LETTERS TO THE EDITOR

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On A V Belinskiĭ's paper "Regular and quasiregular spectra of disordered layer structures"†

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Section 4 of the paper, entitled "Ferroelectric phase of a KDP crystal and its spectral transmission in polarized light" presents the author's experimental findings which he makes public for the first time along with their interpretation. The contents of the section call for comments.

To clarify the matter, it is worth recapitulating, above all, the optical properties of KH_2PO_4 (KDP) crystal.

This ferroelectric crystal (its Curie point is 123 K) is perfectly transparent in the spectral region 10000 – 2000A and, naturally, does not possess dichroism. It was with this crystal that five harmonics (a record-breaking figure!) were generated in the original IR radiation of a neodymium-glass laser [1]. At the time of writing, KDP crystals serve to multiply the frequency of the neodymium-glass laser radiation used in the laser fusion system developed at the Lawrence Livermore National Laboratory, USA. Giant (40×40 cm) KDP crystals several centimeters thick are installed in the laser lines [2].

This stresses how accurate any new reports about the optical properties of KDP crystal must be.

Meanwhile, an attempt is made in Section 4 of the above paper to deduce something new about these crystals from the channeled spectra of the polydomain KDP crystals.

Unambiguous channeled spectra are produced when a white-light beam undergoes spectral decomposition as it passes through a precisely aligned system consisting of a linear polarizer, an optically transparent anisotropic body, and a linear analyzer. With such a system, the continuous spectrum of white light acquires alternating dark and bright fringes which owe their origin solely to polarization effects. Radiation at the wavelengths of white light emerging from an anisotropic body in a linearly polarized state not matching the transmission of the analyzer will not be present in the developed spectrum of white light, and dark fringes will appear instead. The bright fringes in the spectrum apparently correspond to a 90° rotation of the plane of polarization of the radiation at other wavelengths.

† See *Usp. Fiz. Nauk* **165** (6) 691 (1995) [*Phys. Usp.* **38** (6) 653 (1995)]

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Therefore, properly taken channeled spectra can yield information about the birefringence of the crystal in a certain direction if the path length traveled by light in the crystal is known. Also, it is important to know the wavelengths of light at the dark and bright fringes in the spectrum. This can be achieved by taking a well-explored line emission spectrum concurrently with the channeled spectrum.

All of this has been known since the times of Arago [3] and Fizeau and Foucault, and channeled spectra, also used in education [5, 6], have found application in astrophysics. For example, they are the basis of the unique Lio light filter (see, for example, Ref. [7]) with an amazingly narrow transmission band (of less than 1 A).

Nevertheless, in describing his experimental setup, which can yield only an ambiguous picture of quasi-channeled spectra, the author of the paper in question ascribes the spectra he has taken to 'the frequency-angle transmission of the crystal' (sic!) (see Figs 6 and 7 and the microphotograph in Fig. 8).

The terminology quoted above has no physical meaning in respect of the crystal. In the setup in question (Fig. 6), a continuous cone of polarized white light with an apex angle of $\pm 10°$ propagates through the crystal. As a result, there is no way of telling if the crystal exhibits birefringence in a particular direction and no unique value, necessary to calculate birefringence, can be assigned to the path length traveled by light in the crystal. An exact wavelength scale in the form of a reference line emission spectrum is not available either.

Therefore, and quite naturally, the entirely indefinite treatment of the domain structure of the crystal given in Sections 1 – 4, which follow the figures just referred to, disregards the elementary requirements for the design and interpretation of light polarization experiments. In particular, the inevitable alternation of dark and bright fringes in the spectrum, observed with the analyzer rotated through 90°, is recognized as an inherent feature of the spectra under study. The curved images of spectral lines, typical of prism spectrographs, are likewise attributed to the spectra as their peculiarity.

Meanwhile, the domain structure of the KDP crystal has long been established from the diffraction of light on it as a phase grating, and the structure has been found to be exceptionally regular [8].

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Letter to the Editor

I thank Professor I A Yakovlev for his critique of my paper, ''Regular and quasiregular spectra of disordered layer structures''. It is not a priority paper (in contrast to Ref. [6] listed in the paper's References). My primary objective in it was to draw attention to the constructive role of random variations of domain thicknesses in the formation of experimentally observed spectra.

It is true that the formation of regular spectra in rigorously regular periodic structures placed between crossed polarizers has been known for a long time and is not surprising. However, the model of a regular domain structure is unable to explain the spectra, both observed and described in Ref. [6]. If, say, under conditions close to those existing in the experiments for which the graphs of Figs 13 – 16 of the *UFN*'s paper were constructed, we set the variations of domain thickness fluctuations to zero, then the spectra in the form of a great number of equidistant bands over a broad range will disappear as shown in the penultimate paragraph of Section 6.

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