THE GRADUATE SCHOOL
of
THE UNIVERSITY OF COLORADO AT BOULDER

DISSERTATION DEFENSE
of

Amrik Sen

FOR THE DEGREE

DOCTOR OF PHILOSOPHY

Date/Time: December 16, 2013 from 14:00 hrs

Bldg./Rm: ECOT 831

Examining Committee Members:
Annick Pouquet, Keith Julien, Pablo D. Mininni, Tom Manteuffel and Bengt Fornberg

OUTLINE OF STUDIES

Major Field: Applied Mathematics

BIOGRAPHICAL NOTES

Amrik Sen was born and raised in India. He obtained his Baccalaureate in Electrical Engineering from the National Institute of Technology, Silchar in India.

He is currently a doctoral candidate in the Applied Mathematics department at the University of Colorado at Boulder. His research interests include fundamental investigation of wave dynamics in turbulent fluid systems as applied to geophysical and planetary dynamics.

Outside research, he is an accomplished sportsman and an avid reader. He enjoys interacting with students both at the university and high schools around Boulder, on topics relating to mathematics and physics. He is well traveled around the world and loves to learn about different cultures and cuisines.

THESIS

Complete title of thesis:
A Tale of Waves and Eddies in a Sea of Rotating Turbulence

Chair of Dissertation Committee: Annick Pouquet

Faculty Advisors: Annick Pouquet and Keith Julien

ABSTRACT

In this thesis, we investigate several properties of rotating turbulent flows. First, we ran several computer simulations of rotating turbulent flows and performed statistical analysis of the data produced by an established computational model using Large Eddy Simulations (LES). This enabled us to develop deeper phenomenological understanding of such flows, e.g. the effect of anisotropic injection in the power laws of energy and helicity spectral densities, development of shear in specific rotating flows and evidence of wave-vortex coupling. This served as a motivation for detailed theoretical investigations. Next, we undertook a theoretical study of nonlinear resonant wave interactions to deduce new understanding of rotating flow dynamics. The latter analysis pertains to the highly anisotropic regime of rotating flows. To the best of our knowledge, the application of wave-turbulence theory to asymptotically reduced equations in the limit of rapidly rotating hydrodynamic flows is presented here for the first time and aims to further our understanding of highly anisotropic turbulent flows. A coupled set of equations, known as the wave kinetic equations, for energy and helicity is derived using a novel symmetry argument in the canonical description of the wave field sustained by the flow. A modified wave turbulence schematic is proposed and includes scaling law solutions of the flow invariants that spans a hierarchy of slow manifold regions where slow inertial waves are in geostrophic balance with non-linear advection processes.