Dynamics and stability of a thin liquid lithium flow within a tokamak divertor

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Fusion power offers the possibility of providing all of the world’s energy needs without producing dangerous radioactive waste or environmentally harmful CO$_2$ emissions. In a tokamak fusion reactor, magnetic coils trap extremely hot (over $10^8$ K) plasma (ionised gas) inside a toroidal vessel. The effective operation of a tokamak is limited by the ability to remove fusion products and impurities while the reactor is operating. This waste removal is achieved by the divertor, which must be able to capture unwanted ions while withstanding high temperatures and magnetic fields. The most promising way of protecting the divertor is to coat the wall with a thin layer of liquid lithium metal which is constantly recycled.

The aim of this project is to mathematically model the flow of the lithium layer in a divertor subject to very large gradients in temperature and magnetic field. The flow of liquid metal is governed by Magnetohydrodynamics (MHD), which combines Maxwell’s equations of electromagnetism with the Navier–Stokes equations of fluid dynamics. The first task will be to use scaling analysis and lubrication theory to simplify the full MHD equations and boundary conditions. The resulting reduced model will then be analysed and solved numerically. The model will be used to determine the conditions under which the lithium flow may become unstable, possibly leading to drying out of the film and catastrophic failure of the divertor. The ultimate aim is to optimise the geometry of the divertor to guarantee a robust lithium film and maximise the removal of waste products.

- This 4-year ICASE studentship offers an enhanced stipend of £16,296 per annum.
- The student will spend at least three months at Tokamak Energy, participating fully in the experimental and modelling efforts.
- The start date for the project is 1 October 2016.
- The closing date for applications is 28 July 2016.
- For further information visit [https://www.maths.ox.ac.uk/node/16408](https://www.maths.ox.ac.uk/node/16408)