



Einladung zur öffentlichen Defensio

Luigi ROBERTI

Thema der Dissertation

Mathematical aspects of geophysical fluid flows

Abstract:

This thesis builds upon six articles on various topics of mathematical Geophysical Fluid Dynamics (GFD), preceded, in the first chapter, by an introduction which provides the necessary background and an overview of GFD.

The second chapter deals with the oceanic Ekman layer—the relatively thin boundary layer at the top of the ocean, where horizontal pressure-gradient and rotational (Coriolis) forces are balanced by frictional forces due to the wind—in the f -plane approximation, a tangent-plane approximation that permits the use of local Cartesian coordinates. On the one hand, a perturbative approach to the ODE model for steady Ekman flows leads to a quantitative result regarding the angle between the surface current and the generating wind. On the other hand, by means of the Laplace transform, we study the evolution and long-time dynamics of the surface current in the setting of unsteady Ekman flows with time-dependent generating wind and time-dependent (but uniform-in-depth) eddy viscosity.

The third chapter focuses on oceanic flows in spherical coordinates, more specifically on models derived by means of the so-called *thin-shell approximation*, which takes advantage of the small aspect ratio of the ocean to simplify the governing equations while retaining the effects of spherical geometry, and which is applied in two different settings. First, we are concerned with an unsteady model (with constant density) for the Antarctic Circumpolar Current (ACC). After we establish the existence and uniqueness of classical solutions to this model, we show, by using conserved quantities to construct a Lyapunov function, that a certain family of steady solutions—which, under a suitable choice of parameters, closely fits observations of the average velocity field of the ACC—is Lyapunov stable. Then, we investigate steady gyre flows with variable density using elliptic comparison principles, which yield quantitative estimates on the pseudo stream function.

Finally, in the fourth chapter, we discuss the well-posedness of a model—which can be reduced to a semilinear parabolic equation with nonlocal nonlinearities—that describes a

remarkable atmospheric phenomenon known as the ‘morning glory’ cloud pattern. Rewriting the problem as an abstract parabolic problem in an appropriate functional analytic setting, we prove a local strong well-posedness result, then, by means of a Galerkin approximation scheme, we establish the existence of global weak solutions, in a suitable sense, and finally we apply some recent abstract theory for semilinear parabolic equations to prove global well-posedness for the homogenous problem with small initial data.

Prüfungssenat

Univ.-Prof. Mag. Dr. Andreas Cap
(Vorsitz, Universität Wien)

Univ.-Prof. Adrian Constantin, PhD
(Universität Wien)

Prof. Dr. Samuel Walsh
(University of Missouri)

Prof. Dr. Evgeniy Lokharu
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Zeit und Ort

Dienstag, 22. Juli 2025, 16:00 Uhr

Online:

<https://univienna.zoom.us/j/62007185864?pwd=4vgXrAzPNUKjl3tPjwbXV3jY6oenQh.1>

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