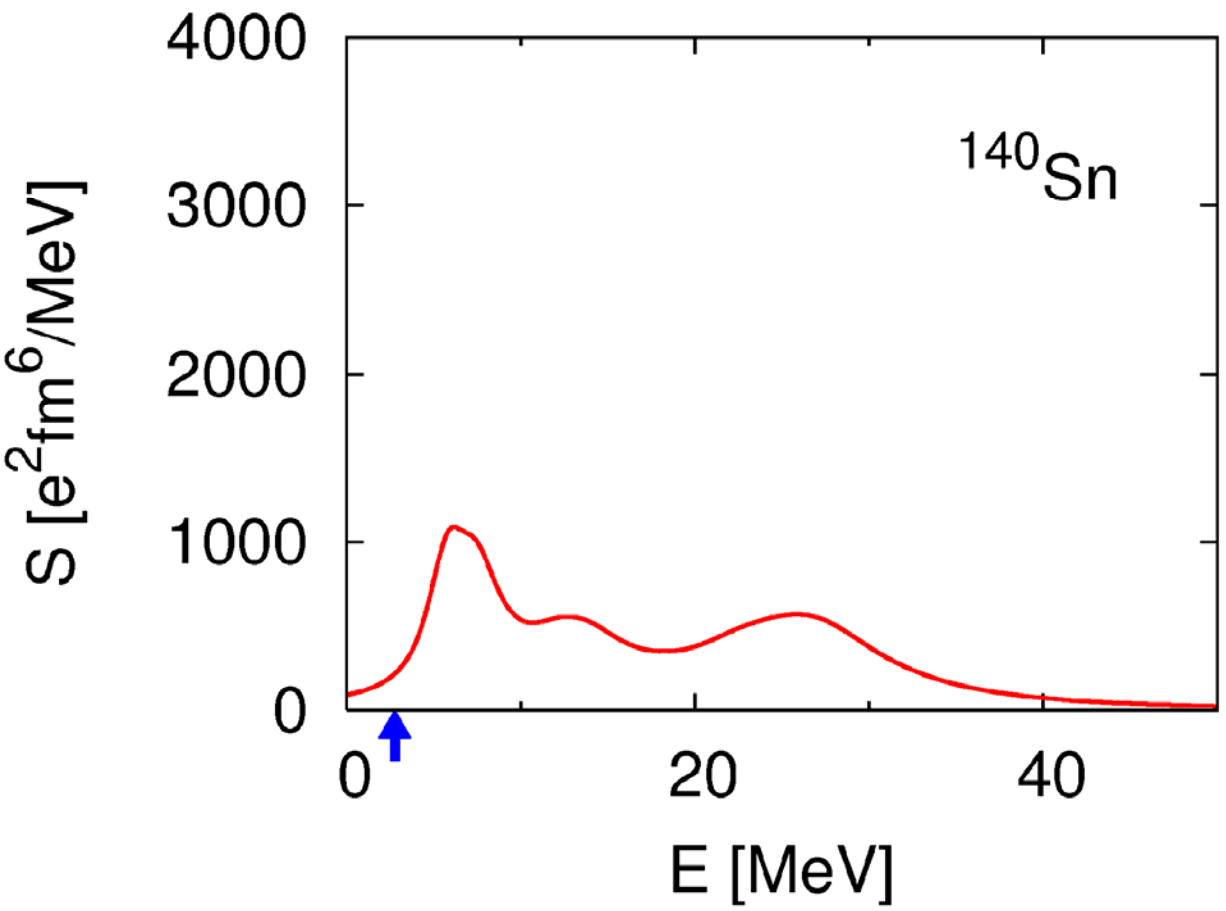

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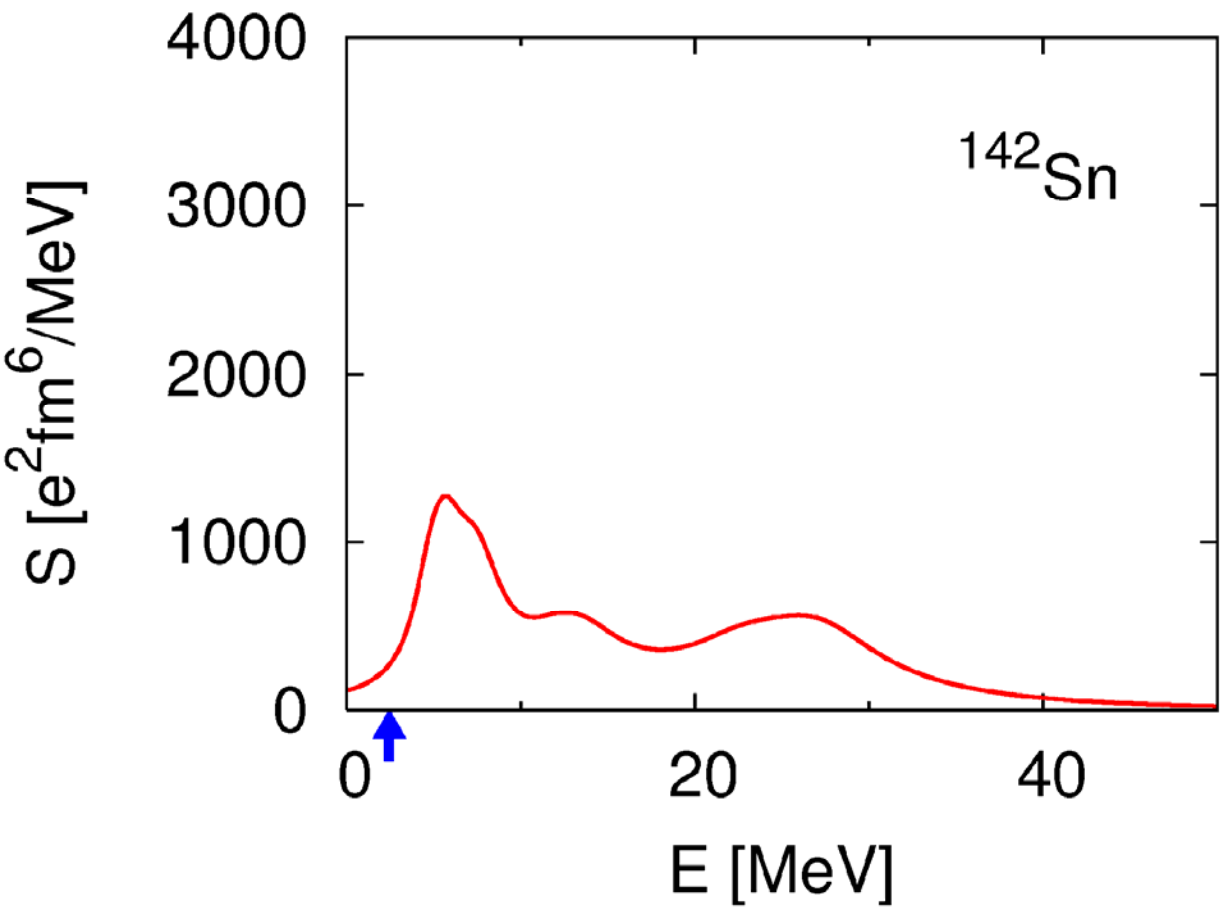

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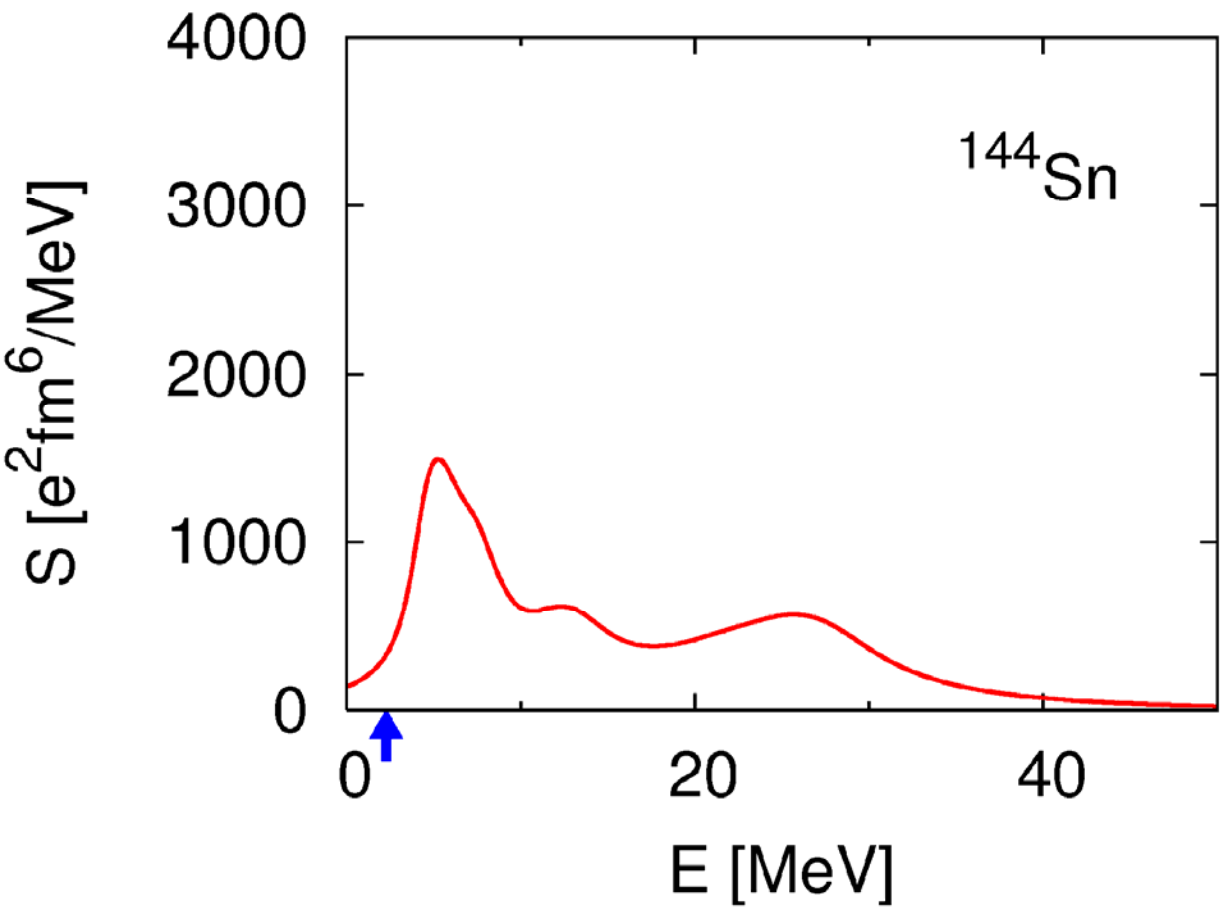

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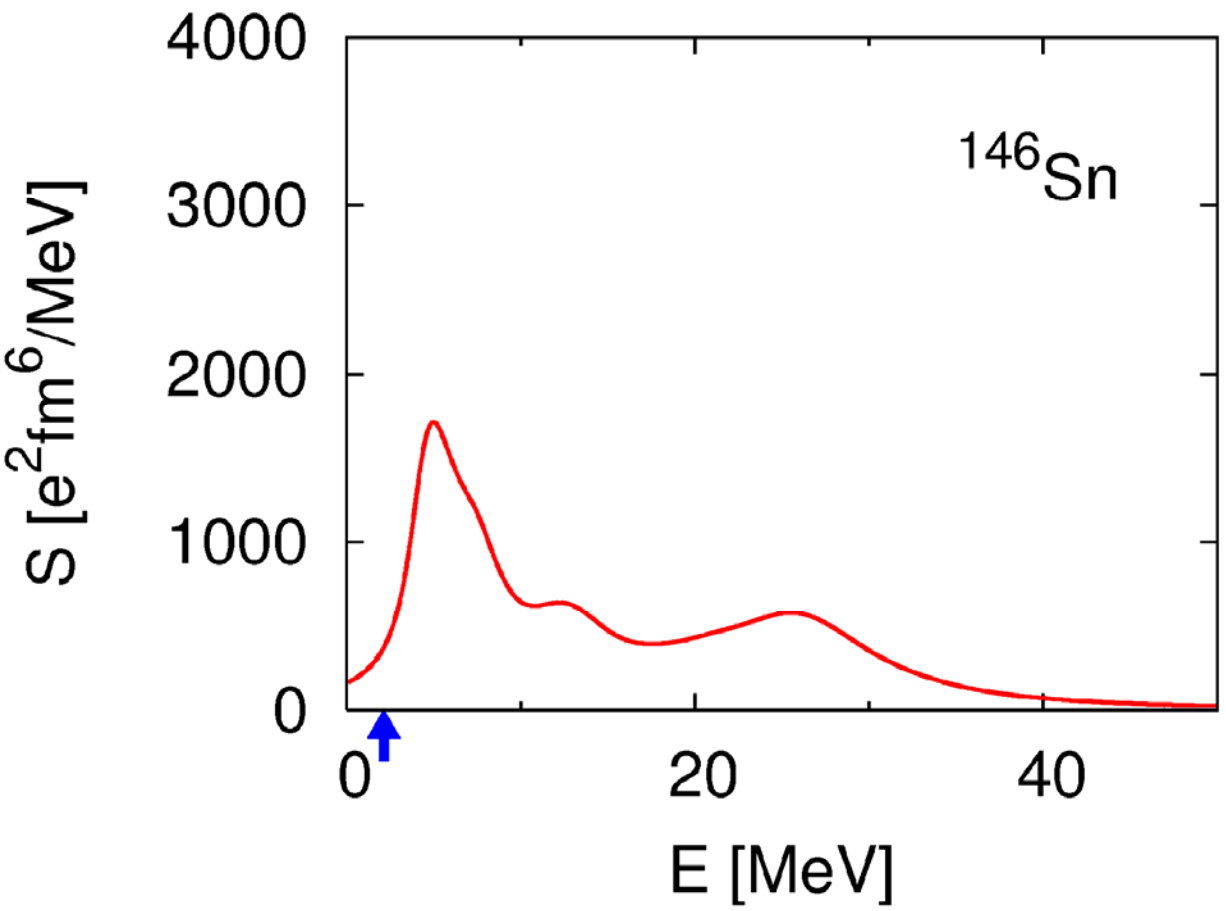

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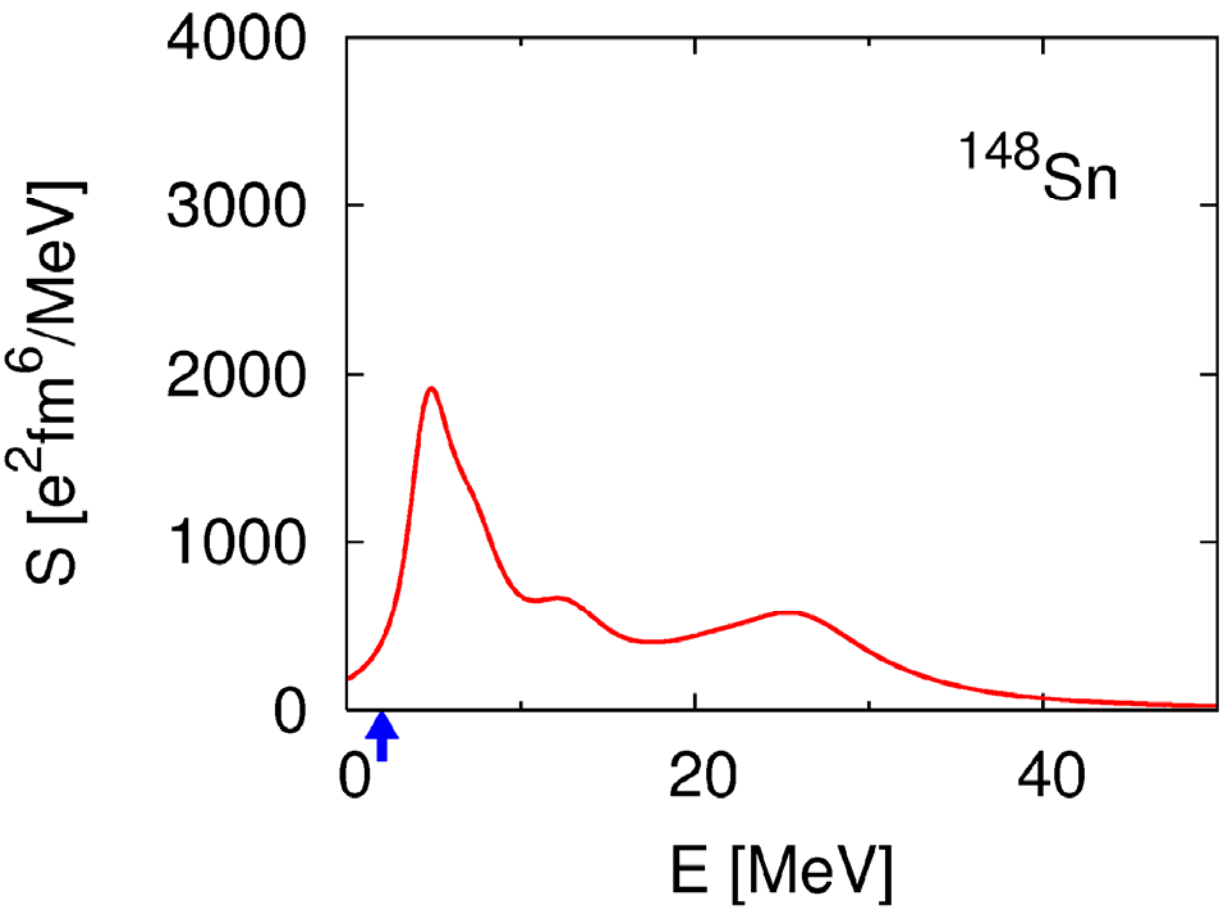

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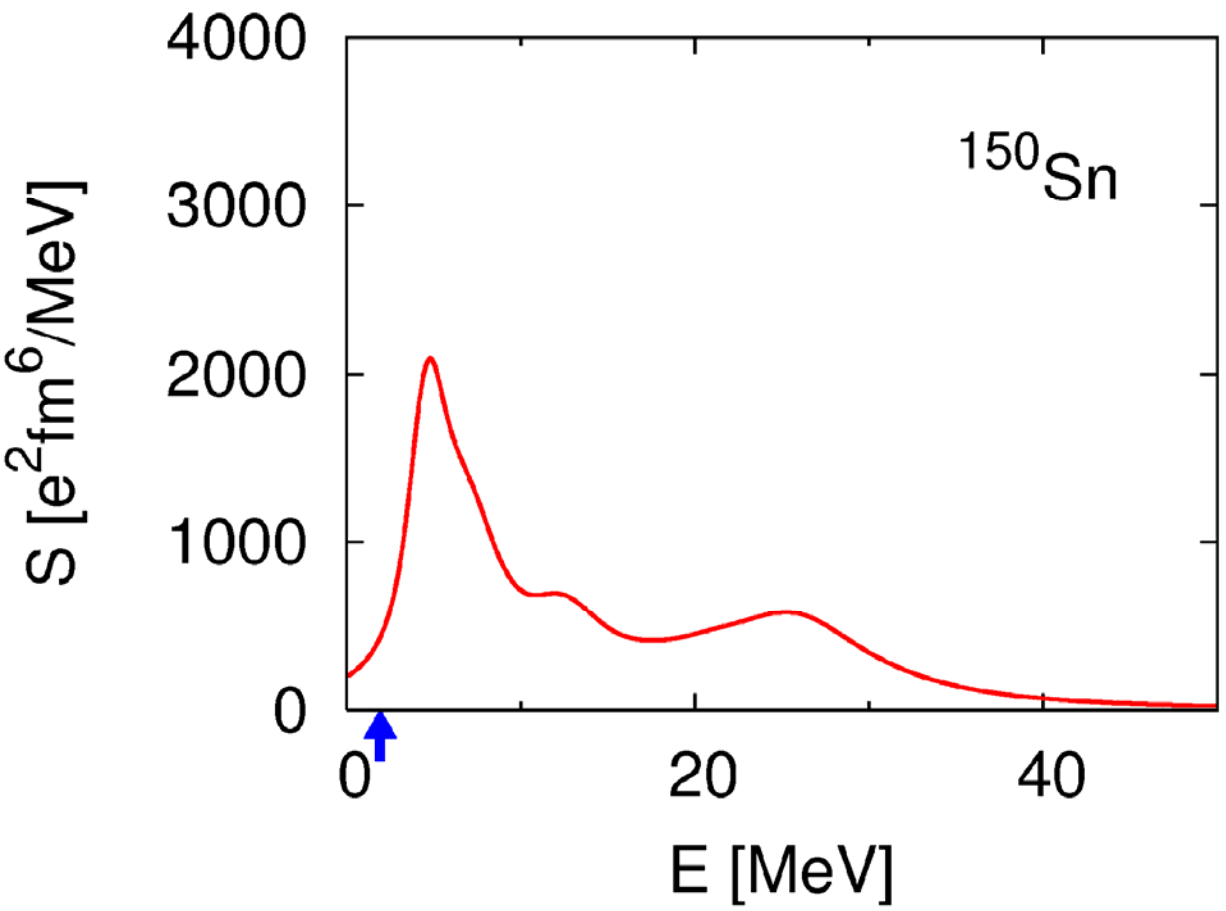

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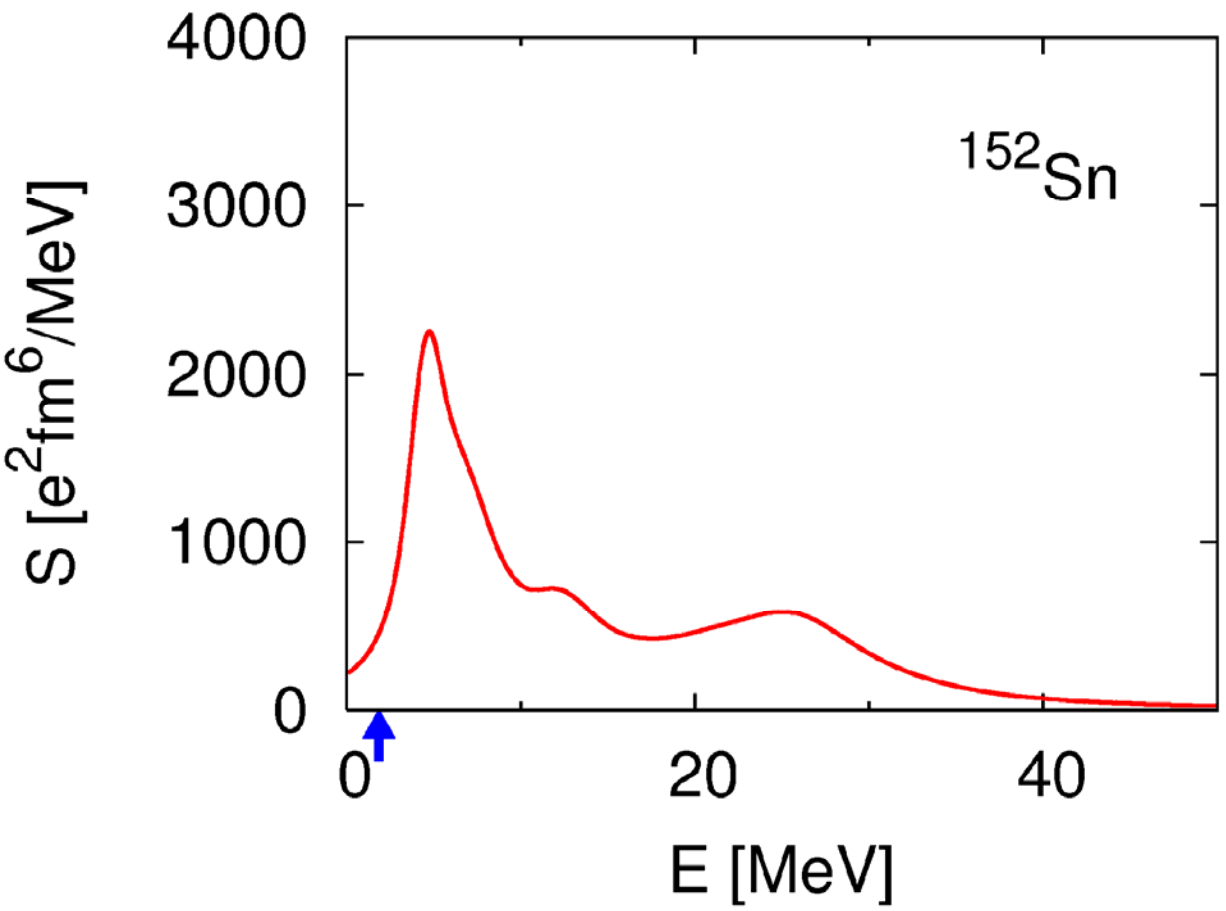
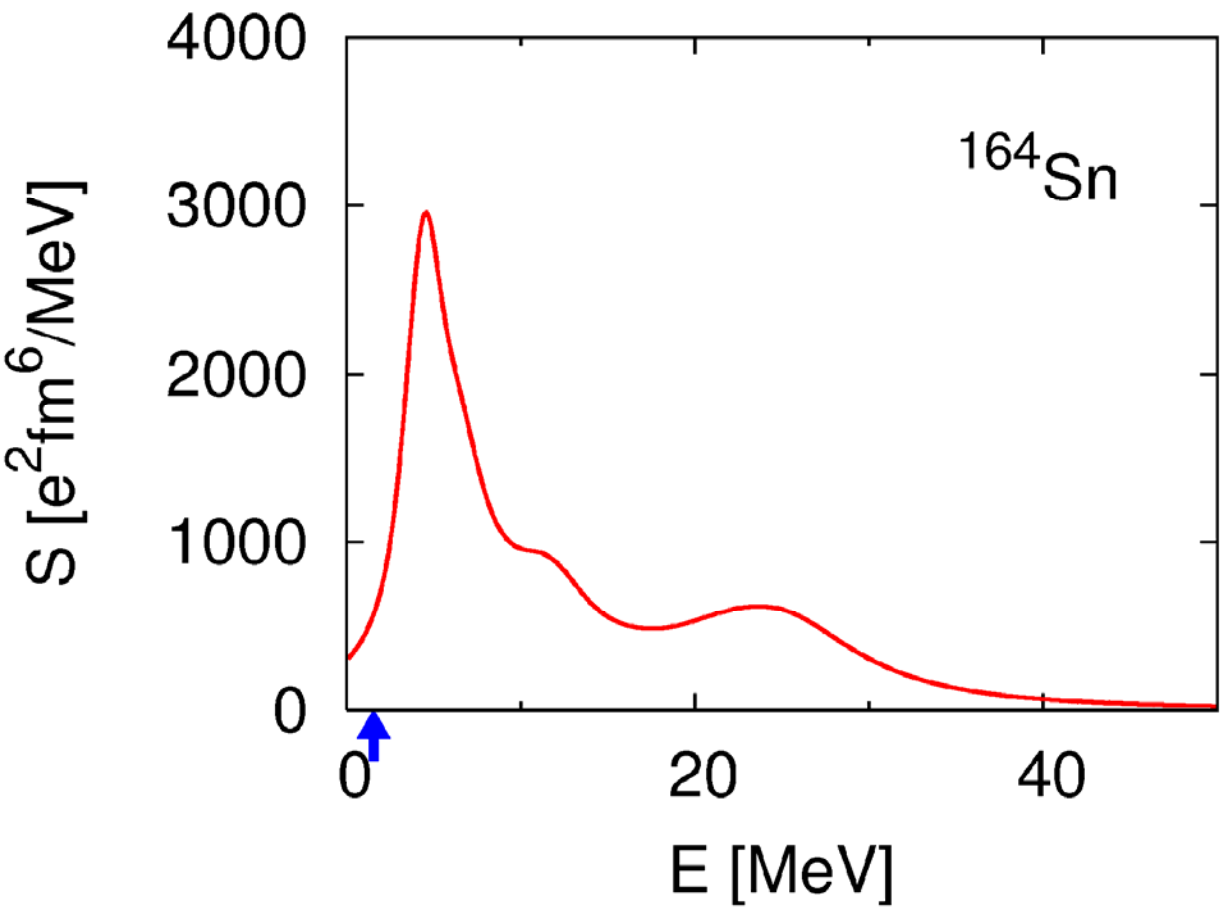


At A = 154 - 162 (N = 104 - 112)
ground states : deformed

Isoscalar 1^- strength functions



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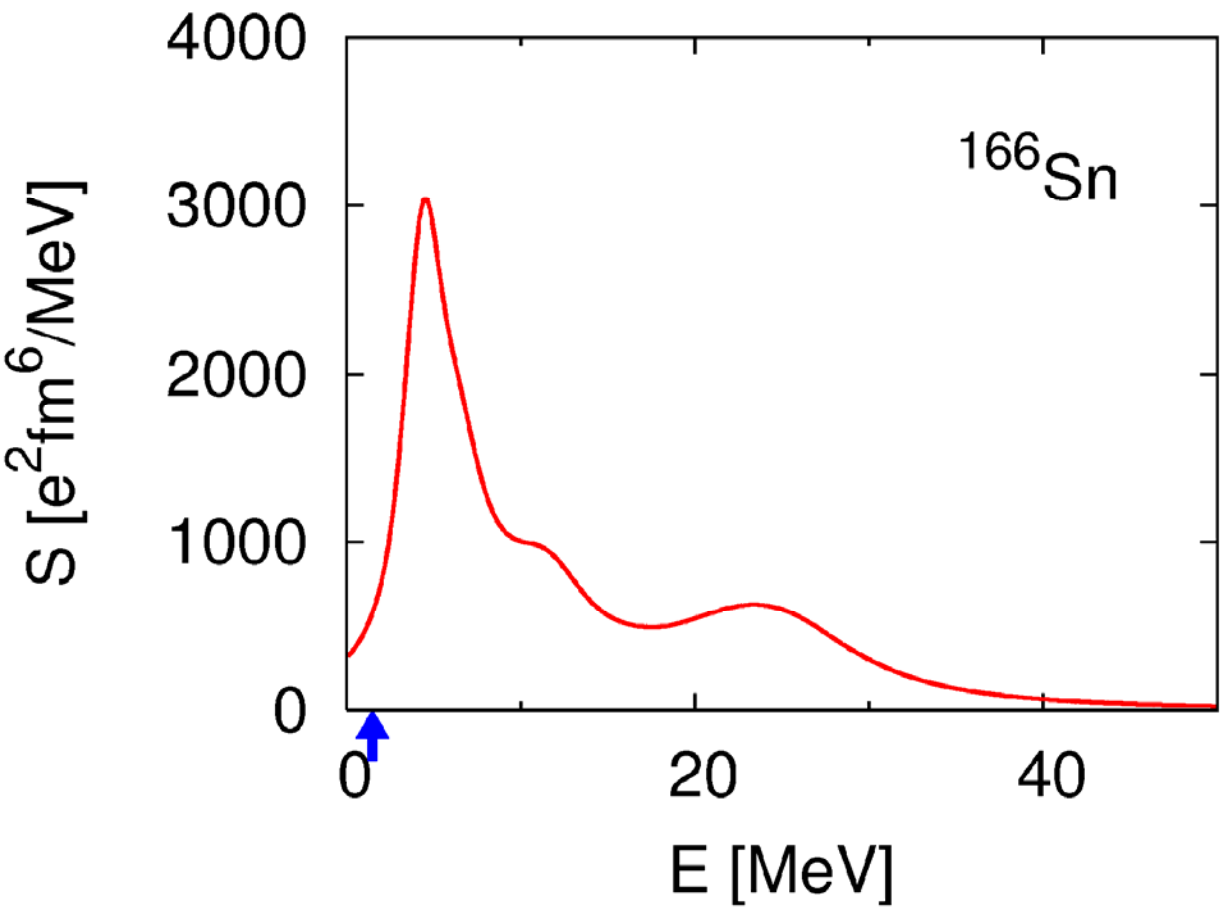

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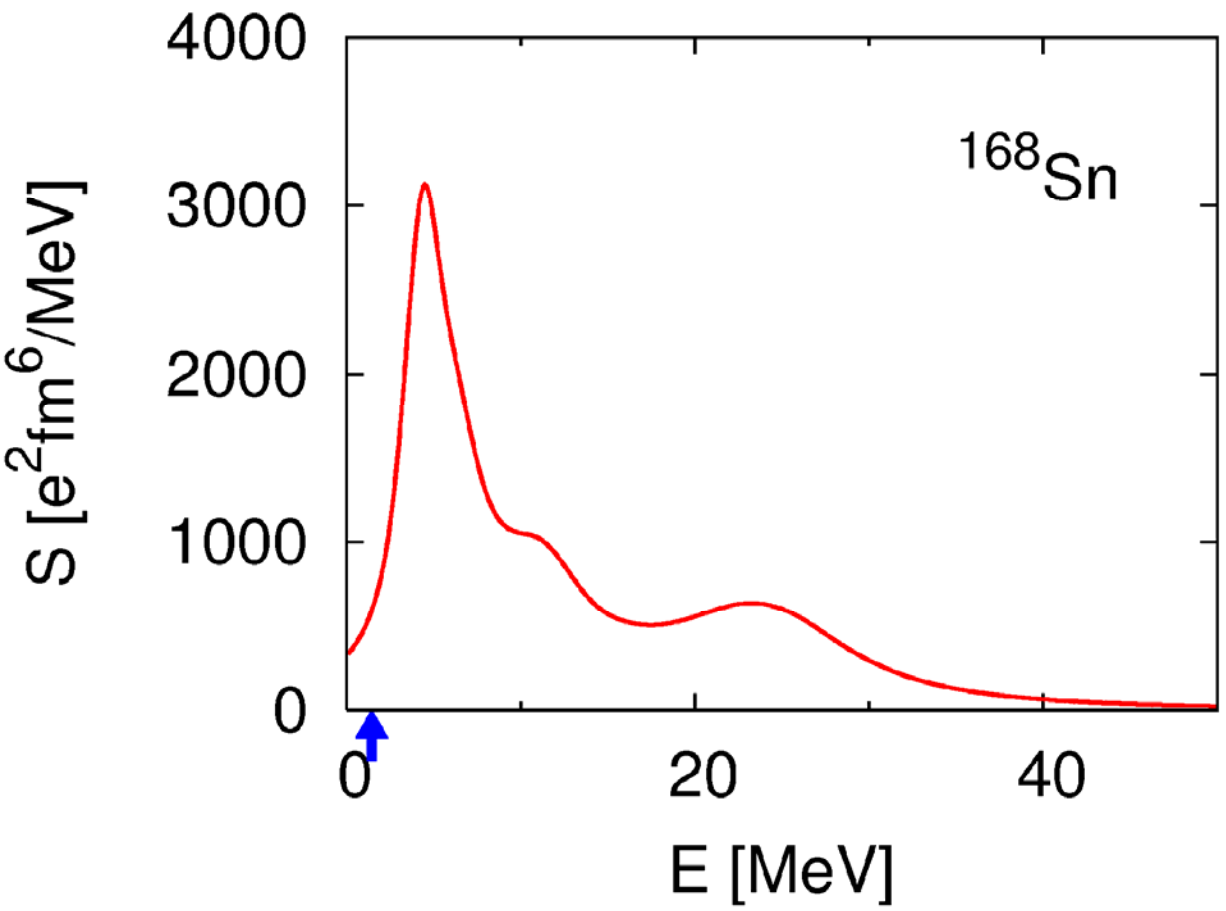

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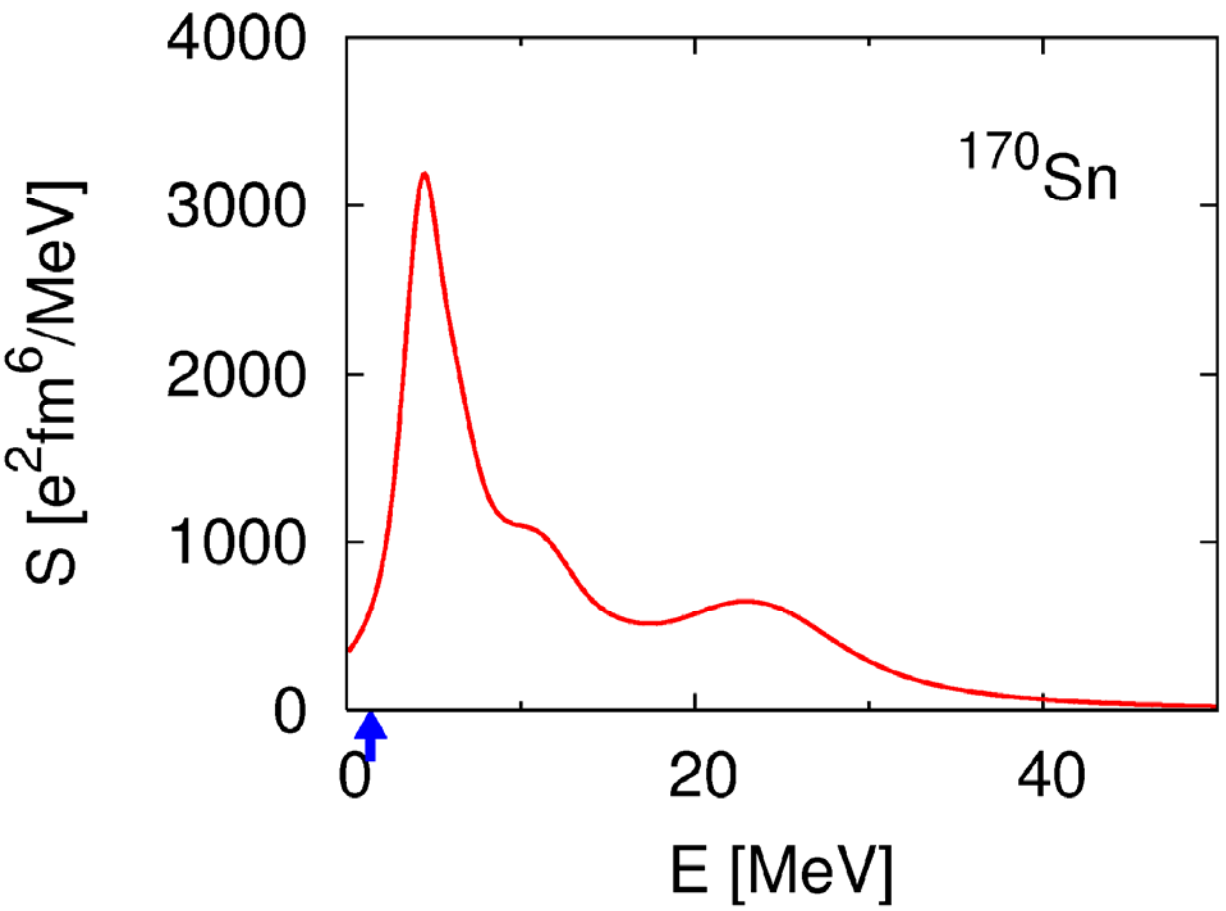

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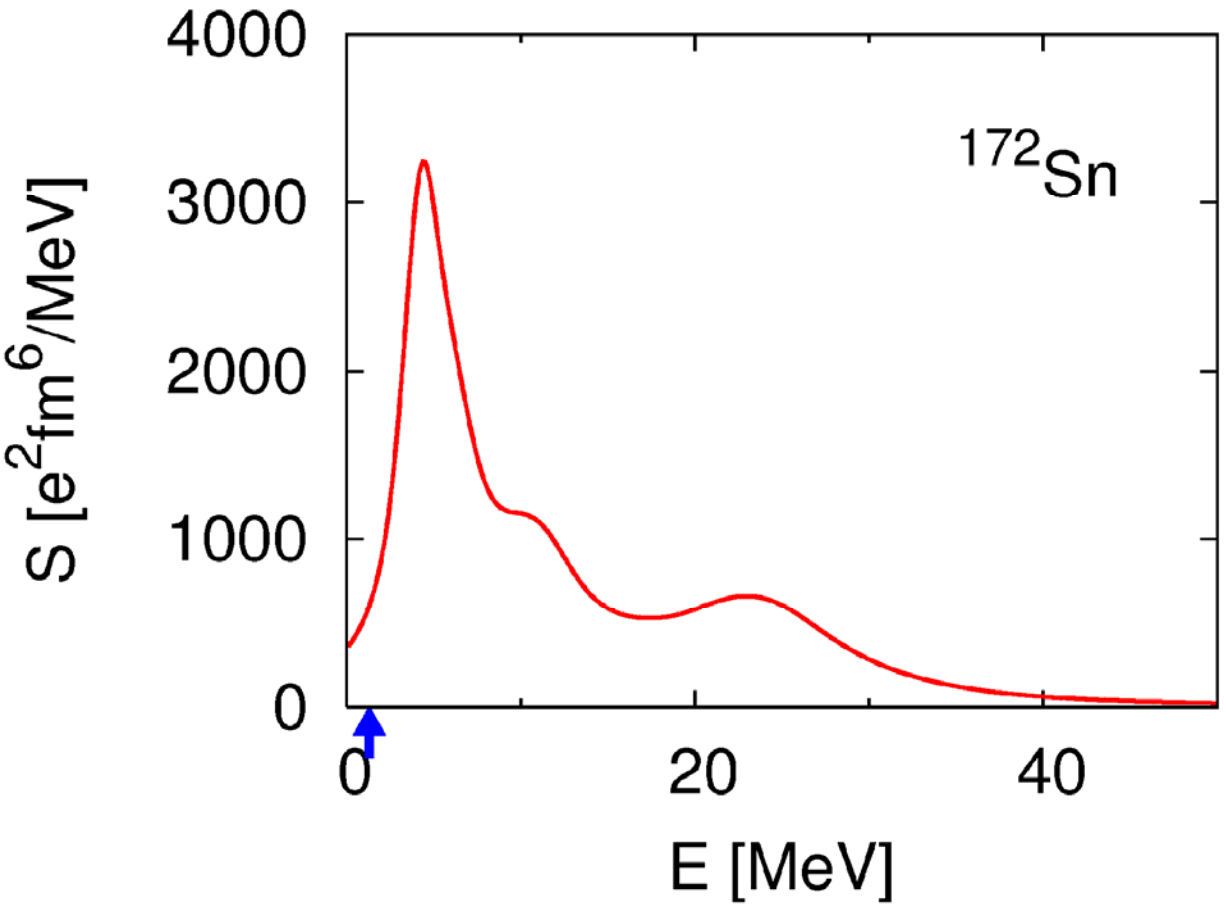

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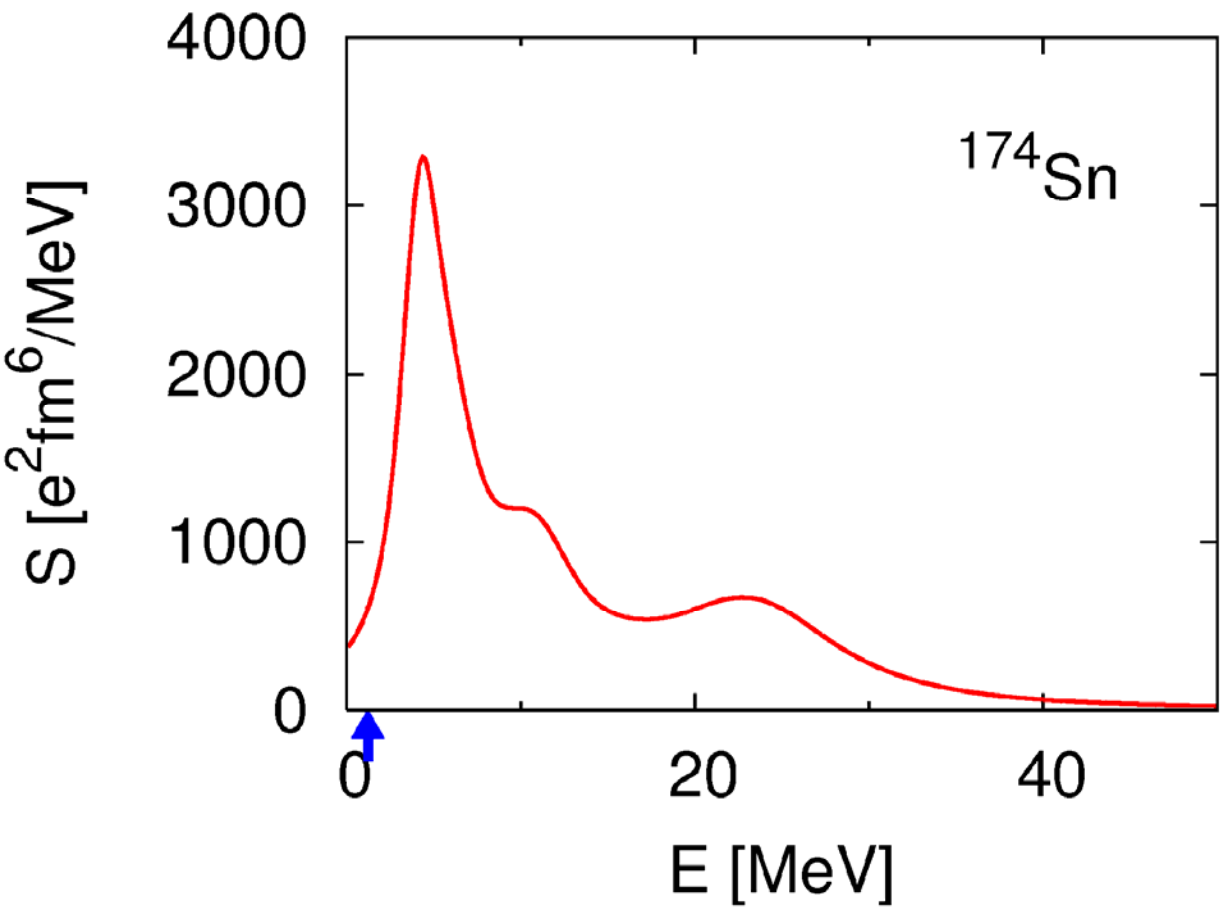

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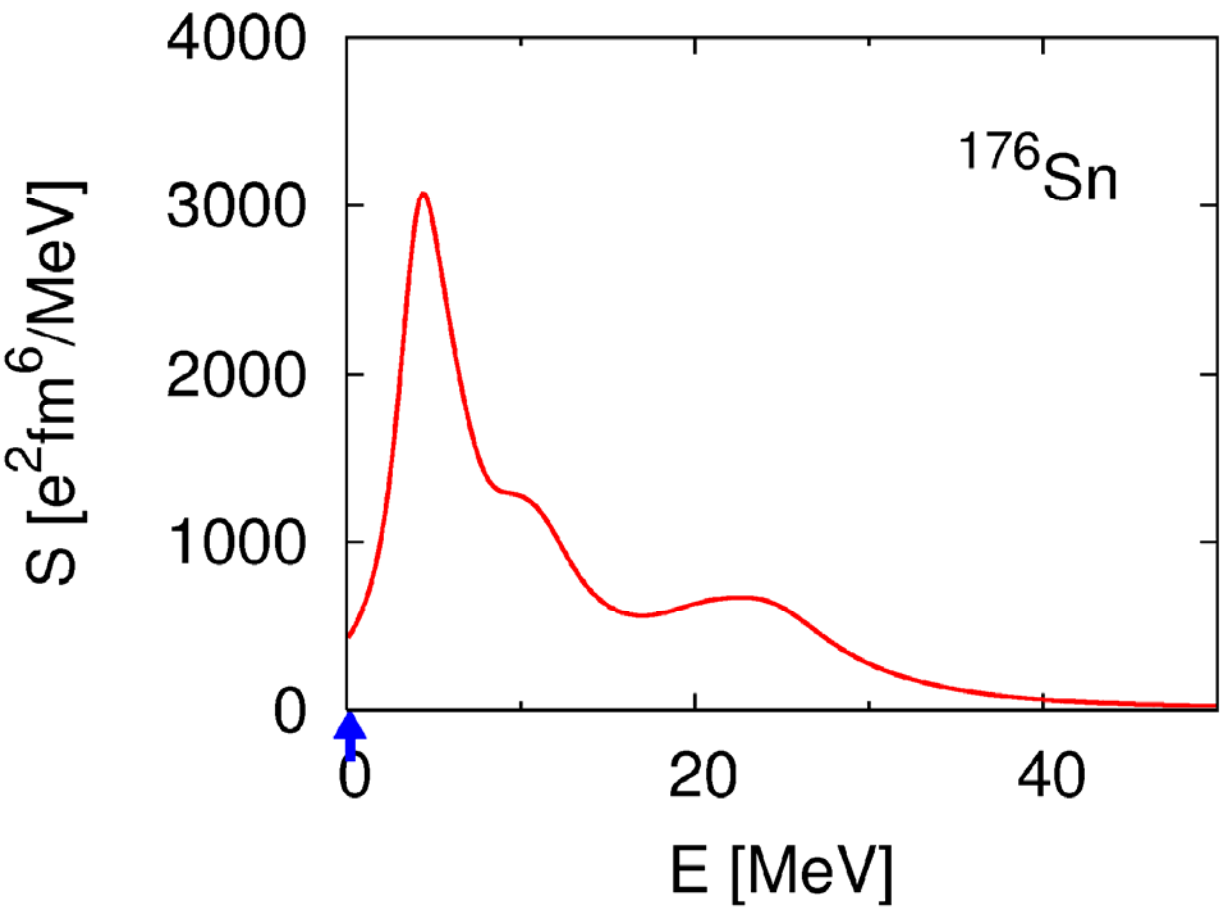


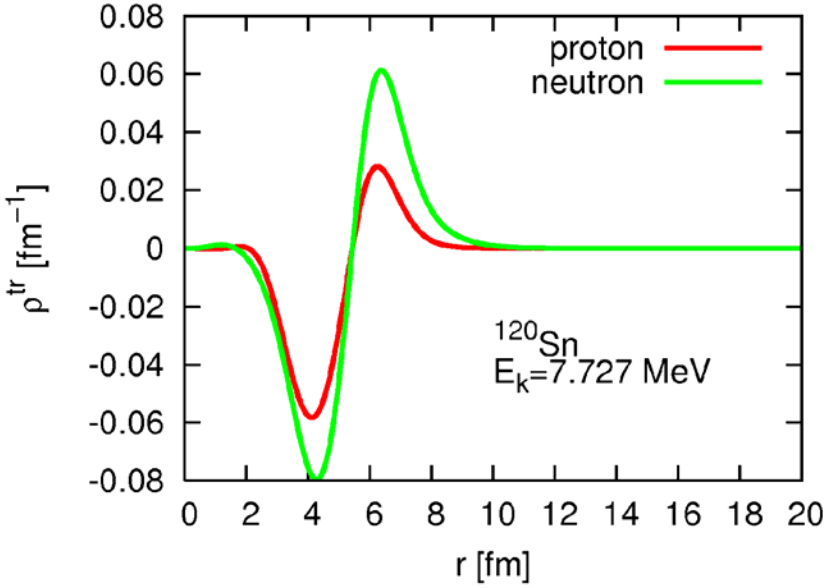
Transition density

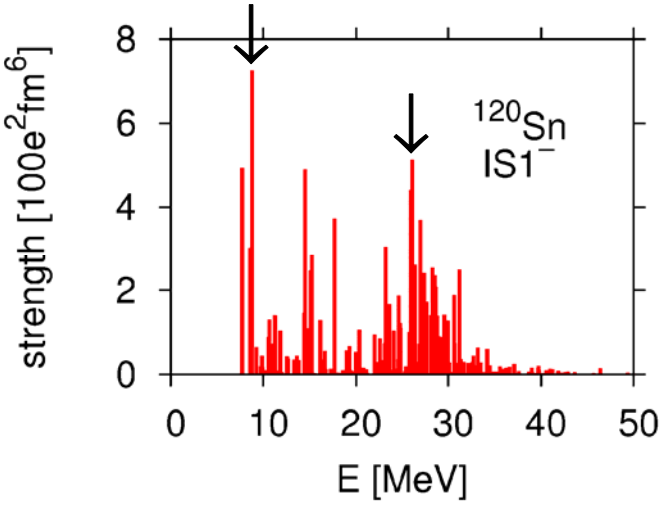
$$\rho^{\mathrm{tr}}_{\mathrm{n\ or\ p}}(\underline{r};k) = \left\langle \Psi_k \left| \hat{\rho}_{\mathrm{n\ or\ p}}(\underline{r}) \right| \Psi_0 \right\rangle$$

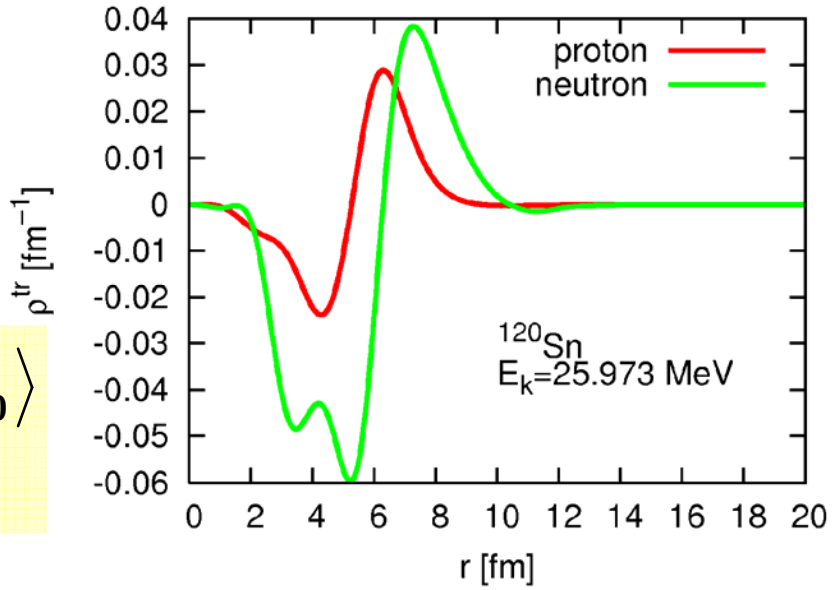
One-dimensional

$$\rho^{\mathrm{tr}}_{\mathrm{n\ or\ p}}(r;k) = r^2 \int d\Omega\, Y_{J0}(\Omega)\, \rho^{\mathrm{tr}}_{\mathrm{n\ or\ p}}(\underline{r};k)$$

Transition densities of a stable nucleus

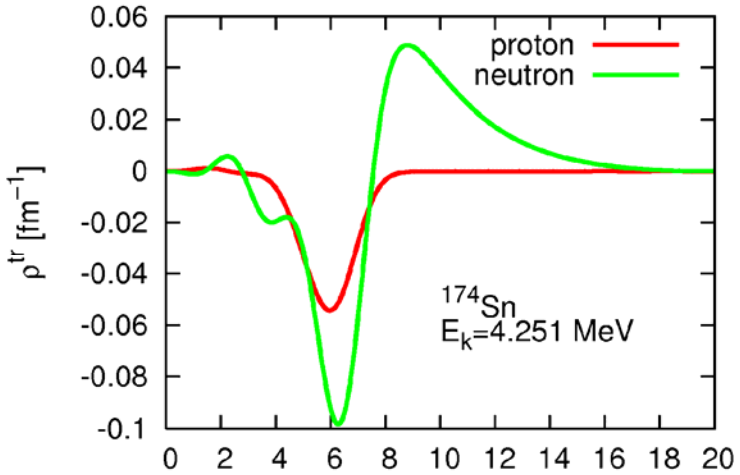


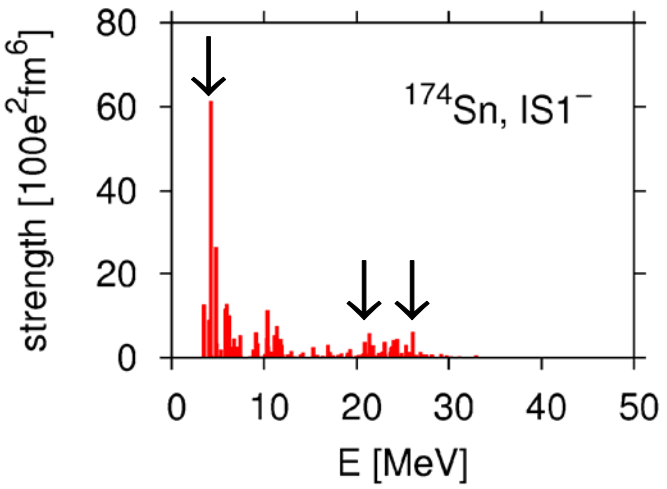


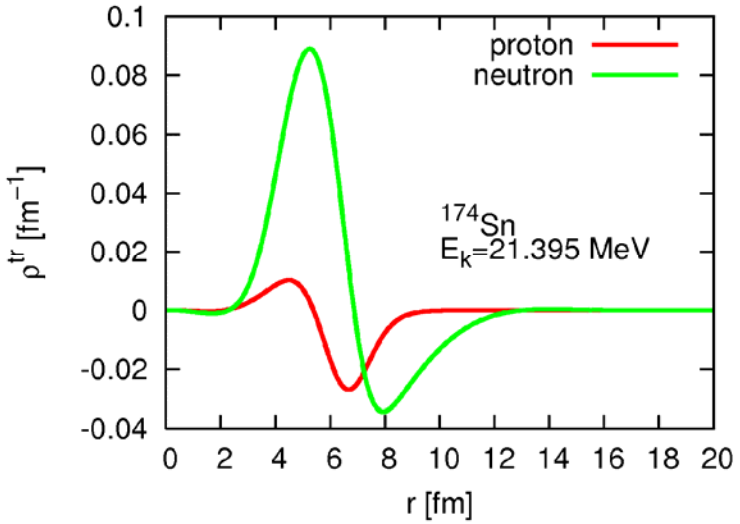


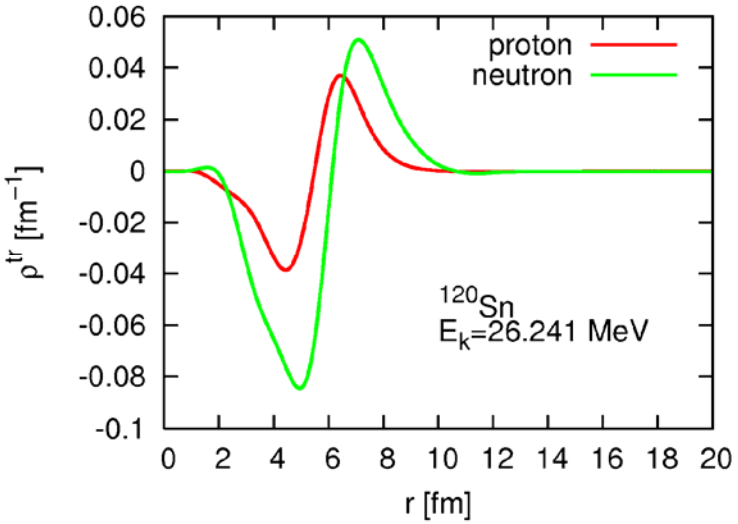
$$\left\langle \Psi_0 \left| e^{-i\hat{F}(t)} \hat{\rho}(r) e^{i\hat{F}(t)} \right| \Psi_0 \right\rangle - \left\langle \Psi_0 \left| \hat{\rho}(r) \right| \Psi_0 \right\rangle$$
$$\cong \left\langle \Psi_k \left| \hat{\rho}(r) \right| \Psi_0 \right\rangle e^{-i\omega t} + \text{c.c.}$$

Near neutron drip line

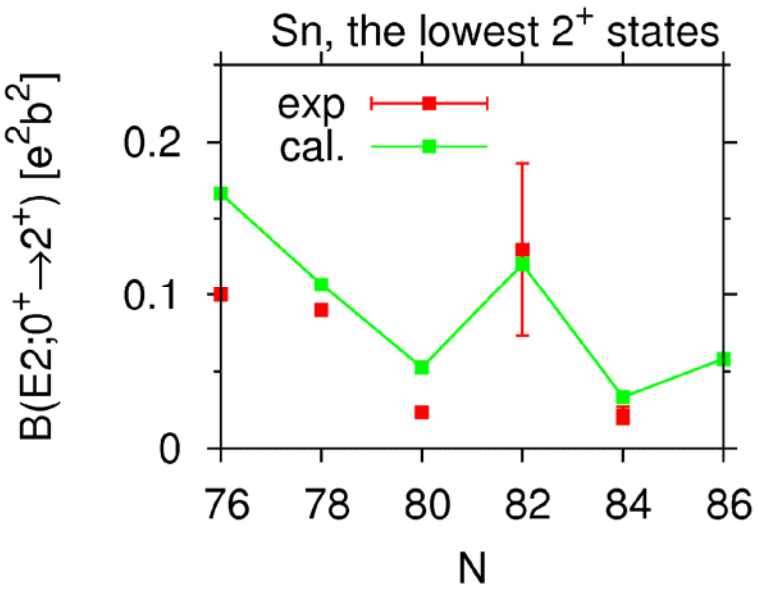


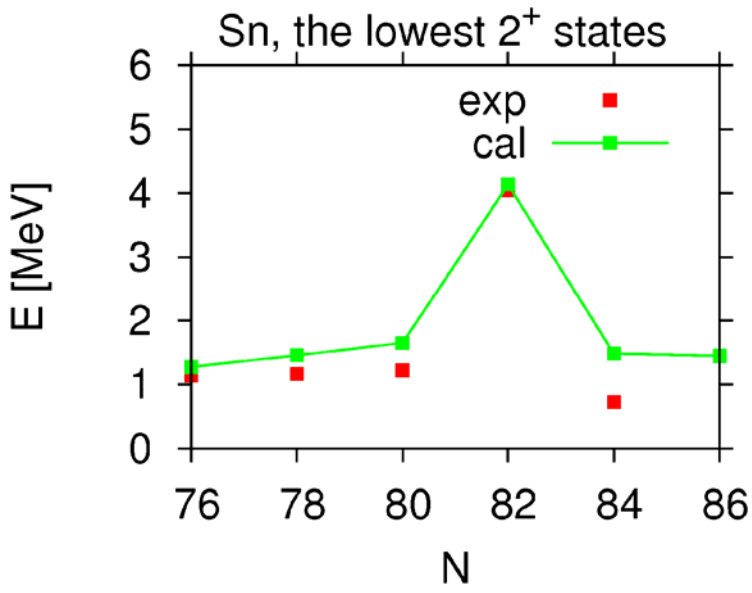






Recent experimental studies near ^{132}Sn





D.C. Radford et al. Phys.Rev.Lett. **88** (2002) 222501,
D.C. Radford, talk at conf. “Exotic Nuclei and Atomic Masses 2004”

Measurement of 1^- strength of ^{132}Sn is in progress at GSI.

Summary

- Strength functions of even Sn isotopes have been investigated from the proton drip line to neutron drip line.
  1. Strength of Isoscalar 1^- mode increases dramatically in a low-energy region as N approaches the neutron drip line.
  2. The state of the low-energy peak looks like a "neutron-skin oscillation" or continuum-energy state.

- We can obtain isoscalar 1^- solutions accurately without contamination of the center-of-mass motion.