The CU Department of Physics Presents...

Special Physics Colloquium

Ivan Smalyukh

University of Illinois at Urbana-Champaign

"Probing and Controlling Order in Soft Matter"

Abstract: Future technologies and devices require materials with well-controlled periodic structures in the nanometer and micrometer ranges, as well as with properties such as optical anisotropy and mechanical flexibility. Ordered soft materials can meet all of these requirements, can respond to low external fields, and can be manipulated by light. This makes them ideal for tunable photonic and all-optical applications, which, however, critically depend on finding the means to control the molecullar and colloidal self-organization as well as on the knowledge of the underpinning physical phenomena. This lecture will discuss optical non-contact control and three-dimensional imaging of self-organized structures in anisotropic soft materials such as liquid crystals and biopolymers. The focused laser beams can generate polarization-controlled optical forces in these media. Unlike in isotropic fluids, colloidal particles can be set to follow well-controlled trajectories solely by changing the polarization state of a stationary-focused laser beam. This polarization-controlled motion of a colloidal particle into or away from the focused beam can be navigated over distances much larger than the particle's radius, because of the "corona" of well-defined molecular alignment and of the effective refractive index around the bead. Polarized-state optical manipulation is possible even in single-component materials with homogeneous chemical composition but spatially-varying molecular orientations and is applied to defects and self-organized structures. Moreover, when the laser beam's intensity exceeds the threshold for the optically-induced realignment, a variety of localized structures can be first optically generated and then spatially translated and organized into superstructures such as periodic arrays. To visualize the three-dimensional patterns of molecular orientations, the fluorescence confocal imaging is performed with a well-controlled polarization states of probing light as well as the used dye molecules follow orientations of the material's host molecules. Optical imaging and trapping techniques provide insights into the physical mechanisms behind the self-organized periodic structures in materials ranging from liquid crystals to DNA biopolymers. The optically-directed periodic structures have a potential for applications in all-optical devices, tunable photonic crystals, and for optical data storage.

Monday, March 19

4:00 PM

Duane G125

3:45 p.m.—Refreshments in G125