POSITRON ANNIHILATION IN SULPHUR, SELENIUM, AND SILICON

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The angular distribution of annihilation γ rays is measured for crystalline and amorphous sulphur, selenium, and silicon.

MEASUREMENTS have shown[1,2] that the difference in the positron-annihilation process for crystalline and for amorphous substances affects the angular distribution of the annihilation γ rays. The angular distribution in a two-quanta annihilation usually has a bell-shaped form. In crystalline substances, as compared to amorphous ones, there is a narrower maximum and a relatively wide base. The narrow maximum is thought to be due to the production of positronium.[3]

In the present experiment, the annihilation of positrons was investigated in crystalline and amorphous sulphur, selenium, and silicon.

The measurements were carried out with the setup described in detail by Baskova and Dzhelepov.[4]

The results of the measurements are presented in Fig. 1 — 3, where the curves of the angular distribution of γ rays produced in the annihilation of positrons in sulphur, selenium, and silicon are shown.

The angular distribution curves for crystalline and amorphous sulfur coincide within the limits of error of the experiment. This result is in agreement with the data of Ferguson and Lewis.[5] It follows from this that, for sulphur, there is no second component in the distribution due to a different lifetime.

As can be seen from Fig. 2, the angular distributions for crystalline and amorphous silicon differ greatly only for large angles. The angular distribution for crystalline silicon is in agreement with that measured by Page and Heinberg.[1] However, the amplitude of the narrow maximum for the amorphous silicon is, according to our data, considerably smaller. This is evidently due to the admixture of about 25% of crystalline silicon in our samples of amorphous silicon.

The angular distribution curves for crystalline selenium and amorphous (vitreous, red, and black) selenium are shown in Fig. 3. It can be seen that the different forms of selenium have angular distribution curves of different width. From a comparison of the half-widths of the curves, it can be seen that the widest curve is that for crystalline selenium. A narrower maximum is observed for amorphous selenium.

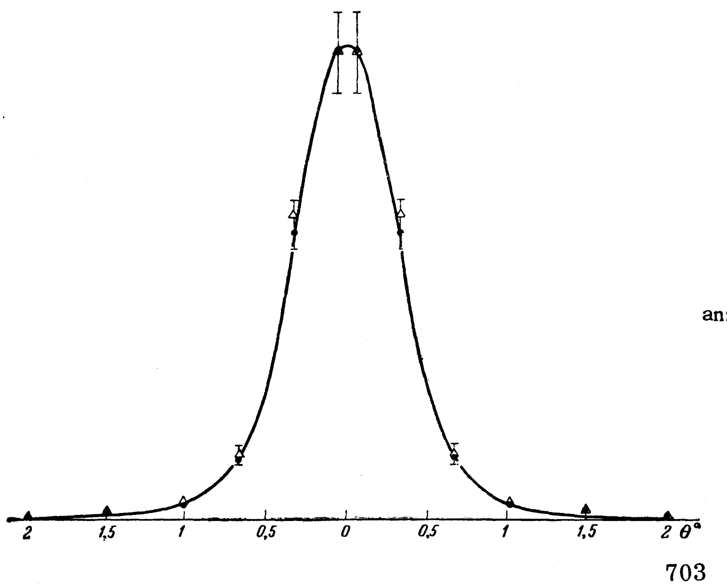

FIG. 1. Angular distribution of γ rays produced in positron annihilation in sulfur: ● – crystalline, Δ – amorphous.

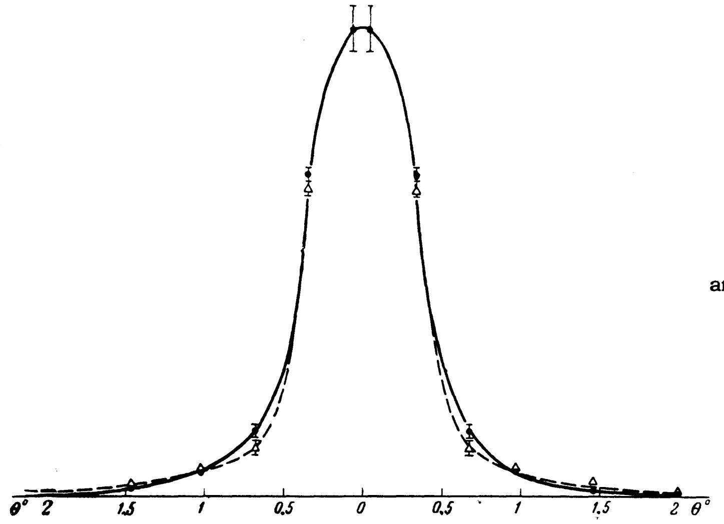

FIG. 2. Angular distribution of γ rays produced in positron annihilation in silicon: ● – crystalline, Δ – amorphous.

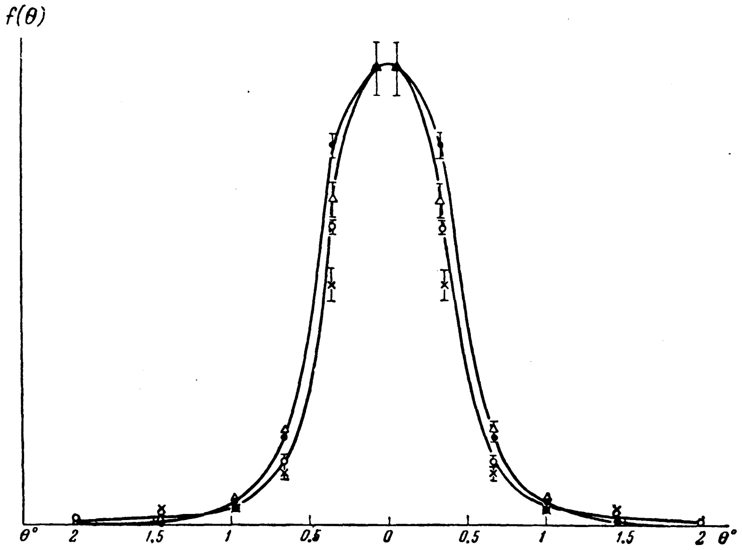

FIG. 3. Angular distribution of γ rays produced in positron annihilation in selenium: ● – crystalline, Δ – amorphous, o – amorphous red, and × – amorphous black.

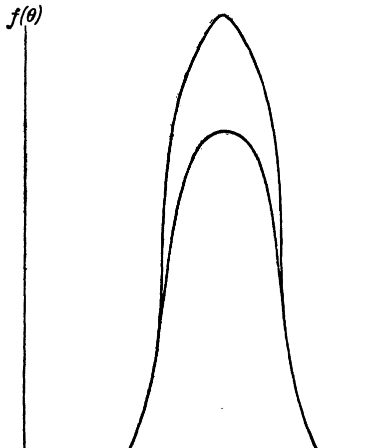

FIG. 4. Narrow component of the angular distribution of γ rays produced in positron annihilation in amorphous selenium.

The narrow component of the angular distribution for black and red selenium is represented in Fig. 4 (as was also done by Page and Heinberg[1]). An estimate carried out permits us to conclude that the intensity of the narrow component amounts to 18 ± 8%. In its order of magnitude, the intensity of the narrow component is in agreement with the values obtained for other amorphous substances.

The value obtained cannot be solely due to the fraction of positronium produced, since freely annihilating positrons also contribute to the narrow component.

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