Suggested title of dissertation:

Evolution of thin liquid films

Dissertation supervisor:

Prof Jim Oliver

Description of the proposal:

Thin liquid films are ubiquitous in the sciences, with applications ranging in scale from microfluidics to the motion of continental ice sheets. The evolution of thin liquid films is typically modelled by one or more highly nonlinear partial differential equations, the film thickness being one of the dependent variables. The asymptotic and numerical analysis of such systems has attracted an immense amount of attention in the literature. The aim of this project is to present a unified account of one or more strands of the literature emanating from the two review articles listed below (under Useful Reading).

Possible avenues of investigation:

The project could begin with a review of the application of lubrication theory, followed by an asymptotic and/or numerical analysis of the evolution of thin liquid films driven by, for example, body forces, thermal effects, intermolecular forces, surfactants, substrate geometry, mass transfer and/or or the presence of a contact line.

Pre-requisite knowledge:

Essential: Material from courses such as B5.3 (`https://courses.maths.ox.ac.uk/node/36404`) and C5.5 (`https://courses.maths.ox.ac.uk/node/36885`).

Recommended: Material from courses such as B5.2 (`https://courses.maths.ox.ac.uk/node/36395`), B5.4 (`https://courses.maths.ox.ac.uk/node/36410`), B5.6 (`https://courses.maths.ox.ac.uk/node/36426`) and C5.7 (`https://courses.maths.ox.ac.uk/node/36918`).

Useful reading:

- R.V. Craster & O.K. Matar. Dynamics and stability of thin liquid films. Reviews of Modern Physics 81(3) 1131-1198 (2009).
- A. Oron, S.H. Davis & S.G. Bankhoff. Long-scale evolution of thin liquid films. Reviews of Modern Physics 69(3) 931-960 (1997).

Further references:

- D. Bonn, J. Eggers, J. Indekeu, J. Meunier & E. Rolley. Wetting and spreading. Reviews of Modern Physics 81(2) 739-805 (2009).
- J.H. Snoeijer & B. Andreotti. Moving contact lines: scales, regimes, and dynamical transitions. Annual Review of Fluid Mechanics 45:262-292 (2013).