Spectroscopic studies in $^{152-154}$Gd

S. Pelonis[1,*], T.J. Mertzimekis[1], A. Chalil[1], A. Zyriliou[1], P. Vasileiou[1], G. Zagoraios[1], D. Papaioannou[1], F. C. L. Crespi[2], A. Bracco[2], N. Florea[3], N. Marginean[3], L. Stan[3], A. Turturica[3]

[1] Department of Physics, National and Kapodistrian University of Athens, Zografou Campus, Athens, GR-15784, Greece
[2] Universita degli Studi di Milano and INFN sez. Milano, I-20122, Italy
[3] National Institute for Physics and Nuclear Engineering, Magurele, R-77125, Romania

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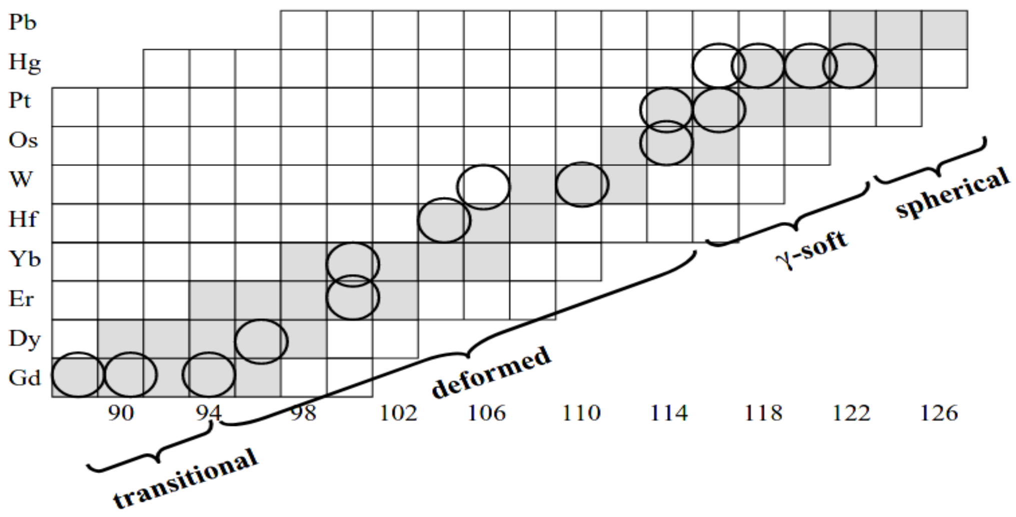
*Present Address: Department of Physics and Astronomy, KU Leuven

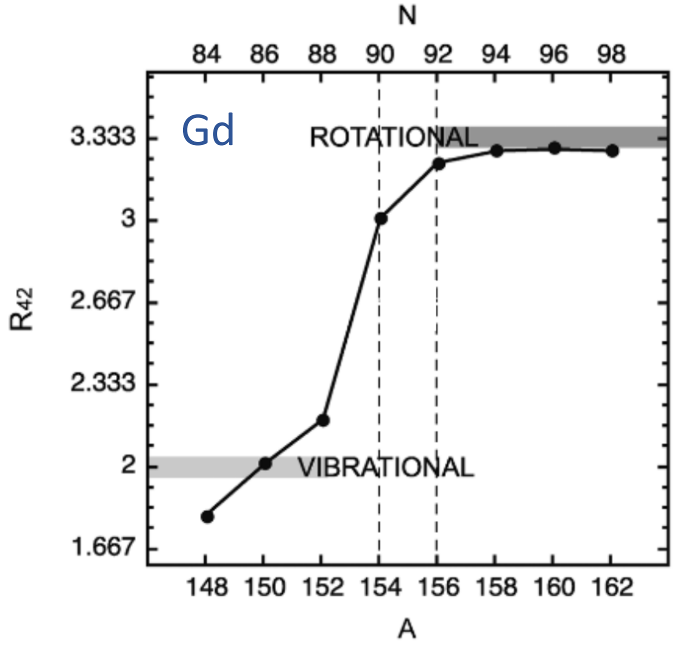
Motivation

The rare-earth region has been one of the main areas of research in Nuclear Physics, due to the rapid changes in collectivity observed in each isotopes.

The Gd isotopes are some of the most prominent nuclei in this region, but still lack necessary spectroscopic information, like cross-section measurements or branching ratios in deformed states.

In this work, we specifically studied $^{152\text{-}154}$Gd, since they are part of the sudden change in collectivity observed in Gd isotopes between 152≤A≤155.

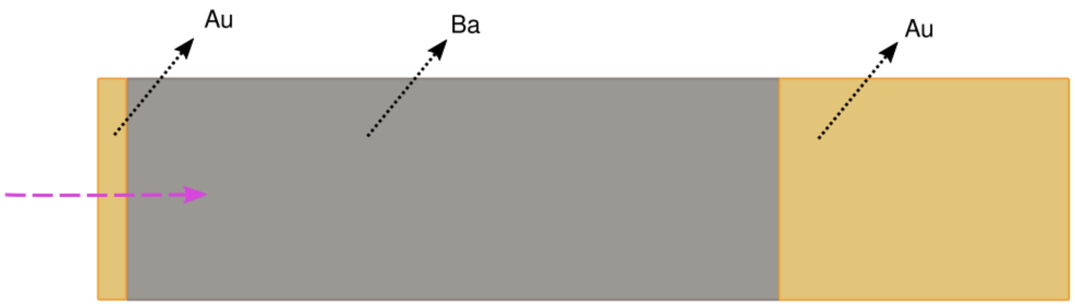




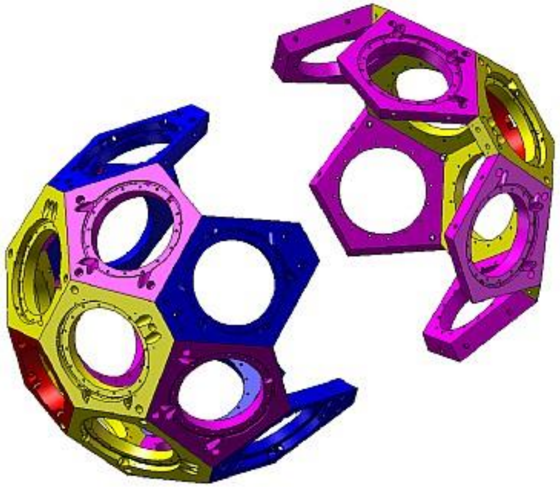
Experimental Setup

The experiment was conducted at the 9 MV Tandem at IFIN-HH in Romania, employing the ROSPHERE array equipped with 15 HPGe across 3 rings at 37^o, 90^o and 143^o.

A beam of ^{18}O was accelerated in the energy range of 61-67 MeV and interacted with a target of natural ^{138}Ba, covered with an Au foil from both sides, since Ba is a metal that oxidizes quickly.

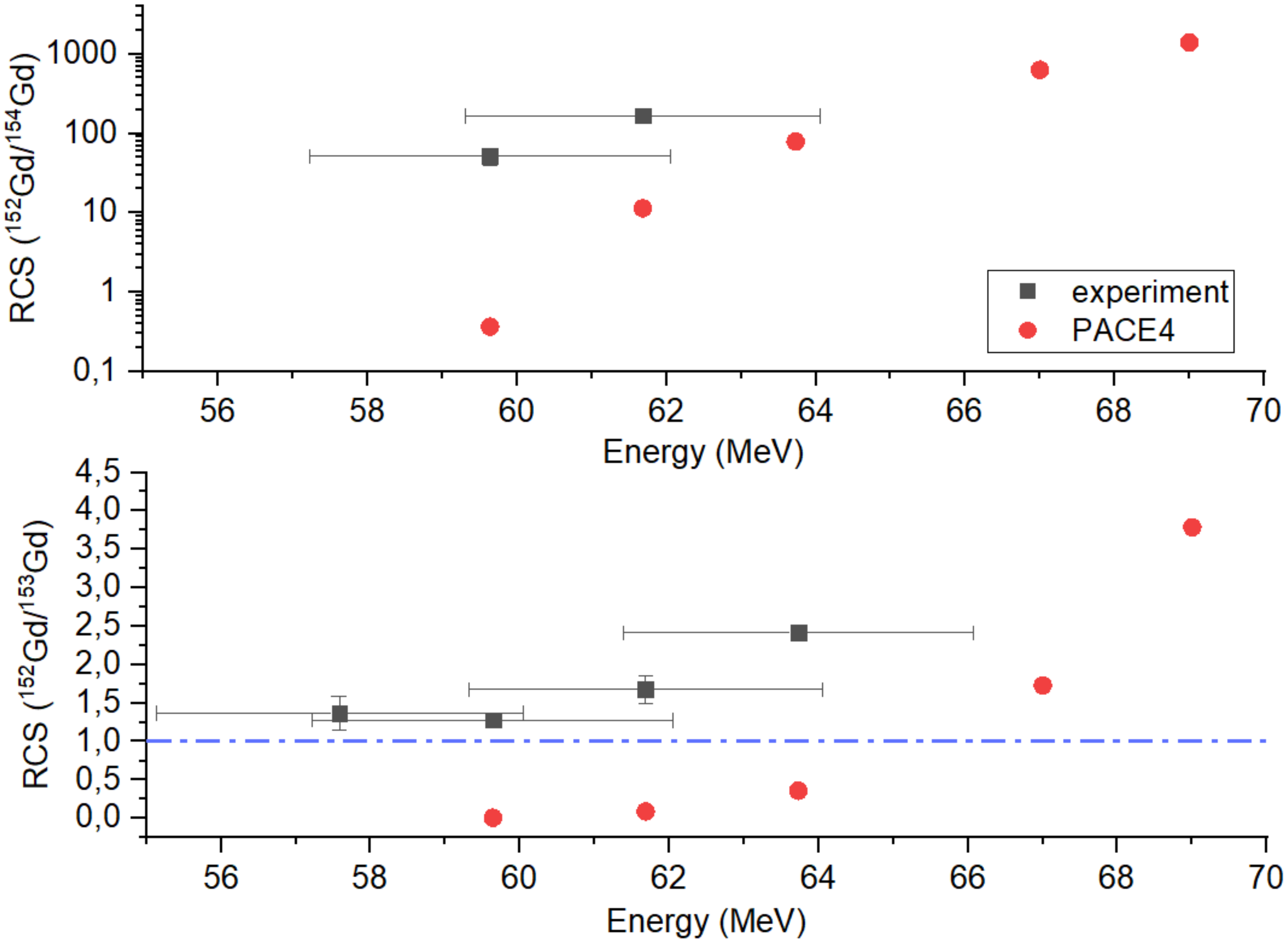


True-to-scale representation of the target



Results

Relative cross-sections:



The PACE4 algorithm is based on the Bass potential and has been proven to work only for energies above the Coulomb barrier and when the fission channel is small.

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Results

Branching rations in ^{152}Gd:

Transition	E_γ (keV)	Exp.	Lit.	Multipolarity
$4_2^+ \rightarrow 4_1^+$	526.88(5)	0.47(5)	0.512(15)	E0 + M1 + E2
$4_2^+ \rightarrow 2_2^+$	351.69(4)	0.53(7)	0.452(14)	E2
$4_2^+ \rightarrow 2_3^+$	172.1(4)	-	0.017(8)	[E2]
$4_2^+ \rightarrow 3_1^-$	159.16(16)	-	0.0184(21)	[E1]
$2_2^+ \rightarrow 2_1^+$	586.2648(26)	0.70(9)	0.800(9)	E0 + M1 + E2
$2_2^+ \rightarrow 0_{gs}^+$	930.50(4)	0.15(4)	0.128(3)	(E2)
$2_2^+ \rightarrow 0_2^+$	315.11(3)	0.15(5)	0.0703(15)	E2
$2_2^+ \rightarrow 4_1^+$	175.09(3)	-	0.0022(5)	[E2]
$11_1^- \rightarrow 10_1^+$	514.3	0.65(10)	0.65	D
$11_1^- \rightarrow 9_1^-$	483.1	0.35(7)	0.35	E2
$10_1^- \rightarrow 10_1^+$	589.9	0.65(19)	0.62	-
$10_1^- \rightarrow 8_1^-$	353.6	0.35(15)	0.38	-
$10_1^- \rightarrow 9_1^-$	558.0	-	-	-
$9_1^- \rightarrow 7_1^-$	451.1	0.86(14)	0.78	E2
$9_1^- \rightarrow 8_1^+$	584.6	0.14(4)	0.22	D
$6_2^+ \rightarrow 4_2^+$	385.9(1)	0.50(7)	0.83(5)	E2
$6_2^+ \rightarrow 6_1^+$	440.8(2)	0.22(6)	0.10(4)	(M1 + E2)
$6_2^+ \rightarrow 5_1^-$	197.4(3)	0.28(8)	0.07(1)	[E1]
$7_1^- \rightarrow 5_1^-$	410.0	0.44(12)	-	-
$7_1^- \rightarrow 6_1^+$	652.9(3)	0.56(15)	-	E1

PRELIMINARY

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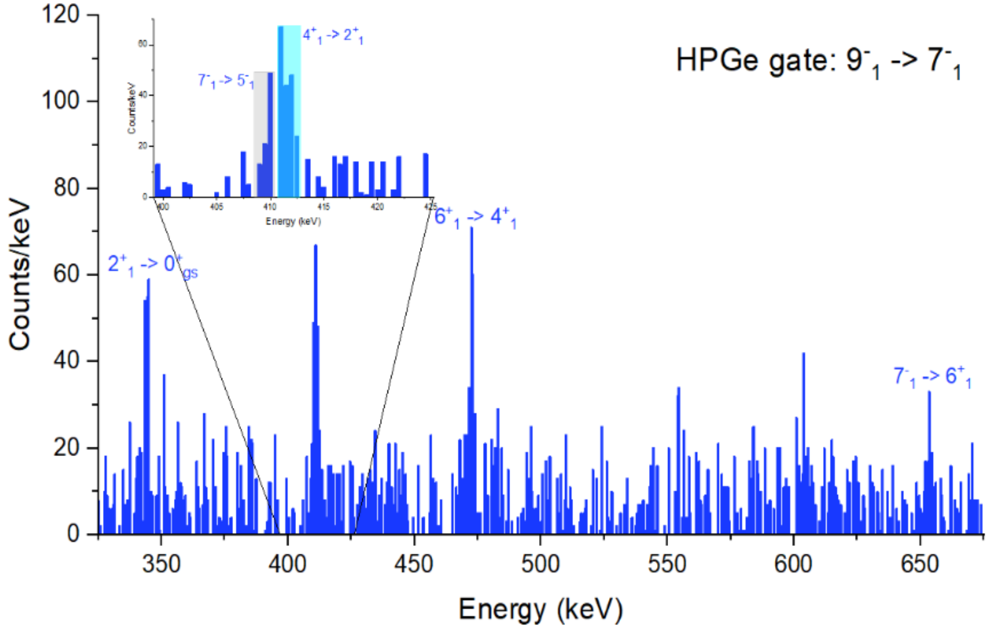
Branching rations in ^{153}Gd:

Transition	E_γ (keV)	Exp.	Lit.	Multipolarity
$\left(\frac{23}{2}^+\right) \rightarrow \left(\frac{19}{2}^+\right)$	460.0(2)	0.59(22)	0.53(4)	E2
$\left(\frac{23}{2}^+\right) \rightarrow \left(\frac{21}{2}^+\right)$	708.7(2)	0.41(25)	0.36(3)	D, Q
$\left(\frac{23}{2}^+\right) \rightarrow \left(\frac{25}{2}^+\right)$	241.7(5)	-	0.111(8)	(M1 + E2)



Conclusion

- A good agreement between current and previous experimental data has been established
- The PACE4 algorithm significantly underestimates the fusion-evaporation channel to ^{152}Gd for energies below the Coulomb Barrier
- This work reports on the first-ever experimental results for relative cross-sections in $^{152\text{-}154}$Gd
- New and updated values for branching ratios in ^{152,153}Gd have been extracted

References

[1] A. Khaliel *et al* 2019 *EPL* **128** 62001
[2] S. Pelonis et al. (in prep)
[3] S. R. Lesher et al. Phys. Rev. C **66** 051305
[4] S. Leoni et al. Phys. Rev. Lett. **118** 162502

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