Special Issue Dedicated to Kristian B. Dysthe

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On the 16th of September 2017, Kristian Dysthe celebrated his 80th birthday, and in November of that year, the conference *Surface Waves in the Ocean* was held at the University of Bergen to commemorate his seminal contributions to the study of nonlinear waves. This workshop featured lectures by international experts on nonlinear water waves, including a large contingent of Norwegian researchers and a few of Kristian Dysthe's former doctoral students. The present issue comprises some papers based on lectures given at the workshop.

Kristian Dysthe's professional life has been intimately tied to two Norwegian institutions: The University of Bergen and the University of Tromsø (now *The Arctic University of Norway*). He enrolled as a student at the University of Bergen in 1956. These were pioneering times, as the university was founded only 10 years earlier in 1946.¹

After a short stint in Oslo (due to a military posting), Kristian returned to Bergen. At the time, there was a considerable push to harness the power of nuclear fusion for civil purposes. Plasma dynamics and research related to nuclear fusion were in vogue, and Professor Sigve Tjøtta who worked in this area became Kristian's supervisor. In 1962, Kristian earned his master's degree in applied mathematics with a thesis on *Adiabatic invariance*.²

At the time, there were no formal PhD programs at the university, but some researchers were awarded a degree called *dr. philos* (short for Doctor of Philosophiae) which was more akin to a habilitation, such as is usual in France and Germany. After completing his thesis in 1962, Kristian expanded his area of research to include non-linear waves, waves in optics, acoustics, and geophysics. He spent time at Culham, UK, and Stanford, USA, and in 1972, he defended a *dr. philos.* at the University of Bergen.³

¹ Universitetet i Bergen sin historie, Bind I, 1996.

² K.B. Dysthe, *Adiabatic invariants*, 1962.

³ K. B. Dysthe, *On some non-linear effects in wave propagation*, 1972.

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In 1972, Kristian was appointed professor in applied mathematics at the University of Tromsø. The university had only recently been founded (1968), and Kristian helped build the mathematics department, and was instrumental in establishing research activities and educational programmes in applied mathematics and related disciplines. He stayed in Tromsø for more than 20 years before moving back to Bergen in 1992. While in Tromsø, sabbatical terms at the University of Cambridge, UK, and the Scripps Institution of Oceanography in San Diego, USA, were used to expand his international network.

In 1979, while on sabbatical in Cambridge, Kristian published a paper in which he derived the equation that now bears his name.⁴ The Dysthe equation is a generalization of the cubic nonlinear Schrödinger (NLS) equation, and this work has had a huge impact, inspiring a great number of mathematicians, oceanographers and coastal engineers to further study similar equations. Although Dysthe derived his equation as a model of water waves, the ideas and methods he presented have been used to obtain more accurate models of pulse propagation in optical fibers, Langmuir waves in plasmas, and coherent structures in Bose–Einstein condensates (BECs). As a model of water waves, the Dysthe equation has been shown to more accurately predict the evolution of mildly sloped, narrow-banded, weakly nonlinear waves on deep water over longer time periods than does the NLS equation. The Dysthe equation and its generalizations remain commonly used to this day!

Over the next 25 years, Kristian continued to make major scientific contributions. Working with mathematicians, oceanographers, and experimentalists, he studied further generalizations of the NLS equation, and tackled a wide variety of problems in this area including frequency downshift, energy leakage, fully dispersive models, and plane-wave stability. Much of this work is summarized in the cleverly titled paper “The Evolution of an Evolution Equation” that Kristian co-authored with one of his former students, Karsten Trulsen.⁵ Towards the end of his career, Kristian studied extreme (or “freak” or “rogue”) waves. His contributions to rogue waves have also been presented at joint science/industry meetings, and have had an impact on the offshore and shipping industries.

In Norway, Kristian is highly respected as a member of the fluid mechanics community, and he is a member of *The Norwegian Academy of Science and Letters*. His interest for and deep insight into physical and geophysical phenomena have brought him into contact with many researchers in the wider community in applied mathematics, physics and geosciences, and he is highly regarded in these circles as well.

First and foremost Kristian is a scientist who is ever seeking deeper insight and who can find order in the chaos surrounding us. Those around him have a keen appreciation of his vision. As Hans Pećseli noted in his speech at the conference dinner, he was never afraid of wasting time talking to Kristian about even the most mundane scientific questions, “because something would always come out of it”.

⁴ K.B. Dysthe. *Note on a modification to the nonlinear Schrödinger equation for application to deep water waves* Proc. Royal Society of London A **369** (1979), 105–114.

⁵ K.B. Dysthe and K. Trulsen. *The evolution of an evolution equation*, Progress in Nonlinear Science **II** (2001), 125–138.

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U N I V E R S I T E T E T I B E R G E N

On some non-linear effects in
wave propagation

by

KRISTIAN BARSTAD DYSTHE

With due permission of the Senate
of the University of Bergen to be publicly
discussed on 22nd April 1972 for the
degree of *Doctor philosophiae*

BERGEN 1972

Title page of Kristian Dysthe's doctoral thesis, Universitetet i Bergen, 1972.

Title page of Kristian Dysthe's master's thesis, Universitetet i Bergen, 1962.

First page of Kristian Dysthe's master's thesis, Universitetet i Bergen, 1962.

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