ESI Erwin Schrödinger International Institute for Mathematics and Physics

universität wien

DVR 0065528

Colloquium Talks

Prof. R. S. Johnson

School of Mathematics, Statistics and Physics

Newcastle University, UK

Physical oceanography: the applied mathematical approach

Wednesday, February 21, 2018

at 14:00 h & 15:10 h

ESI, Boltzmann Lecture Hall

I Introduction

Abstract: We describe the general background to problems in mathematical oceanography, presenting the Navier-Stokes equation, mass conservation equation and boundary conditions in spherical coordinates for a rotating Earth. The relevant non-dimensionalisation is introduced, producing a shallow-water (thin-shell) parameter. As an aside, the tangent-plane approximation is briefly described. We complete this introduction by providing a physical description of some oceanic flows that are amenable to the classical methods of fluid mechanics.

II Examples

Abstract: We expand on the three main examples mentioned in I, but in the context of an inviscid fluid. (At the end, time permitting, we will indicate the progress currently being made with problems that include viscosity.) The first example looks at two different aspects of the Equatorial Undercurrent (EUC), a flow that is present along the Pacific Equator; this is treated as an exercise a simple test-piece because it uses the tangent-plane approximation. We will first outline the problem of linear waves propagating on the surface and on the thermocline and then, more excitingly, show that this reduced system accommodates, for slow evolution in the equatorial direction, some quite intriguing, but accessible, nonlinear, three-dimensional solutions. We then present two exact solutions of the full governing equations; one relates to the EUC and the other to the Antarctic Circumpolar Current. Finally, we show that the shallow-water (thin-shell) approximation can be used to find solutions that represent large gyres on the surface of a rotating sphere.

A. Constantin

February 9, 2018