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crystal E7 (by BDH) before preparation. The experimental setup was the usual one to induce a nonlinear grating in a liquid crystal film.[3] The beam of an argon-ion laser (λ = 5145 Å) was divided by a beam splitter in a pump and a signal beam with a power ratio $I_p/I_s \approx 30$. These beams were finally recombined at a small angle ($\alpha \approx 0.2°$) giving rise to an impinging power I_{in}.

In this configuration no transmitted light beam was observed until I_p reached a value I_p^* necessary to obtain self-transparency on the peak of the Gaussian power distribution. For $I_p \geq I_p^*$ the two beams appeared after the sample. Because of the high ratio I_p/I_s, the self-transparency was induced only by the pump beam: the signal beam did not affect the transmission of the pump beam, while an effect of the opto-optical switch was induced by the pump on the signal beam.

A further increase of the impinging light power gave rise to new diffracted beams. The power I_3 of the first diffracted beam was measured; data are reported vs I_1 in Fig. 1 and vs I_2 in Fig. 2, where I_1 and I_2 are the transmitted powers of the pump and signal beams. The experimental data show that $I_3 \propto I_1^2 I_2$ as expected for a thermal grating of low efficiency and with $I_2 \ll I_1$.[4] A peculiar feature which must be underlined is the threshold behavior which is clear in the figures. The measured time constant of the grating was ~7 ms.

Summarizing: We have reported what we believe to be the first demonstration of nonlinear light diffraction in a PDLC sample. **(Poster paper)**

1. F. Simoni *et al.*, Appl. Phys. Lett. **54,** 896 (1989).
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3. I. C. Khoo and S. L. Zhuang, IEEE J. Quantum Electron. **QE-18,** 246 (1982).
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Poster Wednesday

QWD20 Laser-induced nonlinear dynamics in a liquid crystal film

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Laser beam propagation in a nematic liquid crystal (LC) film is a fascinating problem. Not only does it exhibit some very unique highly nonlinear optical phenomena, but it also displays unusually rich nonlinear dynamic behavior. It has been demonstrated that a sufficiently strong laser field can induce a Freedericksz transition (an orientational structural transition) in a nematic film. Consider a homeotropic film with molecules aligned parallel to the surface normal. Above the transition threshold, a linearly polarized beam normally incident on the film can distort the homeotropic alignment by reorienting the molecules against the elastic torque, while a circularly polarized beam can, in addition to the distortion of alignment, cause the molecules to precess uniformly about the surface normal. The latter is the consequence of a constant rate of deposition of angular momentum from the field to the medium. With an elliptically polarized beam, the situation is even more intriguing. The main difference between circular and elliptical input polarization is that in the former case the molecular reorientation first breaks the azimuthal symmetry of the whole system (radiation + LC). This yields characteristically different results in the two cases. The elliptically polarized input can lead the system through various dynamic regimes: torsional oscillations; nonuniform precession; nutation superimposed on precession; and others. Experimental observations are in good agreement with the theoretical predictions from a continuum model of laser beam propagation in an anisotropic fluid.

The experiment was carried out on a 75-μm homeotropic film of 4-cyano-4'-pentylbiphenyl (5CB). An Ar^+ laser beam, focused to 120 μm and normally incident on the film, was used as the pump beam, and a counterpropagating He-Ne laser beam was used to probe the induced molecular reorientation. The data were taken by keeping the polarization of the pump beam fixed and varying the pump power in 5-mW steps. The results are summarized in Fig. 1 where the various distorted phases of the system in the I-χ plane are indicated, I being the pump intensity and χ the ellipticity angle of the pump polarization. In the figure, U denotes the undistorted regime, S the deformed regime with equilibrium molecular reorientation, O the torsional oscillation regime in which the oriented molecules librate, and R the precession/nutation regime in which the molecules precess as well as nutate about the surface normal. Squares, circles, and triangles are experimental data points in different regimes, with open and solid ones referring to observations with increasing and decreasing pump intensities, respectively. The dashed curve describes the boundary between R and O with decreasing pump intensity. The theoretical calculation is in semiquantitative agreement with the experimental observations. **(Poster paper)**

QWD21 Origin and optical characteristics of the supercontinuum generation

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Intense radiation interacting with nonlinear media can generate a white spectrum emission called supercontinuum (SC)[1] accompanied by ring emission. Proposed models—self-phase modulation, four-wave mixing, and the Raman effect—fail to explain the effect even qualitatively. We present new results on properties of SC cone emission (SCCE) and discuss its similarity to conical emission in metal vapors[2] and class II Raman emission in liquids.[3] These properties are characteristic of emission from a self-trapped filament surface. As a surface effect SCCE obeys a Cerenkov type process condition where the transverse component of linear momentum is not conserved and radiation is expected at the Cerenkov angle if the nonlinear polarization travels faster than the emitted light.[2]

In our experiments a Nd:YAG mode-locked laser beam was focused to an intensity of 10^{12} W/cm^2 in a cell containing D_2O. We found that SCCE has the same circular or linear polarization as the laser. Any circular polarized light contains a small portion of counterrotating polarization. Due to a difference in nonlinear refractive index for different polarizations, the weaker polarization should be self-trapped before the stronger one resulting in a change of the output polarization to linear. This change occurs inside the filaments where saturation is maximal; it was observed for Raman emission originating in filaments. Since SCCE preserves the laser's circular polarization, it is generated in a nonsaturated region at the surface of the filaments. Next the laser beam was focused by a spherical or cylindrical lens. Emission from interior saturated parts of different filaments is spatially coherent and interferes to form an ellipse for cylindrical focusing as observed for class I Raman radiation.[3] Emission from the surfaces of different filaments does not preserve coherence due to the variation of the saturation degree across the surface; it sums up incoherently to produce a ring for any focusing mode. As SCCE has a ring form (Fig. 1) for both modes it does originate at the filament surface.

We found that the SCCE angle is independent of the lens focal length just as for class II Raman radiation. (Class I Raman cone angles are inversely proportional to the lens focal length.) This confirms that SCCE is a surface effect.

We propose a Cerenkov type process for SCCE: The laser-induced nonlinear polarization propagates with the laser-pulse group velocity v_{gr} resulting in emission at frequencies fulfilling the Cerenkov condition at an angle $\cos\theta = v_{ph}/v_{gr}$. Figure 2 shows the analogy between Snell's law and the Cerenkov effect. The role of a boundary is played by the self-trapped filament surface. Constructive interference occurs at a given angle θ for each Fourier component of nonlinear polarization. For normal dispersion $\cos\theta \cong n_L/n_c(\omega)$. n_L and n_c are refractive indices at the laser and emission frequencies. The Cerenkov condition $v_{ph} < v_{gr}$ or $n_L < n_c(\omega)$ is satisfied for 1.06-μm excitation and light emitted in the visible, predicting the SCCE frequency to increase with angle as observed. **(Poster paper)**

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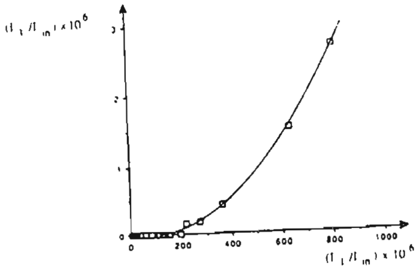
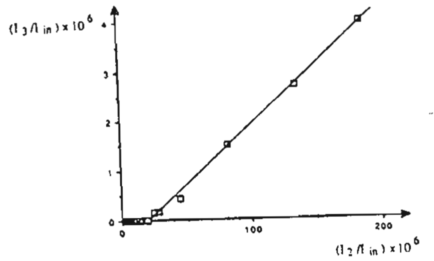
2. I. Golub, G. Erez, and R. Shuker, J. Phys. B **19,** L115 (1986); Opt. Commun. **57,** 143 (1986); I. Golub and R. Shuker, in *Technical Digest, Conference on Quantum Electronics and Laser Science* (Optical Society of America, Washington, DC, 1989), paper THGG3.
3. E. Garmire, Phys. Lett. **17,** 251 (1965).

Wednesday Posters continued on page 156

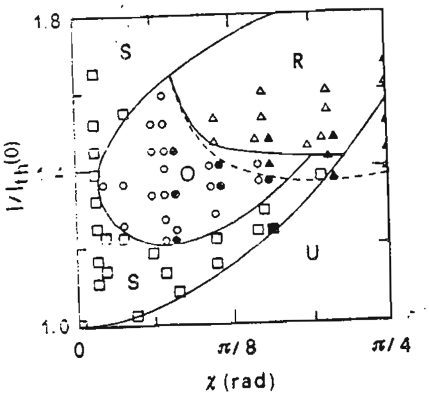


QWD19 Fig. 1. Measured power I_3 of the first diffracted beam is reported vs the transmitted pump beam power I_1 (squares). Both are normalized to the impinging power I_{in}. The continuous line represents a quadratic dependence.

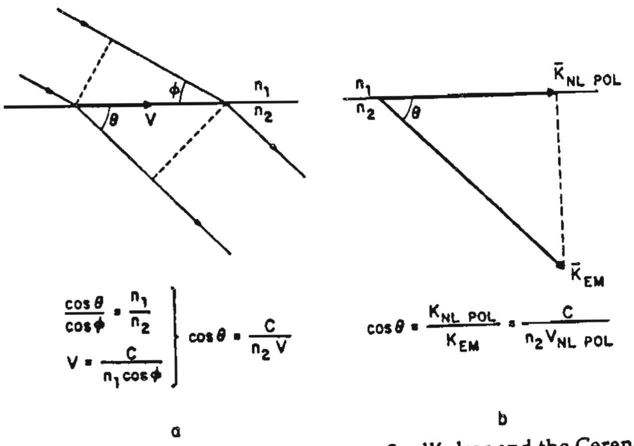


QWD19 Fig. 2. Measured power I_3 of the first diffracted beam is reported vs the transmitted signal beam power I_2 (squares). Both are normalized to the impinging power I_{in}. The continuous line represents a linear dependence.

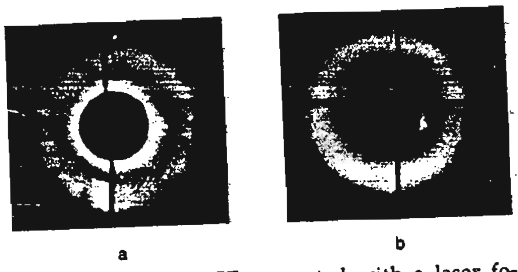
Poster Wednesday



QWD20 Fig. 1. Zone diagram in the χ-I plane for the observed dynamical regimes. $I_{th}(0)$ is the Freedericksz threshold intensity for linear polarization.



QWD21 Fig. 2. (a) Analogy between Snell's law and the Cerenkov effect. The point of intersection of a light pulse impinging on a boundary between two media moves with velocity $v = c/n_1 \cos\phi$. Combining this relation with Snell's law one obtains the Cerenkov relation, $\cos\theta = c/n_2 v$. (b) Cerenkov angle relation can be obtained from the conservation of the longitudinal component of the linear momentum at a boundary between two media along which a nonlinear polarization is propagating.



QWD21 Fig. 1. SCCE generated with a laser focused into D_2O by a spherical lens (a) or by a cylindrical lens (b). The focal line of the cylindrical lens is vertical.