Nuclear Structure Investigations in the Region of Transfermium Elements

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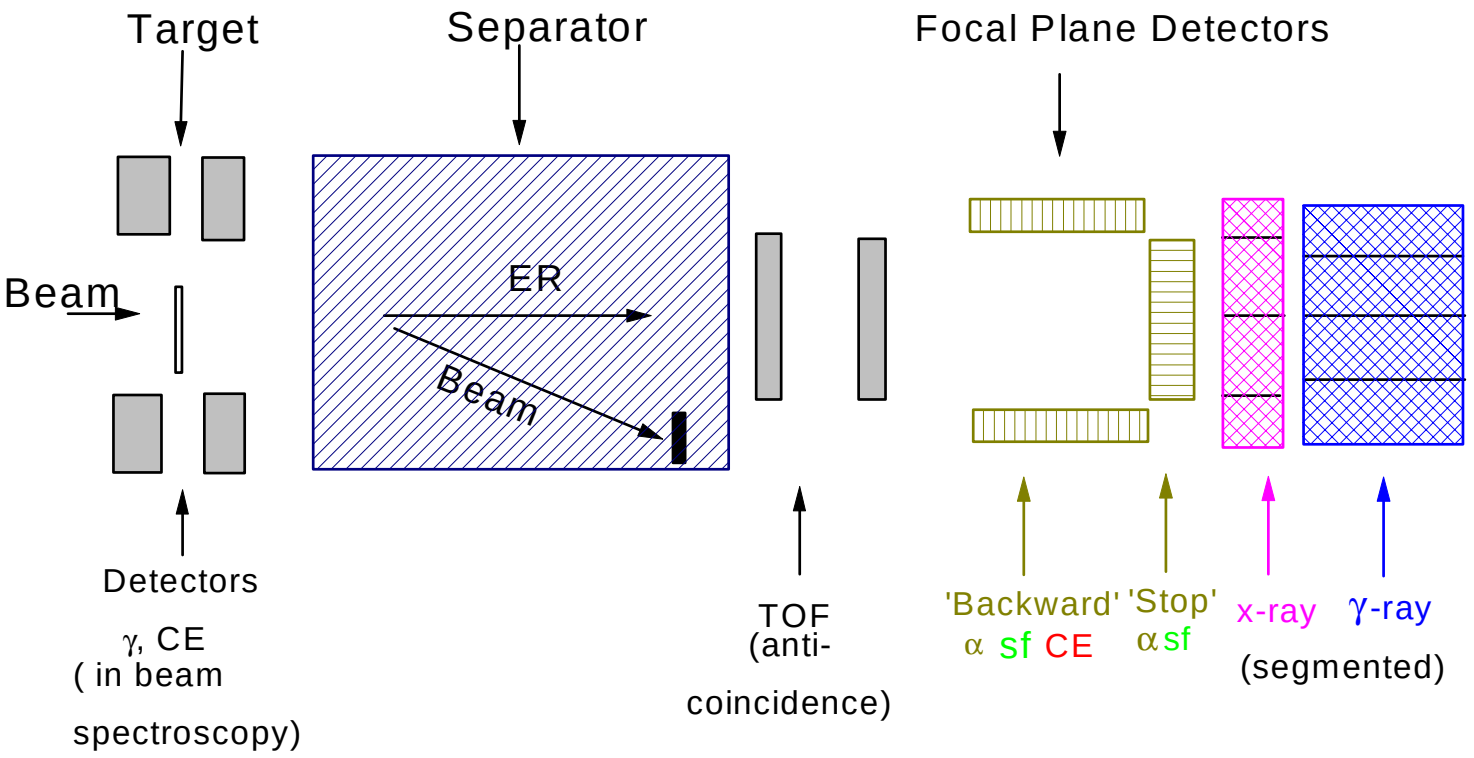
Why nuclear structure investigations ?

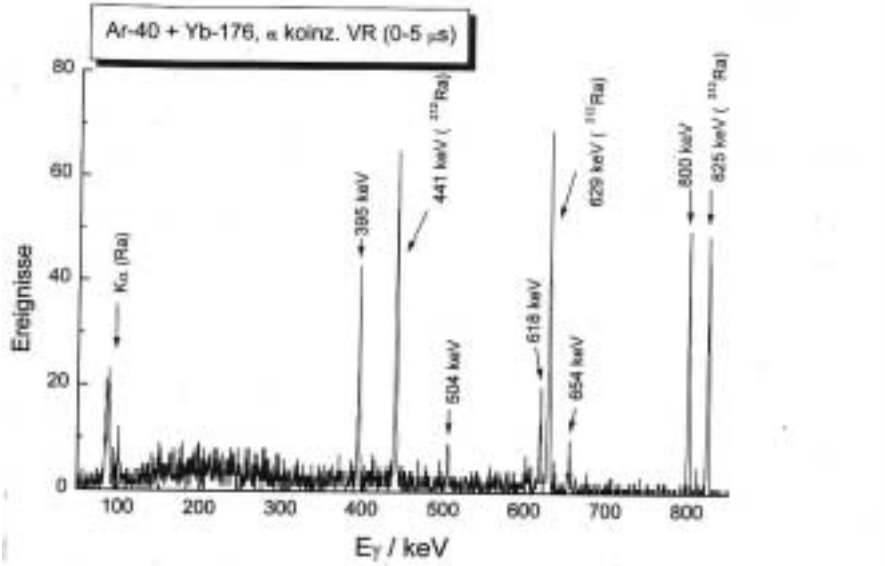
Detailed study of nuclear decay is stringest test for nuclear models !

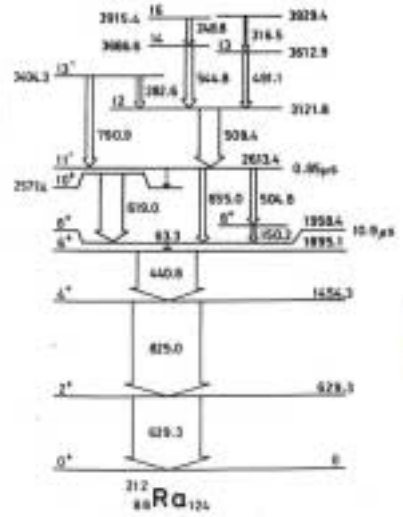
FPH - Folie 1

Experimental set-up for nuclear structure investigations

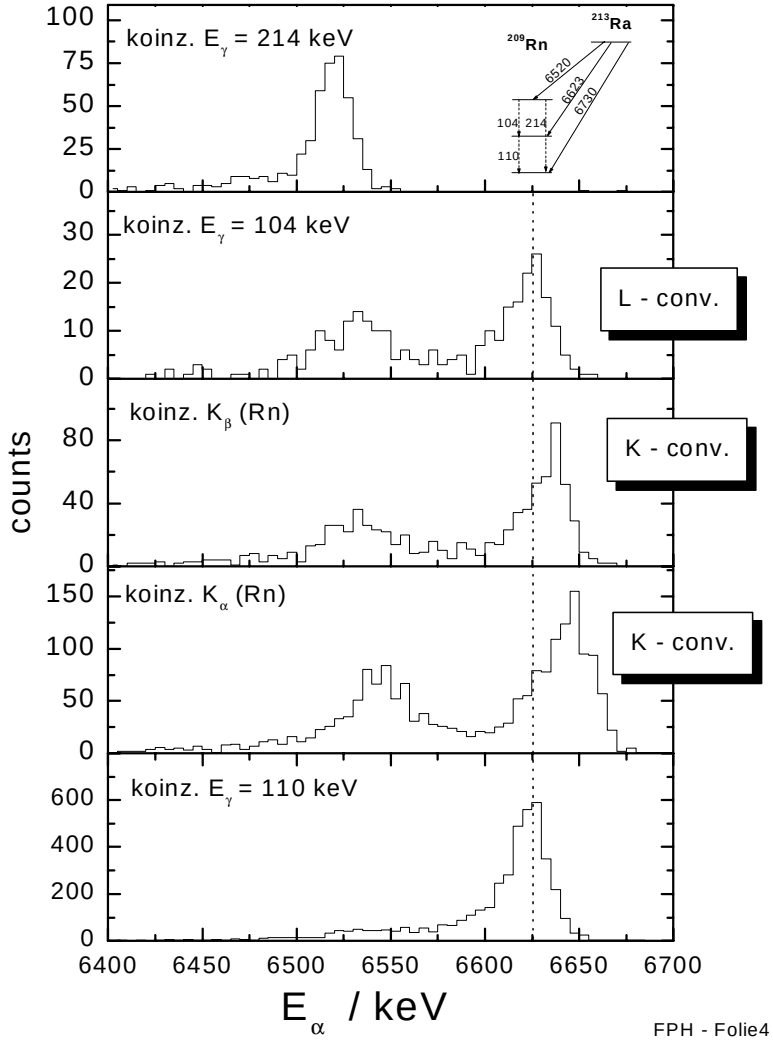


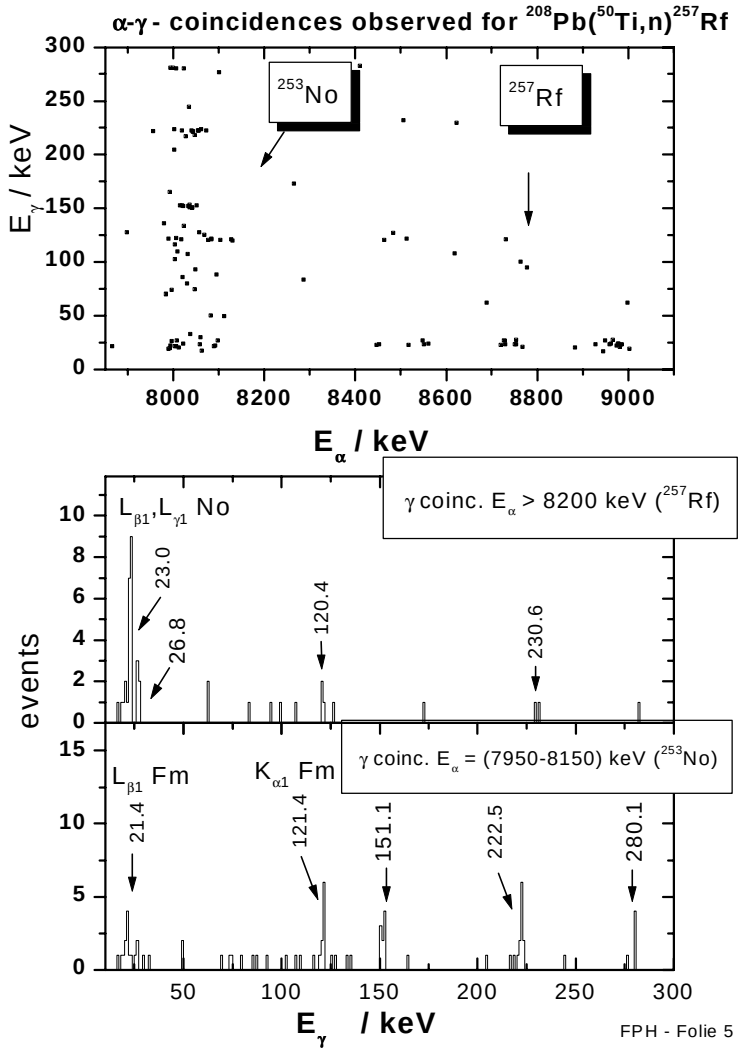
FPH - Folie 2



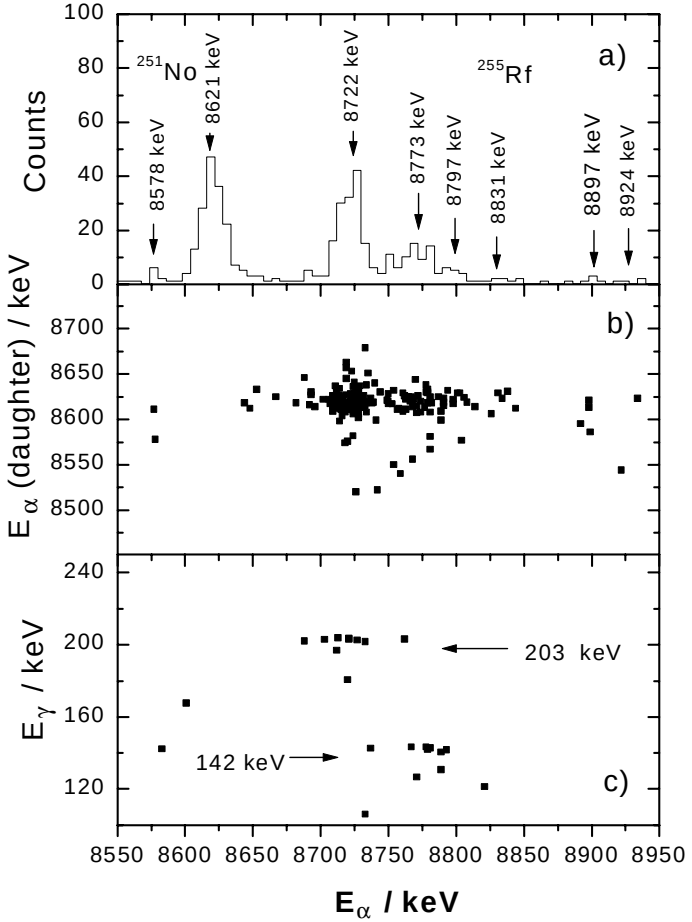


T. Kohno et al.
Phys. Rev. C 33,352 (86)


koinz. Eγ = 214 keV
213Ra
209Rn
6520
6623
6730
104
214
110
koinz. Eγ = 104 keV
L - conv.
koinz. Kβ (Rn)
K - conv.
koinz. Kα (Rn)
K - conv.
koinz. Eγ = 110 keV
counts
Eα / keV
FPH - Folie4

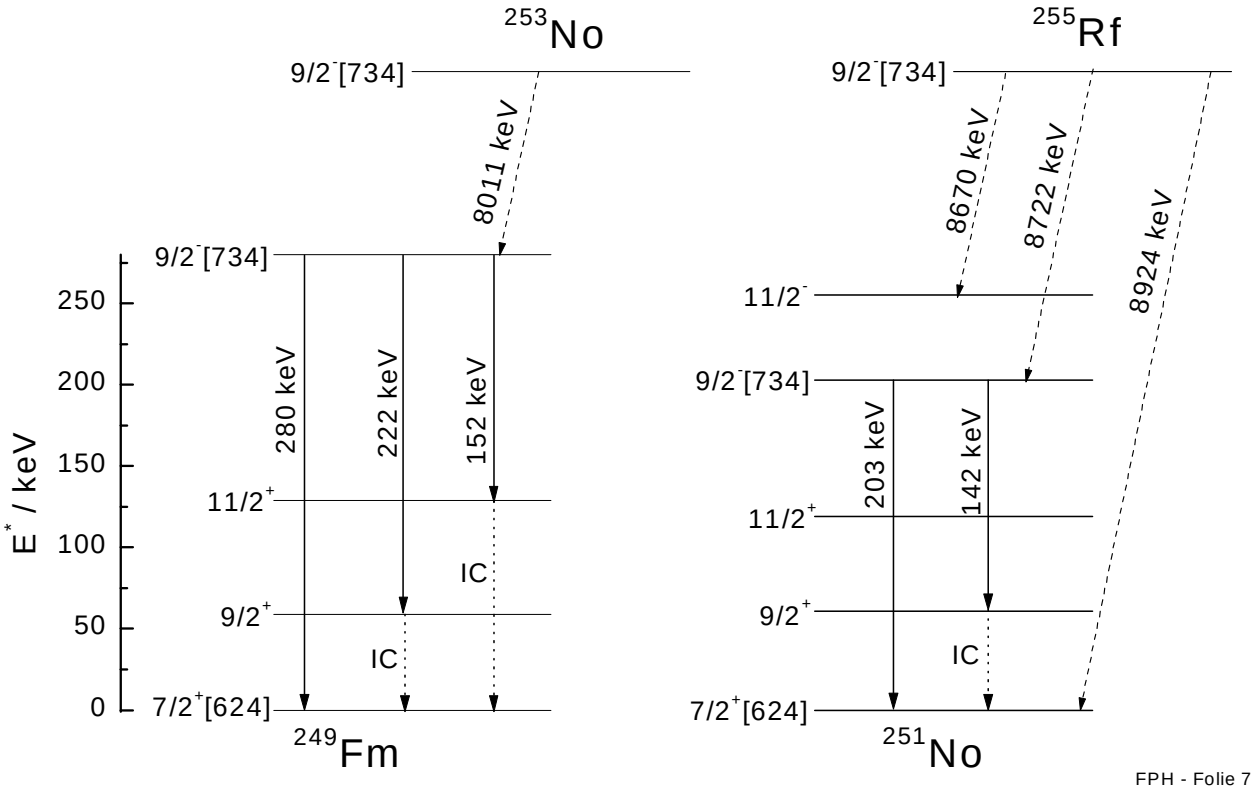

α-γ - coincidences observed for 208Pb(50Ti,n)257Rf
253No
257Rf
Eγ / keV
Eα / keV
γ coinc. Eα > 8200 keV (257Rf)
Lβ1,Lγ1 No
23.0
26.8
120.4
230.6
events
γ coinc. Eα = (7950-8150) keV (253No)
Lβ1 Fm
Kα1 Fm
21.4
121.4
151.1
222.5
280.1
Eγ / keV
FPH - Folie 5

α und α-γ - Spektren aus ^{50}Ti + ^{207}Pb

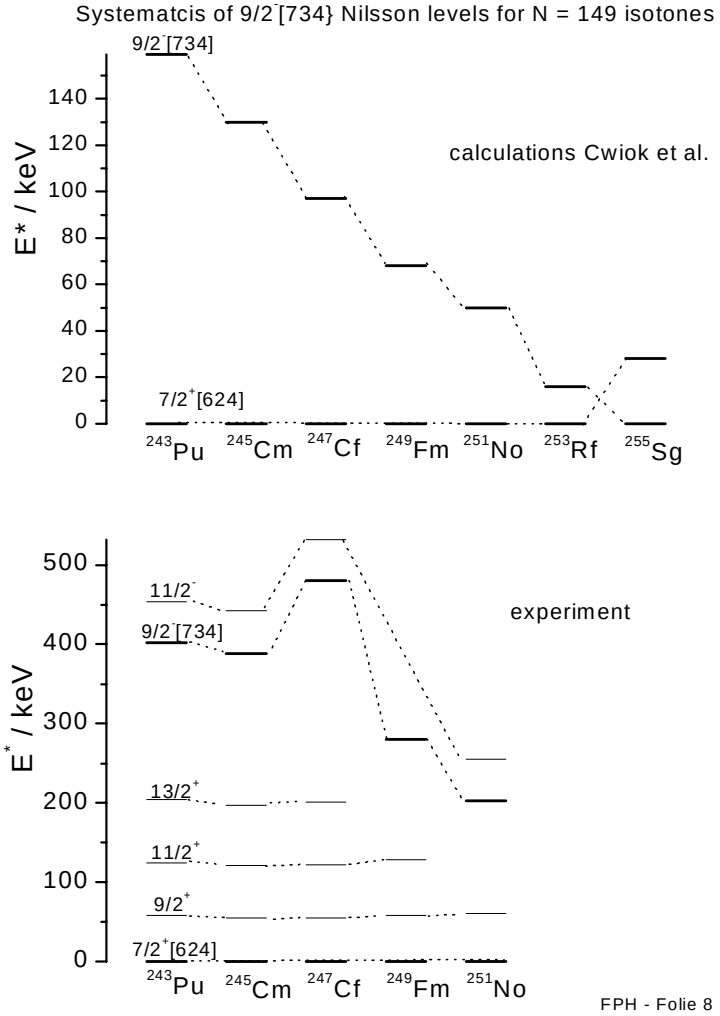


FPH - Folie 6

tentative decay schemes



FPH - Folie 7


Systematcis of 9/2[734} Nilsson levels for N = 149 isotones
9/2[734]
7/2+[624]
E* / keV
0
20
40
60
80
100
120
140
243Pu
245Cm
247Cf
249Fm
251No
253Rf
255Sg
calculations Cwiok et al.
11/2-
9/2-[734]
13/2+
11/2+
9/2+
7/2+[624]
E* / keV
0
100
200
300
400
500
243Pu
245Cm
247Cf
249Fm
251No
experiment
FPH - Folie 8

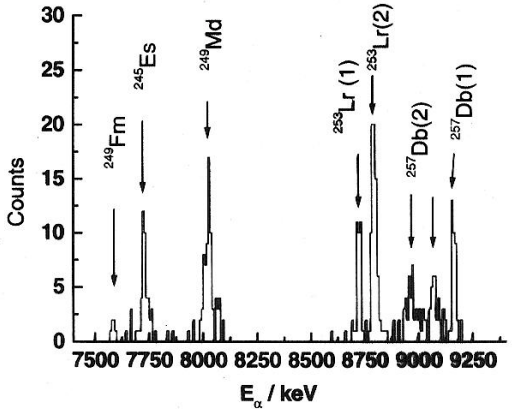
α - spectroscopic results from $^{209}Bi(^{50}Ti,2n)^{257}Db$

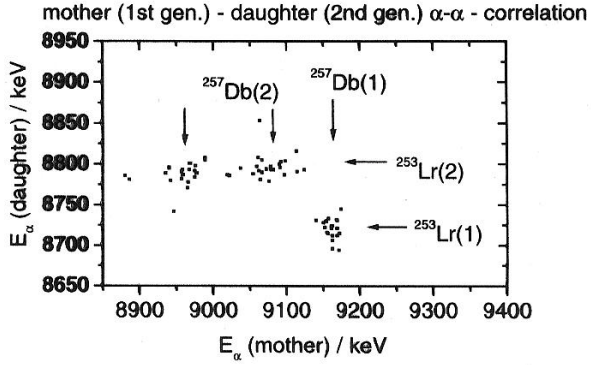
$^{257}Db(1)$: $E_\alpha = 9163 \pm 10$ keV $T_{1/2} = 0.76^{+0.15}_{-0.11}$ s

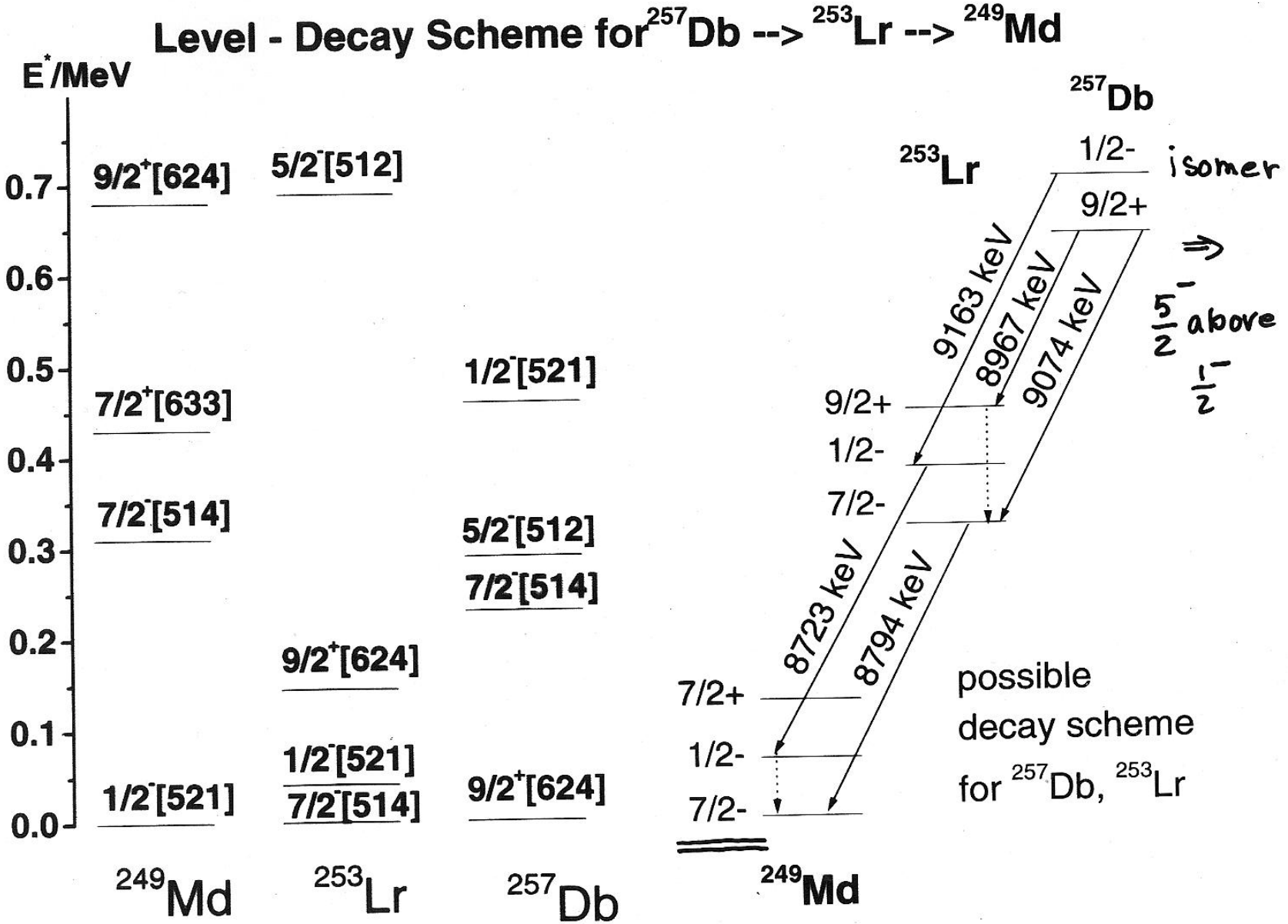
$^{253}Lr(1)$: $E_\alpha = 8723 \pm 10$ keV $T_{1/2} = 1.49^{+0.30}_{-0.21}$ s

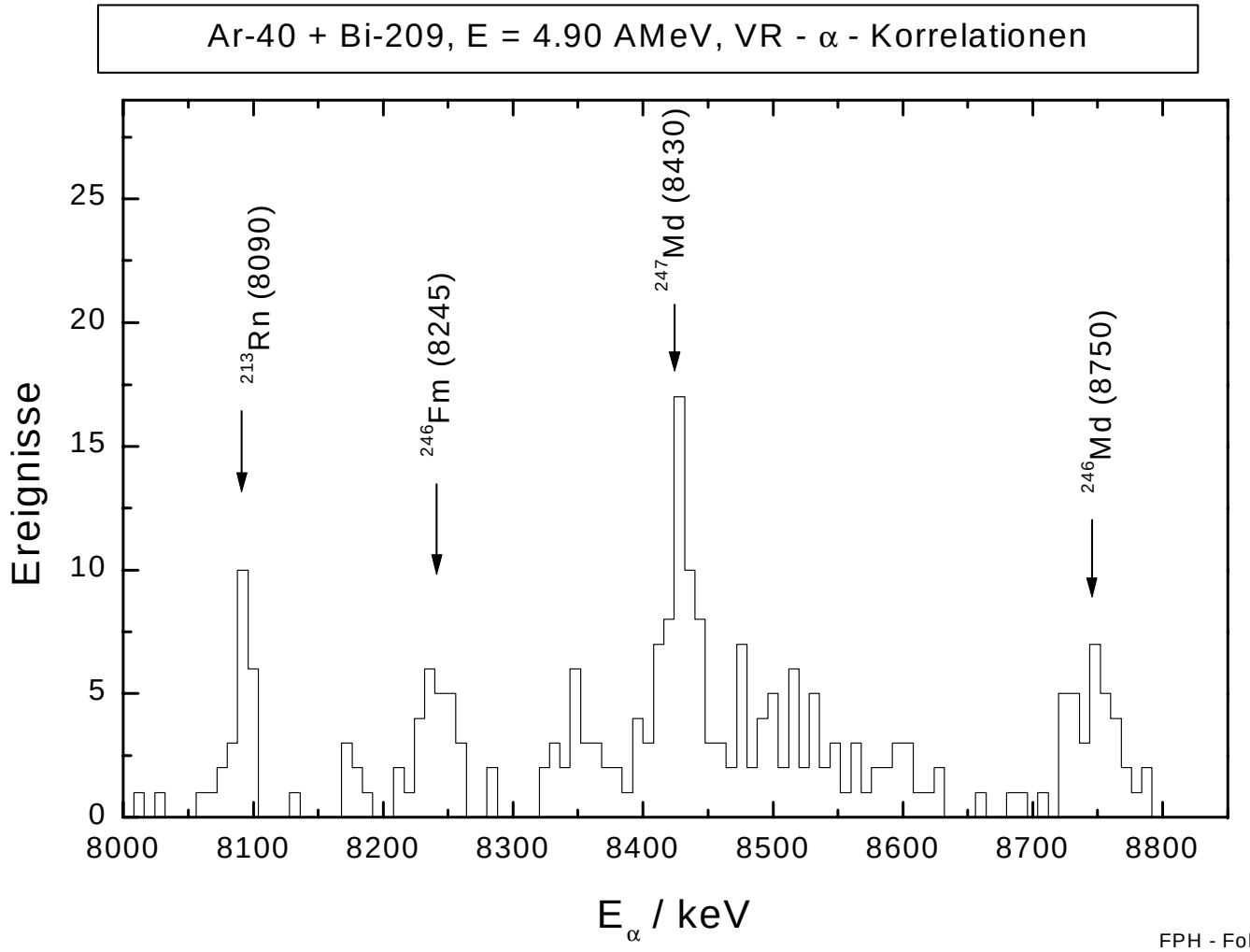
$^{257}Db(2)$: $E_\alpha = 9074 \pm 10$ keV (0.38), 8967 ± 10 keV (0.33) ...
$T_{1/2} = 1.50^{+0.19}_{-0.15}$ s

$^{253}Lr(2)$: $E_\alpha = 8794 \pm 10$ keV $T_{1/2} = 0.57^{+0.07}_{-0.06}$ s

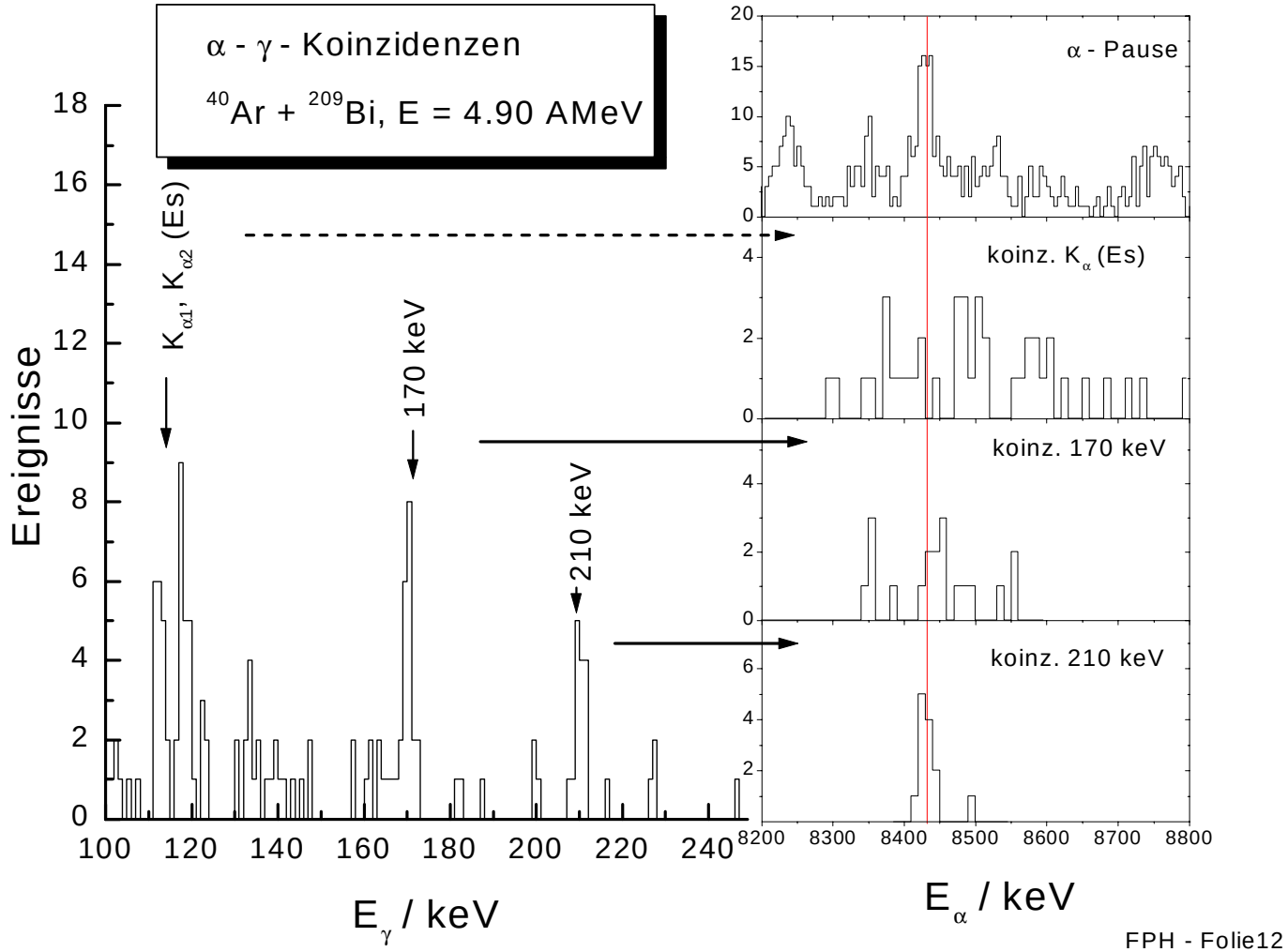





Level - Decay Scheme for 257Db --> 253Lr --> 249Md
E*/MeV
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
9/2+[624]
7/2+[633]
7/2-[514]
1/2-[521]
5/2-[512]
9/2+[624]
1/2-[521]
7/2-[514]
1/2-[521]
5/2-[512]
7/2-[514]
9/2+[624]
249Md
253Lr
257Db
257Db
253Lr
1/2- isomer
9/2+
9163 keV
8967 keV
9074 keV
⇒ 5/2- above 1/2-
9/2+
1/2-
7/2-
8723 keV
8794 keV
7/2+
1/2-
7/2-
249Md
possible
decay scheme
for 257Db, 253Lr

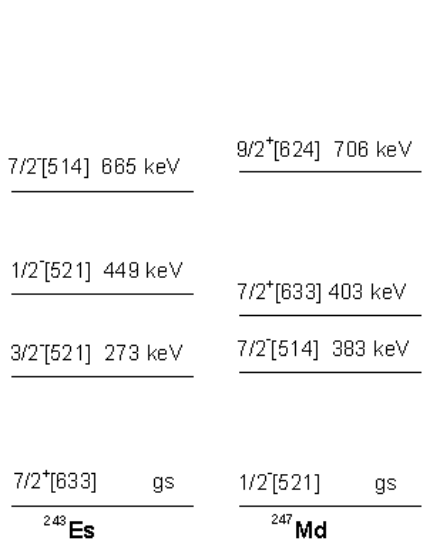

Ar-40 + Bi-209, E = 4.90 AMeV, VR - α - Korrelationen
Ereignisse
E_α / keV
213Rn (8090)
246Fm (8245)
247Md (8430)
246Md (8750)
0
5
10
15
20
25
8000
8100
8200
8300
8400
8500
8600
8700
8800

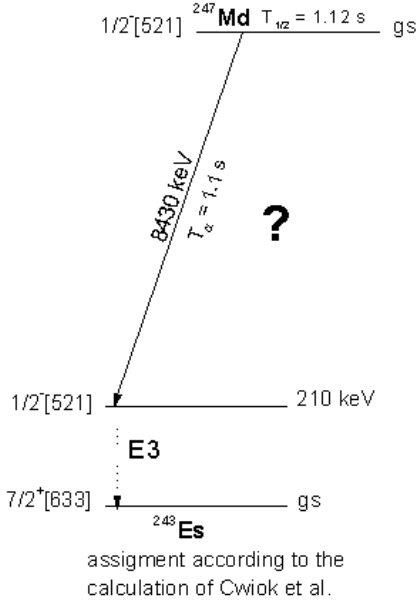
FPH - Folie 11


α - γ - Koinzidenzen
40Ar + 209Bi, E = 4.90 AMeV
Ereignisse
Eγ / keV
Kα1, Kα2 (Es)
170 keV
210 keV
α - Pause
koinz. Kα (Es)
koinz. 170 keV
koinz. 210 keV
Eα / keV

FPH - Folie12

Decay of ^{247}Md





Problems:

→ α - decay is unhindered, should connect equivalent Nilsson - levels 1/2⁻[521] (^{247}Md) -- α → 1/2⁻[521] (^{243}Es)

→ 1/2⁻[521] (^{243}Es) -- γ → 7/2⁺[521] (^{243}Es) should be E3

→ For E3, E_γ = 210 keV

→ $\alpha_k \approx 0.25$, $\alpha_L \approx 9$ (transition highly converted)

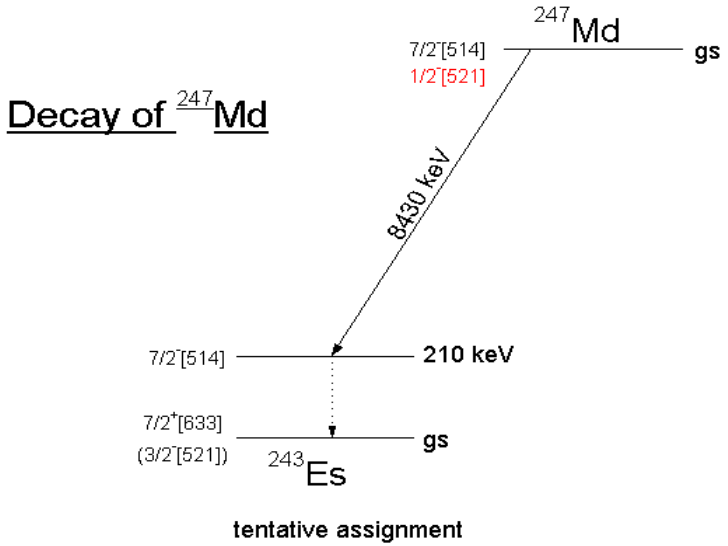
→ strong α - EC - sum line expected (at E ≈ 8640 keV)

→ Weisskopf - estimation for E3, E_γ = 210 keV

T ≈ 20 ms → isomeric state, no α - γ - coincidences

FPH - Folie 13

Preliminary Data



Possible transitions:

	Δl	π_i x π_f	Mult.	α_k	α_L
$1/2^- \rightarrow 7/2^+$	3	-1	E3	0.3	8.4
$1/2^- \rightarrow 3/2^-$	1	1	M1	4.3	1.0
$7/2^- \rightarrow 7/2^+$	0	-1	E1	0.1	0.02
$7/2^- \rightarrow 3/2^-$	2	1	E2	0.15	0.7

Experimental Limits for α_K, α_L

^{247}Md: E_α = 8430 keV (8410-8440) keV
^{247}Md + CE(K) (K-conv.): E = 8430 keV + ≈90 keV (8440-8550) keV
^{247}Md+ CE(L) (L-conv.): E = 8430 keV + ≈190 keV (8550-8650) keV (60%)

	E /keV	Σ(α-α)		Σ(γ,K-x)	
^{247}Md	8410-8440	17		10	
^{247}Md + CE(K)	8440-8550	18	$\alpha_K < 1.1$	14	$\alpha_K < 1.4$
^{247}Md + CE(L)	8550-8650	6	$\alpha_L < 0.6$		

(upper limits, contributions of ^{246}Md ignored !!!!)