

Stability of surface and internal ring waves PhD

Primary supervisor: Dr. K.R. Khusnutdinova, Department of Mathematical Sciences, Loughborough University

Secondary supervisor: Dr. D. Tseluiko, Department of Mathematical Sciences, Loughborough University

Project Description:

Surface and internal waves are ubiquitous in the oceans. The waves have a strong effect on offshore structures, underwater cables and submersibles. They also contribute to the ocean mixing processes. The Korteweg - de Vries (KdV) type integrable and near-integrable long wave weakly-nonlinear models became the basic paradigm for interpretation and modelling of oceanic observations, e.g. [1]. Recently, the KdV model for waves in stratified fluids has been generalised to include cylindrical divergence and underlying current [2, 3, 4], which is relevant to the modelling of the waves generated in straits, river-sea interactions zones and waves generated by localised topographic features at the bottom of the ocean.

The research will be a systematic study of stability of

- linear surface and internal ring waves in stratified shear flows (see [2, 4]);
- nonlinear surface and internal ring waves modelled mathematically by such weakly-nonlinear models, to azimuthal perturbations (see [5]).

It will involve a combination of asymptotic derivations and approximations combined with numerical simulations. The project will require good knowledge of differential equations and familiarity with computational packages such as MATLAB or similar.

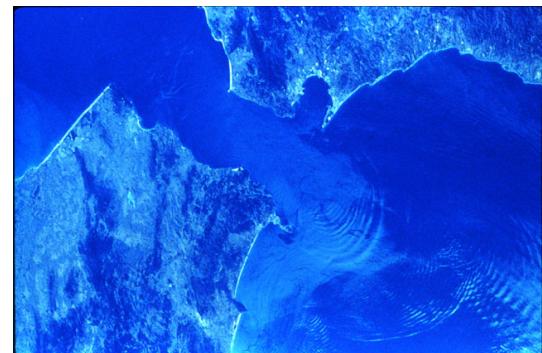
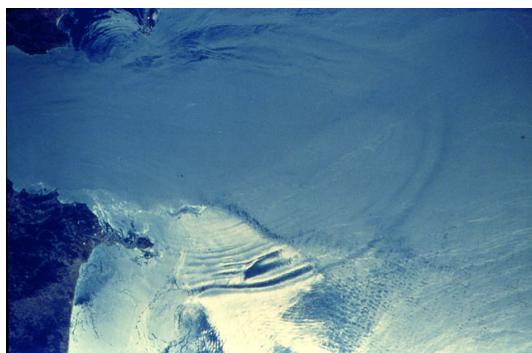


Figure 1: Internal waves generated in the Strait of Gibraltar: NASA images STS17-34-098 (left) and STS17-34-081 (right).

References:

1. R. Grimshaw (ed.) Solitary Waves in Fluids. Advances in Fluid Mechanics, Vol. 47, WIT Press, 2007.
2. K.R. Khusnutdinova and X. Zhang, Long ring waves in a stratified fluid over a shear flow, *J. Fluid Mech.* 794 (2016) 17-44.
3. K.R. Khusnutdinova and X. Zhang, Nonlinear ring waves in a two-layer fluid, *Physica D* 333 (2016) 208-221.
4. K. Khusnutdinova, Long internal ring waves in a two-layer fluid with an upper-layer current, *Russ. J. Earth Sci.* 20 (2020) ES4006.
5. L.A. Ostrovsky and V.I. Shrira, Instability and self-refraction of solitons, *Sov. Phys. JETP* 44 (1976) 738-743.