MANIFESTATION OF THE FISSION DYNAMICS IN MUON-INDUCED PROMPT FISSION

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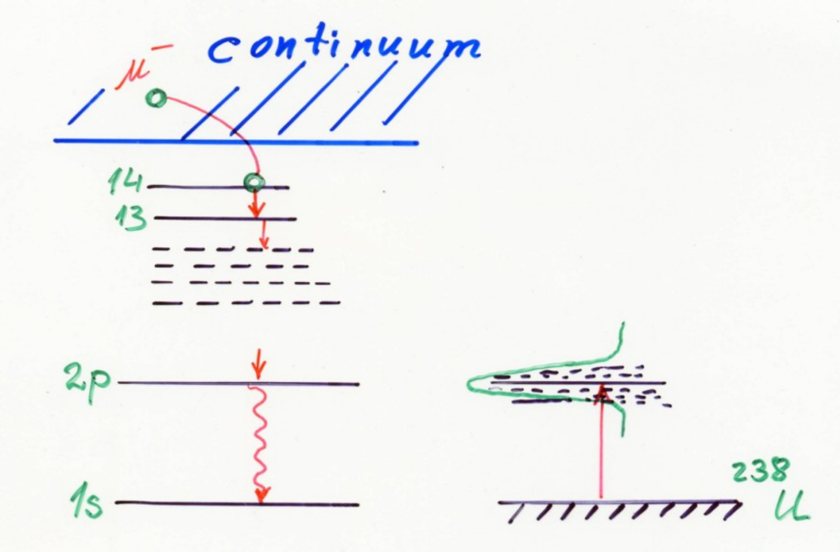
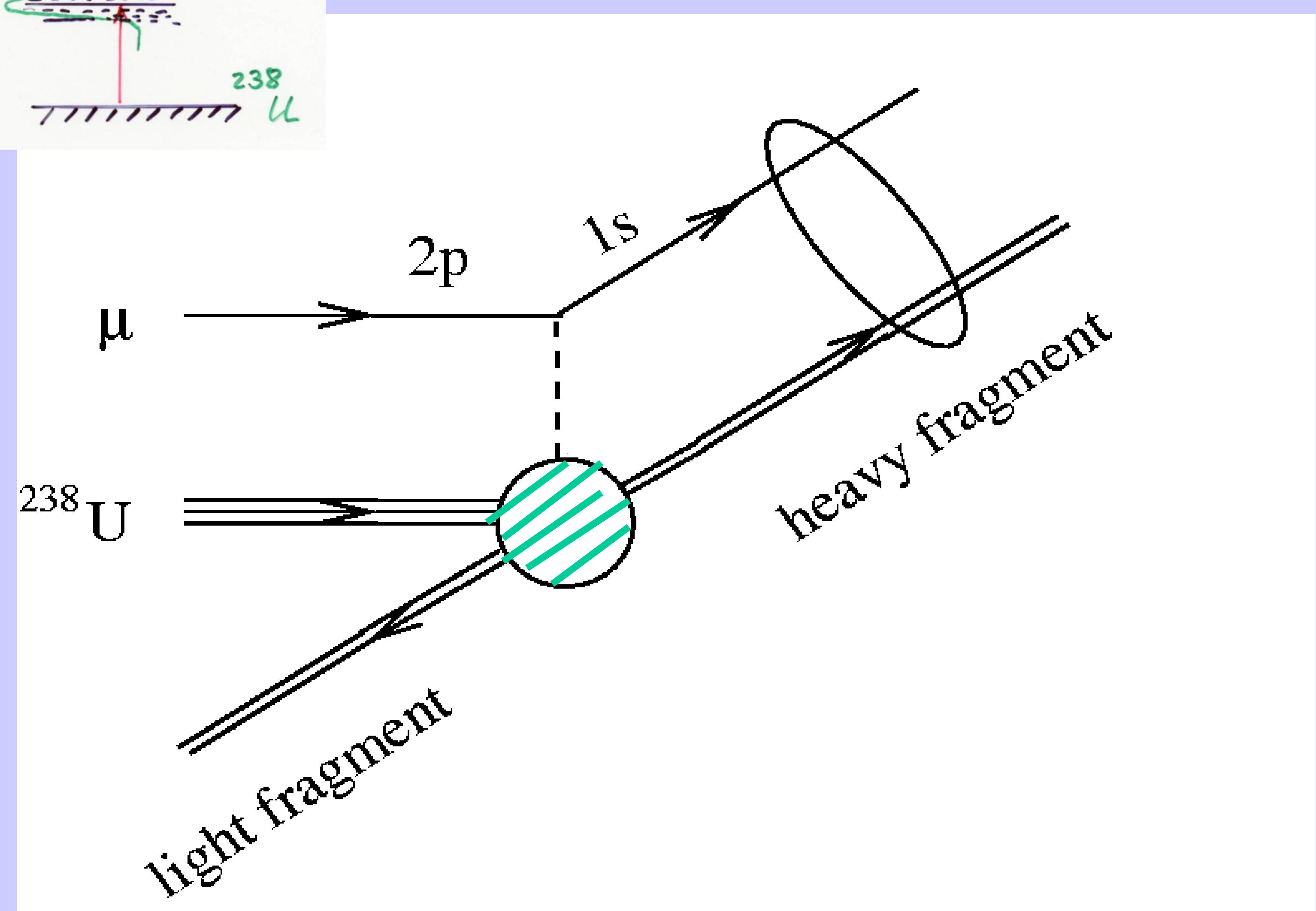
- In muonic atoms of ^{238}U, the nuclei can undergo prompt fission through non-radiative transitions of the muon: 2*p* – 1*s*, 3*p* – 1*s*, 3*d* – 1*s* etc. Main features of the fission dynamics are studied in prompt fission: augmentation of the barrier, dynamics of the saddle-to-scission descent, muonic conversion and characteristic X-rays from fission fragments supply information on the multipolarity of electromagnetic transitions and charge distribution, structure of nuclear transition currents. Revision of the non-radiative transition probabilities comprises the present purpose.

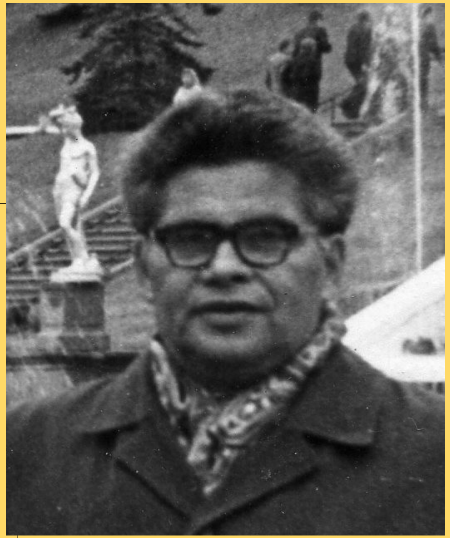


μ⁻
continuum
14
13
2p
1s
238
U



μ
2p
1s
238U
heavy fragment
light fragment

μ-Atom Transitions



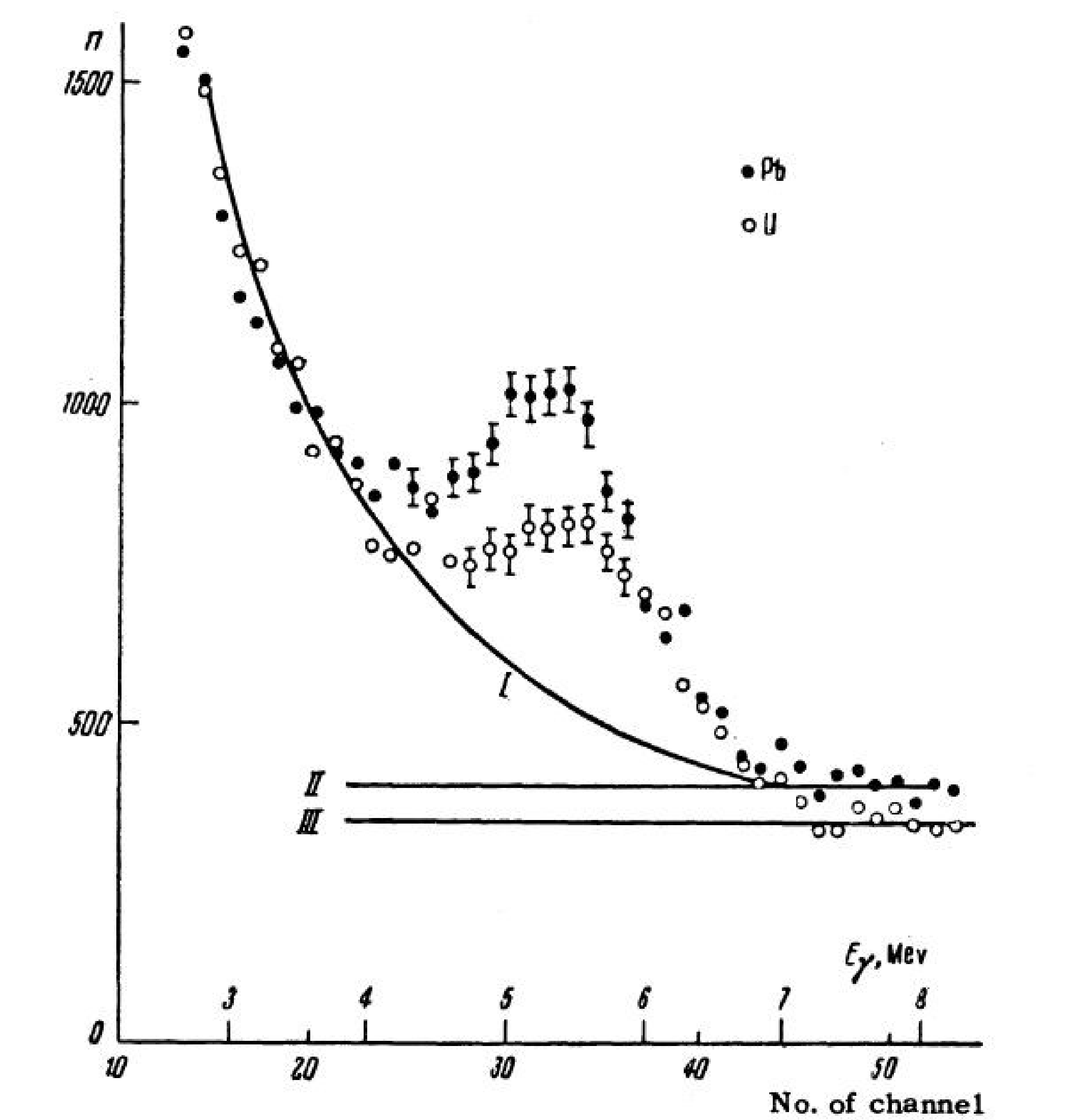
ый крестик, попробуйте удалить рисунок и вставить его заново.

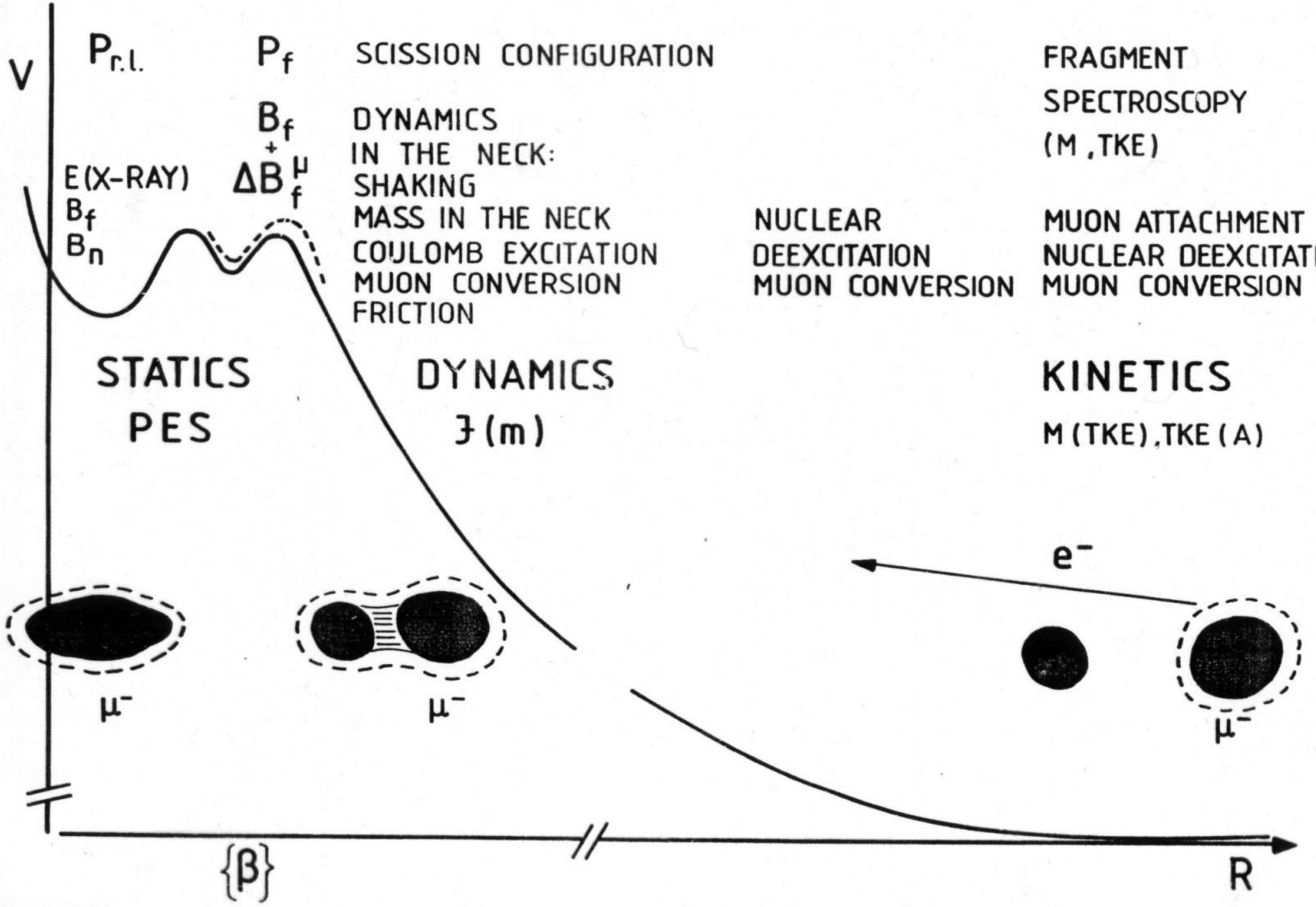
15%

NON-RADIATIVE TRANSITIONS IN MUONIC ^{238}U ATOMS

M.Ya.Balatz, L.N.Kondrat'ev, L.G.Landsberg, P.I.Lebedev, Yu.V.Obukhov, and B. Pontecorvo.

Soviet Phys. ZETP, **11**, 1239 (1960)




V
$P_{r.l.}$
P_f
SCISSION CONFIGURATION
FRAGMENT
SPECTROSCOPY
(M ,TKE)
B_f
+
ΔB_f^{μ}
DYNAMICS
IN THE NECK:
SHAKING
MASS IN THE NECK
COULOMB EXCITATION
MUON CONVERSION
FRICTION
E(X-RAY)
B_f
B_n
NUCLEAR
DEEXCITATION
MUON CONVERSION
MUON ATTACHMENT
NUCLEAR DEEXCITATION
MUON CONVERSION
STATICS
PES
DYNAMICS
Ӡ (m)
KINETICS
M (TKE), TKE (A)
e^-
μ^-
μ^-
μ^-
$\{\beta\}$
R

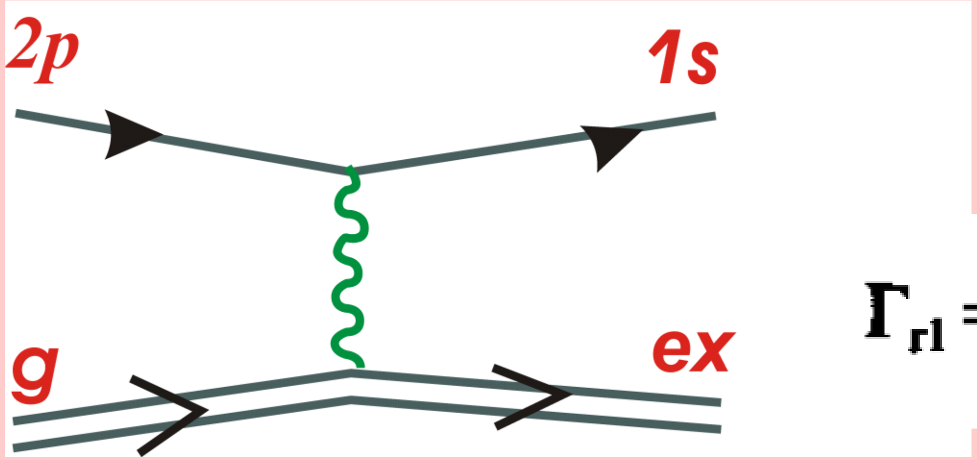
EXPERIMENTAL NON-RADIATIVE TRANSITION PROBABILITIES

Ch. Roesel, P. David, H. Folger, H. Haenscheid et al.
Radiationless transition probabilities in muonic 208Pb, 232Th, and 238U. Z. Phys. A - Hadrons and Nuclei **340**, 199-208 (1991)

	$2p \to 1s$	$2p^l \to 1s$	$2p^h \to 1s$	$3p \to 1s$	$3d \to 1s$
This work	26.2 ± 2.6	$21.6 \pm 3.2(1.6)$	$31.1 \pm 2.8(1.3)$	88.9 ± 4.3	12.8 ± 1.4
Zaretski & Novikov [2, 3]					
with σ_t from [27]	22.4	21.1	24.2	64.7	
with σ_t from [28]	29.8	28.4	32.0	68.5	
Teller & Weiss [7]	20.7	20.0	21.7	59	9.6
Karpeshin & Nesterenko [8]	$11 \div 15$ [a]			$55 \div 65$ [c]	$19 \div 24$ [e]
	$19 \div 26$ [b]			$57 \div 69$ [d]	$25 \div 32$ [f]

MICROSCOPIC NON-RADIATIVE TRANSITION PROBABILITIES

F F Karpeshin and V 0 Nesterenko,
J. Phys. B **17**, 705 (1991)



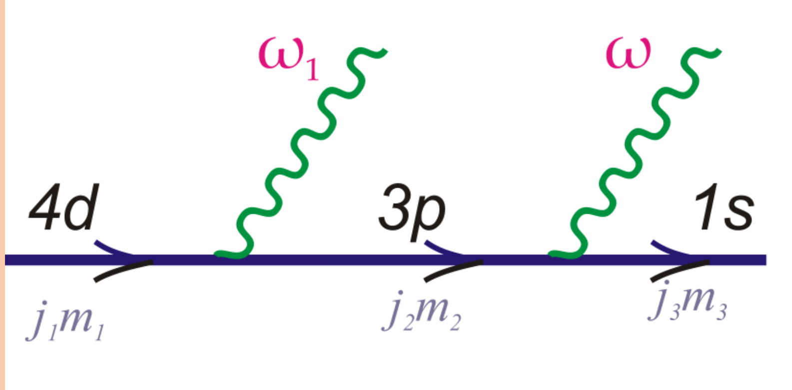
$$\Gamma_{r1} = \alpha_{\mu}^{(d)}(i \to f)\,\frac{8\pi(L+1)}{[(2L+1)!!]^2}\,\omega^{2L+1} b(\mathrm{E}L;0 \to \omega)$$

QPNM:

$$b(\mathrm{E}L;0 \to \omega) = \sum_{g} B(\mathrm{E}L;0 \to \omega)\,\frac{\Delta/2\pi}{(\omega-\omega_g)^2+(\Delta/2)^2}$$

Theory of nonradiative transitions

F.F. Karpeshin, I.M. Band, M.B.Trzhaskovskaya, M.A. Listengarten, Phys. Lett. B 372, 1 (1996).

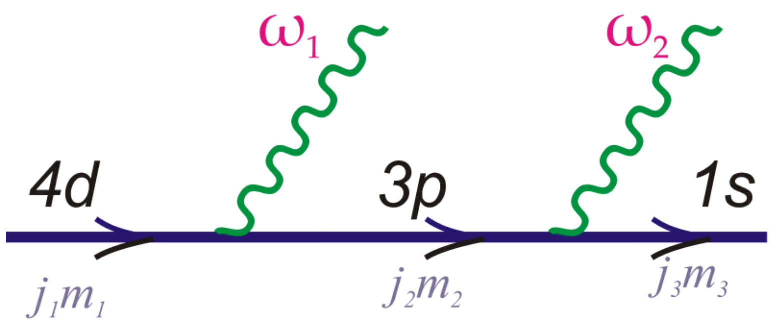


$$F_{nr} = \frac{C(I_2M_2\lambda\mu|I_1M_1)}{\sqrt{2I_1+1}}\frac{C(j_2m_2\lambda\mu|j_3m_3)}{\sqrt{2j_3+1}}\langle I_2j_2||H_c'(\lambda)||I_1j_3\rangle\frac{C(j_1m_1LM|j_2m_2)}{\sqrt{2j_2+1}}\langle j_2||H_\gamma'(L)||j_1\rangle$$

$$\frac{d\Gamma_{nr}(2\to3)}{d\omega_1} = \alpha_d(2\to3;\epsilon_1-\omega_1)\left(\frac{\omega}{\pi}\right)^2\sigma_{ph}(\omega)\frac{\Gamma_\gamma(1\to2;\omega_1)/2\pi}{\epsilon_1-\epsilon_2-\omega_1)^2+(\Gamma_2/2)^2}$$

$$\Gamma_{nr}(3p\to1s) = \alpha_d(2\to3;\epsilon_1-\omega_1)\sigma_{ph}(\omega)\left(\frac{\omega}{\pi}\right)^2\frac{\Gamma_\gamma^{(a)}(1\to2)}{\Gamma_2}$$

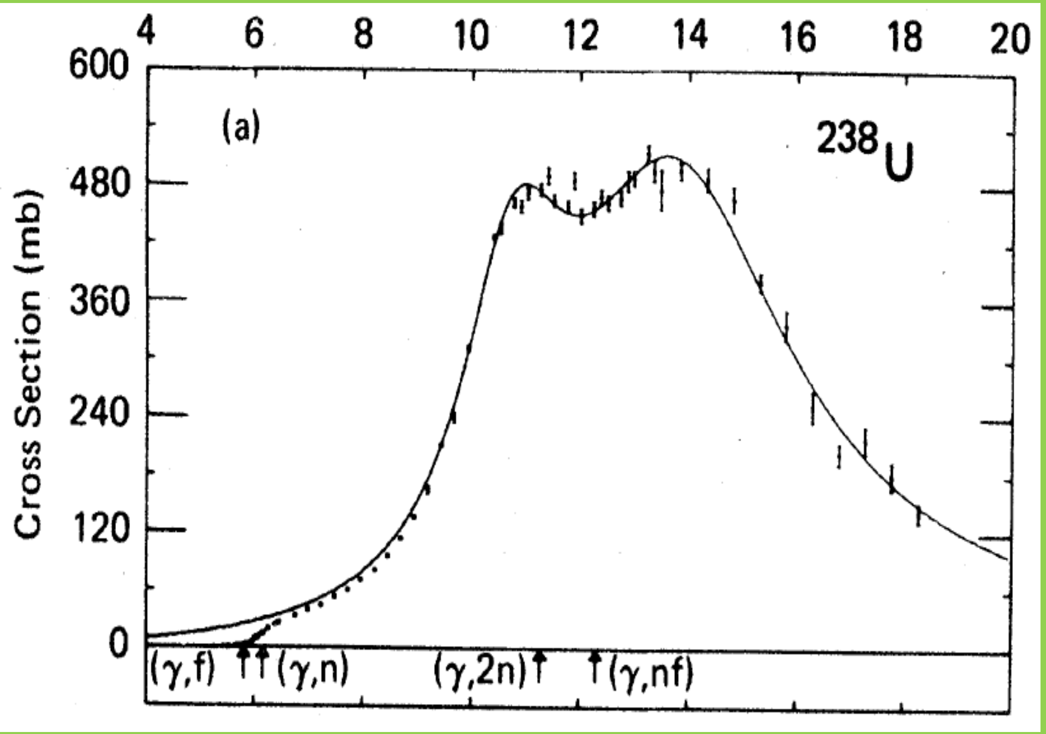
2-photon radiative width:



$$\Gamma_{2\gamma}(1-2-3) = \Gamma_\gamma^{(a)}(1\to 2)\frac{\Gamma_\gamma^{(a)}(2\to 3)}{\Gamma_2}$$

$$\frac{\Gamma_{nr}}{\Gamma_{2\gamma}} = \sigma_{ph}(\omega)\frac{\alpha_d(2\to 3;\omega_1)}{\Gamma_\gamma^{(a)}(2\to 3)}\left(\frac{\omega}{\pi}\right)^2$$

NON-RADIATIVE EXCITATION OF *GDR*



J. T. Caldwell et al. Phys. Rev. C **21**, 1215 (1980)

Transition	W_{nr}, %		$\Gamma_{nr}/\Gamma_{\gamma}^{(a)}$	
	theory	experim.	theory	experim.
$2p_{3/2} \rightarrow 1s$	31.6	31.1±2.8	0.46	0.45
$3p_{3/2} \rightarrow 1s$	80	88.9±4.3	3.95	5.49 – 13.7

CONCLUSION

- Prompt fission provides multilateral information about fission dynamics. We understand a lot of data results concerning $2p - 1s$ nonradiative transitions. Augmentation of fission barrier and suppression of the fission mode is of great interest.
- Former contradiction between theory and experiment for the $3p - 1s$ transition has been considerably smoothed. At the same time, such a factor like suppression of the fission decay channel in muonic atoms is not involved in the analysis. This channel comprises as much as 20% of the total decay width. Such ruling out a decay channel may increase the potoabsorption cross-section by the same factor. This also depends on the decay-to-spread width. Therefore, this circumstance remains challenging for future investigations.

Thanks!