VISIT TO UIB, FEBRUARY AND MARCH 2022

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The main goal of my current research is to introduce uncertainty into the classical water wave theory. The latter has a long history and is still under development conducted both by mathematical and engineering communities. It concerns the evolution of the surface waves in the ocean. Many different phenomena were explained, such as wave breaking and tsunami stability. However, when it comes to prediction of particular behaviour of the ocean, it turns out that we may lack data needed for exploiting the water wave models. At the coarse scale one may rely on the classical equations, whereas uncertainty at the fine scale can be introduced through a random flow.

Turbulent effects are introduced via the stochastic Lagrangian flow $\boldsymbol{X}_t$ defined by the decomposition

$$d\boldsymbol{X}_t = \boldsymbol{u}(\boldsymbol{X}_t, t)dt + \boldsymbol{\sigma}(\boldsymbol{X}_t, t)d\boldsymbol{B}_t.$$

Here $\boldsymbol{u}$ is the large-scale velocity component at the point $\boldsymbol{X}_t$. The small-scale component $\boldsymbol{\sigma}(\boldsymbol{X}_t, t)d\boldsymbol{B}_t$ is a centered Gaussian process. In our recent work [5] we have showed how such random extension of the fluid kinematic description can lead to a generalisation of the well-known Craig-Zakharov formulation of the water wave problem. The latter can be used for deriving different asymptotic models in the long wave regime. Analysis of the corresponding stochastic dispersive equations is of an increasing interest nowadays, see for example [1, 2, 3].

The main objective of my visit to the University of Bergen was to continue our collaboration with professor H. Kalisch. During my stay we had many fruitful discussions on particle movement under surface gravity waves, Stokes drift and wave breaking. Those phenomena that are affected by the turbulence first of all. We also had an opportunity to finish an old project [4].

With professor S. Selberg we have found some common interests in analysis of stochastic dispersive equations and so we started to work on a particular extension of the so called Dirac-Klein-Gordon system.

As a part of the research program, I gave a series of lectures on L^2 theory of the stochastic nonlinear Schrödinger equation [1]. The goal of the course was to give an introduction to the contemporary theory of stochastic nonlinear dispersive equations by focusing on a particular example. The main techniques covered by the course were truncation of nonlinearity, use of stopping times and of dispersive estimates.

I would like to thank the University of Bergen for providing me with excellent working conditions. My special thanks are to my host, professor Henrik Kalisch, for his kind help in organizing my visit.

References

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