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ON REGULARITY AND DECAY OF THE SOLUTIONS TO A LIQUID CRYSTAL SYSTEM.

The flows of nematic liquid crystals can be treated as slow moving particles where the fluid velocity and the alignment of the particles influence each other. The hydrodynamic theory of liquid crystals was established by Ericksen and Leslie in the 1960s. As Leslie points out in his 1968 paper: liquid crystals are states of matter which are capable of flow, and in which the molecular arrangements give rise to a preferred direction.

In this talk I will consider the simplified model for the flow of nematic liquid crystals:

$$\begin{aligned} \rho_t + \nabla \cdot (\rho u) &= 0, \\ (\rho u)_t + \nabla \cdot (\rho u \otimes u) + \nabla p &= \triangle u - \nabla \cdot (\nabla d \otimes \nabla d) \\ d_t + u \cdot \nabla d &= \triangle d - f(d) \\ \nabla \cdot u &= 0 \end{aligned} \tag{0.1}$$

Here $u = u(x,t)$ is the velocity, $\rho = \rho(x,t)$ is the density, $p = p(x,t)$ is the pressure and, $d = d(x,t)$ is the director field. The function f is given as the gradient of $F(d)$ the penalty term of the Ginzburg-Landau approximation, where

$$F(d) = \frac{1}{4\eta^2}(|d|^2 - 1)^2, \quad f(d) = \nabla F(d) = \frac{1}{\eta^2}(|d|^2 - 1)d.$$

In my lecture I will discuss the regularity and the asymptotic behavior of as system of liquid crystals equations in two and three dimensions. The results in two dimensions are for large data. In three dimensions for existence the data will be small, in case of large data we obtain the existence only for short time. For decay I will consider the model with constant density.

Date: October 11, 2013.