

the polar scattering decreases exponentially, whereas the contribution of the acoustic scattering decreases more slowly, in power-law fashion. At some temperature the effect reaches a maximum, followed by a decrease connected with the reduced role of the acoustic scattering and the dominating scattering by the impurities or by the carriers, wherein there is either no energy dependence of the relaxation time (neutral impurities) or a dependence that increases like $\tau \sim E^{3/2}$.

Thus, the effect observed by us can be interpreted as the consequence of the existence of hole scattering by acoustic phonons over a rather broad range of temperatures.

In conclusion the authors thank V. L. Bonch-Bruевич and E. M. Kuznetsov for a useful discussion.

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EXCHANGE EFFECT IN ELASTIC SCATTERING OF POLARIZED IDENTICAL NUCLEI

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Submitted 19 July 1965

Polarization investigations are among the most important tasks of nuclear physics and are carried out on an ever increasing scale. Along with the scattering of polarized nucleons by polarized targets, increasing significance is being attached to experiments on the polarization of the products of direct nuclear reactions, for the purpose of explaining their concrete mechanism of determining the spectroscopic characteristics of the nuclei. Most experimental and theoretical studies of polarization phenomena have hitherto pertained, however, to fast particles, for which the nuclear interaction is decisive. At the same time, definite interest attaches to the problem discussed in the present note, that of elastic scattering of Coulomb-interacting polarized identical particles.

The elastic Coulomb scattering amplitude of two identical particles with spin I is obviously equal to

$$A_{M_1 M_2}^{M_1' M_2'}(\theta) = \delta_{M_1 M_1'} \delta_{M_2 M_2'} f(\theta) + (-1)^{2I} \delta_{M_2 M_1'} \delta_{M_1 M_2'} f(\pi - \theta) \quad (1)$$

where M_1 and M_2 are the projections of the spins of the beam and target nuclei in the initial state, M_1' and M_2' are the projections of the spins in the final state, $\delta_{M_1 M_2}$ is the Kronecker symbol, and

$$f(\theta) = \frac{z^2 e^2}{Mv^2} \frac{\exp[-i\eta \ln \sin^2 \theta/2]}{\sin^2 \theta/2} \quad (2)$$

is the amplitude of elastic Coulomb scattering of a spinless particle. The differential cross section summed over the spin projections of the final state

$$\frac{d\sigma_{M_1 M_2}}{d\Omega} = \left(\frac{z^2 e^2}{Mv^2}\right)^2 [|f(\theta)|^2 + 2(-1)^{2I} \text{Re} f(\theta) f^*(\pi - \theta) \delta_{M_1 M_2} + |f(\pi - \theta)|^2] \quad (3)$$

must be averaged over the spin states of the beam and of the target, which are described respectively by the spin density matrices $\rho_{M_1 M_2}^{(b)}$ and $\rho_{M_1 M_2}^{(t)}$.

We thus have

$$\frac{d\sigma}{d\Omega} = \left(\frac{z^2 e^2}{Mv^2}\right)^2 \left[\frac{1}{\sin^4 \theta/2} \frac{1}{\cos^4 \theta/2} + 2(-1)^{2I} \sum_{M_1} \rho_{M_1 M_1}^{(b)} \rho_{M_1 M_1}^{(t)} \frac{\cos(\eta \ln \tan^2 \theta/2)}{\sin^2 \theta/2 \cos^2 \theta/2} \right] \quad (4)$$

In the scattering of unpolarized nuclei by an unpolarized target we have

$$\rho_{M_1 M_1}^{(b)} = (2I + 1)^{-1} \delta_{M_1 M_1} \quad \text{and} \quad \rho_{M_2 M_2}^{(t)} = (2I + 1)^{-1} \delta_{M_2 M_2}$$

and formula (4) goes over into the well known Mott formula.

When a completely polarized beam ($M_1 = M_1^0$) is scattered by a completely polarized target ($M_2 = M_2^0$) we have

$$\rho_{M_1 M_1}^{(b)} = \delta_{M_1 M_1^0} \quad \text{and} \quad \rho_{M_2 M_2}^{(t)} = \delta_{M_2 M_2^0}$$

i.e., in this case the interference takes place only when the polarizations of the beam and the target coincide, which is the quantum analog of a fact well known in optics, that there is no interference between two light rays which are polarized in mutually perpendicular planes.

In the particular case of collision of spin-1/2 particles we have

$$2(-1)^{2I} \sum_M \rho_{MM}^{(b)} \rho_{MM}^{(t)} = -(1 + P^{(b)} P^{(t)})$$

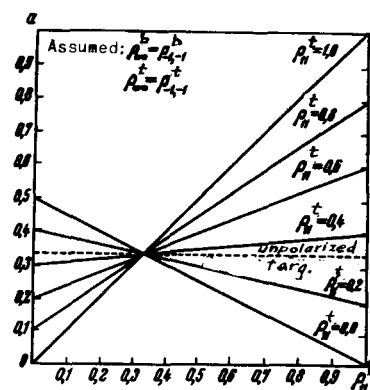
where $P^{(b)} P^{(t)} = \rho_{\frac{1}{2} \frac{1}{2}}^{(b)} \rho_{-\frac{1}{2} -\frac{1}{2}}^{(t)} - \rho_{\frac{1}{2} -\frac{1}{2}}^{(b)} \rho_{-\frac{1}{2} \frac{1}{2}}^{(t)}$ is the degree of polarization of the beam and of the target, respectively.

If all the nuclei of the beam and of the target are fully polarized in directions making an angle α , then $P^{(b)} P^{(t)} = \cos \alpha$, and we arrive at the well known result given in [1] (p. 608). In this case, with $\alpha = 0$, the oscillation intensity \underline{a} , equal to the ratio of the exchange term to the sum of the classical terms at $\theta = 90^\circ$, is double the value given by Mott's formula.

The dependence of the oscillation intensity on the beam polarization for different target polarizations, in the case of particles with spin $I = 1$, is illustrated in the Figure.

Thus, in the general case it follows from (4) that the intensity of the oscillations of the exchange term depends essentially on the degree of polarization of the beam and of

the target. This can serve as a basis for a new method of detecting polarization of slow charged particles. Since the procedure for obtaining polarized targets is being continuously perfected and there are now already twenty different methods for accomplishing this [2], the proposed method can find application in a large group of experiments, including measurement of polarization of slow protons [3] and of nuclei of light and medium elements, which is of particular importance in connection with the ever increasing use of multiply-charged ions in nuclear physics.



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ANISOTROPY OF THE MOSSBAUER EFFECT IN SINGLE CRYSTALS OF TIN AT LOW TEMPERATURES

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Submitted 20 July 1965

We report here the results of measurements of resonant absorption of recoilless 23.8-keV γ rays produced by the decay of $\text{Sn}^{119\text{m}}$ in single crystals of tin, in the temperature interval 4.2 - 280°K.

The measurements were made with a setup in which the absorber was caused to move at constant speed relative to the source, using a specially shaped eccentric. Figure 1 shows an over-all view of the installation without the radio apparatus: 1 - eccentric cam, 2 - bellows, 3 - cap, 4 - mounting stand, 5 - helium Dewar, 6 - foamed-plastic container for liquid nitrogen, 7 - lead screen, 8 - thermostat of radiation detector, 9 - NaI(Tl) crystal, 10 - FEU-13 photomultiplier, 11 - commu-

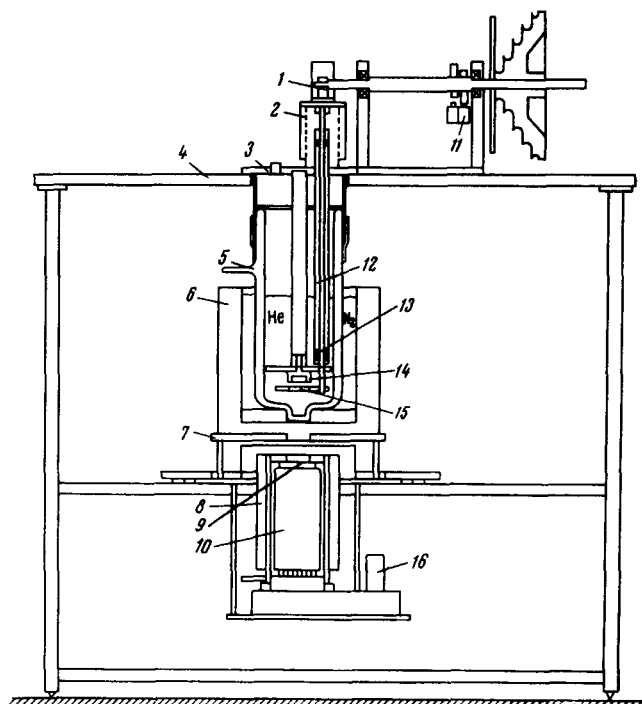


Fig. 1. Over-all view of the installation