Universität Hamburg
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Fakultät für Mathematik, Informatik
und Naturwissenschaften
Fachbereich Mathematik

Lothar-Collatz-Kolloquium für Angewandte Mathematik

Donnerstag, den 23. November 2023, um 17:15 Uhr, im Hörsaal 5

Dr. Bin Cheng*
(University of Surrey, Department of Mathematics)

"Near resonant approximation in Geophysical Fluid Dynamics"

Zusammenfassung/Abstract:

Consider the rotating stratified Boussinesq system on three-dimensional tori with arbitrary aspect ratios, a well-studied model for GFD and foundation to the dynamic core of operational weather forecast. The quasi-geostrophic approximation of this system, introduced by Charney, captures the slow dynamics governing potential vorticity, up to an error at the order of the Rossby/Froude numbers. Fast inertia-gravity waves are filtered out based on the convention that they are "too fast", hence having negligible effect on the slow PV part. GFD literature however has seen counterexamples. In this mathematical study using rigorous PDE analysis, we introduce a novel treatment of near resonance that no longer fully neglects fast waves, and instead capture the important portion of the nonlinear wave interactions selected using NR criteria. We prove global existence for the proposed NR approximation with a key technique being a sharp counting of the relevant number of nonlinear interactions -- such counting is tied to the nonlinear estimates on the advection terms. An additional regularity advantage arises from a careful examination of some slow/fast mixed type interaction coefficients. In a wider context, the significance of our near resonant approach is a delicate balance between the inclusion of more interacting modes and the improvement of regularity properties, compared to the well-studied singular limit approach based on exact resonance.

We have a similar NR approximation applied to the rotating Navier-Stokes equations (without stratification) but with crucial differences which seem to make this an easier case.

Joint work with Zisis N. Sakellaris

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Stand: 03.11.2023 (Katrin Kopp)