MAGNETIC MOMENT OF THE 23.8-keV *EXCITED STATE OF* Sn^{119}

V. A. BRYUKHANOV, N. N. DELYAGIN, and V. S. SHPINEL

Nuclear Physics Institute, Moscow State University

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The magnetic moment of the 23.8-keV excited state in Sn^{119} was measured using the method of resonance absorption of γ quanta. The resonance absorption spectrum was obtained using a source of Sn^{119m} in tin dioxide and an absorber in the form of the alloy with iron (1.7% tin). A value of 0.75 ± 0.04 nuclear magnetons was found for the magnetic moment. The magnetic field acting at the tin nucleus in the alloy was 68 ± 2 kOe.

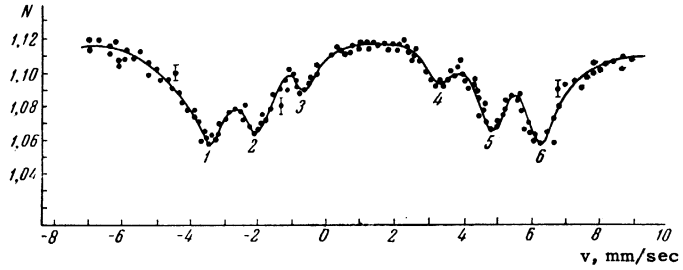
THE first measurements of resonance absorption spectra for the 23.8-keV γ quanta from Sn^{119} for the case of magnetic splitting were carried out[1,2] by applying an external field to the absorber. The magnitudes of constant fields attainable in the laboratory were not sufficient to give well-resolved absorption spectra and a reliable determination of the magnetic moment of the 23.8-keV excited state of Sn^{119}. Much larger magnetic fields can be gotten at the tin nuclei if one uses ferromagnetic alloys of tin (with iron or manganese) as the source (or absorber) of the γ quanta.

Such ferromagnetic alloys have been used recently to investigate the nuclear Zeeman effect in Sn^{119}. Hanna, Meyer-Schützmeister, Preston, and Vincent[3] used alloys of tin with manganese corresponding to the composition of the compound Mn_2Sn; they found a value of 0.78 ± 0.08 n.m. for the magnetic moment of this state in Sn^{119}. Boyle, Bunbury, and Edwards[4] found the value 0.83 ± 0.03 n.m. by a similar method. Kistner, Sunyar, and Swan[5] obtained a well-resolved spectrum using an alloy of tin and iron containing 4% tin; their value for the moment was 0.672 ± 0.025 n.m. This result agrees with the value of Hanna et al,[3] but differs from that found in [4].

In the present work we have undertaken to repeat the measurement of the nuclear Zeeman effect of Sn^{119} using the method of Mössbauer absorption. The absorbers were alloys of tin and iron (tin content 1.7—40 wt %) and tin with manganese (Mn_2Sn). The source for all the measurements was the dioxide SnO_2 containing the Sn^{119m} isomer. The characteristics of the source have been given in an earlier paper.[6]

Preliminary measurements of resonance absorption spectra were done with an arrangement for varying the absorber velocity linearly with time. These measurements showed that both for the Mn_2Sn alloy and the iron-tin alloys with tin content up to 10% one obtains spectra with well-resolved magnetic splitting components. For iron-tin alloys with a higher tin content, resolved spectra were not observed because of the reduction in the magnetic field acting at the tin nucleus and also because such alloys are apparently a mixture of different phases. To measure the magnetic moment, one must select an alloy with a sufficiently large internal magnetic field, without impurities and without any significant influence of quadrupole interaction in the crystal. These conditions are satisfied by the tin-iron alloy containing 1.7% tin enriched to 75% in the Sn^{119} isotope, with which the main measurements were made. These measurements were carried out on an apparatus in which the absorber was given a constant velocity relative to the source; the absorber motion was set by using an appropriately profiled cam. The speed was changed by a system of gears and pulleys. This equipment enabled us to obtain much greater accuracy in determining the position of the absorption maxima than could be gotten with the variable speed apparatus used in the preliminary measurements. During the measurements, the absorber was cooled with liquid nitrogen.

The resonance absorption spectrum is shown in the figure. All six components in the spectrum are well resolved; their intensities correspond to those which should be found for an unpolarized absorber. The table gives the identifications of the lines and the velocities corresponding to each of the absorption maxima. From these data we determined the quantities $\mu_0 H$ and μH (where μ_0 and μ are the magnetic moments of the ground and excited states of Sn^{119}, and H is the value of the magnetic field): $\mu_0 H$ = 2.80 ± 0.06 mm/sec,



Resonance absorption spectrum for an iron-tin alloy (1.7% tin). The ordinates are the counting rate of quanta in relative units. The numbers on the curve correspond to the label of the transition in the table.

Number of transition	Type of transition	Position of maximum, mm/sec
1	$+^3/_2 \rightarrow +^1/_2$	$-3,44 \pm 0,08$
2	$+^1/_2 \rightarrow +^1/_2$	$-2,10 \pm 0,08$
3	$-^1/_2 \rightarrow +^1/_2$	$-0,77 \pm 0,10$
4	$+^1/_2 \rightarrow -^1/_2$	$+3,48 \pm 0,10$
5	$-^1/_2 \rightarrow -^1/_2$	$+4,85 \pm 0,08$
6	$-^3/_2 \rightarrow -^1/_2$	$+6,21 \pm 0,10$

$\mu H = 2.02 \pm 0.07$ mm/sec. The ground state moment is known, $\mu_0 = -1.041$ n.m.,[7] so we get $\mu = +0.75 \pm 0.04$ n.m. This result is very close to those of [3-5], though the difference from the results of [4,5] somewhat exceeds the experimental errors quoted above.

The isomer shift in the alloy was found to be $+1.36 \pm 0.04$ mm/sec. The magnetic field acting at the tin nucleus in the alloy was 68 ± 2 kOe. This value may be compared with the values 78.5 and 81 kOe, found in [5,8] in alloys of similar composition. It should be noted, however, that the internal field is strongly dependent on the composition of the alloy. Thus, for an iron-tin alloy containing 10% tin, the field was found to be 57 ± 4 kOe.

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