**Phase Behavior of Lyotropic Chromonic Liquid Crystal Mixtures**

**Abstract:**
The goal of this study about the mixtures of lyotropic chromonic liquid crystals (LCLCs) is to understand the phase behavior of LCLCs including such properties as orientational and positional orders. The study is particularly important because it provides rich information about molecular interactions in condensed phases and it is expected to help an understanding of the primordial behaviors of DNA self-assembly and sequencing.

**Prospectus:**
LCLCs are usually formed when the disk-like molecules dissolved in water stack to form rod-like aggregates. The three phases – called isotropic, nematic, and columnar phases – are observed depending on the degree of the molecules’ orientational and positional order. Based on the similarities of hydrophobic interaction and stacking of bases between the DNA and LCLCs, we hypothesize that the mixtures of LCLCs are expected to be able to form a long polymer composed of columns of molecules.

This research was started for the purpose of understanding the primordial formation of DNA or RNA using much simpler organic molecules, liquid crystals. One of the ideal goals of this project is to make a long polymer composed of the columns of liquid crystal molecules which is analogous to the DNA structure.

In the beginning of this project, I focused on the mixture of Sunset Yellow FCF (SSY) (well known as a food dye), and disodium cromoglycate (DSCG) (used for the treatment of asthma), with water. In order to study the phase behaviors of SSY and DSCG, and their mixtures, I observed the textures of the mixtures of LCLCs based on the visual observation with polarized light microscopy. A ternary phase diagram was made to report the complete phase behavior of SSY and DSCG mixtures. By varying the concentration of each dye and water, mainly seven different types of phase coexistence were observed. In an isotropic phase, no clear phase separation of the two dyes was observed. The phase separation was observed in most nematic and columnar phase mixtures.

As a subsequent step, I will focus on the mixture of SSY and PDMAEMA (Poly(2-dimethylamino)ethyl methacrylate methyl chloride quaternary salt), well known as a gene delivery polymer, with water. The PDMAEMA salt is cationic in solution and SSY is anionic, which enables pairs to form complexes which have an overall geometry similar to DNA. These complexes will be explored for liquid crystal behavior.

For the further investigation, the spectroscopic information of each LCLCs and the mixtures will be studied and other LCLCs mixtures will be observed; to contextualize this work, the earlier studies of SSY, DSCG, and PDMAEMA done by Lydon and Heung-Shik Park [1-3] would be referenced.
Bibliography:


Timeline:

By January 27:
- Goal 1: Start making mixtures of PDMAEMA and Sunset Yellow (SSY)
- Goal 2: Revise the SSY and DSCG Phase diagram

By February 10:
- Goal 1: make a brief phase diagram of PDMAEMA and SSY mixture
- Goal 2: 

By February 24:
- Goal 1: make a detailed phase diagram of PDMAEMA and SSY mixture
- Goal 2: Start preparation for the presentation at APS March meeting

By March 10:
- Goal 1: Start observing SSY and DSCG mixture local concentration
- Goal 2: Keep making a phase diagram of PDMAEMA and SSY mixture

By March 24:
- Goal 1: SSY and DSCG mixture local concentration observation
- Goal 2: 

By April 7:
- Goal 1: Finish SSY and DSCG mixture local concentration observation
- Goal 2: 

By April 21:
- Goal 1: Start making DSCG and PDMAEMA mixture
- Goal 2: 

Dates: (Estimation)
5/19/2014 any crucial milestone that it will be important to plan in advance to meet
8/1/2014 complete main research activities
8/4/2014 start writing thesis
9/15/2014 provide initial draft to advisor for feedback
10/20/2014 provide polished thesis to committee that incorporates research advisor’s feedback (>1 week prior to defense)
11/10/2014 defend thesis