STRATHCLYDE PHYSICS: FOURTH YEAR PROJECT PROPOSAL
PH 450 and PH 550
(Form for new or revised project descriptors.)

Project Title: Simulation of electromagnetic waves in magnetized plasmas

Project Area: Plasmas (delete as appropriate)

Project Supervisor (1): Bengt Eliasson

Project Supervisor (2): Kevin Ronald, David Speirs

Project Description: Plasmas are ubiquitous in space and laboratory. The Earth is surrounded by a plasma layer, the so-called ionosphere, which shields us from radiation and energetic particles from the sun, and in the laboratory, plasmas are artificially created and studied with application to magnetic confinement fusion and basic research. A plasma is an ionised gas in which there are free electrons and ions so that the gas is electrically conducting. The Earth's ionosphere is magnetized by the geomagnetic field, and in the laboratory, an external magnetic field is used to confine the plasma and prevent it from escaping to the walls. The plasma changes the propagation characteristics of electromagnetic waves, and the magnetic field breaks the symmetry and makes the plasma anisotropic. Electromagnetic waves such as radio waves can be reflected from and interact with the plasma in the ionosphere, and microwaves are used to study artificially created plasma in the laboratory. The plasma and the magnetic field also introduces a number of new wave modes in addition to the usual electromagnetic waves in vacuum. Hence, the propagation of electromagnetic waves into a plasma is a non-trivial problem.

The project aims at building a numerical model of the propagation of electromagnetic waves into a magnetised plasma, to study the propagation and nonlinear interactions between the electromagnetic wave and the plasma. Through similarity principles, the physics of a plasma can be scaled so that ionospheric physics with length-scales of the order 10 km or more can be studied in the laboratory with length-scales of the order 1 m, and vice versa. Hence, the project has relevance to the study of microwaves propagating into magnetically confined plasma (an experiment currently under construction at Strathclyde), as well as to existing experiments involving radio waves injected into ionospheric plasmas from ground-based transmitters or from satellites surrounding the Earth and other planets in the Solar system. Experience with programming in Matlab or other simulation languages is beneficial.

Key Reference (if applicable): Bengt Eliasson: Full-scale simulations of ionospheric Langmuir turbulence. Modern Physics Letters B 27(8), 1330005 (27 pages), doi:10.1142/S0217984913300056 (2013).

Ratio of effort: Exp/Theo/Comp	**Exp:**	**0%**
	Theo:	**30%**
	Comp:	**70%**

Suitability: **MPhys BSc BSc (Phys with Teaching) BSc (Maths Physics)**

***For MPhys students the project should be designed to last for two years**

Additional comments:

Safety Training Requirements: N/A