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VI–10 Calculations of Magnetic Properties in the Lead Region

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In this paper magnetic dipole and octupole moments as well as M1-, M2- and M4-transition rates are calculated for the odd mass nuclei ^{207}Pb, ^{207}Tl, ^{209}Pb and ^{209}Bi. The calculations are done using the linear response theory of finite Fermi systems.[1] The many-body matrix elements of the magnetic multipole operator A are obtained from the equation[1]

$$J_{12}(\Omega_{\alpha\beta}; A) = J^{w}_{12}(A) + \sum_{3,4} F^{w}_{1234} \frac{n_3-n_4}{\varepsilon_3-\varepsilon_4-\Omega_{\alpha\beta}} J_{43}(\Omega_{\alpha\beta}; A)$$

The subscripts of matrix elements and quasiparticle energies refer to single particle quantum numbers; n_3, n_4 are shell model occupation numbers; $\Omega_{\alpha\beta}$ is the transition energy. $J^{w}_{12}(A)$ represents the matrix ele-

Table I.

Core	State(s)		Energy	s.m.	exp	J^w	Theor
Dipolmoments							
Bi^{209}	$1h_{9/2}$		0. 0	2. 624	4. 08	3. 21	3. 974
	$1i_{13/2}$		1. 609	8. 793	8. 00±. 13	9. 09	8. 241
Pb^{207}	$3p_{1/2}$		0. 0	0. 637	0. 59	0. 510	0. 498
	$2f_{5/2}$		0. 570	1. 365	0. 79±. 03	1. 037	0. 840
	$3p_{3/2}$		0. 898	−1. 911	−1. 09±. 11	−1. 651	−1. 361
	$1i_{13/2}$		1. 633	−1. 911	−1. 00±. 03	−1. 851	−1. 172
Pb^{209}	$2g_{9/2}$		0. 0	−1. 911	−1. 33±. 06	−1. 771	−1. 432
Octupolmoment							
Bi^{209}	$1h_{9/2}$		0. 0	−0. 1472	−0. 55±. 03	−0. 275	−0. 582
M1–transition							
Bi^{209}	$2f_{7/2}$	$1h_{9/2}$	0. 897	···	1. 68*	···	0. 441*
	$2f_{5/2}$	$2f_{7/2}$	1. 925	2. 814	1. 19	2. 031	1. 000
	$3p_{3/2}$	$2f_{5/2}$	0. 294	···		···	
Tl^{207}	$2d_{3/2}$	$3s_{1/2}$	0. 351	···	26. 2*	···	2. 00*
Pb^{209}	$1i_{11/2}$	$2g_{9/2}$	0. 778	···		···	0. 046*
Pb^{207}	$3p_{3/2}$	$3p_{1/2}$	0. 898	1. 152	0. 37±. 09	0. 798	0. 483
	$2f_{7/2}$	$2f_{5/2}$	1. 770	1. 459	0. 38	1. 013	0. 507
M2–transition							
Pb^{209}	$1j_{15/2}$	$1i_{11/2}$	0. 644	254	33. 2	178	31. 6
M4–transition							
Tl^{207}	$1h_{11/2}$	$2d_{3/2}$	0. 990	1. 633	0. 305±. 025**	1. 269**	0. 273**
Pb^{207}	$1i_{13/2}$	$2f_{5/2}$	1. 063	1. 135	0. 245±. 08**	0. 799**	0. 250**

The units of all the momenta are $\mu_K \cdot \mathrm{barn}^{(L-1)}$, those of the transitions are $\mu_K \cdot \mathrm{fermi}^{2(L-1)}$.
* values quoted by an asterisk times 10^{-3}
** values quoted by two asterisks times 10^{6}

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ment of the effective operator associated with the external field A. It contains deviations from the shell model matrix elements being due to mesonic degrees of freedom and to configuration space truncation. Because of the long warelength of the external fields the effective operator $J^{w}(A)$ is approximated by a local operator. Besides effective g-factors for the spins and for the orbital motion there appears a $(Y_2\sigma)$-spin-polarization term. However the latter one is not taken into account in the numerical calculations. For a detailed treatment the reader is referred to ref. 2.

The renormalized particle-hole interaction F^{w} is the same as in the invited paper "Calculation of effective charges and g-factors with a density dependent residual interaction" by J. Speth.

For the numerical calculations 6 parameters (2 force parameters and 4 effective g-values) were varied in order to obtain an optimum overall fit of the 16 experimental data contained in Table I. With the exception of the magnetic moment of the g.s. of ^{207}Pb and of two forbidden M1-transitions the agreement between theory and experiment is very satisfactory. It is to be supposed that the three cited discrepancies can be removed, if the spin-polarization term $(Y_2\sigma)$ is included.

References

1) A. B. Migdal: *Theory of Finite Fermi Systems*, (Interscience Publ., New York, 1967).
2) R. Bauer, V. Klemt, P. Ring, J. Speth, E. Werner, T. Yamazaki: to be published.