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**SOLITON MECHANISM OF OPTICAL ANISOTROPY  
PHOTOINDUCTION  
IN LAYERED MOLECULAR STRUCTURES**

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**Abstract.** A theory of the influence of linearly polarized light on ordering in layered molecular systems is given.

We consider a two-dimensional system of anisotropic molecules whose centers form a square lattice. Its orientational energy per unit area has the form

$$F = I(\nabla\varphi)^2 - \frac{1}{2}A \cos 4\varphi \quad (1)$$

where  $\varphi(\vec{r})$  is the angle between the large molecule axis and the coordinate axis  $X, I$  and  $A$  are positive energy constants. We will discuss the orientational distributions that characterized by fourth order symmetry axis (optical isotropic distributions). The simplest example of such a distribution is

$$\varphi = -\arctan \frac{\sinh \alpha y}{\sinh \alpha x}, \quad \alpha^2 = 2A/I \quad (2)$$

It is seen that this vortex-like structure may be regarded as an intersection of two mutually perpendicular  $\frac{\pi}{2}$ -kinks situated on the lines  $y = \mp x$ . When a molecular layer is irradiated by polarized light  $\vec{E}(\vec{r}, t) = \vec{E} \cos(Q\vec{r} - \omega t)$  ( $\omega$  is the electronic eigenfrequency of the layer) some molecules occur excited and in the orientational energy there are the terms that depend on the number of excited molecules

$$F_{int}(\vec{r}) = -\frac{1}{2}A_{ex}N(\vec{r}) \cos 4\varphi(\vec{r})$$

where  $A_{ex} \sim (\mu_{ex} - \mu_{gr})^2$  ( $\mu_{ex}(\mu_{gr})$  is the molecular dipole moment in the excited (ground) state),  $N(\vec{r})$  is the probability for finding the  $r$ -th molecule in the excited state. The order in the irradiated layer can be described by the equations [1]:

$$\begin{aligned} &I\nabla^2\varphi(\vec{r}) - (A + A_{ex}N(\vec{r})) \sin 4\varphi(\vec{r}), \\ &N(\vec{r}) = N_{ex} \cos^2(\varphi(\vec{r}) - \psi) \end{aligned} \quad (3)$$

where  $N_{ex} = (Ed)^2/(\Gamma\gamma)$  is the ratio of the number of excited molecules to the total number of molecules ( $d$  is the transition dipole moment,  $\Gamma(\gamma)$  is the transversal (longitudinal) rate of the excited state),  $\psi$  is the angle between  $\vec{E}$  and the X axis. The analysis of (3) shows

that under the light action the walls  $y = \pm x$  are moved to the new positions: in the vicinity of vortex center at  $\rho \leq 1$  ( $x = \rho \cos \theta$ ,  $y = \rho \sin \theta$ )

$$\theta = \pm \frac{\pi}{4} \mp \frac{N_{ex}}{32} (\alpha \rho)^2 \ln(\alpha \rho) \cos 2\psi;$$

far from the center at  $\vec{r}$  satisfying inequalities

$$1 < \sinh^2 \alpha x + \sinh^2 \alpha y < \exp\left(\frac{2}{N_{ex}}\right)$$

$$\sinh \alpha y = \pm \left(1 + \frac{N_{ex}}{8} \cos 2\psi \ln(\sinh^2 \alpha x)\right) \sinh \alpha x.$$

At  $x, y \rightarrow \infty$  the kinks are moved almost freely with constant velocity [1]

$$v = -\frac{5c^2 \alpha}{24\lambda\sqrt{2}} N_{ex} \cos 2\psi$$

where the parameter  $\lambda$  characterizes the dissipation process in the orientation system,  $c$  is the velocity of libration waves. The estimations show that e.g. in molecular Langmuir-Blodgett films  $v = 10^1 - 10^2 \text{ cm/s}$ . Thus as one areas reduce the others grow and optical anisotropy in the layer arises.

## References

- [1] Yu.B.Gaididei and A.S.Trofimov Journ.of Mol.Electronics 5(1989),239.