ULTRASONIC SPLITTING OF THE MÖSSBAUER ABSORPTION LINE IN $Sn^{119}O_2$

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Splitting of the Mössbauer absorption line in tin oxide $Sn^{119}O_2$ deposited on a piezoquartz plate with a natural frequency of 20 Mc was obtained with ultrasonic vibrations of the absorber at a frequency of 18.5 Mc. The intensity of the first, second, and third order lines increases with increasing voltage on the piezoquartz plate, while their positions are in good agreement with the frequency of acoustic excitation.

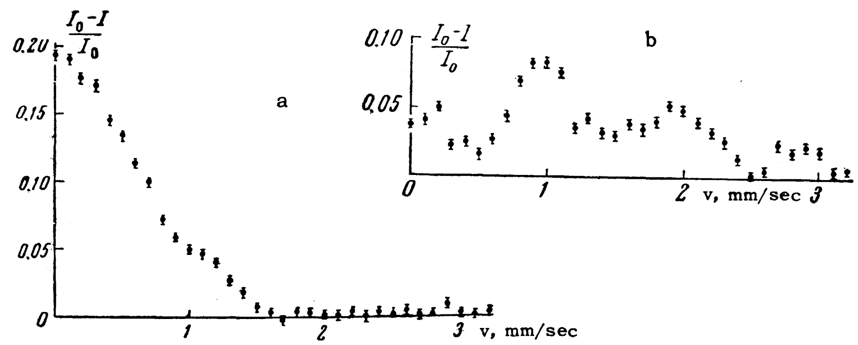
EXPERIMENTS on acoustic splitting of the Mössbauer line in Fe^{57} have been described by Ruby and Bolef.[1] In the present paper we describe the results of similar experiments with the 23.8 keV γ radiation from Sn^{119}.

The source was Sn^{119m} in the form of the oxide SnO_2.[2] The high Debye temperature of the oxide crystals assures us of a sizable probability (around 50%) of Mössbauer emission at room temperature, which simplifies the equipment considerably. The source was deposited on aluminum foil by precipitation in BF-2 glue. The foil carrying the source, which was obtained by neutron excitation of enriched Sn^{118}, was fixed to a system for moving the source and giving it a reciprocating motion with any velocity up to 5 mm/sec with an accuracy of 5×10^{-3} mm/sec.

The absorber in the form of the oxide of normal tin, which contains Sn^{119}, was deposited on an X-cut quartz plate 16 × 18 mm having a natural frequency of 20 Mc. The density of the layer deposited was 25 mg/cm^2 or 35 mg/cm^2.

Between the source and absorber, which were 7 cm apart, we placed a palladium filter to attenuate the parasitic 26 keV x-radiation; the γ radiation was recorded by a scintillation crystal of NaI(Tl) and photomultiplier, from which the signal went to an AADO-1 pulse-height analyzer and a PS-10000 scaler. The quartz plate with the absorber deposited on it was excited by an 18.5 Mc electrical signal. Nonresonant excitation was used in order to reduce the effect of a possible drift of the frequency of the exciting voltage, which becomes particularly important if one works at the natural frequency of the plate, since its Q value is so high. The maximum voltage applied to the plate was 95 V (the voltage from a standard signal generator was amplified by an auxiliary stage).

Since the emission and absorption lines coincide in frequency and are symmetric in shape, the acoustically split line is also symmetric. For this reason, in measuring the counting rate as a function of relative velocity of source and absorber it was not necessary to take account of the sign of the relative velocity. To reduce the effects of a possible systematic drift, immediately after taking a point with a given relative speed of source and absorber, we took a point with the source at rest; the result of the first measurement was normalized relative to the second. Measurements of the shape of the absorption line with different values of the voltage U applied to the quartz plate showed



a splitting of the absorption line into a series of equally spaced lines.

The results are shown in Fig. a (U = 0) and b (U = 95 V). They show clearly the appearance of the first, second and third order lines. The intensity of these lines increases with increasing voltage, while their position is in good agreement with the acoustic excitation frequency.

The width of the unsplit line is approximately twice as large as expected; this can be explained by parasitic vibration of the equipment, a certain amount of which could not be eliminated.

The behavior of the intensities of the main line and its satellites as a function of applied voltage permits an estimate of the amplitude of the acoustic vibration; this gives a value in good agreement with that calculated from the piezoelectric properties of the quartz plate. Thus the study of the split Mössbauer line can be used for measuring absolute magnitudes of displacements. For example, in our case the displacement amplitude was ~ 1 A.

It may be useful in experimental nuclear physics to produce γ multiplets with regularly spaced lines. This can be accomplished by acoustic splitting of the Mössbauer line.

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[1] S. L. Ruby and D. I. Bolef, Phys. Rev. Letters **5**, 5 (1960).

[2] Delyagin, Shpinel', and Bryukhanov, JETP **41**, 1347 (1961), Soviet Phys. JETP **14**, 959 (1962).

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209