[4] C. Haas, Critical Rev. Sol. State Science 1, 47 (1970).

SINGLE-PARTICLE TUNNELING IN SUPERCONDUCTING LEAD SINGLE CRYSTALS IN A MAGNETIC FIELD

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We investigated tunnel junctions made of single-crystal lead, lead oxide, and a tin film (or a lead film). The samples were obtained by a method close to that used in [1].

Just as in [1], two singularities, corresponding to two values of the energy gap in the lead single crystal, were observed for all samples in the single-particle tunneling region ($eV = \Delta_{Pb} + \Delta_{Sn}$). With increasing magnetic field parallel to the junction plane, a gradual coalescence of the singularities into one is observed.

The figure shows the experimental data obtained at 0.8°K with the Pb single crystal + Sn film junction. The magnetic field in Oersteds is indicated near each curve.

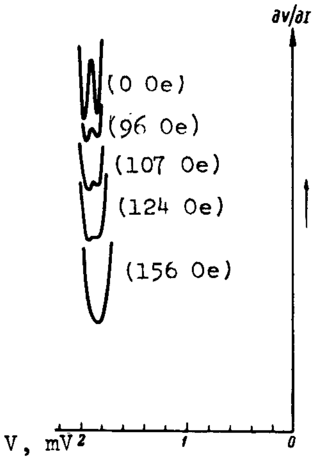
We note the following characteristic features of the observed effect:

1. The tests were performed on six samples with random orientation of the junction plane relative to the single-crystal axis. In none of the samples was there a noticeable dependence on the junction orientation.

2. The magnetic field in the plane of the junction is independent of the orientation.

3. The effect does not depend on the polarity of the electrodes.

4. When the magnetic field was perpendicular (accurate to 5%) to the junction plane, the coalescence occurs at larger intensities than in the case of a field parallel to the junction. Thus, a curve similar to that for 107 Oe in the figure was obtained in a perpendicular field of 215 Oe.



The formation of a single singularity can be ascribed to the following factors: 1) singularity broadening connected with the Sn film (a field of 150 Oe constitutes an appreciable fraction of the critical field of tin); 2) broadening of the contribution from each band of Pb in a magnetic field; 3) entanglement of states belonging to different bands of Pb. To verify the first assumption, the tin film was replaced with a lead film. This did not change the results.

The second and third assumptions call for further study.

The facts described above are interesting in connection with measurements in the voltage range $V \approx \Delta_{Pb}/e$ [2]. In the case of samples consisting of a lead single crystals and tin films, a splitting of the singularities is observed, due to the fact that the lead is monocrystalline. In fields up to 270 Oe, this form of splitting undergoes no changes whatever, whereas the single-particle singularity becomes single already in a field ∿150 Oe. These results will be reported in greater detail in a separate paper.

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[1] B.L. Blackford and R.H. March, Phys. Rev. 186, 397 (1969).
[2] B.A. Taylor and E. Burstein, Phys. Rev. Lett. 10, 14 (1963).

POLARIZATION DEPENDENCE OF THE INTERFERENCE OF NUCLEAR AND ELECTRONIC γ-RAY SCATTERING

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In earlier investigations of interference phenomena in the diffraction of resonant γ rays [1 - 4], no singularities connected with the existence of sharp polarization dependence of the resonant nuclear scattering were observed. In the present investigation we created conditions under which this dependence becomes clearly pronounced, particularly in the fact that different interference lines in the same Mossbauer spectrum have different asymmetry directions.

The experiment was performed at room temperature using a Mossbauer diffractometer [5]. A γ-ray beam with divergence 1°, from a Co^{57} source in Cr (100 mCi), was incident on an α-Fe_2O_3 single crystal placed in the symmetrical Bragg reflection position (666), with $2\theta_B = 69°$. The crystal was in a magnetic field of ∿1 kOe, which oriented the magnetic fields at the ion nuclei in the different experiments either in the scattering plane or perpendicular to this plane. The source moved with constant acceleration, and the information was accumulated in a multichannel analyzer. The measurement results are shown in the figure. We see that the spectral lines have the clearly pronounced dispersion shape which is typical of the interference of nuclear resonant and Rayleigh scattering, and the direction of the asymmetry of lines 2 and 5 (Fig. a) is opposite to the direction of the asymmetry of the remaining lines. This feature of the spectrum is due, in particular, to the dependence of the amplitude of the coherent nuclear scattering of the crystal unit cell on the magnetic field orientation and on Δm of the nuclear transition.

In our case this amplitude is proportional to the quantity

$$P = \frac{1}{2}(1 - \delta_{\Delta m,0})(\mathbf{h}_0\mathbf{h}_1) + \left(-\frac{1}{2}\right)^{|\Delta m|}(\mathbf{h}_0\mathbf{n})(\mathbf{h}_1\mathbf{n}).$$

Here $\vec{h}_0$ and $\vec{h}_1$ are the magnetic-field polarization vectors of the incident and scattered waves, and $\vec{n}$ is a unit vector in the direction of the magnetic field at the iron nucleus. The values of P for π and σ polarizations of the incident radiation, and for different orientation of the magnetic field $\vec{H}_n$ at the ion nuclei are listed in the table. We see from the table that for transitions with Δm = 0, at both orientations of the magnetic field, only one of the polarizations contributes to the scattered radiation. The fact that P(σ) is negative at $\vec{H}_n \parallel (\vec{K}_0\vec{K}_1)$ causes inversion of the interference curves corresponding to the transitions with Δm = 0 (Fig. a). When $\vec{H}_n \perp (\vec{K}_0\vec{K}_1)$ the values of P for both polarizations have the same signs (or are simply equal to zero). In this case