

Proposal for MAST and 4th year dissertations

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Fluids play an important role in our everyday lives, from the flow of air around a Formula 1 car to the lift experienced by an airplane wing. A fundamental model for the flow of certain incompressible fluids is the "Navier-Stokes equations", which are a partial differential equation conceived almost 200 years ago.

Despite being widely used in applications today, the rigorous mathematical understanding of the Navier-Stokes equations remains unsatisfactory. It is not clear if these equations give mathematically rigorous predictions that are consistent with physical reality. There is an award of 1 million dollars for understanding if the Navier-Stokes equations remain smooth for all times or develop a singularity corresponding to the (unphysical) development of an infinite magnitude of the fluid's velocity field.

The mathematically rigorous investigation of the Navier-Stokes equations was initiated by Leray almost 90 years ago. In this dissertation you will review and refine certain classical results in the rigorous mathematical theory of the Navier-Stokes equations.

This dissertation topic would be ideal for anyone who has taken/planning to take (and enjoyed) the following modules.

- **year 3:** Theory of PDEs, Functional Analysis 1-2
- **year 4** Advanced PDEs, Topics in PDEs, Advanced Real Analysis, Fourier Analysis.