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Random lasers using chiral nematic and smectic liquid crystals

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Random lasers, whereby the feedback occurs as a result of multiple scattering instead of a well-defined cavity, have been of interest in recent years as they exhibit a range of properties that are not readily achievable with conventional lasers [1]. In particular, the output from these lasers can occur in all directions and can be made to have a broad or narrow linewidth depending upon whether the modes are extended or localized. Liquid crystals are an excellent candidate for these lasers as they possess very strong scattering that can be controlled using external stimuli. In this presentation, results are presented on random laser emission in both the chiral nematic and smectic A phases demonstrating how the emission characteristics can vary when in the presence of electric fields [2 - 4]. It is found that, for multistable organosiloxane liquid crystals, the threshold for random lasing is lower when electro-hydrodynamic instabilities are present than for a static scattering state in the absence of an applied electric field, Figure 1 [3]. Results are also presented that show how the laser feedback mechanism can be controlled using chiral nematic liquid crystals that have a negative dielectric anisotropy. For low frequencies of a bipolar square wave, electrohydrodynamic instabilities result in random laser emission due to the multiple scattering of light whereas band-edge lasing is observed at high frequencies of the applied electric field where the helicoidal structure is stabilized through dielectric coupling [4].

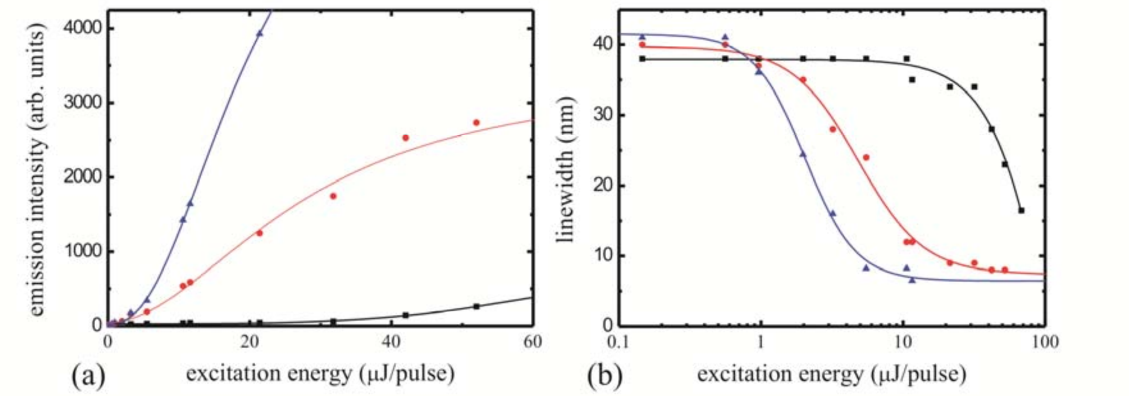

Figure 1. Emission characteristics of the dye-doped smectic A sample for the three different states: transparent (squares), static scattering (circles), and dynamic scattering (triangles) (a) the peak emission intensity as a function of excitation energy and (b) the full-width at half maximum (FWHM) as a function of excitation energy. The lines in (b) represent sigmoidal fits to the experimental data.

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