QThO7 **6:15 pm**

Optical spatial shock waves in photorefractive media

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Shock waves have been extensively investigated in diverse areas of physics.[1] However, their occurrence in optics is rather rare (see for example refs. 2–5) and thus far no such optical structures have been experimentally observed. In this paper we report a new family of kink-antikink shock waves that is possible in unbiased photorefactive media via the two wave mixing process. These waves move together as locked states, and have the interesting property of moving outside their initial ±θ sector of propagation. The apparent direction of propagation and the spatial widths of these shock wave beams are directly related to their relative intensity. In what follows we provide a detailed analysis of these waves, and we will illustrate their behavior with pertinent examples.

Consider two co-directional planar beams referred to as *a* and *b*, propagating in the xz plane of a photorefractive crystal at angles +θ and –θ respectively. Being planar, we neglect any variation of these beams along y. The two beams are also assumed to be broad enough so as to neglect diffraction effects. In the absence of any external bias, these two optical wavefronts interact with each other via diffusion-induced two-wave mixing as described by the Kukhtarev-Vinetskii transport model.[6] The equations governing the intensities I_a and I_b of these two optical beams are given by:

$$\frac{\partial I_a}{\partial z} - \upsilon\frac{\partial I_a}{\partial x} - \gamma\frac{I_a I_b}{I_d + I_a + I_b} = 0 \qquad (1a)$$

$$\frac{\partial I_b}{\partial z} + \upsilon\frac{\partial I_b}{\partial x} + \gamma\frac{I_a I_b}{I_d + I_a + I_b} = 0 \qquad (1b)$$

Here, z is the propagation axis, υ the spatial "velocity" (υ = tanθ), γ the two-wave mixing power-coupling coefficient and I_d is the so-called dark irradiance. For convenience we will study these equations in a normalized fashion with $I_a(x,z) = rI_dX(x,z)$ and $I_b(x,z) = sI_dY(x,z)$ where *X* and *Y* are normalized functions bounded between 0 and 1. The shock wave pair is characterized by two infinite tails, and we assume symmetric boundary condition $Y(x,z) = 1 - X(x,z)$ i.e. $Y = 1$ when $X = 0$ and $Y = 0$ when $X = 1$. From these conditions and by assuming that both waves propagate together locked along a common coordinate $x - Vz$, one can then find the exact analytical solutions for the two shock intensities I_a and I_b. The apparent angle of propagation $\varphi = \tan^{-1}(V)$ and the spatial widths of these waves can also be analytically obtained in terms of relevant parameters. Moreover, we show that the apparent direction of propagation φ of these two beams is always outside the initial ±θ sector, and it is always closer to the direction of propagation of the beam with the highest intensity. Figure 1 and 2 show the propagation of such entities through a photorefractive crystal of the SBN type when $\gamma = 53.2\ cm^{-1}$ and θ = 1.4°. As shown in figure 1, the pair propagates undistorted at an angle of 4.19° that greatly exceeds the initial launch angle of 1.4°. Similar conclusions hold for Fig. 2. The stability of these shock waves will be finally discussed.

To conclude we have presented a new family of photorefractive shock-wave pairs. These kink like solutions are made possible via the two-wave mixing process, and propagate undistorted through the crystal even in the absence of any external bias.

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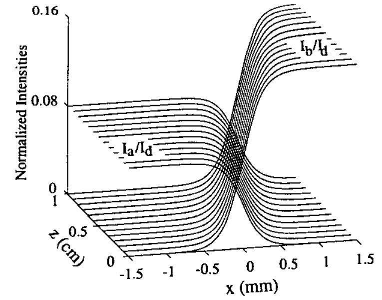
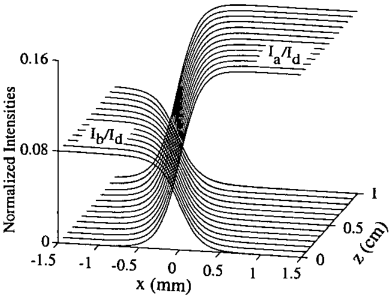


QThO7 **Fig. 1.** A shock-wave pair propagating in a SBN:75 crystal when r = 0.08 and s = 0.16.



QThO7 **Fig. 2.** A shock-wave pair propagating in a SBN:75 crystal when r = 0.16 and s = 0.08.

QThP **4:45 pm–6:30 pm**

Room 341/342

Intraband and Interband Effects

Michael Woerner, *Max Born Inst., Germany, Presider*

QThP1 **(Invited)** **4:45 pm**

Femtosecond Dynamics of Inter-Landau Level Excitations of a Two Dimensional Electron Gas in the Quantum Hall Regime

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The ultrafast optical response of systems with strong ground-state correlations, such as a two dimensional electron gas (2DEG) in the quantum Hall (QH) regime, is extremely difficult to describe and, in fact, still unexplored. The first study of electronic dephasing in the presence of a 2DEG in the QH regime was recently reported,[1] focusing on the excitation of the 2DEG within the lowest Landau level (LL). We present here the first investigation of the dynamics of the 2DEG inter-LL excitations.

Measurements were performed at $T = 1.7$ K, in magnetic fields $8 \leq B \leq 11.5$T, in an n-modulation doped GaAs/AlGaAs multiple quantum well (QW) sample with carrier density under illumination $n = 2.15 \times 10^{11}\ cm^{-2}$. Spectrally resolved FWM (SR-FWM) experiments were carried out with co-circularly polarized 100 fs laser pulses, tuned to excite varying amounts of the lowest LL (LL1) and the second LL (LL2). For comparison, measurements were performed on an undoped QW with similar parameters.

Fig. 1 compares a SR-FWM measurement of the doped (1a) and undoped (1b) QW's exciting both LL's equally (1 inset). In both cases we see a very pronounced beating vs. time delay, with a beat frequency corresponding to the LL energy separation. However, the striking feature is that there is no FWM emission from LL2 for the doped QW, despite the excitation of a considerable number of carriers into this level, whereas for undoped QW the beats are accompanied as expected by strong emission from both LL1 and LL2 in proportion to the excitation. The transfer of spectral weight from LL2 to LL1 implies a coherent process by which electrons are promoted to LL2, transfer to LL1 through an inter—LL 2DEG shake-up, and recombine from LL1. Furthermore, the total Δ*t*-domain beats of the LL1 emission also show that the 2DEG produces a strong Coulomb coupling between the two LL.

As shown in Fig. 2, the *LL2* → *LL1* spectral weight transfer is even more pronounced when the laser is tuned in resonance with LL2, with a