15:15 PM

FrM5 Precise Polarizing and Analyzing of Laser Light with Second Harmonic Generators and Sum-Frequency Converters

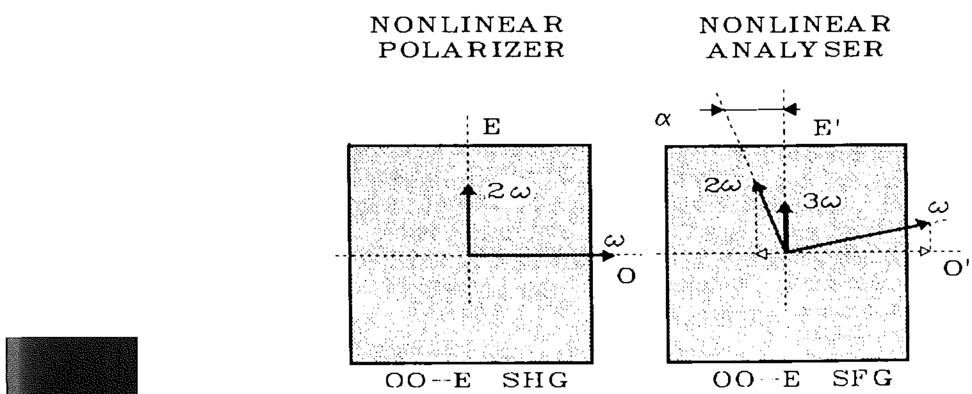
D. PARASCHUK, Department of Physics, Moscow State University, Moscow 119899, Russia; N. ZHELUDEV, Department of Physics, University of Southampton, Southampton S09 5NH, U. K.

For the first time a "nonlinear polarizer" and a "nonlinear analyzer" were simultaneously used for precise polarizing and analyzing of laser light, and linearly polarized laser light of wave length 532 nm, with degree of elliptically less than 6 10^{-9} was generated. Previously [1] we demonstrated a hybrid system consisting of a Glan prism and a frequency doubler employed as a polarizer, while here we report the "completely nonlinear" polarimeter and discuss its advantages.

The following idea forms the basis of the work (see Fig. 1.). If a nonlinear crystal with 00-E type phase matching is used for generation of second harmonic (SH) radiation, the SH wave has to be, in principal, ideally linearly E-polarized ("nonlinear polarizer"). Analysis of the polarization state may be done by a second nonlinear transformation such as 00-E sum frequency generation (SFG) ("nonlinear analyzer"). Here, the residual fundamental wave from the polarizer and the highly polarized second harmonic wave produce the sum frequency wave. Only O-projections of electric field strength vectors contribute to the sum frequency generation, therefore the efficiency of the process depends on the orientation of the plane of polarization of the second harmonic wave in the "nonlinear analyzer" crystal frame. This may be used for analyzing the orientation of the second harmonic polarization plane.

The combination of "nonlinear polarizer" and "nonlinear analyzer" behaves much the same as a conventional pair of polarizer and analyzer, except that the output wave has three times the frequency of the input wave. In order to perform high-accuracy polarization measurements one should try to get the minimum extinction ratio of the "crossed" polarizer and analyzer. In this sense "nonlinear" polarizers an analyzers have some pronounced advantages over conventional birefrigent-prism-based devices. Specifically the main contribution for the unwanted extinction value comes from non-phase-matched nonlinear processes, such as 00-0, EE-0, E0-0 which may be minimized or suppressed by proper choice of nonlinear crystal type, orientation and length.

With two 20 mm long potassium dideuterium phosphate (DKDP) crystals employed in the "nonlinear polarizer" and the "nonlinear analyzer", a very low extinction ratio of 6 10^{-9} was obtained. We found that with proper crystal installation the main factors which affect the purity of linear polarization created by the polarizer, and the sensitivity of the analyzer, are: residual growth stress in the crystal structure and crystal surface quality, while light-induced thermal stress does not play an important role in DKDP. In our particular nonlinear elements, with a 20x20 mm^2 aperture, extinction varies by one order of magnitude from point to point in the aperture.



FrM5 Fig. 1: Polarizations of the fundamental (ω), the second harmonic (2ω) and the sum-frequency (3ω) waves in the nonlinear polarizer and the nonlinear analyzer installed near "crossed" positions. The angle α of rotation of the plane of polarization of the highly-polarized second-harmonic wave is introduced by the Faraday rotator.