ESI SENIOR RESEARCH FELLOW LECTURE COURSE
Winter Term 2016/17

The Erwin Schrödinger International Institute of Mathematics and Physics (ESI) of the University of Vienna offers the following Lecture Course held by a Senior Research Fellow in residence during the Winter Term 2016/2017:

Theoretical fluid dynamics and oceanic flows
Robin S. Johnson (Newcastle University)

Lecture Course (250 059 VU): October to December 2016
Tuesday 9:30 - 11:30 hrs
Start: October 11, 2016
There will be an extra lecture on Monday, October 31, 2016, 9:30 - 11:30 hrs.
End: December 13, 2016

Problem Class: October to December 2016
Thursday 9:30 - 10:30 hrs
Start: October 6, 2016
There will be an extra and final Problem Class on Friday, December 9, 2016, 9:30 - 10:30 hrs.

Note there will be no activities in the period November 1 - 22, 2016.

Venue: ESI, Schrödinger Lecture Hall

Background:

The study of the flow of fluids has a long and illustrious history, with strong links to both pure and applied mathematics, and to physics and engineering. At the theoretical level, we are beginning to understand, in depth, some of the processes involved in the motions of fluids in many different contexts: pipes and arteries, rivers, oceans, the atmosphere, and much more. However, in order to undertake an investigation in any one of these areas requires a significant grounding in the mathematics of fluid flows. With this in place, a study of a more specific nature is possible. So, for example, we can begin the process of examining the mathematical issues that pertain to ocean flows. This is one application, which only in recent years has begun to show some successes, that has been made possible, to a large extent, by the explosion in the available data. Even so, a comprehensive mathematical approach is quite beyond us: oceanographers often have to resort, by necessity, to much ad hoc modelling.

The flows associated with our oceans are obviously complex; they are affected by the winds at the surface, large- and small-scale currents, considerable areas of upwelling or downwelling, thermal and saline variations, variable bottom topography, and more. However, in some regions of some oceans, the observed flows follow a more well-ordered pattern; one such is the flow in the neighbourhood of, and along, the Pacific Equator, and another is the only fully circular flow on Earth: the Antarctic Circumpolar Current. The first example, which

includes a complicated vertical structure, is highly nonlinear, three-dimensional and contains a thermocline, but is amenable to a mathematical approach based on classical theoretical fluid dynamics; for the second type of flow, we have only recently found that a mathematical description (in spherical coordinates on a rotating Earth) can be attempted. This course will introduce all the basic and relevant ideas of theoretical fluid dynamics, define the classical water-wave problem, and then describe and analyse some oceanic flows.

Course outline:

The material to be covered is provided in the syllabus (see below); primarily, the ideas will be presented via a set of lectures, but additional calculations, and associated examples, will be described in the problem classes. Handouts will be available at the start of each lecture and problem class, and a full text of all the material, in extended form, will be available at the completion of the course.

1. Basic ideas and governing equations
2. The classical water-wave problem I
3. Asymptotic expansions
4. The classical water-wave problem II
5. Oceanic flows

For further details see the course website:
http://www.esi.ac.at/activities/events/2016/robin-johnson-senior-fellow-course-2016

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