● チャブチャブ アミン 特定准教授

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研 究 課 題： 極大波の研究 — モデリングと制御と予測
（Extreme Ocean Waves: Modelling, Control and Prediction）
専 門 分 野： 非線形力学系，海洋物理学（Nonlinear Dynamics, Physical Oceanography）
受入先部局： 防災研究所（Disaster Prevention Research Institute）
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ブレーメン大学（ドイツ）で応用数学／機械工学の修士号を、ハンブルグ工科大学（ドイツ）で博士号を取得しました後、インペリアル･カレッジ･ロンドン（英国）、スウィンバーン工科大学（オーストラリア）、東京大学（日本）におけるポスドク研究員を経て、アールト大学（フィンランド）機械工学研究科で流体力学の助教、シドニー大学（オーストラリア）土木工学研究科で環境流体力学の准教授を務めました。私の専門分野は、巨大海洋波、非線形力学、海洋物理学です。白眉プロジェクトでは、沖合・沿岸を含む海洋における巨大波現象の理解を深め、現象を予測するための技術改善に焦点を当てる予定です。水波の新しい数理モデルを開発し、さらに、防災研究所の先進的な実験施設を利用した実験と計算によりモデルの検証を進めます。

I received a MSc in Applied Mathematics / Mechanical Engineering from the University of Bremen (Germany) and my PhD from Hamburg University of Technology (Germany). I previously worked as Associate Professor in Environmental Fluid Mechanics at the School of Civil Engineering of the University of Sydney (Australia) and Assistant Professor of Hydrodynamics at the Department of Mechanical Engineering of Aalto University (Finland). Before these faculty appointments, I was a Postdoctoral Researcher and Research Scientist at Imperial College London (UK), Swinburne University of Technology (Australia) and The University of Tokyo (Japan). My areas of expertise and research interests are ocean extreme waves, nonlinear dynamics and physical oceanography. My research at Kyoto University will be focusing on improving understanding and prediction of extreme wave events in the ocean including offshore and coastal areas. New mathematical water wave models will be developed and tested numerically and experimentally in advanced water wave facilities.

What are rogue waves?

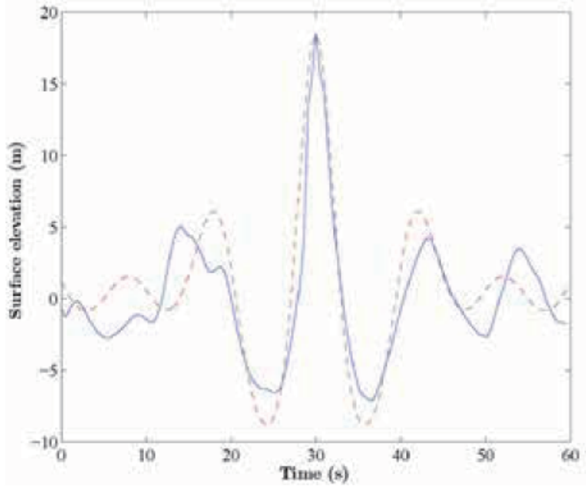
Ocean rogue waves are extreme wave localizations that appear either in offshore or coastal zones. The height of such waves can reach up to 30 m and can cause severe damage to ships, marine structures, coastal installations as well as environment. These waves have been at the same time frightening and fascinating mariners, scientists and even artists like Hokusai, as he illustrated in his famed “The Great Wave off Kanagawa” masterpiece.

(Hokusai's The Great Wave off Kanagawa)

Such giant waves have been part of marine folklore for centuries until scientifically confirmed on the first day of the year 1995 by the measurement of the New Year Wave at the Draupner platform, installed in the North Sea. The New Year Wave has a remarkable wave height of 25.6 m. Indeed, there are two major mechanisms that can explain the sudden formation of offshore extreme waves, which arise from the wave dynamics only. The first is based on the trivial superposition principle of waves while the second is attributed to the instability of water waves, also referred to as modulation instability. Interestingly, such instability also occurs in electromagnetic waves and therefore, interdisciplinary analogies can be established and drawn in optical sciences. Extreme waves can emerge in coastal areas in form of devastating Tsunami or as a result of storm surge.

Modelling of rogue waves

Extreme waves in the ocean, which appear out of nowhere and disappear without a trace, have similar feature to pulsating wave envelopes, also known as breathers. Mathematically speaking, breathers are exact solutions of the nonlinear Schrödinger equation that describe the nonlinear stage of modulation instability. A number of theoretical studies have suggested that breathers might be appropriate models for the description of rogue waves due to the type of wave localization and significant amplitude amplification reached at the maximal compression location.



Peregrine breather model vs. the New Year Wave ocean measurement

Recently conducted studies confirmed that rogue deep-water waves can propagate in shallow areas while maintaining their extreme form, suggesting that such type of extreme waves could be also impact coastal areas. New and more advanced breathers-type waves, which also include the effect of the wave field directionality at different water depth conditions, will be investigated to complement the existing fundamental knowledge on breather hydrodynamics.

Numerical and experimental studies

One of the significant developments made in this area over the last decade is the experimental realization of such deterministic and pulsating wave envelopes in water waves. By applying corresponding wave signals to the wave maker, the dynamics of such extreme wave evolution has been observed in different state of the art water wave flumes. This allows the control of extreme waves in a laboratory environment, understanding the limitations of the modelling and the quantification of other relevant feature such as forces or pressure loads on structures. On the other hand, numerical simulations, which solve the hydrodynamic evolution equations, enable us to predict the extreme wave behaviour beyond the laboratory limitations by using experimental data and increasing the scales to realistic oceanic configurations. A series of laboratory and numerical testings will be conducted at the Disaster Prevention Research Institute (DPRI) to analyse the behaviour of extreme waves at different water depths for the sake of a deterministic forecast of such extreme waves events in deep- and shallow-seas. Moreover, innovative mechanisms will be developed to tame the considerable height of rogue waves.

References

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