Director fluctuations in nematic LCs: simulations, issues and opportunities

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Even though nematic liquid crystals present an average order, the local fluctuation of the highly birefringent molecules induces considerable scattering that translate into optical losses or speckle formation. In this work, we use the de Gennes' theory of director fluctuation in nematic liquid crystals to model the refractive index modulations. Until now the de Gennes' theory has been used only to predict the variance of the director and the value of the order parameter, while in our case we use the complete co-variance matrix to generate correlated noise that will be able to predict the director fluctuations in much more detail [1]. In particular we are able to reproduce typical speckle patterns that appear when a laser beam travels through a typical nematic layer thickness of a few tens of micrometer (see figure 1).

In particular, we have applied this theory to model the propagation of spatial optical solitons in nematic LCs. It is well known that the beam path of spatial solitons fluctuates in time and this effect becomes even more pronounced at higher optical powers. With our model, not only the scattering losses of the optical soliton are predicted well. Also the beam path fluctuations as a function of optical power corresponds very well the measured data.

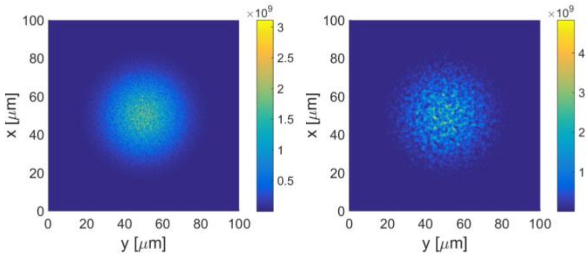

Figure 1. Transmission of visible (532 nm) light through a 50-μmthick cell for the case of uncorrelated (a) and correlated (b) thermal noise (reproduced from [1]).

The model can be used to predict other phenomena where director fluctuations has a strong influence of the propagation of light.

[1] S. Bolis, S.P. Gorza, S.J. Elston, K. Neyts, P. Kockaert, J. Beeckman, Spatial fluctuations of optical solitons due to long-range correlated dielectric perturbations in liquid crystals, Physical Review A, 96 (2017).