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1) Magnetic moment

The magnetic moment μ of a particle is defined as the expectation value $<\mu_z>$ of the vector operator

$\vec{\mu}_{op} = g_1 \vec{j}_1 + g_2 \vec{j}_2$

where $\vec{j}_i$ is the angular momentum of particle i, and the total j is given by the sum $\vec{j} = \vec{j}_1 + \vec{j}_2$.

a) Show that the general expression holds for the g value $g_j = \mu / j$:

$2 g_j = g_1 + g_2 + (g_1 - g_2)\cdot\{ j_1 (j_1+1) - j_2 (j_2+1)\}/[j(j+1)]$

and specify it for $j_1 = l$, $j_2 =$ s (with s=½) und $j = l \pm ½$.

b) In the model of Schmidt, the magnetic moment results from the unpaired nucleon in an odd-even ug- or even-odd gu-nucleus, resp..

Give μ for the unpaired proton or neutron, resp. ($g_l = 1$, $\mu_p = 2.79\ \mu_k$ for the proton; $g_l = 0$, $\mu_n = -1.91\ \mu_K$ for the neutron) (the total angular momentum of this unpaired nucleon equals the total angular momentum of this nucleus as a whole).
Sketch the so-called „Schmidt-lines" (μ as a function of j from 1/2 up to 13/2).

2) Recoil

Following the thermal neutron capture of ^{10}B according to the reaction $^{10}B + n \rightarrow {}^{7}Li^* + \alpha + Q$ the excited $½^-$-level in ^{7}Li at 477 keV is populated (Q = 2.793 MeV). Calculate the Doppler shift of the γ–quantum being emitted in the direction or opposite to the emission of the α-particle. Show that the γ -emission is isotropic.
How large is the observable quadrupole moment of ^{7}Li in this $½^-$-level at 477 keV?