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LETTER TO THE EDITOR

THE ^{164}Dy$(d,p)^{165}$Dy REACTION

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The ^{164}Dy$(d,p)^{165}$Dy reaction was investigated with very high resolution. The spectra were recorded with two sets of measurements, with $E_d = 14$ MeV at the angle of 45° and $E_d = 22$ MeV at 35°. The intensity ratio of these measurements is a measure for the transfered angular momentum Δl.

The nuclides ^{161}Dy and ^{163}Dy have been investigated some years ago with (n,γ), (d,p) and (d,t) reactions [1,2]. In order to complete these studies we performed the ^{164}Dy$(d,p)^{165}$Dy reaction with very high resolution. The purpose of these experiments is the understanding of odd deformed nuclides with the coupling of single particle and vibrational excitations. Previous information on ^{165}Dy was compiled in Ref. 3. A thorough (n,γ) measurement was done with the crystal spectrometers at ILL, Grenoble [4]. Our experiment was made at the Q3D spectrograph [5] of the Tandem Accelerator of the University of Munich and the Technical University of Munich.

The data were recorded partly with a long (4000 wires) and partly a short (576 wires) multiwire detector [6] (wire distance 0.5 mm), operated with a scintillation counter in coincidence. Two sets of measurements were performed, one with a deuteron energy of $E_d = 14$ MeV and at a laboratory scattering angle of 45° and one with $E_d = 22$ MeV and at an angle of 35°. The spectra were recorded in the range 0–1600 keV by taking several overlapping runs, since the detectors did not cover the whole energy range. The energies were calibrated using the level energies determined by gamma rays. The targets consisted of $^{164}Dy_2O_3$ of a thickness 33 $\mu g/cm^2$ on a carbon backing (thickness 4.1 $\mu g/cm^2$). The resolution was about 5–7 keV. The results are given in Table 1. In Fig. 1 the intensity ratios of the $E_d = 22$ MeV and $E_d = 14$ MeV measurements are shown for levels with known Δl–values as a function of energy. The figure indicates that the ratio is a measure for the Δl–value.

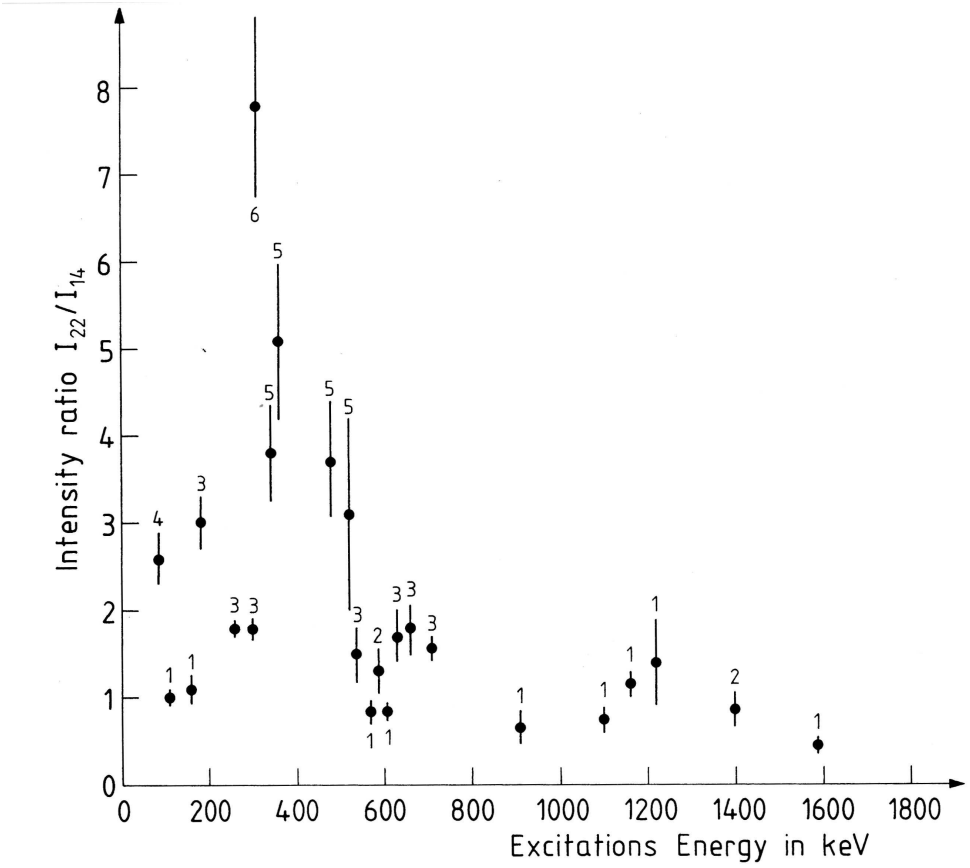

Fig. 1. Intensity ratio of the level population with 22 and 14 MeV deuterons as a function of excitation energy.

TABLE 1.
Levels populated in the $^{164}Dy(d,p)^{165}Dy$ reaction.

level energy[a] (keV)	intensity[b] I_{14} (MeV)	intensity[b] I_{22} (MeV)	intensity ratio I_{22}/I_{14}	Δl from other experiments [3]	level energy from [3,4] (keV)
–	< 0.5	< 0.5	–	4	0.0
83.44(16)	6.0(6)	15.4(1.1)	2.6(3)	4	83.386
108.13(10)	100(4)	100.0(2.4)	1.00(5)	1	108.155
158.73(16)	6.9(7)	7.5(8)	1.09(16)	1	158.589
180.8(3)[c]	15.4(1.3)[c]	46(3)[c]	3.0(3)[c]	3	180.923
184.9(5)[c]	6.3(1.0)[c,d]	5.0(2.2)[c,d]	0.8(4)[c,d]	3+6	184.254 +186.095
261.84(8)	98(3)	178(4)	1.82(7)	3	261.770
297.75(15)	40.7(2.2)	73(3)	1.79(12)	3	297.683
307.74(12)	6.3(8)	49.4(1.8)	7.8(1.1)	6	303.3
336.94(16)	3.2(4)	12.2(8)	3.8(6)	5	337.163
360.73(16)	3.1(5)	15.6(8)	5.1(9)	5	360.630
404.6(9)	1.2(3)	–	–	–	–
479.98(24)	1.48(25)	5.4(5)	3.7(7)	5	480.07
518.65(23)	1.9(6)	6.1(6)	3.2(1.1)	5	520.49
534.4(3)[e]	2.1(3)[e]	3.3(4)[e]	1.5(3)[e]	3(+2)	533.492 +538.634
572.6(3)[e]	9.5(6)[e]	8.2(6)[e]	0.86(9)[e]	1	570.265 +573.584
584.2(3)	3.1(6)	4.0(5)	1.3(3)	2	583.996
605.37(13)	117(6)	97(7)	0.83(7)	1	605.092
628.84(11)	11.4(1.1)	19.9(2.2)	1.7(3)	3	628.837
657.99(9)	17.1(1.2)	30(3)	1.78(23)	3	657.996
706.16(13)[f]	39.7(1.6)	61.9(2.3)[e]	1.56(8)[e]	3	702.892 +705.911
730.4(8)	0.9(4)	3.2(4)	3.4(1.6)	–	–
738.4(4)	2.1(4)	1.8(4)	0.88(24)[g]	3	737.855
771.4(4)	3.0(6)	1.2(3)	0.39(13)	–	–
785.2(8)	1.0(3)	0.55(24)	0.6(3)	–	–
803.2(5)	1.1(4)	3.6(5)	3.3(1.2)	–	803
818.8(5)	–	1.8(3)	–	–	–
834.5(8)	–	1.0(3)	–	–	–
877.2(5)	3.4(8)	1.9(4)	0.58(17)	–	–
911.9(4)	1.6(4)	1.0(3)	0.67 (24)	1	911.968
921.35(22)	4.1(7)	3.5(5)	0.85(18)	–	–
957.1(5)	–	1.8(3)	–	–	–
976.4(10)	–	0.7(3)	–	–	976.766
988.1(1.1)	1.8(7)	1.8(5)	1.0(5)	–	–
1031.6(9)	–	1.8(5)	–	–	–
1051.9(6)	–	7.4(7)	–	–	–
1064.9(6)	–	1.3(3)	–	–	–
1087.8(6)	–	1.4(3)	–	–	1088.007
1102.91(17)	8.0(1.0)	5.6(1.2)	0.74(17)	1	1103.042
1135.71(18)	3.7(6)	14.3(1.3)	3.8(7)	–	1135.814

TABLE 1.
Continuation

level energy[a] (keV)	intensity[b] I_{14} (MeV)	I_{22} (MeV)	intensity ratio I_{22}/I_{14}	Δl from other experiments [3]	level energy from [3,4] (keV)
1159.65(10)	56(3)	66(4)	1.18(10)	1	1158.116
1169.4(5)	5.5(9)	–	–	–	–
1174.3(9)	–	1.9(6)	–	–	1174.953
1197.1(5)	0.6(3)	1.9(4)	3.0(1.4)	–	–
1218.8(6)	1.7(4)	2.5(6)	1.4(5)	1	1218.350
1256.60(16)	5.6(4)	48(5)	0.86(12)	–	1256.498
1283.0(3)	5.5(1.8)	11.5(1.8)	2.1(7)	–	1283
1309.35(12)	77(6)	88(10)	1.14(15)	–	1309.296
1316.7(4)	3.9(1.2)	9.0(1.8)	2.3(8)	–	–
1327.7(7)	1.4(4)	2.4(1.0)	1.7(8)	–	–
1337.23(17)	75(12)	30(4)	0.40(8)	0,2	1337.091
1356.1(7)	–	2.9(9)	–	–	–
1380.75(14)	87(9)	78(13)	0.91(17)	–	1380.881
1384.29(24)	40(6)	43(11)	1.1(3)	–	–
1400.36(12)	46(4)	39(5)	0.83(13)	2	1400.269
1439.4(8)	2.8(4)	–	–	–	1440.458
1444.31(18)	11.0(1.0)	10.9(1.8)	1.00(19)	–	1444.726
1460.6(1.0)	–	2.1(1.0)	–	–	(1456.390 +1464.844)
1477.29(24)	4.6(5)	8.5(1.2)	1.8(3)	–	–
1500.39(25)	112(9)	62(7)	0.56(8)	–	1501.05
1509.9(4)	4.3(9)	4.7(1.0)	1.1(3)	–	–
1523.1(3)	3.6(4)	5.2(9)	1.4(3)	–	–
1535.18(21)	3.9(6)	5.6(1.0)	1.5(3)	–	–
1555.29(18)	147(13)	127(17)	0.86(14)	–	1555.41
1561.37(15)	65(6)	43(10)	0.66(17)	–	1560.07
1591.83(9)	190(17)	86(10)	0.45(7)	1	1591.77
1607.5(3)	5.6(9)	7.2(1.5)	1.3(3)	–	–
1621.8(3)	7.0(1.9)	6.9(1.6)	1.0(3)	–	1623.19
1643.71(18)	27(3)	40(5)	1.48(25)	–	–
1652.4(5)	–	15(3)	–	–	–

Footnotes to Table 1.

a) *Mean value obtained from all (d,p) measurements*

b) *Relative intensities I(108* keV*)= 100.*

c) *Multiplet structure; intensities and intensity ratios not quite reliable.*

d) *Possible contamination from the population of the level at 2127* keV *in* ^{164}Dy.

e) *Unresolved doublet.*

f) *Result from the 14* MeV *measurement only; result from 22* MeV *measurement is 705.25* keV*, probably because of the 703* keV *level ($\Delta l = 5$), which is expected to be populated stronger in the 22* MeV *measurement.*

g) *Intensity ratio does not match the Δl-value supposed for this level.*

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NUKLEARNA REAKCIJA ^{164}Dy$(d,p)^{165}$Dy

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Istraživana je nuklearna reakcija ^{164}Dy$(d,p)^{165}$Dy s visokom rezolucijom. Preliminarni spektri dobiveni su za dva niza mjerenja, s $E_d = 14$ MeV pod kutom od 45° i s $E_d = 22$ MeV pod kutom od 35°.