expression for the electromagnetic diffraction wave taking the Kottler formulae as a starting point. A. KUJAWSKI [22, 23] carried out investigations concerning different formulations of the reciprocity theorem and their significance for deriving the Lorentz-Huygens principle. He proved also that the results obtained by Laporte and Meixner in 1958 for the diffraction field of electromagnetic waves are equivalent to the previously known formulae of Kottler from 1923. Common works done by A. KUJAWSKI and J. PETYKIEWICZ [24, 25, 26] in the period of time 1968-1971 were dealing with a generalization of the Huygens principle for the electromagnetic fields in uniaxial anisotropic media. T. KRIPIEC [27, 28, 29] in the years 1967–1969 obtained, in a very simple and compact way, a solution of formerly discussed problems of diffraction of multipole electromagnetic waves on a perfectly conducting edge, basing on the modified Sommerfeld method proposed by PETYKIEWICZ [30] in 1967. J. KREBS [31] showed in 1967 how a rigorous formula for a spherical wave may be obtained from the series defining vectorial potential of Miyamoto and Wolf. The papers [32, 33, 34] by PETYKIEWICZ deal with scalar theory of light and are devoted to Kirchhoff diffraction problems for multipole radiation. In the years 1967–1970 K. GNIADEK [35, 36, 37, 38] and J. Petykiewicz [39, 40], by applying optical methods to certain problems of elastic wave diffraction, obtained results of extremely perspicacious interpretation, basing on the Kirchhoff theory of diffraction. T. NIEPOKOJCZYCKI [41] derived, working under the quidance of J. Petykiewicz, as symptotic expressions for the electromagnetic diffraction wave for the case of the so-called double critical point.

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The Poznań Division of the Institute of Physics, Polish Academy of Sciences, Research in Optics

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Investigations carried out in the Poznań Division of the Institute of Physics, Polish Academy of Sciences, are concentrated mainly in the field of physical properties of solid state (like crystals, ferromagnetic alloys and thin films, ferroelectric crystals, dielectrics) and also intermolecular interactions (radiospectroscopy, spectroscopy of gases, dielectric methods). Independently, the optical examination methods which appear to be a valuable complement of

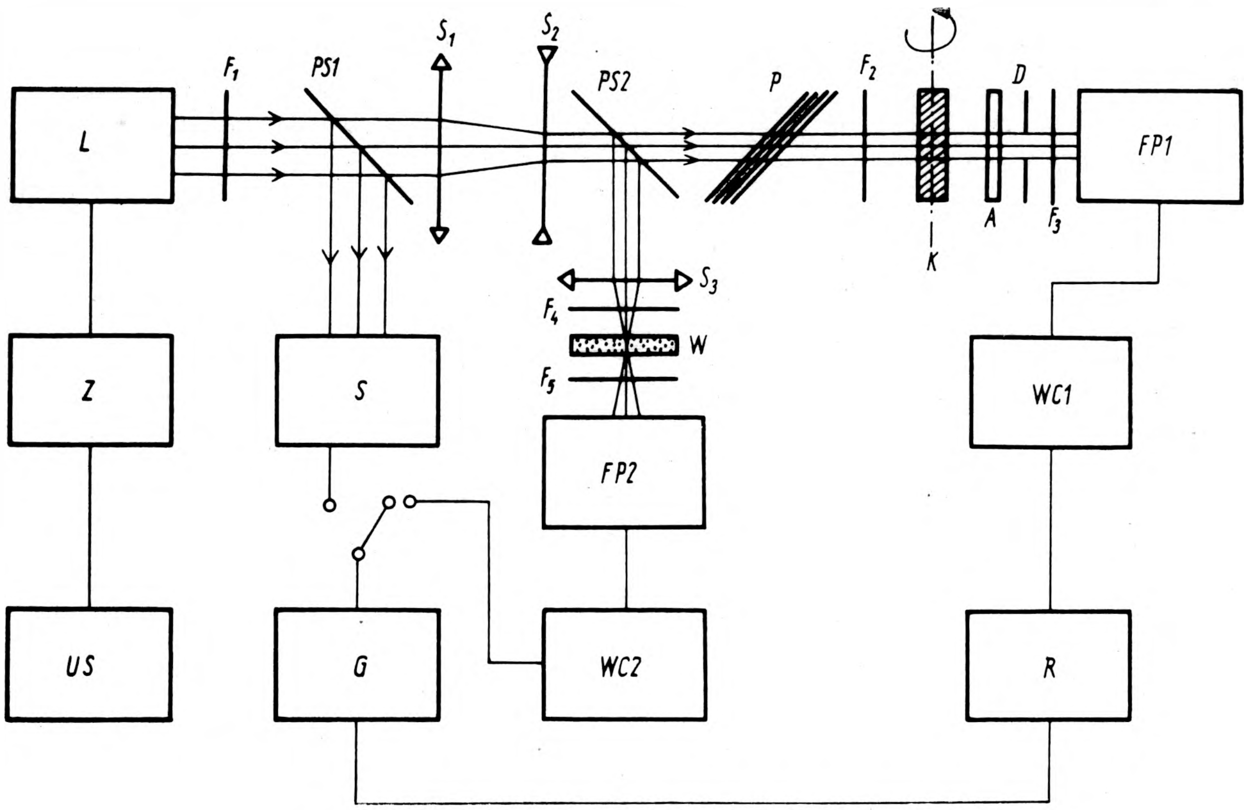

Fig. 1. A scheme of the setup for examining the second harmonic generation

spectroscopic, dielectric and magnetic investigations are occasionally under study.

During the past ten years the methods of non-linear optics as applied to studies of piezoelectric crystals were of particular interest in our Institute. Investigations of the non-linear effects produced by the intense light beams were initiated by the precursory theoretical work done by Professors Piekara and Kielich in the fifties [1–3]. On this strong theoretical basis preparations to experimental studies in the field of non-linear optics began in the Dielectrics Laboratory already in 1962. In the first period the work was concentrated on design problems of lasers and various auxiliary devices [4–6]. At the beginning of 1966 the phenomenon of second harmonic generation was observed [7]. Frequency doubling of the ruby laser ($\lambda = 694.3$ mm) was obtained in the ADP-crystal by using an arrangement designed specially for this purpose (Fig. 1).

The most important achievement of the Institute in the field of non-linear optics was the application of the powder method to examine the second harmonic generation [8]. This method was worked out in 1968 and awoke much interest among the research workers of the non-linear optical phenomena. In the papers [9] and [10] the basic assumptions of the method have been specified precisely and laws describing the optical frequency doubling formulated.

Among other results achieved the following are worth mentioning: (a) formulae for calculating matching angles and average values of elements of the optical non-linear polarizability tensor, (b) a method for the determination of anisotropy angle and coherence length, enabling various parameters to be found which describe the non-linear optical properties and being extremely helpful when looking for new non-linear materials. New crystals of non-linear optical properties have been found by applying the powder method for generating the second harmonic. Special attention in this respect warranted the application of ammonium pentaborane, whose applicability to frequency doubling is comparable to that of ADP-crystal. Also the current works on second harmonic generation in crystals defected by gamma radiation [11] appeared to be very interesting.

In experimental non-linear optics the problem of gaining greatest possible value for light transformation efficiency from the fundamental frequency into the second harmonic is very important. Considerable efficiency may be achieved by positioning the crystal in the direction of phase matching and by respectively focusing the laser beam. When focusing the laser beam in the crystal placed along the matching direction two competitive processes occur. On the one hand the focusing process increases the power density in the light beam and, by the same means, augments the power of the second harmonic. On the other hand part of the rays propagate in the direction different from that of matching, which reduces the power of the second harmonic generated. An optimal focal length value for the lens and its most advantageous position with respect to the crystal sample [12] (Fig. 2a, b) have been found. The influence of the space-time distribution in the laser beam on the effectiveness of the second harmonic generation [13, 14] was analyzed.

From the field of classical applications of optical methods to investigation of ferroelectric crystals and thin ferroelectric layers the following two results deserved some attention: a method of refractive index measurement in the ultraviolet part of the spectrum and a photoelectric polarimeter for measuring the small angles of the polarization plane rotation.

Dielectric and spectroscopic investigations of the triglycine sulphate crystals with impurities and defects induced by

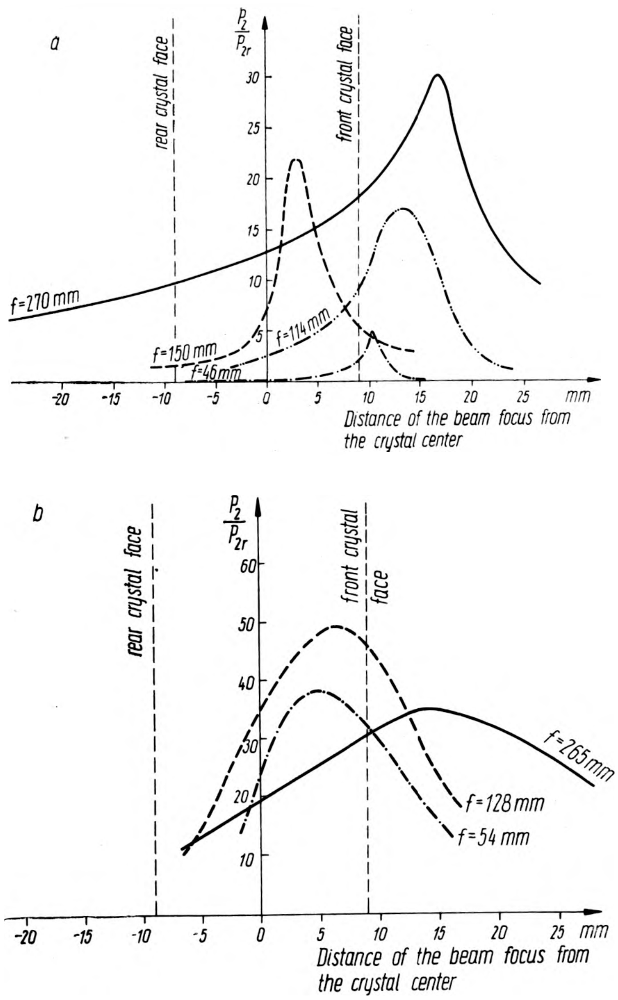

Fig. 2. Dependence of the power gain of the second harmonic as a function of the distance between the focus position and the crystal centre for several spherical (a) and cylindrical (b) lenses

irradiation were supplemented by the measurements of refractive indices especially in the ultraviolet region. The basic difficulty consisted in elaborating a simple and accurate method of detecting the radiation refracted in the region of non-visible spectrum. A photomultiplier was applied as detector of the refracted radiation. The most advantageous geometry of the setup was applied (perpendicular incidence of the ray on a fixed prism), which rendered possible to align the system by using the non-visible radiation. As a source of monochromatic radiation a Spectromom 203 was used, while a 1P28-photomultiplier fastened to a movable arm of a goniometer was as a detector. The photomultiplier was automatically driven and coupled with the movement of the photocurrent registrator (Fig. 3). The method mentioned above [15] was applied to measuring the refractive indices in the TGS crystal and its derivatives [16]. It can be also used for any transparent crystals.

The photoelectric polarimeter designed for measurements of small rotation angles was constructed in the Ferromagnetics Laboratory [17]. A half-shadow Polaroid was used as an analyzer. Two light beams after passing this Polaroid were directed onto two identical photomultipliers operating in the push-pull

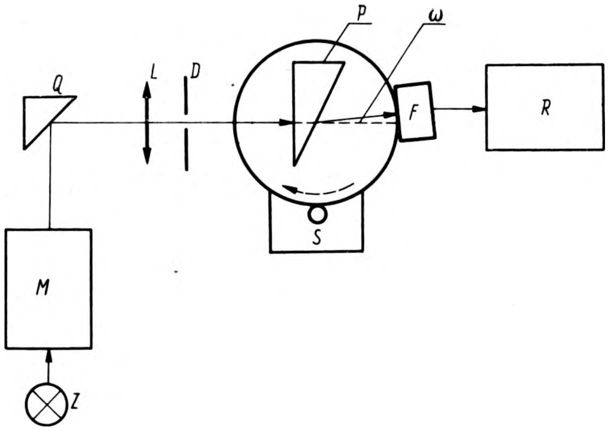

Fig. 3. A block scheme of the setup for refractive index measurement in crystals for the ultraviolet region of the spectrum

circuit. The photoelectric current was registered by a galvanometer. The achieved measurement accuracy of the polarization plane, rotation angle was about 15 seconds of arch. The polarimeter was applied to examination of the magnetic properties of the thin ferromagnetic layers by means of a method based on the magneto-optic Faraday effect. As the rotatory power angle for the light passing the sample is proportional to magnetization it was possible to determine the hysteresis loop for a ferromagnetic thin layer by measuring this angle. The device may be applied also to other measurements, where the twisting of the polarization plane is very small, and in particular if the changes in rotatory power depend on such parameters like magnetic and electric strength, temperature and others.

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