NEW METHOD OF INVESTIGATING THE PROPERTIES OF SINGLE CRYSTALS

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1. An effect involving the distortions of the angular distributions of the charged nuclear-reaction products, or scattering when single crystals were used as targets, were described in [1,2]. These distortions are due to the additional Coulomb scattering of the product particle by the nuclei contained in chains corresponding to definite crystallographic axes in the crystal, and are accordingly observed near these directions.

The results of experiments on the dependence of this effect on different factors, for the case of elastically scattered protons from single-crystal tungsten, are described in [3]. The above-mentioned papers deal with an effect connected with one crystallographic axis, [111]. At the same time, it is obviously of interest to observe an effect that pertains simultaneously to a whole set of crystallographic axes, i.e., to the "proton plot" of the crystal.

2. The experiment was carried out with a beam of 500-keV protons from the cascade generator of the Nuclear Physics Institute of the Moscow State University. The protons were incident on the surface of a thick molybdenum single crystal. The crystal [100] axis made an angle of 150° with the direction of the incident beam. The beam diameter did not exceed ~ 0.3 mm. The elastically scattered protons were registered with a photographic plate mounted perpendicular to the [100] axis.

To eliminate the low-energy part of the proton spectrum, the photographic plate surface was covered with an organic film 150 mg/cm^2 thick.

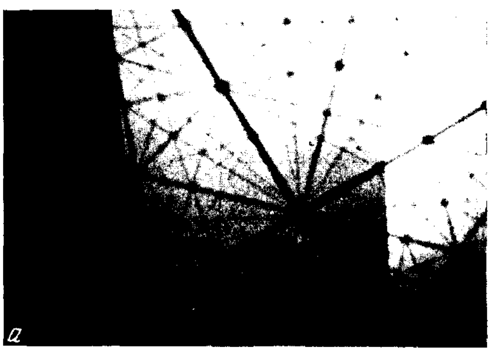

Fig. 1

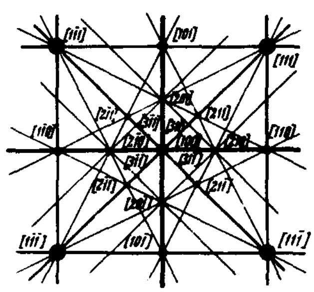

Fig. 2

The image obtained in this manner is shown in Fig. 1.

3. The lines shown in Fig. 1 are lines where the crystallographic planes intersect the emulsion surface. This can be easily verified by comparing Figs. 1 and 2. The latter shows the proposed scheme of such lines for a body-centered lattice in the case when the [100] axis is directed perpendicular to the plane of the figure. The diagram shows the lines connected only with the planes of lower indices.

Figure 1 demonstrates thus the fact that at relatively low energies the "pits" due to the crystallographic axes practically merge into continuous lines, so that the particles are deflected from their initial direction not so much by individual chains of nuclei as by aggregates of such chains, which form entire planes.

Analogous measurements, made with different crystals at varying incident-particle energies and at varying thicknesses of the absorbers in front of the emulsions show that there are great possibilities for varying the "degree of density" of the proton pattern, i.e., of including or excluding tracks connected with the planes of relatively high indices. This circumstance, as well as the clarity of the picture, apparently permit extensive use of the described phenomenon for investigations of crystal properties. Since the proton wavelength is small so that the wave properties of the beam exert little influence on the structure of the "pits" or of the lines, their study can yield in many cases more useful information on the character of motion of the nuclei in the crystal lattice, than methods which essentially use the wave properties of the radiation.

[1] A. F. Tulinov, Paper at the 15th Annual Conference on Nuclear Spectroscopy and the Structure of the Atomic Nucleus (January, 1965).

[2] A. F. Tulinov, DAN SSSR 162, No. 3 (1965), Soviet Phys. Doklady, in press.

[3] A. F. Tulinov, V. S. Kulikauskas, and M. M. Malov, Phys. Lett. (in press).