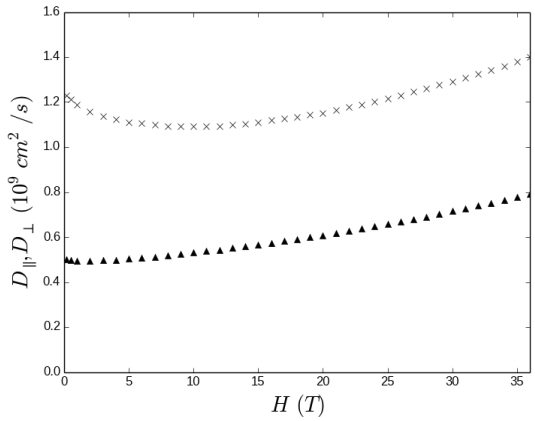
Simulation of radiation transfer and coherent backscattering in nematic liquid crystals

E. V. Aksenova,[1] D. I. Kokorin,[1,*] and V. P. Romanov[1]

1 Department of Physics, Saint Petersburg State University, Saint Petersburg, Russia

We consider the multiple scattering of light by fluctuations of the director in a nematic liquid crystal. Using methods of numerical simulation the peak of the coherent backscattering and the coefficients of anisotropic diffusion are calculated. The calculations were carried out without simplifying assumptions on the properties of the liquid crystal. The process of multiple scattering was simulated as a random walk of photons in the medium. We investigated in detail the transition to the diffusion regime. The dependence of the diffusion coefficients on the applied magnetic field and the wavelength of light were studied. The results of simulation showed a non-monotonic dependence of the diffusion coefficients on the external magnetic field. The observed behavior doesn't agree with results of approximate analytical calculations[1] which predict a smooth growth of both $D_{\parallel}$ and $D_{\perp}$.



Dependence of the diffusion coefficients of photons $D_{\parallel}$ (×) and $D_{\perp}$ (▲) on the magnetic field.

A qualitative explanation of this behavior was suggested using a simple scalar model.

For calculation of the peak of the coherent backscattering we used the semianalytical[2] approach as long as in nematic liquid crystals this peak is extremely narrow. Simulation shows that noticeable contributions to intensity peak are made by lower orders of scattering. These contributions are not described in the framework of the diffusion approximation.

The parameters of backscattering peak and of diffusion coefficients which were found in numerical simulations were compared with the experimental data[1][3][4] and the results of analytical calculation[1][5].

References:
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* presenting author; E-mail: dmitry@kokorin.org