ENERGY SHIFTS OF GAMMA TRANSITIONS OBSERVED IN RESONANCE ABSORPTION OF GAMMA QUANTA IN CRYSTALS

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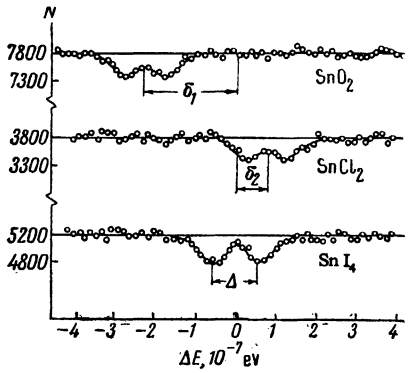
IN previous notes[1,2] we have reported an investigation of resonance absorption of gamma quanta in crystals (Mössbauer effect) for the 23.8-kev γ transition in Sn^{119}. In particular, it was shown that in a crystal of white metallic tin (β-tin) the emission and absorption lines are split into two components. According to our latest measurements the separation between these two components is $\Delta = (1.10 \pm 0.15) \times 10^{-7}$ ev.

In the present work, using a source of Sn^{119m} (white metallic tin) at liquid nitrogen temperature, we have obtained absorption spectra for absorbers prepared from different crystalline compounds containing tin (in the normal isotopic mixture): SnI_4 (~ 30 mg/cm^2), $SnCl_2$ (~ 60 mg/cm^2) and SnO_2 (5.3 mg/cm^2). For SnI_4 and $SnCl_2$, the measurements were done with the absorber cooled by liquid nitrogen; for the SnO_2 absorber, the cooling was not done since it did not give any significant increase of the effect. The dependence of the effective cross section for resonance absorption on the velocity of the source relative to the absorber was measured with the apparatus described briefly in an earlier report.[1] The absorption spectra obtained are shown in the figure (where N is the total number of pulses).

The spectra have the doublet structure which we also observed earlier for the $SnNb_3$ crystal.[1] This structure is caused by the splitting of the emission of the source, which we mentioned above. In addition to the doublet structure, for SnO_2 and $SnCl_2$ we also observed an energy shift of the absorption line. For the SnO_2 crystal, the energy shift is negative, $\delta_1 = -(2.4 \pm 0.3) \times 10^{-7}$ ev, while for the $SnCl_2$ crystal it is positive, $\delta_2 = +(0.72 \pm 0.10) \times 10^{-7}$ ev (if we choose as our reference point the energy of the absorption line for SnI_4, which corresponds to zero source velocity in the notation used on the figure). Relative shifts of lines in a source and absorber which are not chemically identical and which are at different temperatures may be due to various causes.[3]



The shifts observed by us can be explained by assuming that the energies of the states between which the transition occurs include an interaction between the nucleus and those electrons which have a nonzero wave function in the region of the nucleus. This interaction depends on the charge distribution in the nucleus, and can differ by an amount ΔE for two different states of the nucleus. Thus the energy of the emitted quantum can be written as $E = E_0 + \Delta E$, and the experimentally observed shifts must be due to the difference in ΔE for the different crystalline compounds. A theoretical computation of such shifts would enable us to obtain additional information concerning the distribution of charge in the nucleus.

[1] Delyagin, Shpinel', Bryukhanov, and Zvenglinskii, JETP **39**, 220 (1960), Soviet Phys. JETP **12**, 159 (1961).

[2] Delyagin, Shpinel', Bryukhanov, and Zvenglinskii, JETP **39**, 894 (1960), Soviet Phys. JETP **12**, 619 (1961).

[3] O. C. Kistner and A. W. Sunyar, Phys. Rev. Letters **4**, 412 (1960).

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ON THE ENERGY DEPENDENCE OF THE SCATTERING CROSS SECTION AT SMALL ENERGIES

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F. L. Shapiro[1] has shown that the first two terms in the expansion of the total inelastic cross section