The 5th Bremen Winter School and Symposium "Dynamical systems and fluids"
Universität Bremen, March 27-31 2017
Abstracts of the main courses

1. **Mariana Haragus** (*Université de Franche-Comté, Besancon, France*)
Local bifurcations and reduction methods in reversible systems. Application to water-wave models
Starting with the simplest bifurcation problems arising for ordinary differential equations in one and two dimensions, the purpose of these lectures is to describe several tools from the theory of infinite-dimensional dynamical systems, allowing to treat more complicated bifurcation problems, as for instance bifurcations arising in partial differential equations. Such tools are extensively used to solve concrete problems arising in physics and natural sciences. We focus on two specific methods, namely the center manifold reduction and the normal form theory. We illustrate these methods on different water-wave models.

2. **Edgar Knobloch** (*University of California Berkeley, USA*)
Rotating convection
In this series of lectures I will describe basic properties of Boussinesq convection in a rotating horizontal layer, starting from the primitive equations. In lecture 1 I will discuss in the linear and weakly nonlinear theories for steady convection and for standing and traveling waves (for low Prandtl number convection) in the plane.
I will discuss modifications when the domain is a rotating circular cylinder and the distinction between body and wall modes. In lecture 2 I will discuss spatially localized structures in this system. In lecture 3 I will discuss the properties of geostrophic turbulence that is present at large Rayleigh numbers in the limit of low Rossby numbers (the rapid rotation limit).

3. **Lev Lerman** (*Lobachevsky University of Nizhny Novgorod, Russia)*
Hamiltonian dynamics and fluid motions
Lecture 1. “Introduction to the dynamics of Hamiltonian systems”
In the lecture some background needed to understand what Hamiltonian systems are, the sources of their appearance in mathematics, their special structure and why they require special tools for the study, the main geometric base for studying Hamiltonian systems, which classes of Hamiltonian systems are more or less studied by now.
Lecture 2. Soliton-type topics in Hamiltonian systems: homo- heteroclinic orbits and around them. I shall discuss possible types of homoclinic structures in Hamiltonian dynamics, how they depend on the type of equilibria (periodic orbits, invariant tori), problems from physics leading to the study of such behavior.
Lecture 3. “Two-dimensional hydrodynamics and Hamiltonian systems” Two-dimensional fluid motions can be described by the related equation for the stream function. This function is a Hamiltonian of the system in the ideal two-
dimensional hydrodynamics. Some other models from hydrodynamics leading to the study of Hamiltonian systems (interaction of vortices, etc.). Elliptic PDEs which arise as models of these Hamiltonians, patterns in such equations.
Lecture 4. “Advection and transport: applications of Hamiltonian dynamics.” We discuss briefly some models of the transport of passive impurity along two-dimensional Hamiltonian flows, how this model arises and some conclusions that can be extracted from this description.