Mathematics: University of Twente & University of Leeds

Fast Simulations of Fast Ships in Heavy Seas

JAAP VAN DER VEGT & ONNO BOKHOVE & RENE HUIJSMANS

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AIMS

To model and predict:

1. **3D numerical waves** in MARIN’s test basins with bottom topography, beaches and the wave-makers

2. **wave resistance** of slow ships (linear & full coupling)

3. **wave resistance** of fast ships in high seas with **wave breaking**

Innovation theme: **clean/smart ships** (fuel reduction & safe seakeeping)

Knowledge area: **hydrodynamics & design**
OUR CURRENT TECHNOLOGY

2D & 3D variational space-time discontinuous Galerkin finite element models DGFEM for water waves:

- Implementation in software environment hpGEM
- Cutting-edge stable time integrators for fluid-structure interactions
- Use of variational/Hamiltonian CFD for water waves essential!
SUGGESTED MILESTONES

- To simulate 3D fully variational water waves –DGFEM
- To couple DGFEM waves & slow moving ship –linear ship dynamics
- To validate against tank data [prof Huijsmans & MARIN]

- To couple DGFEM waves & moving ship –nonlinear ship dynamics
- To validate against tank data [prof Huijsmans & MARIN]

- To formulate DGFEM of smoothed wave breaking, reduction to variational DGFEM for smooth waves
- To couple DGFEM (breaking) waves & fast ships & validate.
WHY VARIATIONAL FEM?

- Conventional CFD too dissipative for water waves:
  - wave amplitudes diminish too quickly & drag calculations inaccurate
- E.g. SPH for bore-soliton-splash can’t get wave & jet height right:

Variational DGFEM wave modelling offers the right mathematics! But.
TEAM & DELIVERABLES

Team with integrated simulations & experiments:
• Profs Jaap van der Vegt & Onno Bokhove & René Huijsmans [TUD]
• You!

Current projects:
• STW & NWO projects on waves, EU Industry Doctorates [MARIN] subm.

Deliverables for fast ships in heavy seas:
• Wave tank tests [TUD] & simulation tools [UT] & your suggestions?
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Dredging the Depths of Maths

ONNO BOKHOVE & JAAP VAN DER VEGT

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DREDGING: WATER-PARTICLE INTERACTIONS

Aims:
• To explore Hele-Shaw dredging laboratory experiments, 2D to 3D:
  • To investigate blockage of pumps as function of particle loading:
    - prototyping late March
  • To perform corresponding mathematical and numerical simulations
• Theme: smart ships & harbors. Knowledge: hydrodynamics & safety
To investigate submarine landslides, caused by suction dredging

• To explore resulting wave generation
• To investigate wave impact on dredging ship
• To investigate run-up of tsunami in nearby harbors
• To model & simulate coupled bottom-wave interactions
• Case study: landslide harbor construction Nice, with 3m tsunami.
SUBMARINE LANDSLIDES: WAVE TANK

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TEAM & DELIVERABLES

- Profs Onno Bokhove & Jaap van der Vegt & ... your team & suggestions!
- Hele-Shaw beach formation by breaking waves (Leverhulme Fund subm)
- Wave impact tests on ships & in harbors (-) + simulations tools (UT)