E1 STRENGTH FUNCTIONS
FOR PHOTOABSORPTION AND EMISSION
WITHIN CLOSED-FORM METHODS

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1. Introduction

2. Average description of gamma-transitions by radiative (gamma-ray) strength functions. Closed-form models

3. Renewed data base of the GDR parameters

4. Calculations and comparisons with experimental data. Role of folding procedure in microscopic calculations of RSF

5. Brink's hypothesis violation

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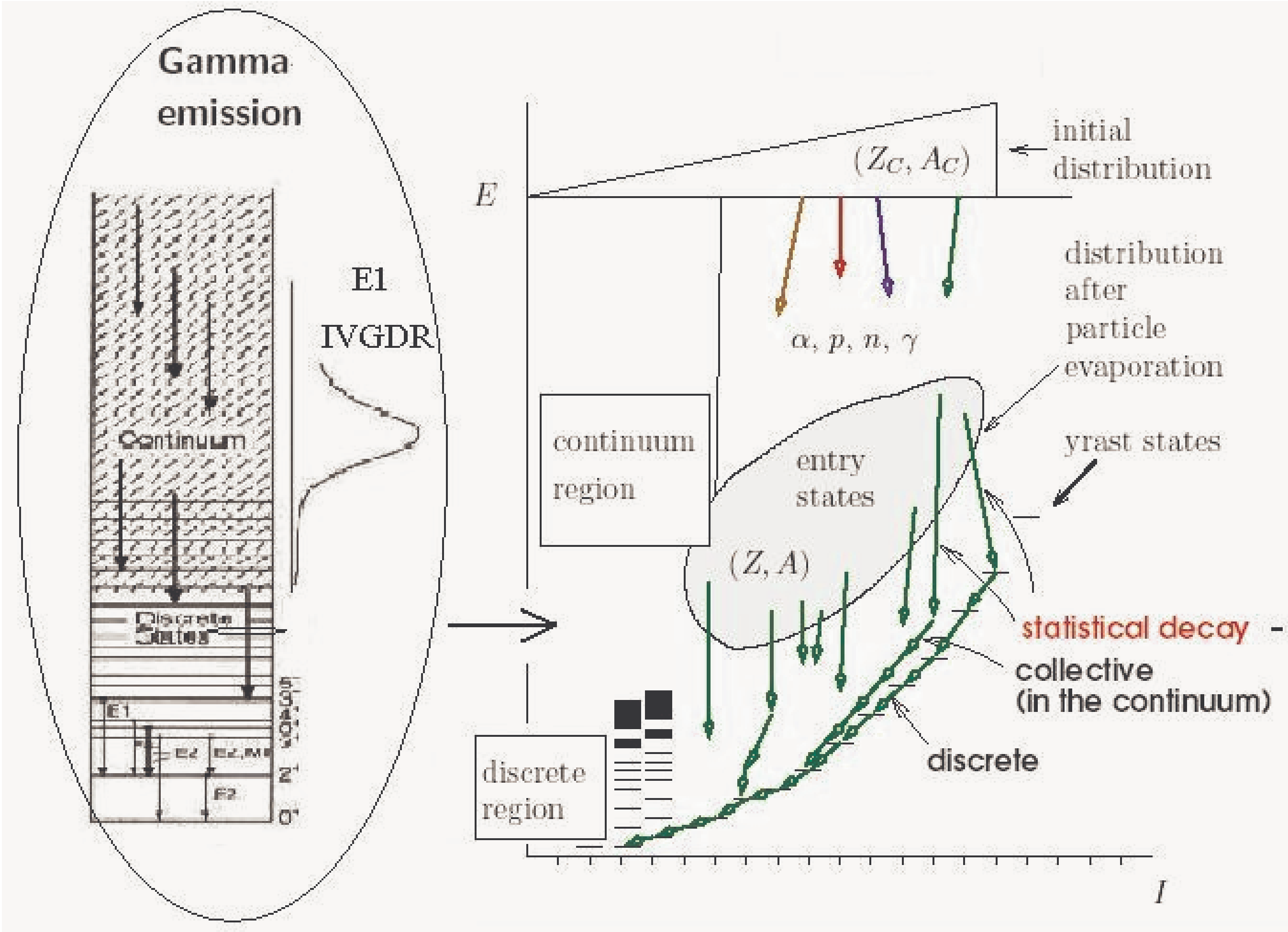
INTRODUCTION

Gamma-emission is one of the most universal channels of the nuclear de-excitation processes which can accompany any nuclear reaction



Schematic picture of the nuclear decay

Radiative (photon) strength functions (RSF)

Gamma-decay strength functions

for c-d gamma-transitions

$$\overleftarrow{f}_{E\lambda} = \frac{\left\langle \Gamma_{i\to f} \right\rangle_i}{E_\gamma^{2\lambda+1} D_i}$$

average partial gamma-decay width

average level spacing

for c-c gamma-transitions (E1 example)

$$\overleftarrow{f}_{E1}\left(E_\gamma\right) = E_\gamma^{-3} \frac{d\Gamma_{E1}\left(E_\gamma\right)}{dE_\gamma} \frac{\rho\left(U_i\right)}{3\rho\left(U_f = U_i - E_\gamma\right)}, \quad \rho = 1/D$$

γ-ray transmission coeff.

$$T_{E1}(\varepsilon_\gamma) \sim 2\pi\varepsilon_\gamma^3 \overleftarrow{f}_{E1}(\varepsilon_\gamma)$$

Photoexcitation strength functions (E1)

$$\vec{f}_{E1} = \frac{\sigma_{E1}}{3E_\gamma (\pi \hbar c)^2}$$

$\leftarrow$ photoabsorption cross-section

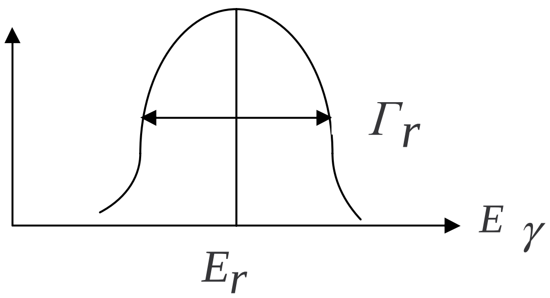
$$\vec{f}_{E\lambda} = \vec{\Phi}\left(E_\gamma, T_i\right), \qquad \overleftarrow{f}_{E\lambda} = \overleftarrow{\Phi}(E_\gamma, T_f)$$

$T_i,\ T_f = \varphi(T_i, E_\gamma)$ - **the temperatures of initial and final states**

CLOSED-FORM COMPONENT OF E1 RSF DUE TO GDR EXCITATION

Standard Lorentzian (SLO)

[D. Brink. PhD Thesis(1955); P. Axel. PR 126(1962)]



$$\overleftarrow{f} = \overrightarrow{f} \sim \frac{E_\gamma \Gamma_r^2}{(E_\gamma^2 - E_r^2)^2 + E_\gamma \Gamma_r^2} \underset{E_\gamma \to 0}{\Rightarrow} 0$$

$$\Gamma_r = const \neq \varphi(E_\gamma) \sim 5\,MeV\ (T = 0)$$

Enhanced Generalized Lorentzian (EGLO)

[J. Kopecky , M. Uhl, PRC47(1993)]

[S. Kadmensky, V. Markushev, W.Furman, Sov.J.N.Phys 37(1983)]

$$\overleftarrow{f} = \frac{E_\gamma \Gamma(E_\gamma, T_f)}{(E_\gamma^2 - E_r^2)^2 + E_\gamma^2 \Gamma_\gamma^2(E_\gamma, T_f)} + \frac{0.7\Gamma(E_\gamma = 0, T_i)}{E_r^3}$$

$$\overleftarrow{f} \Rightarrow const \neq 0\ \ [E_\gamma \to 0]$$

$$T_f = \sqrt{\frac{U - E_\gamma}{a}};$$

Infinite fermi- liquid (two-body dissipation)

$$\Gamma(E_\gamma, T_f) = \Gamma_r \frac{E_\gamma^2 + 4\pi T_f^2}{E_\gamma^2} \cdot K(E_\gamma)$$

$$K(E_\gamma) \rightarrow$$

empirical factor from fitting exp. data

Weak points of the approximations

Shapes of RSF within the models of realistic shape are, in fact, interpolations

$$\overleftarrow{f}_{E\lambda}^{\,\text{models}} = F\left\{ \overleftarrow{f}_{E\lambda}^{\,KMF}(E_\gamma \to 0),\ \overleftarrow{f}_{E\lambda}^{\,SLO}(E_r) \right\}$$

inconsistent with general relation between gamma-decay RSF of heated nuclei and nuclear response function on electromagnetic field (with detailed balance principle for gamma-transitions between C-C states)

(J.L.Egido, P.Ring, J.Phys.G:Nucl.Part.Phys.19(1993)1)

Dependences of shape parameter (”width”) on gamma-ray energy and the final state temperature

$$\Gamma\left(E_r, T\right) \ \Rightarrow\ \Gamma\left(E_\gamma, T_f\right) \ ???$$

in expressions of EGLO and GFL models were introduced in phenomeno-logical way by substitutions of the gamma-ray energy instead of GDR energy and the temperature of final states instead of initial states

RSF within modified Lorentzian (MLO)

based on expression for gamma-width averaged on microcanonical ensemble of initial states

$$\overline{\Gamma}_{\lambda}(J_i,E_\gamma)=\sum_{\substack{\nu_f,J_f\\ \Delta Z,\Delta N,M_i,\Delta\nu_i}}\frac{d\Gamma_{if}}{dE_\gamma}/N_i\,,\quad N_i=\rho(E,N,Z,J_i)(2J_i+1)\Delta E\Delta Z\Delta N$$

$$\frac{d\Gamma_{if}}{dE_\gamma}=d_\lambda(E_\gamma)B_{if}\,\delta(E_i-E_f-E_\gamma),\quad d_\lambda\ \sim\ E_\gamma^{2\lambda+1}$$

$$B_{if}=\sum\left|<J_fM_fE_f\nu_f\left|Q_{\lambda\mu}\right|J_iM_iE_i\nu_i>\right|^2,\quad Q_{\lambda\mu}=\sum_{\nu\nu'}q_{\nu\nu'}a_\nu^*a_{\nu'}$$

General expression for gamma-decay RSF

Transformations by Green-function method with the use of saddle point approximation lead to

$$\overleftarrow{f}\left(E_\gamma\right)=8.674\cdot 10^{-8}\frac{1}{1-\exp\left(-E_\gamma/T_f\right)}s\left(\omega=\frac{E_\gamma}{\hbar},T_f\right),\ \ \mathrm{MeV}^{-3}$$

$$s\left(\omega,T_f\right)=-\frac{1}{\pi}\chi''\left(\omega,T_f\right)$$

Peculiarity – presence of low-energy enhancement factor

$$N_{1p1h}\equiv\frac{1}{\hbar\omega}\int d\varepsilon_1 d\varepsilon_2 f_0\left(\varepsilon_1\right)\left(1-f_0\left(\varepsilon_2\right)\right)\delta\left(\varepsilon_1-\varepsilon_2+\hbar\omega\right)=\frac{1}{1-\exp\left(-E_\gamma/T_f\right)}=(E_\gamma\to 0)=\frac{T_i}{E_\gamma}\gg 1$$

Zero-energy limit

$$\overleftarrow{f}_{E1}(E_\gamma=0)\ \sim\cdot T_i\cdot\Phi''_{E1}(\omega->+0),\qquad \Phi''_{X\lambda}(\omega)\equiv\chi''_{X\lambda}(\omega)/\omega$$

Response function within semiclassical Landau-Vlasov approach is used in approximation of one strong collective state

(spherical nuclei)

$$\operatorname{Im}\chi\left(\omega,T_f\right)\propto\frac{E_\gamma\Gamma\left(E_\gamma,T_f\right)}{\left(E_\gamma^2-E_r^2\right)^2+\left[\Gamma\left(E_\gamma,T_f\right)E_\gamma\right]^2}$$

Parameter of line spreading ("energy-dependent width")

$$\Gamma\left(E_\gamma=\hbar\omega,T\right)=\Phi\left(\frac{\hbar}{\tau_\Sigma(\omega,T)}\right)$$

METHOD OF INDEPENDENT SOURCES OF LINE SPREADING

(Kolomietz, Plujko, Shlomo, PRC 54 (1996) 3014)

$$\frac{\hbar}{\tau_{\Sigma}(\omega,T)} = \frac{\hbar}{\tau_{coll}(\omega,T)} + \frac{\hbar}{\tau_{w}}$$

Two-body collisional damping is relaxation due to coupling of 1p-1h to more complicated states (2p2h and so on) lying at the same excitation energy (in the kinetic theory simulated by the collision integral.

One-body dissipation corresponds to strength-function fragmentation caused by interaction of particles with the time-dependent self-consistent mean field. In the RPA calculations this contribution to the damping indicates a redistribution of 1p-1h excitations in a vicinity of collective state (in kinetic equation approach imitated by the one-body ("wall") relaxation).

Deformation splitting is considered in approximation of axially-deformed nuclei (2-component RSF) with $\beta_{2,eff} = f(Q_2[\{\beta_j\}])$

PECULARITIES OF TWO-PARTICLE COLLISIONS IN PRESENSE OF AN EXTERNAL FIELD

Energy conservation law is changed and becomes dependent on field frequency due to possibility of exchange of the energy $\hbar\omega$ between the particles and field

It means changing arguments of δ function which is ensured the conservation of the energy of the colliding particles

$$\delta(\Delta\varepsilon \equiv \varepsilon_1 + \varepsilon_2 - \varepsilon_3 - \varepsilon_4) \quad \Rightarrow \quad \delta(\Delta\varepsilon \pm \hbar\omega)$$

As a result, a probability of two-body collisions is also dependent on field frequency

RSF for gamma-decay

Modified Lorentzian approximation (MLO)

(spherical nuclei)

$$\overleftarrow{f}\left(E_\gamma\right)=8.674\cdot 10^{-8}\,\frac{\sigma_r\,\Gamma_r}{1-\exp\left(-E_\gamma/T_f\right)}\,\frac{E_\gamma\Gamma\left(E_\gamma,T_f\right)}{\left(E_\gamma^2-E_r^2\right)^2+\left[\Gamma\left(E_\gamma,T_f\right)E_\gamma\right]^2}$$

Shape parameters (“widths”)

$$\Gamma(E_\gamma,T_f)=a+bE_\gamma^\alpha+cT_f^\delta$$

$$MLO1(SMLO1)\ \Rightarrow\ \Gamma(E_\gamma,T_f)=b(E_\gamma+U_f)=bU_i$$

$$MLO2(3)\ \Rightarrow\ \Gamma(E_\gamma,T_f)=a+bE_\gamma^2+cT_f^2$$

RSF for photoabsorption

$$\vec{f}_{E1}\left(E_\gamma\right) = 8.674 \cdot 10^{-8} \sum_{j=1}^{n} \sigma_{r,j} \Gamma_{r,j} \frac{E_\gamma \Gamma_j(E_\gamma)}{\left(E_\gamma^2 - E_{r,j}^2\right)^2 + \left[\Gamma_j(E_\gamma) \cdot E_\gamma\right]^2}, \ \mathrm{MeV}^{-3}$$

$$MLO1(SMLO1) \ \Rightarrow \ \Gamma(E_\gamma) = E_\gamma \qquad MLO2(3) \ \Rightarrow \ \Gamma(E_\gamma) = a + bE_\gamma^2$$

$$\Gamma_j(E_\gamma) \equiv \Gamma_j(E_\gamma, T=0), \quad \Gamma_j(E_\gamma = E_r) = \Gamma_r$$

$$E_{r,j},\ \Gamma_{r,j},\ \sigma_{r,j} \ - \ \text{fitted parameters}$$

n=2 in axially deformed nuclei

GDR parameters with uncertainties from renewed database

V.A.Plujko, R.Capote, O.M. Gorbachenko, At.Data Nucl.Data Tables, 2010, in press

Shape parameters of the models were obtained by fitting the theoretical calculations for photoabsorption cross sections to reanalyzed experimental and estimated data from the EXFOR library and library of Moscow Photonuclear Data Center [with allowance for (γ, p) reaction]

Adjustment was performed by the least square method with minimizing

$$\chi^2 = \frac{1}{N - N_{par}} \sum_{i=1}^{N} \left(\frac{\sigma_{theor}\left(E_{\gamma,i}\right) - \sigma_{\exp}\left(E_{\gamma,i}\right)}{\Delta\sigma_{\exp}\left(E_{\gamma,i}\right)} \right)^2$$

Energy dependent errors were used for estimated data

Spherical nuclei

$$\delta\left(E_\gamma\right) = \delta_{\min} + b\left|E_r - E_\gamma\right|$$

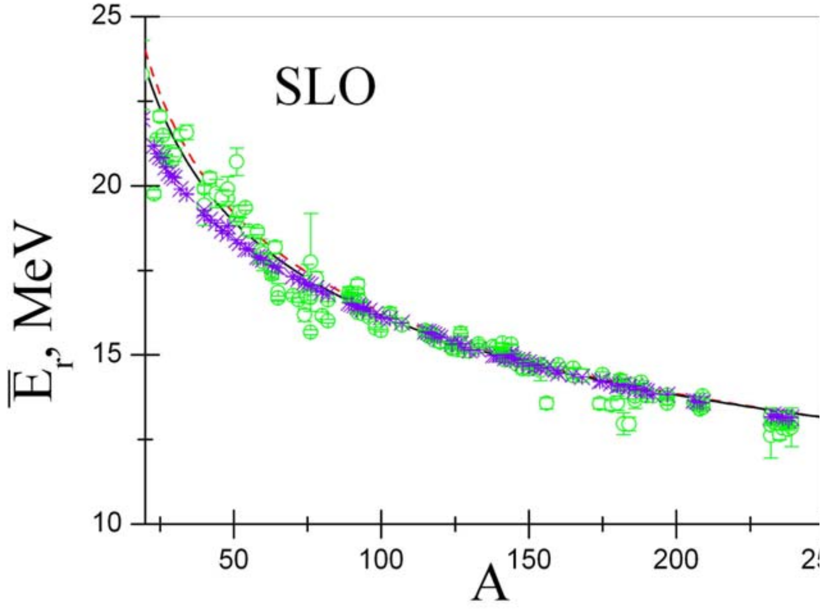
$$\delta_{\min} = 0.1;\ \delta\left(E_{\gamma,\min}\right) = 0.5$$

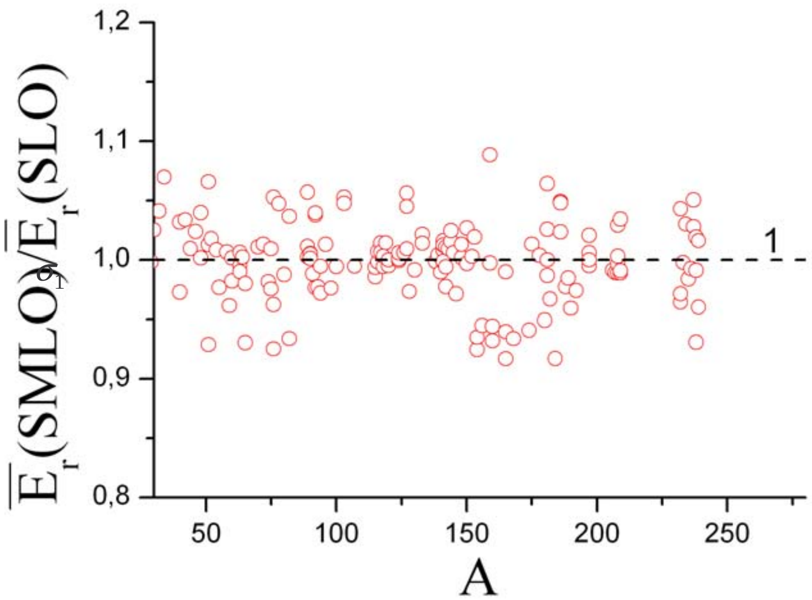
Deformed nuclei

$$\delta\left(E_\gamma\right) = \begin{cases} \delta_{\min} + b\left(E_1 - E_\gamma\right),\ E_\gamma < E_1, \\ \delta_{\min},\ E_1 \le E_\gamma \le E_2, \\ \delta_{\min} + b\left(E_\gamma - E_2\right),\ E_\gamma > E_2. \end{cases}$$

GDR energies

$$\bar{E}_r = \frac{E_1\sigma_1 + E_2\sigma_2}{\sigma_1+\sigma_2} = \begin{cases} (E_1+2E_2)/3; & \beta_2 > 0\ (\sigma_2 = 2\sigma_1) \\ (2E_1+E_2)/3; & \beta_2 < 0\ (\sigma_2 = \sigma_1/2) \end{cases}$$





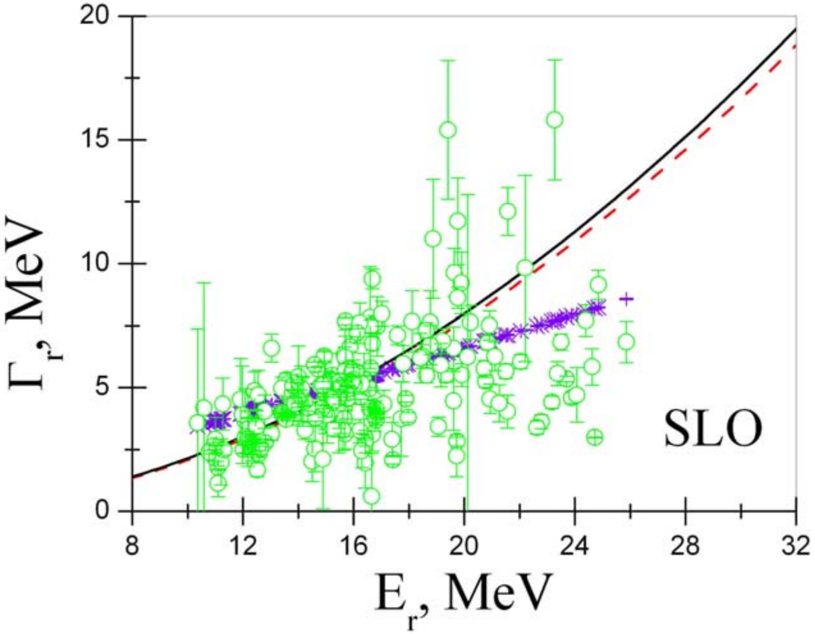
Systematic for renewed data : —— $\bar{E}_r = 31.2/A^{1/3} + 20.6/A^{1/6}\ (MeV)$

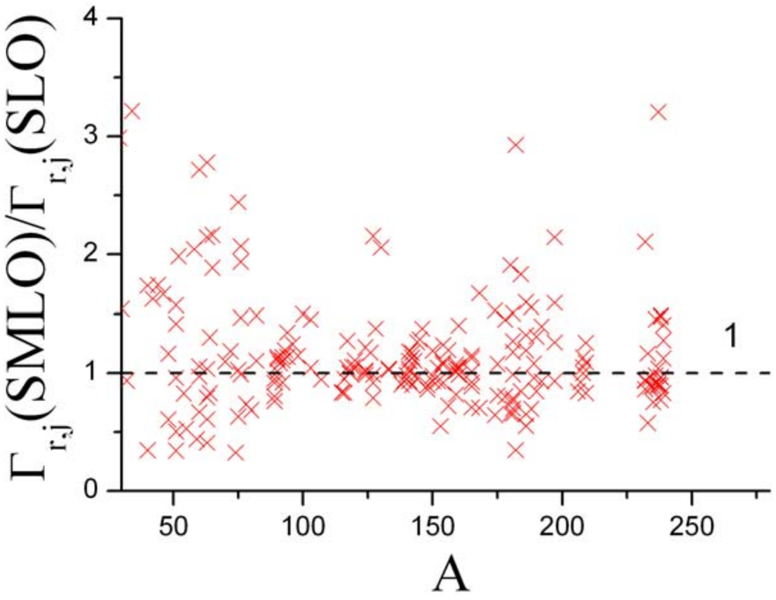
X – $\bar{E}_r = 4.755(1+108.0I^2)/A^{1/3} + 32.788(1-7.5899I^2)/A^{1/6}\ (MeV); I = (N-Z)/A$

- - - - S.S. Dietrich, B.L. Berman(1988), $\bar{E}_r = 27.47/A^{1/3} + 22.06/A^{1/6}\ (MeV)$

O – new values

GDR widths





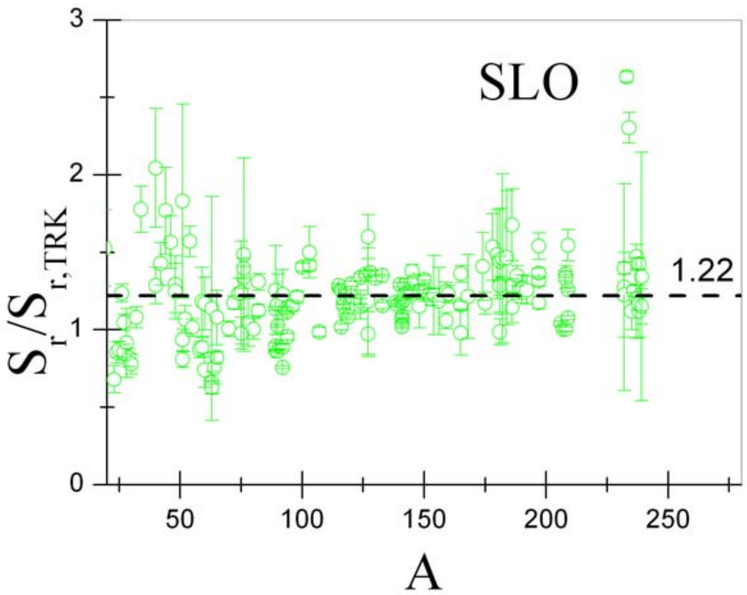
Curves: **X** - $\Gamma_r = 0.37E_r - 0.14E_r\beta_2 - 0.6E_{2_1^+}\ (MeV)$

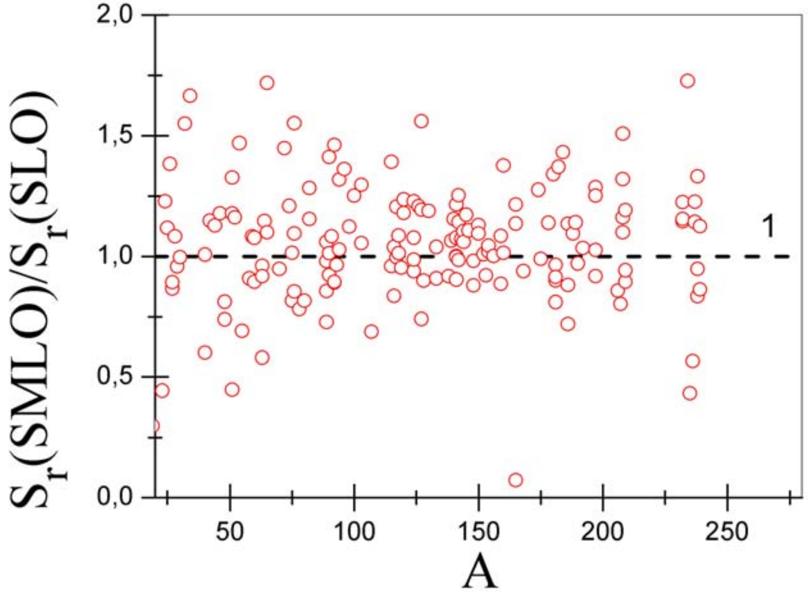
—— - $\Gamma_r = 0.026E_r^{1.91}\ (MeV)$,

- - - - - $\Gamma_r = 0.027E_r^{1.91}\ (MeV)$, S.S. Dietrich, B.L. Berman(1988)

O – new values

Energy weighted sum rule for isovector E1 transitions





$$S_{EWSR} = \mathrm{const}\cdot S_r, \quad S_r = \int_0^{\infty} \sigma(E_\gamma)\,dE_\gamma, \quad S_r(\mathrm{SLO}) = \pi/2 \sum_{j=1}^{n} \sigma_{r,j}\Gamma_{r,j}$$

$$S_r(\mathrm{SMLO}) = \int_0^{50\,MeV} \sigma(E_\gamma)\,dE_\gamma \qquad S_r(\mathrm{TRK}) = 60\cdot NZ/A \ (\mathrm{mb}\cdot\mathrm{MeV})$$

Mean value of enhancement factor of TRK sum rule ~ 1.22

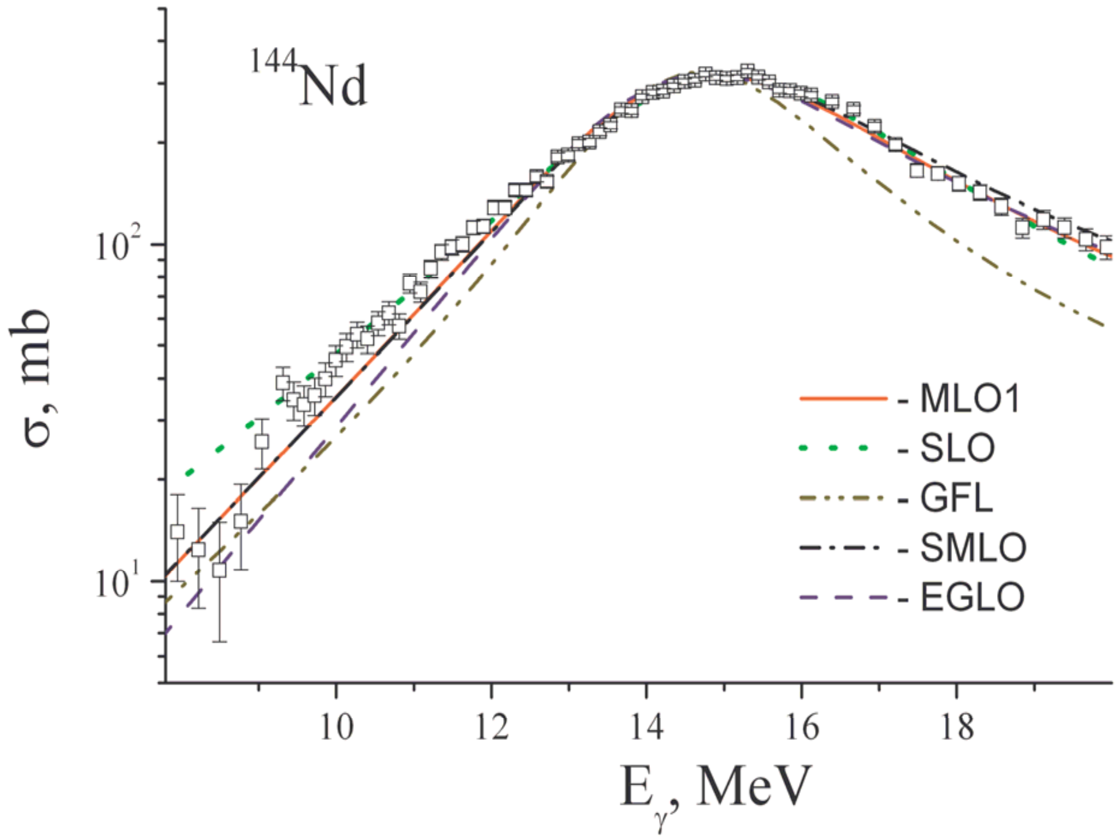
Volume(J) and surface(Q) coefficients of the symmetry energy

$$\overline{E}_r = a_1 A^{-1/3} / \sqrt{1 + a_2 A^{-1/3}}, \qquad \boxed{a_1 = c \cdot J;\; a_2 = d \cdot J/Q}$$

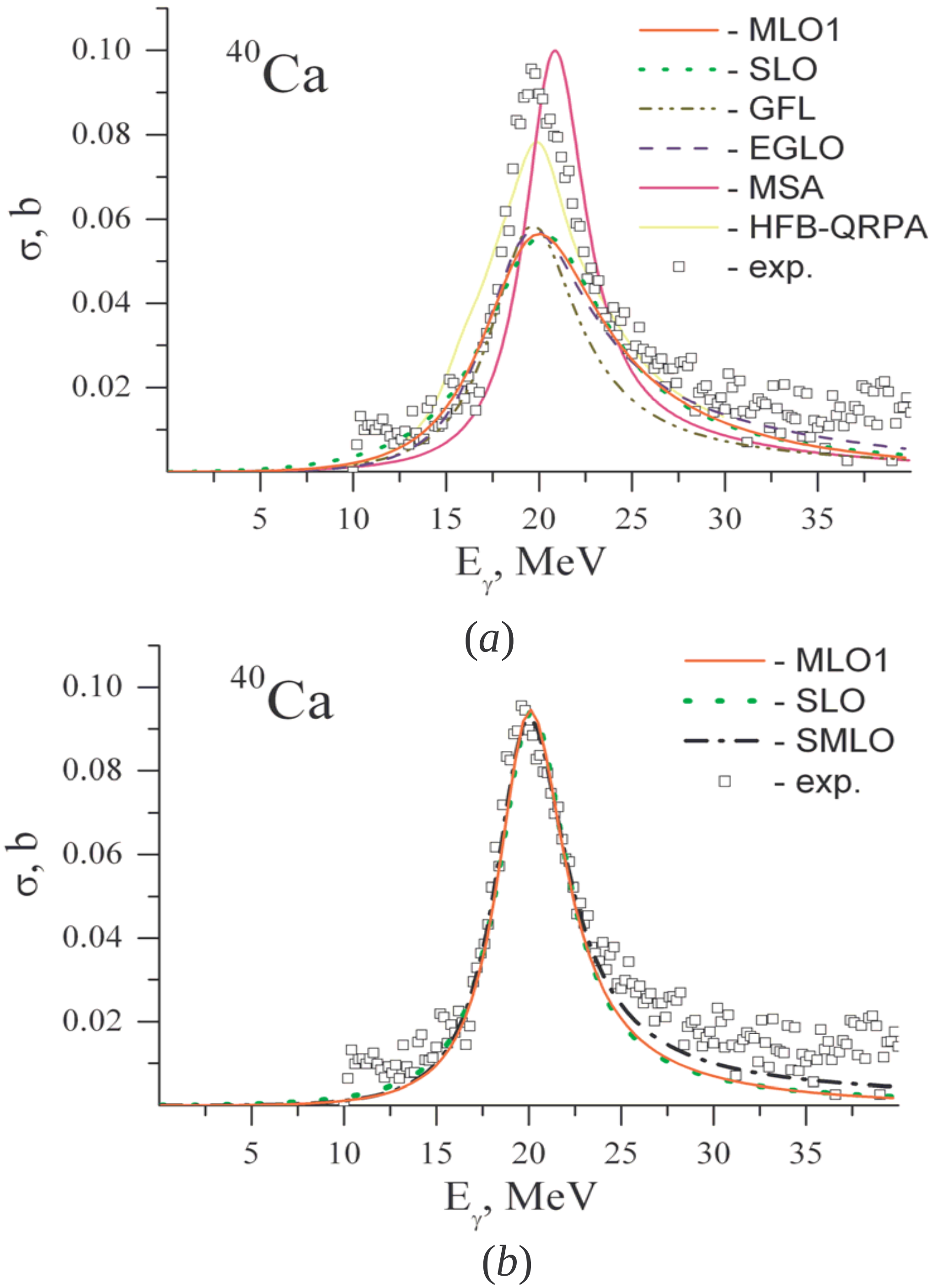
$$E_{sym} = \frac{I^2}{2} b_v / (1 + \frac{b_v}{b_s} A^{-1/3}),\; I = \frac{N - Z}{A},\; b_v = 2J,\; \frac{b_s}{b_v} = \frac{9J}{4Q}$$

J, J/Q	***Myers et al.*** ($c = 3$)	*Lipparini et al.* ($c = 15/4$)	*Abrosimov et al.* ($c = 15/2$)
Used previously	36.8, 2.18	33, 0.89 32.5, 1.00	30, 04 32.5, 0.9
Sph. + axial def. nuclei	37.09*(27)*, 2.42*(03)*	42.39*(33)*, 1.91*(02)*	42.39*(33)*, 0.95*(01)*

The photoabsorption cross sections and RSF



Comparison of calculated photoabsorption cross-section
on Nd with experimental data



Comparison of the photoabsorption cross section calculated with different database for GDR parameters: (*a*) - old systematics (Berman&Fultz); (*b*) - renewed GDR parameters.

Averaged HFB-QRPA microscopic approach by S. Goriely et al NP A706 (2002) 217; A739 (2004) 331

MSA - semiclassical moving surface method by V.I. Abrosimov, O.I.Davidovskaya Izvestiya RAN. 68 (2004)200; Ukrainian Phys. Jour. 51 (2006)234

Exp.data - V.A. Erokhova et al Izvestiya RAN. Seriya Fiz. **67** (2003) 1479

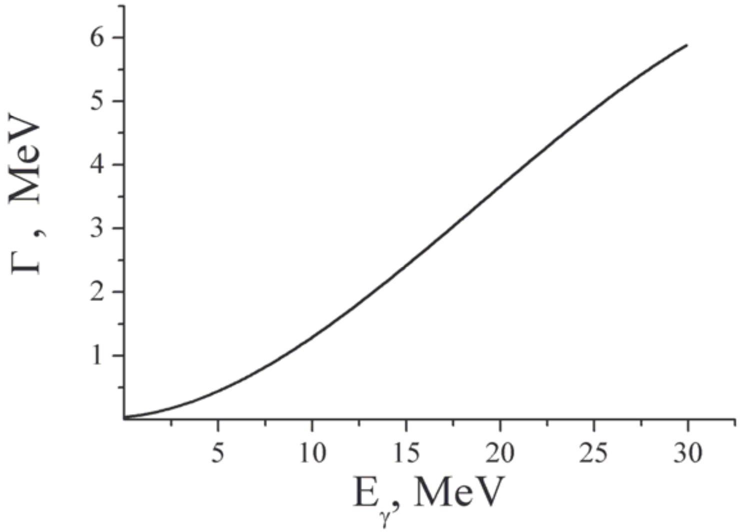
Folding procedure within microscopic calculations without 2p2h states

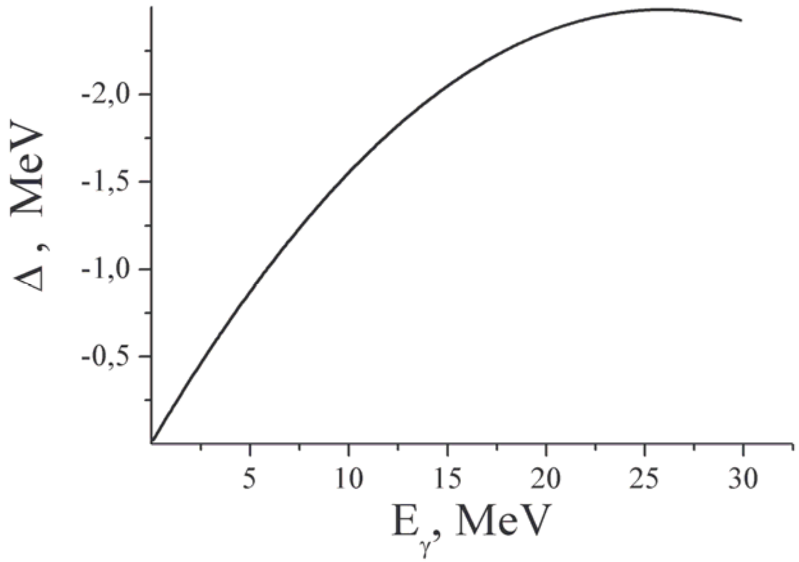
$$f_{fold,E1}\left(E_\gamma\right) = \int_{-\infty}^{+\infty} f_L(E'_\gamma, E_\gamma)\, f_{E1}(E'_\gamma)\, dE'_\gamma$$

$$f_L(E'_\gamma, E_\gamma) = \frac{1}{2\pi} \frac{\Gamma(E_\gamma)}{\left(E'_\gamma - E_\gamma - \Delta(E_\gamma)\right)^2 + \Gamma^2(E_\gamma)/4}$$

R.D. Smith et al. P R**C38** (1988)100; *S.Drozdz et al*. P Rep. **197** (1990)1; *F.T.Baker et al*. P Rep. **289** (1997)235

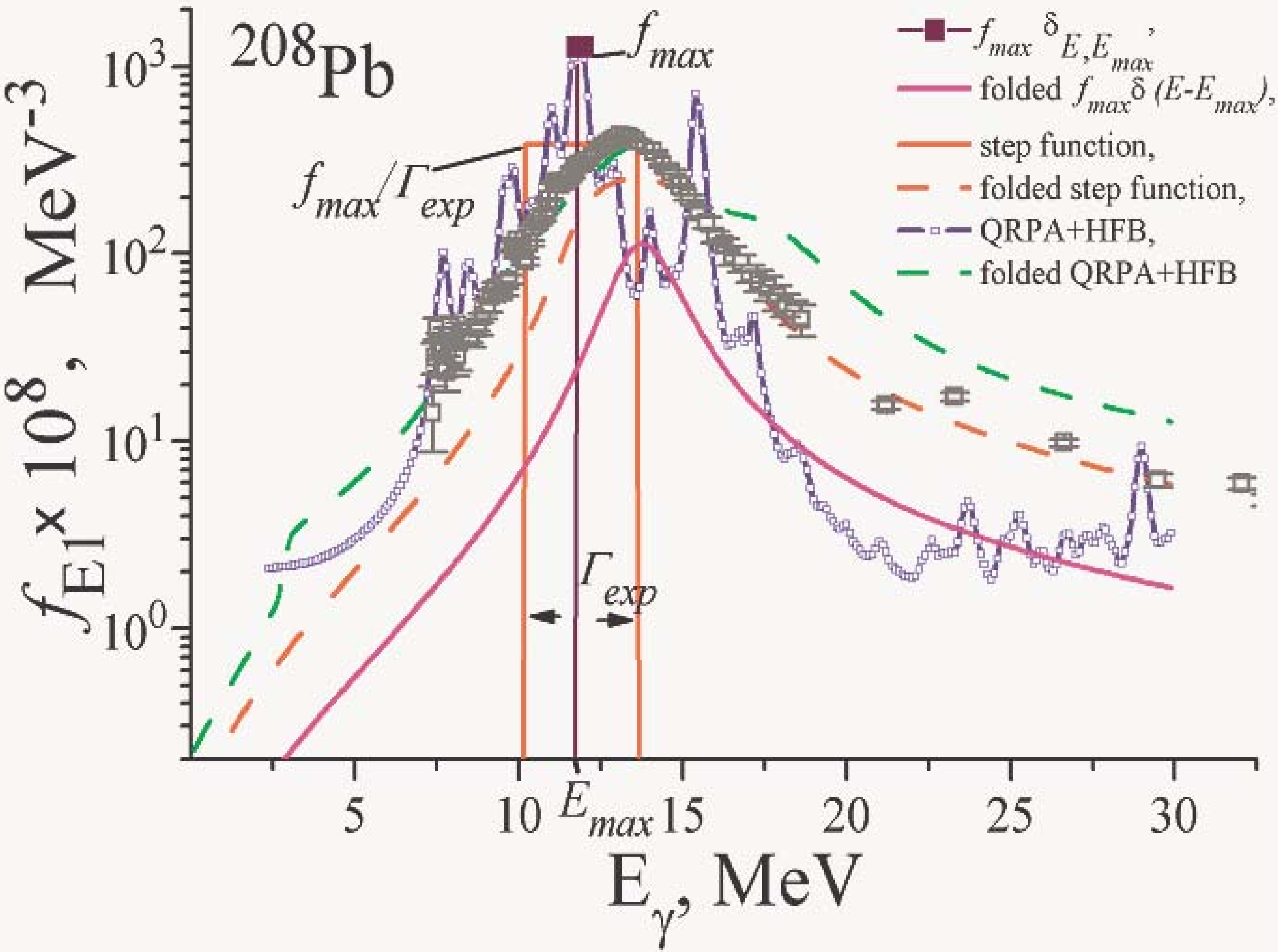
Width and energy shift for averaging HFB+QRPA results





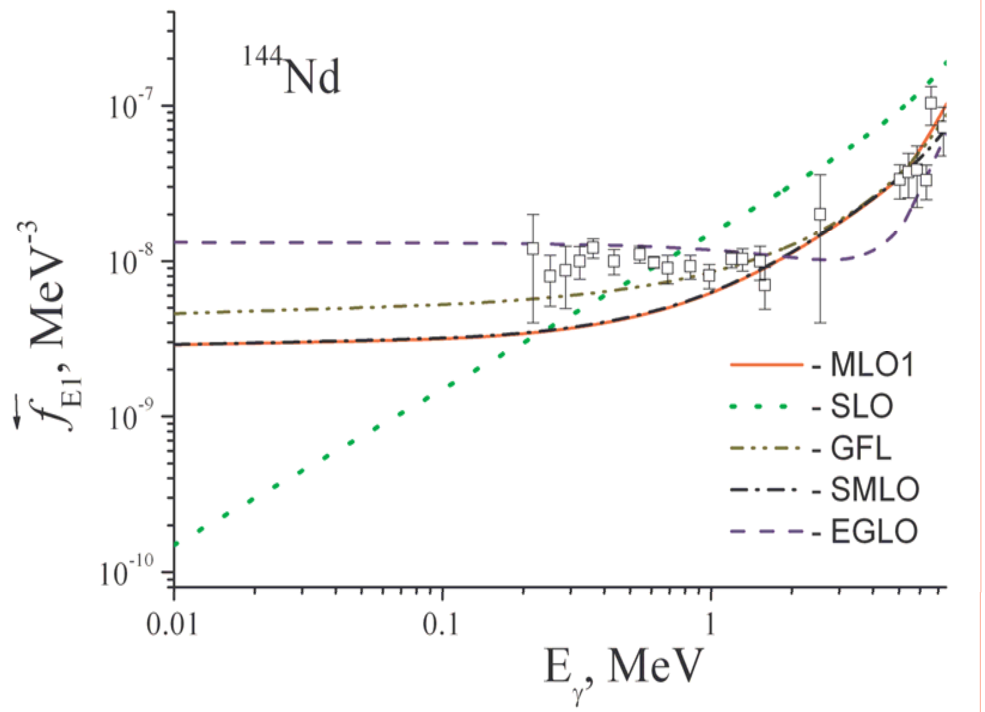
$$\Gamma(E_\gamma) = a_0 + a_1 E_\gamma + a_2 E^2{}_\gamma + a_3 E^3{}_\gamma \qquad \Delta(E_\gamma) = b_0 + b_1 E_\gamma + b_2 E^2{}_\gamma$$

S. Goriely et al. NPA **706**, 217 (2002); **739**, 331 (2004);
S. Goriely, private communication



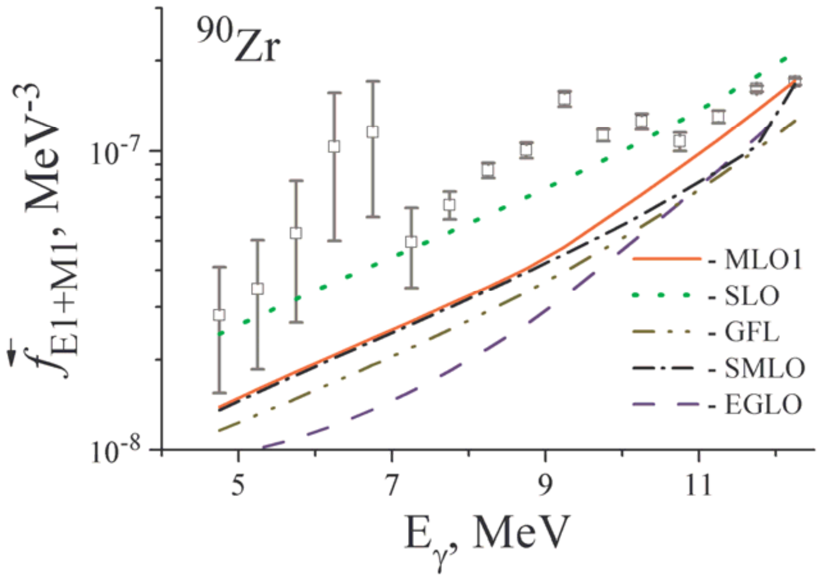
^{208}Pb
f_{max}
f_{max}/Γ_{exp}
Γ_{exp}
$f_{max}\,\delta_{E,E_{max}}$,
folded $f_{max}\delta\,(E-E_{max})$,
step function,
folded step function,
QRPA+HFB,
folded QRPA+HFB
$f_{E1}\times 10^8$, MeV-3
E_γ, MeV
E_{max}

Comparisons of gamma-decay RSF

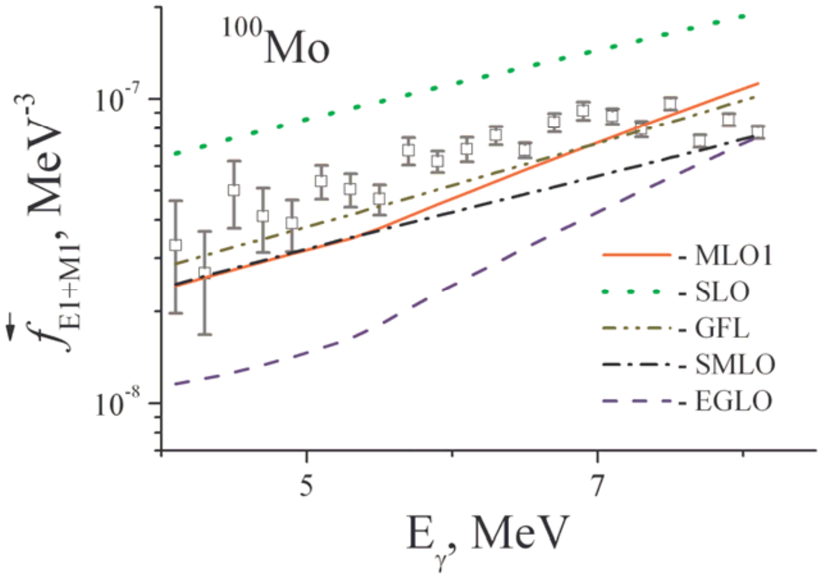


The E1 gamma-decay strength function on ^{144}Nd. The experimental data: Yu.P. Popov, in Neutron induced reactions, Proc. Europhys. Topical Conf., Smolenice, 1982, Physics and Applications, Vol. 10, Ed.P.Oblozinsky (1982) 121; $\overleftarrow{f}_{M1} = const$.

Model	EGLO	SLO	GFL	MLO1	MLO2	MLO3	SMLO
χ^2	2.2	22.9	2.6	6.47	6.52	7.16	6.06



(a)



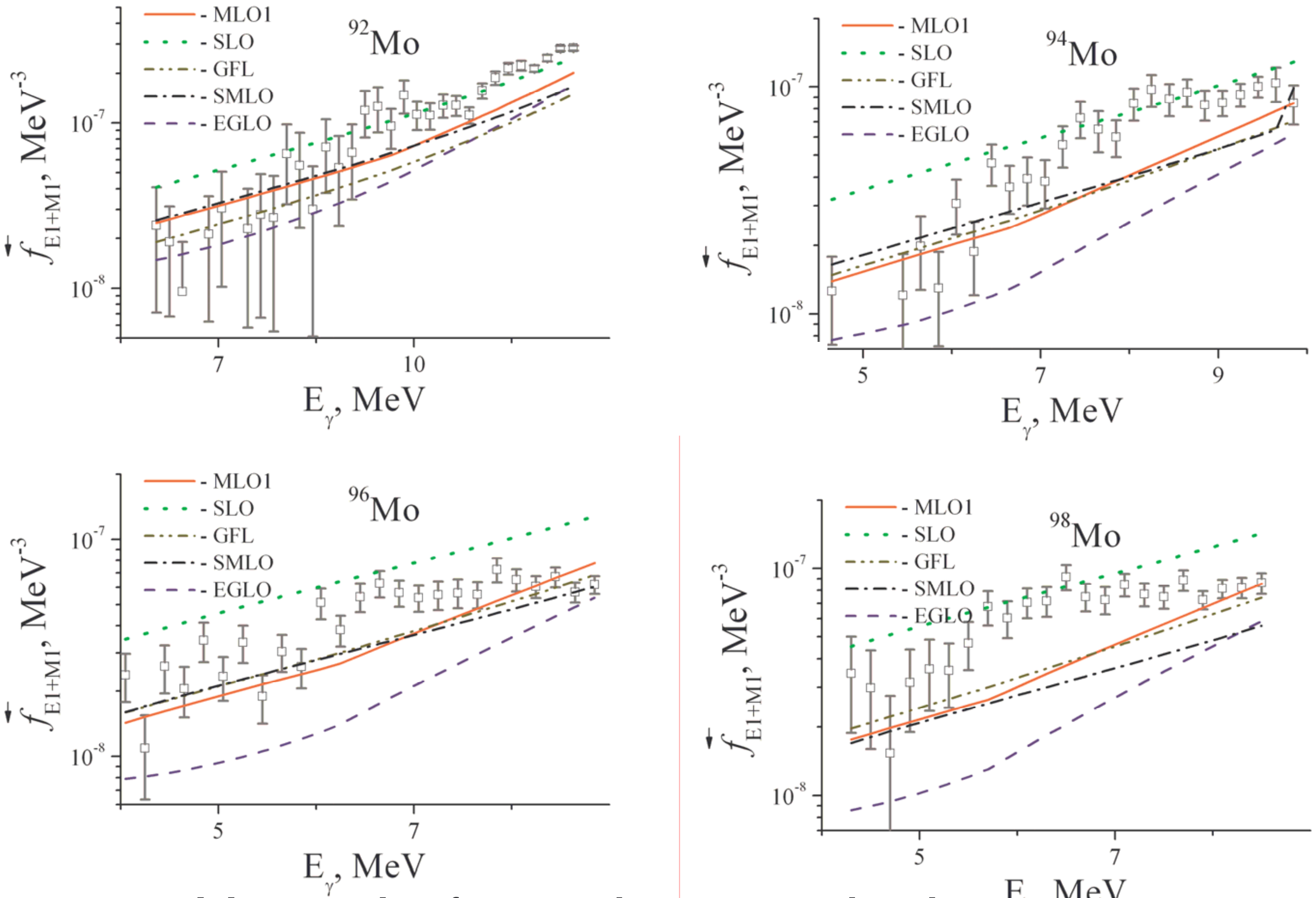
(b)

Dipole strength functions of $E1$ and $M1$ gamma-decay for ^{90}Zr (a) and ^{100}Mo (b): $U = S_n$. Experimental data are taken from *R. Schwengner, et al.* // Phys. Rev. **C78**, 064314 (2008); Phys. Rev. **C81**, 034319 (2010)

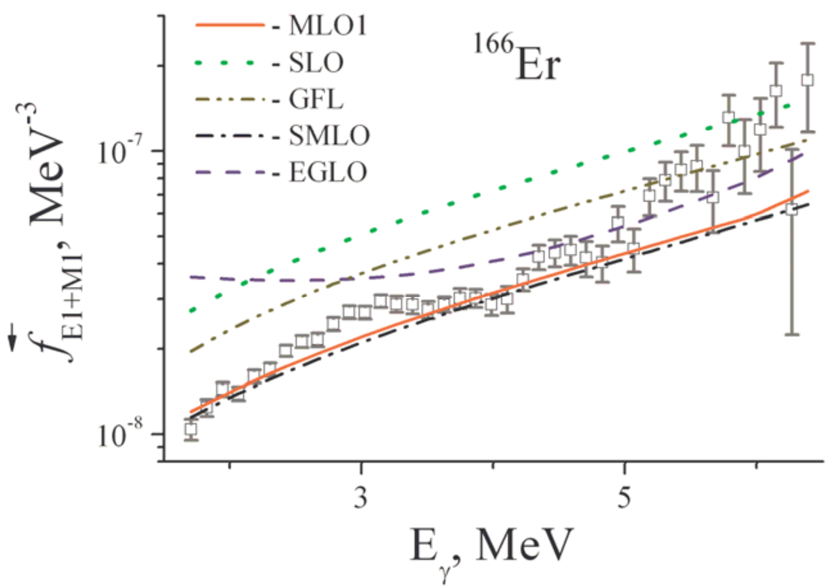
Values of χ^2 deviation of calculated gamma-decay strength functions from estimated experimental data for nuclei ^{90}Zr, ^{92}Mo, ^{94}Mo, ^{96}Mo, ^{98}Mo, ^{100}Mo, ^{139}La.

Nucleus	EGLO	SLO	GFL	MLO1	SMLO
^{90}Zr	69.7	17.9	72.0	36.8	55.5
^{92}Mo	21.9	3.6	26.5	11.6	19.4
^{94}Mo	10.2	5.5	5.3	4.2	5.1
^{96}Mo	11.8	25.5	2.9	3.7	3.4
^{98}Mo	16.8	10.5	6.4	6.0	11.5
^{100}Mo	38.3	191.2	7.7	13.5	15.1
average	28.1	42.4	20.1	12.6	18.3

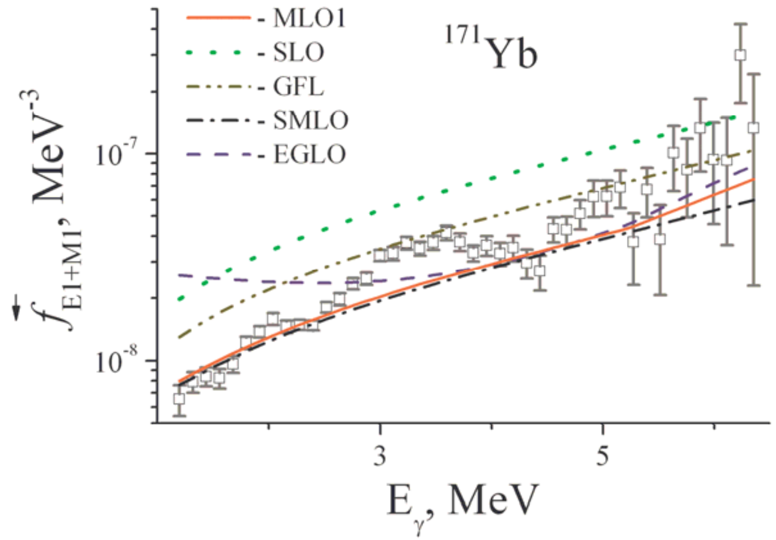
Dipole strength functions of $E1$ and $M1$ gamma-decay for ${}^{92}Mo, {}^{94}Mo, {}^{96}Mo, {}^{98}Mo: U = S_n$.



Experimental data are taken from *R. Schwengner, et al.* // Phys. Rev. **C81**, 034319 (2010)



(*a*)



(*b*)

Dipole strength functions of $E1$ and $M1$ gamma-decay for ^{166}Er (a) and ^{171}Yb (b): $U = S_n$. Experimental data are taken from *E. Melby, M. Guttormsen, J. Rekstad, A. Schiller, and S. Siem* // Phys. Rev. **C63**, 044309 (2001) and *U. Agvaanluvsan, A. Schiller, J. A. Becker, L. A. Bernstein, et al.* // Phys. Rev. **C70**, 054611 (2004)

Values of χ^2 deviation of calculated gamma-decay strength functions from experimental data for nuclei ^{160}Dy, ^{162}Dy, ^{166}Er, ^{171}Yb, ^{172}Yb.

Model	EGLO	SLO	GFL	MLO1	SMLO
^{160}Dy	187.9	159.8	45.8	5.1	5.4
^{162}Dy	74.3	201.6	55.4	5.2	6.3
^{166}Er	119.8	201.1	47.9	3.6	5.0
^{171}Yb	58.6	184.1	31.2	5.6	6.7
^{172}Yb	62.6	292.7	78.3	4.5	5.3
average	100.5	207.9	51.7	4.8	5.7

Averaging procedure in the Oslo method of gamma-decay strength function measurements

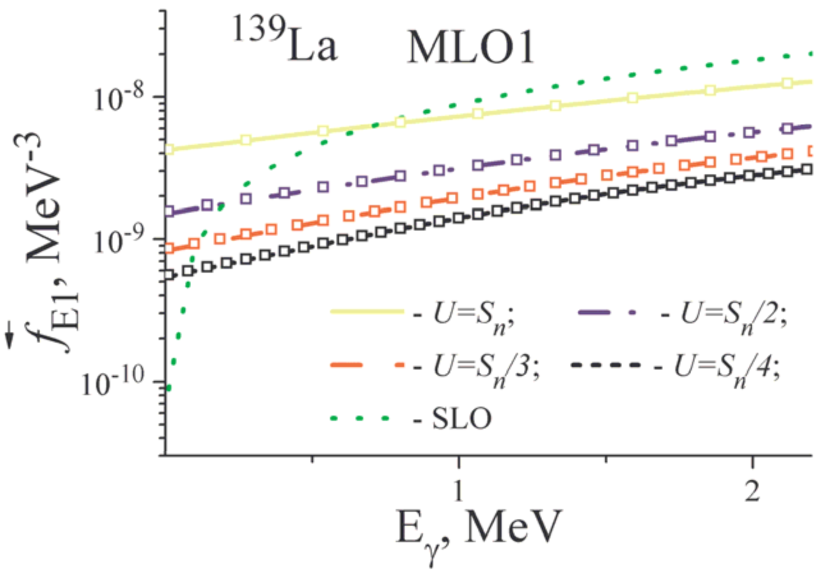
$$f_{\exp}\left(E_\gamma\right)=\frac{1}{\Delta}\int_{U_i^*-\Delta/2}^{U_i^*+\Delta/2}\overleftarrow{f}_{E1}\left(E_\gamma,U_i\right)dU_i$$

$$\Delta\equiv\Delta\left(E_\gamma,U_i^*\right)=\begin{cases}U_i^*-E_\gamma, & U_i^*>E_\gamma\geq U_i^*-4,\\ 4\quad, & E_\gamma< U_i^*-4,\quad MeV\end{cases}$$

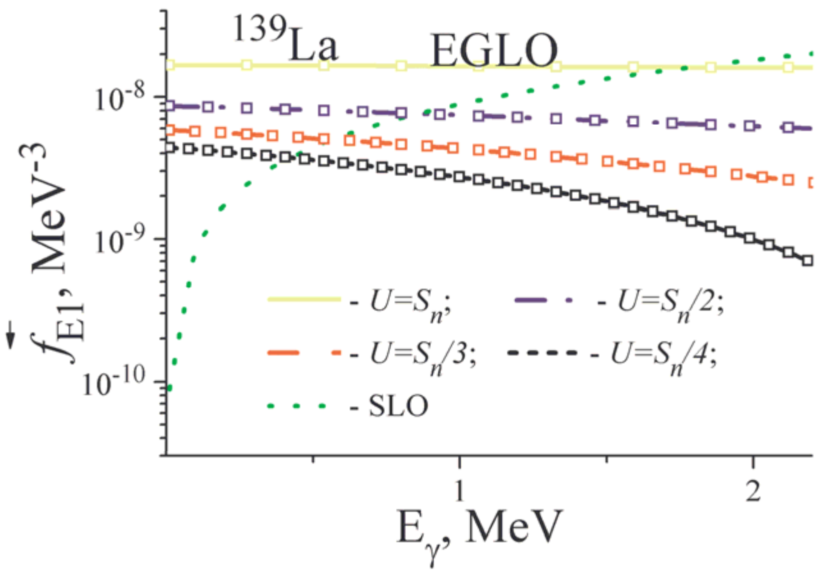
$$E_\gamma<U_i^*,\ \ U_i^*\cong S_n$$

A.V.Voinov & M. Guttormsen, private communications, 2009

Effect of energy averaging within MLO1 (a) and EGLO (b) models at different excitation energies

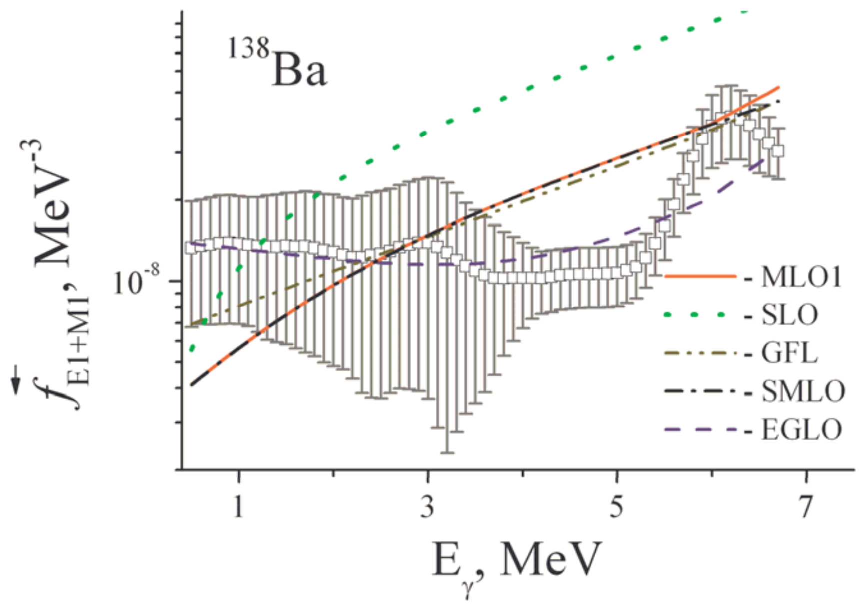


(a)

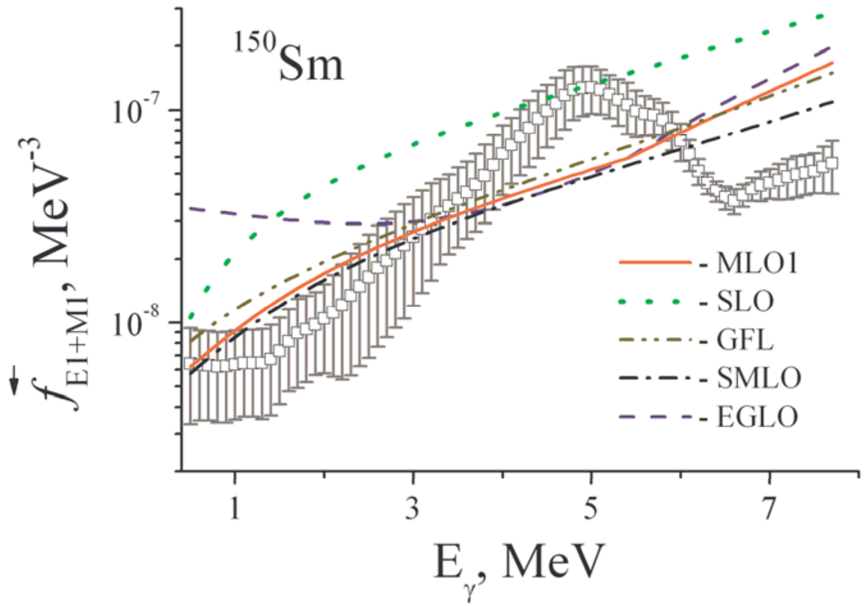


(b)

Open colored squares - averaged values of the RSF



(a)



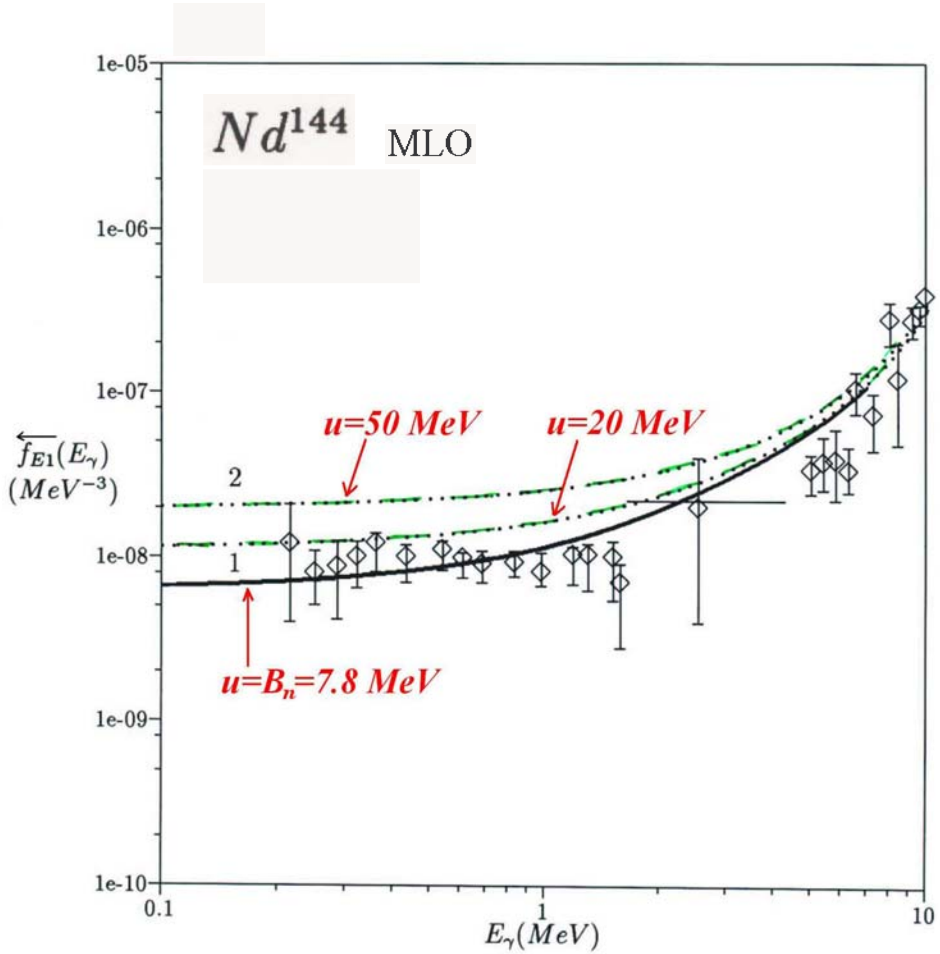
(b)

Dipole strength functions of $E1$ and $M1$ gamma-decay for ^{138}Ba (a) and ^{150}Sm (b): $U = S_n$. Experimental data are taken from *Vasilieva E.V., Sukhovoj A.M., Khitrov V.A.* // Yad.Fiz., 2001. V. 64. P. 3.

Values of χ^2 deviation of calculated gamma-decay strength functions from experimental data for nuclei ^{118}Sn, ^{138}Ba, ^{150}Sm, ^{146}Nd, ^{124}Te.

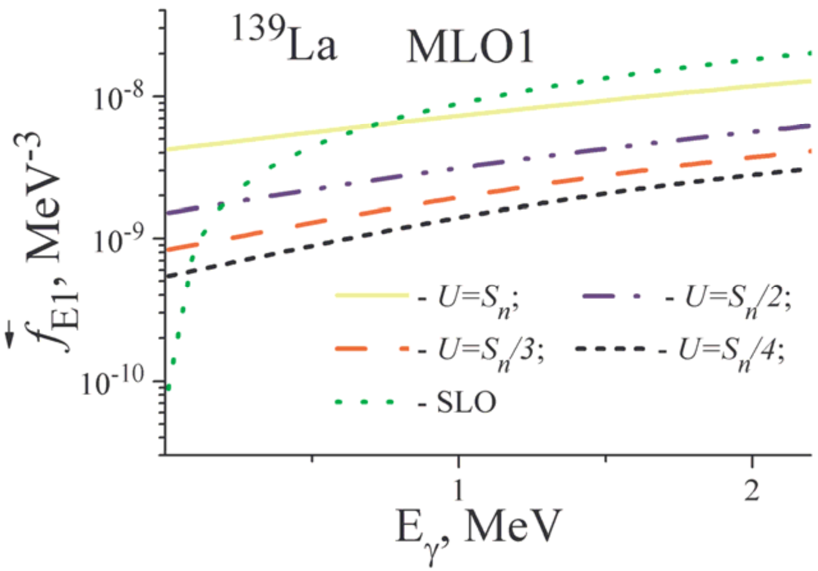
Nucleus	EGLO	SLO	GFL	MLO1	SMLO
^{118}Sn	13.0	44.5	12.7	15.1	12.1
^{138}Ba	0.6	109.1	6.9	9.0	8.8
^{150}Sm	49.4	167.7	22.1	24.2	8.7
^{146}Nd	25.6	129.2	19.9	17.0	21.9
^{124}Te	2.1	195.9	19.7	22.8	18.7
average	18.1	129.3	16.3	17.6	14.0

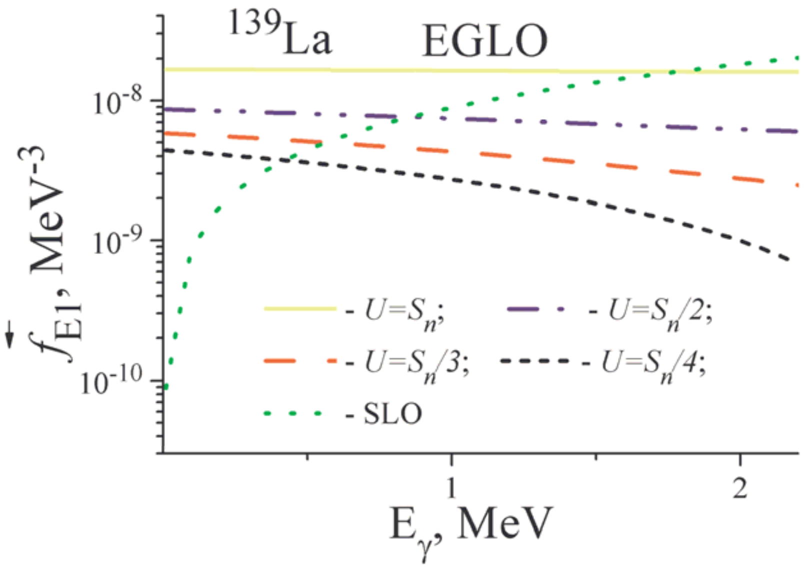
A violation of the Brink hypothesis



The gamma-decay RSF depends on excitation energy.
The dependence is the most important for transitions with low gamma-ray energies where values of RSF are growing with excitation energy

Dipole strength functions of $E1$ gamma-decay within MLO1 and EGLO models at different excitation energies





Low-energy part of gamma-decay RSF *increase* with excitation energy

(EGLO, GFL, MLO)

$$\overleftarrow{f}\left(E_\gamma \to 0\right) \sim T_i = const$$

Main conclusions

- **Most reliable simple description of E1 RSF for gamma-decay can be obtained by the use of models of asymmetric shapes with dependence of line spreading on excitation energy**

- **The energy dependence of parameter of line spreading ("width") is governed by complex mechanisms of nuclear dissipation&splitting (two-body collisions, strength fragmentation, deformation splitting) and contributions of different relaxation channels are still open problem**

- **Renewed values of GDR parameters with uncertainties should be used for more reliable description of gamma-transitions and studies of GDR properties**

Main conclusions

- Among other simple models, MLO approach potentially can lead to more reliable predictions of RSF for E1 gamma-transitions between c-c states because it is based on general relations between RSF and nuclear response function in hot nuclei

- To better understand role of the temperature and energy dependence of the RSF, experimental data, especially in low gamma-ray energy range, are needed as the functions of both gamma-ray and excitation energies

R.Capote, M.Herman, P.Oblozinsky, P.G.Young, S.Goriely, T.Belgya, A.V.Ignatyuk, A..J..Koning, S. Hilaire, V.A.Plujko et al.,
Nucl. Data Sheets 110 (2009) 310; http://www-nds.iaea.or.at/ripl3/

V.A.Plujko, R.Capote, O.M. Gorbachenko, **At.Data Nucl.Data Tables, 2010, in press**

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Dr. Ronald Schwengner **,**

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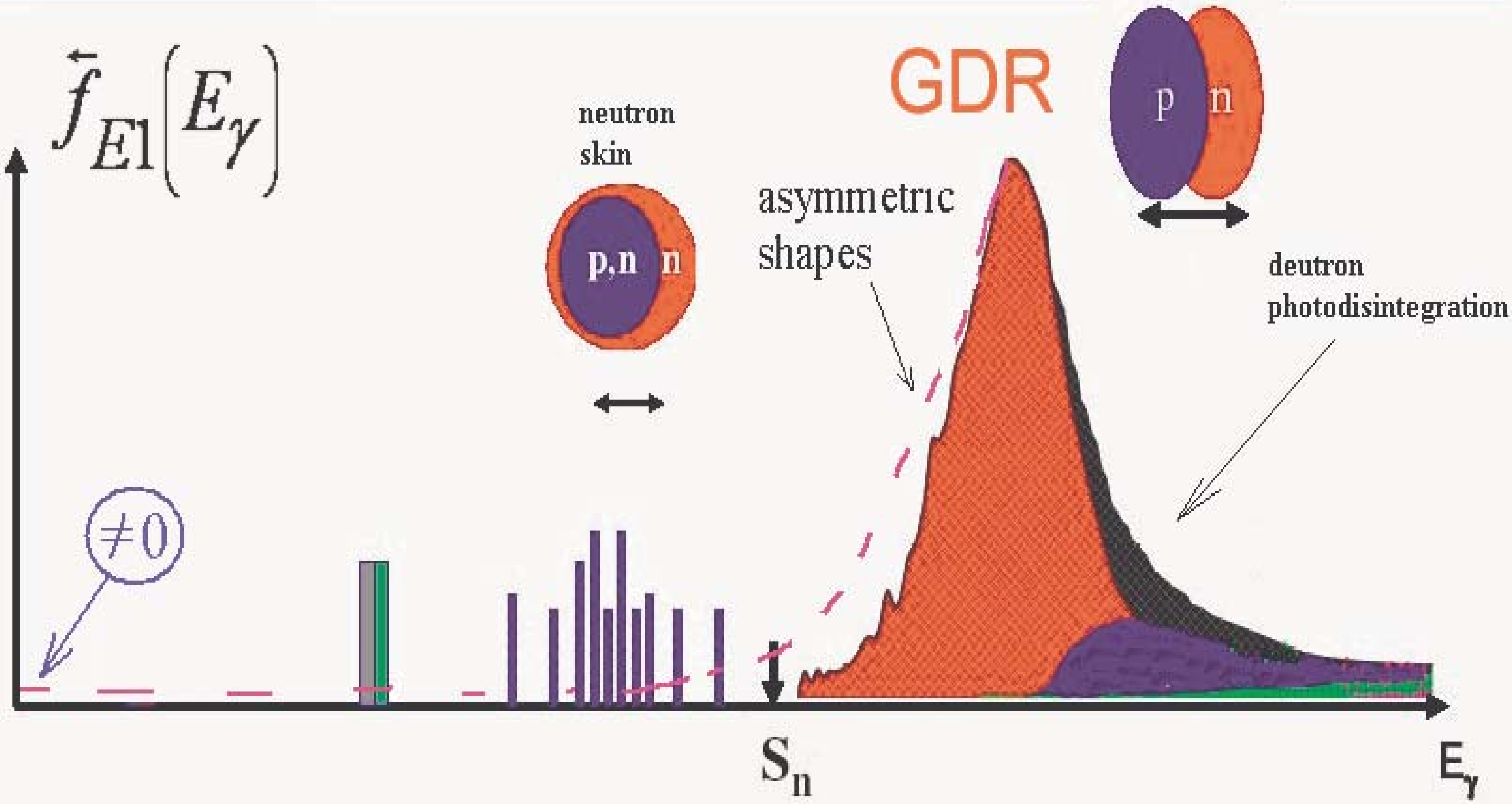
THANK YOU !!!

Main features of E1 RSF for gamma-decay



- Giant Dipole Resonance: E_γ ~ 12 -:- 20 MeV, ~ 100 % of IVEWSR (B(E1) ~ W.u)
- Pygmy Dipole Resonance: $E_\gamma \sim S_n$, E1 ~ 1 % of IVEWSR
- Two Phonon Excitation: E_γ ~ 4 MeV, B(E1) ~ 10^{-3} W.u.