1. Abstract

My primary interests are in asympotics and complex variable methods, and their applications, mostly in fluid dynamics. Recently, with collaborators, I have been involved in thin-film fluid flows.

There is a wide range of industrial and engineering systems where thin films are used for cooling micro-electronic components or as evaporators in chemical reactions; coating flows of magnetic storage media, electro-statically induced self-assembly or self-consgtruction for micro-lithography. For instance, a thin-film model incorporating multiple thin layers is of the following form in one space dimension is

$$\boldsymbol{\eta}_t + \mathbf{A}\boldsymbol{\eta}_x + \mathcal{L}\boldsymbol{\eta} + \nu\mathbf{D}_0\boldsymbol{\eta}_{xxxx} = 0 \ , \tag{1}$$

where $\boldsymbol{\eta} = (\eta_1, \eta_2)$ and $A_{j,k} = \alpha_{j,k} + \beta_{j,k}\eta_1 + \gamma_{j,k}\eta_2$, $\mathbf{D}_0$ is some constant matrix and $\mathcal{L}$ is some general linear but non-local operator. Like any dynamical system, one wishes to settle questions of global existence or singularity formation, determine steady or periodic solution sets and determine their stability.

We will give examples of problems in this class, their derivation and give a flavor of the kind of mathematics involved and their physical consequences.