SOVIET PHYSICS JETP VOLUME 15, NUMBER 4 OCTOBER, 1962

OBSERVATION OF THE MÖSSBAUER EFFECT IN $Sm_2^{149}O_3$

V. P. ALFIMENKOV, Yu. M. OSTANEVICH, T. RUSKOV, A. V. STRELKOV, F. L. SHAPIRO, and YEN WU-KUANG

Joint Institute for Nuclear Research

Submitted to JETP editor December 9, 1961

J. Exptl. Theoret. Phys. (U.S.S.R.) **42**, 1036-1037 (April, 1962)

The Mössbauer effect has been observed on the 22-keV line of Sm^{149}. It is thus shown that the 22-keV transition goes to the ground state of Sm^{149}. The upper limit for the natural width of the level is $\Gamma \leq 6 \times 10^{-7}$ eV.

RECENTLY Dzhelepov et al [1] found a 22-keV γ transition in Sm^{149}. They proposed a level scheme for Sm^{149} according to which the 22-keV transition goes to the ground state. If this is actually the case, one should be able to observe nuclear resonance absorption. [2]

The experiment to observe the resonance absorption was set up as follows (Fig. 1). A source of $Sm_2O_3 + Eu_2^{149}O_3$ several mg/cm^2 thick was fixed to the stationary part of a loudspeaker, and an absorber of Sm_2O_3, 35 mg/cm^2 in thickness, was fixed rigidly to the moving system (center of the cone). The Sm^{149} radiation passing through the absorber was recorded by a scintillation spectrometer (2.5 mm thick NaI(Tl) crystal and FÉU-11B photomultiplier). A 50-kc sinusoidal voltage, whose amplitude went through a sequence of 25 discrete values, was applied to the loudspeaker. After passing through a single-channel analyzer, pulses from the detector entered an electronic circuit which, after equal time intervals (10.24 sec), switched the recording channel and the amplitude of the sinusoidal voltage.

Thus a definite counting channel was associated with each voltage amplitude, and consequently with each value of the relative velocity of source and absorber. The measurements were made at room temperature. The results are shown in Fig. 2, which gives the counting rate as a function of the velocity of the absorber. The method used enables us to obtain on a velocity scale an absorption curve which is distorted and somewhat broadened compared to its intrinsic value, since the velocity of the absorber is varying and the effective value of the velocity is less than its amplitude. Taking this broadening into account gives the following values for the natural width and mean life of the 22-keV level: $\Gamma \leq 6 \times 10^{-7}$ eV and $\tau \geq 10^{-9}$ sec. We give limiting values for Γ and τ, since the accuracy of the experiment is not enough to guarantee the absence of splittings which would lead to an additional broadening of the line.

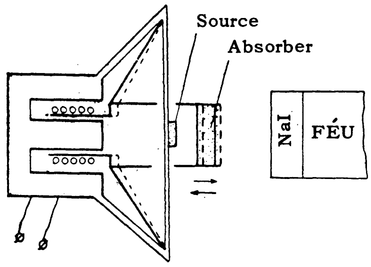

FIG. 1. Schematic of experimental arrangement.

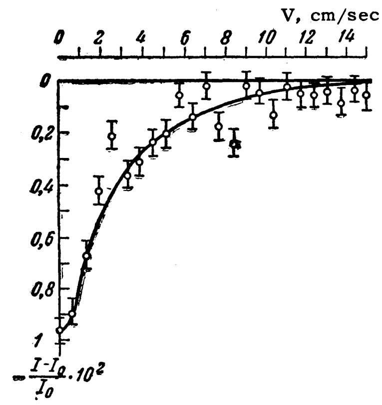

FIG. 2. Dependence of relative change in counting rate on absorber velocity.

The measurement of the nuclear resonance absorption in Sm^{149} is complicated by the low intensity of the 22-keV line compared to the background of x rays, which have an energy of 40 keV. This compelled us to do the following control experiments. We measured the counting rate I of filtered radiation for zero amplitude of the relative velocity and the counting rate I_0 for an amplitude sufficient for complete destruction of resonance. The following three control measurements were made:

1) with the window of the single-channel analyzer set on the 40 keV line and a filter of Sm_2O_3;

2) with a source of Sn^{119} (E = 24 keV) and a filter of Sm_2O_3;

3) with a copper filter between source and absorber, reducing the intensity of the 22-keV radiation by a factor of 12 and the 40-keV radiation by a factor of 1.5, which should give a reduction of the observed effect by a factor of eight.

The results of these measurements were the following:

	$E = 40$ keV	$E = 24$ keV	Cu filter	Operating conditions
$(I-I_0)/I_0$,%:	$+0.17 \pm 0.1$	$+0.1 \pm 0.18$	-1.03 ± 0.15	-1.07 ± 0.07

The control measurements showed the absence of any significant apparatus asymmetry which might be associated with motion of the absorber, and the observed dependence of the counting rate on relative velocity of source and absorber can be explained only by resonance absorption of the 22 keV γ radiation from Sm^{149}.

The measurements of $(I-I_0)/I_0$ were also done with a SRT-2 x-ray proportional counter, which has a resolution at 22 keV which is twice as good as the scintillation counter. These measurements gave the value $(I-I_0)/I_0 = (-2.8 \pm 0.3) \times 10^{-2}$; they confirm that the observed effect is caused by resonance absorption of the 22 keV γ radiation of Sm^{149}.

In conclusion the authors take this opportunity to express their thanks to K. Ya. Gromov, Zh. T. Zhelev, and V. A. Khalkin for preparing the source.

[1] B. S. Dzhelepov et al, Nuclear Phys. **30**, 110 (1962).

[2] R. Mössbauer, Z. Physik **151**, 124 (1958).

Translated by M. Hamermesh
171