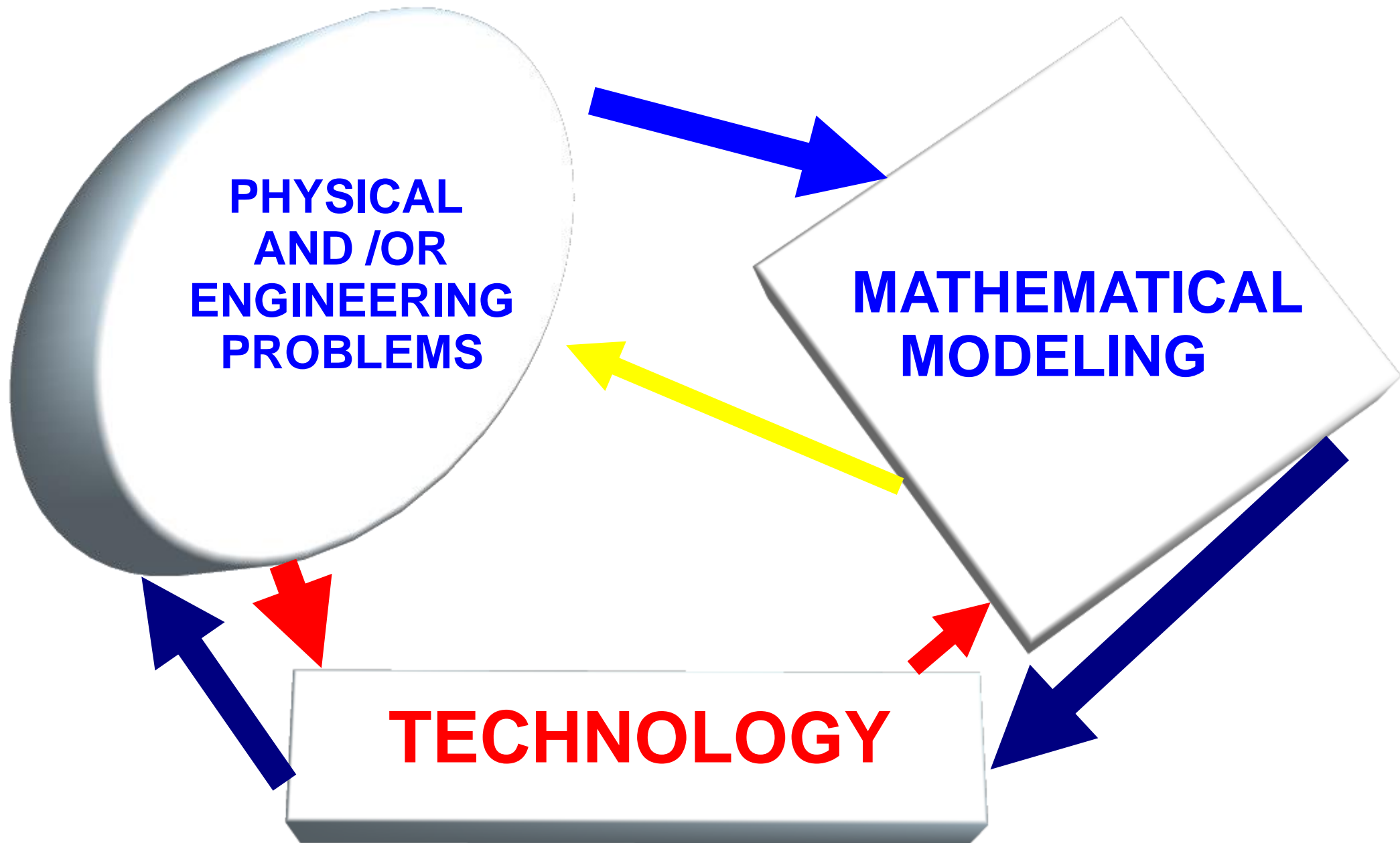


MATHEMATICAL SIMULATION OF ENGINEERING PROBLEMS

Ruperto P. Bonet

rpbonet@unsl.edu.ar

APPLIED MATHEMATIC



PHYSICAL PROBLEMS

- MULTI-PHYSIC PROBLEMS
- MULTI-SCALE PROBLEMS
- COUPLED PROBLEMS
- REAL-TIME SYSTEMS

AVANCED NUMERICAL METHODS

- **EXTENSIONS OF FEM**
 - EXTENDED FEM METHOD
 - DISCONTINUOUS GALERKIN METHOD
 - BUBBLES STABILIZED METHODS
 - ISOGEOMETRICAL METHODS
 - MOLECULAR FEM METHODS
- **DOMAIN DECOMPOSITION METHODS**
- **STRONG COUPLING ALGORITHMS**
- **PARALLEL METHODS (MPI, OPENMPI)**

TECHNOLOGY AND APPLIED MATHEMATICS

- NANO-MATHEMATIC
- INDUSTRIAL MATHEMATIC
- INVERSE PROBLEM MODELING
- MATH - APPLICATIONS TO SMARTPHONE

SPECIFIC PHYSICAL PROBLEMS

INTERACTION OCEAN-ATMOSPHERE

- *STRATIFIED ROTATING FLUIDS IN A SPHERICAL LAYER*
- *REFRACTION-DIFFRACTION WATER WAVES PROBLEM*
- *STABILIZED METHODS TO SHALLOW WATER EQUATIONS*
- *INTERACTION FLUID-STRUCTURE IN THE DESIGN OF SPORTING HARBORS*

NUMERICAL COMPUTATIONS OF SURFACE WAVES IN A COASTAL ZONE WITH MULTIPLE HARBORS- ECCOMAS 04

Ruperto P. Bonet

Department of Applied Physic, Technical University of Catalonia
BARCELONA, SPAIN

ruperto.bonet@upc.es <http://www-fa.upc.es>

A satellite map of Toulon Bay, France, showing the coastline, surrounding land with urban and forested areas, and the deep blue water of the bay. The text is overlaid on the map.

NUMERICAL SIMULATION OF WAVE PROPAGATION IN TOULON BAY

Waves 2005

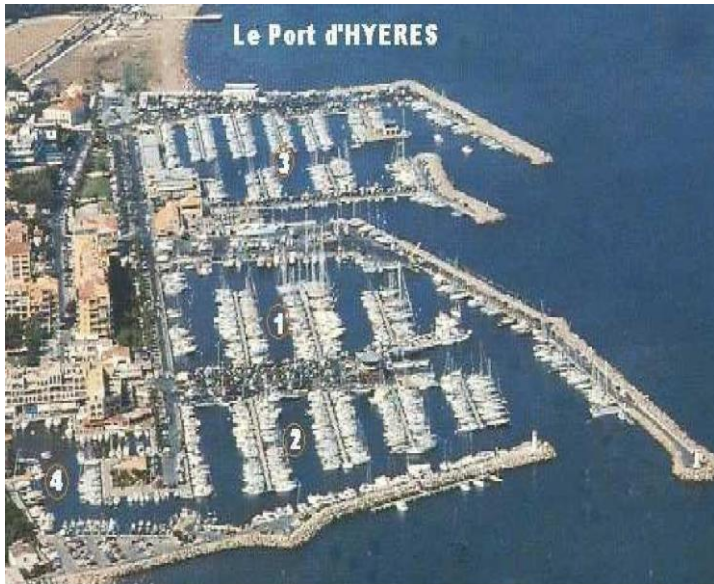
Ruperto P. Bonet, José Ma. Redondo

Department of Applied Physics, Technical University of Catalonia

BARCELONA, SPAIN

ruperto.bonet@upc.edu <http://www-ma1.upc.edu>

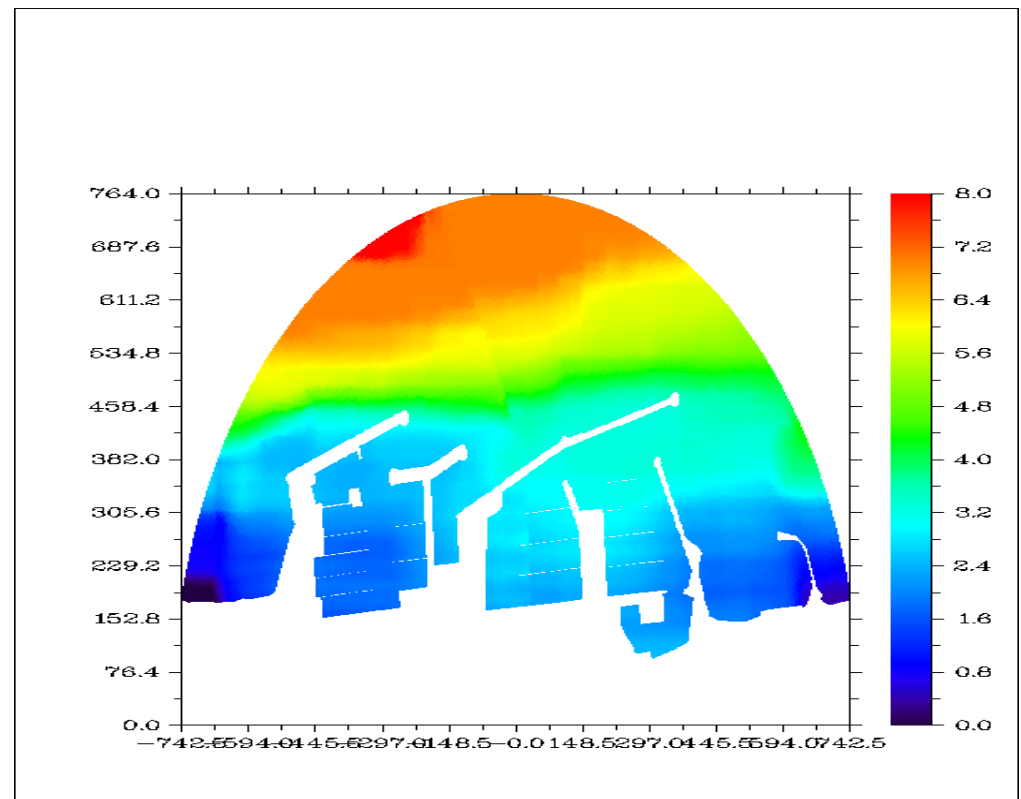
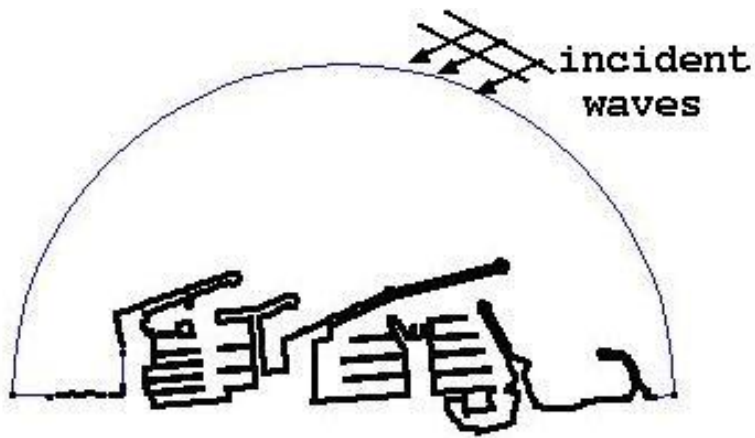
Waves in Hyeres Harbor



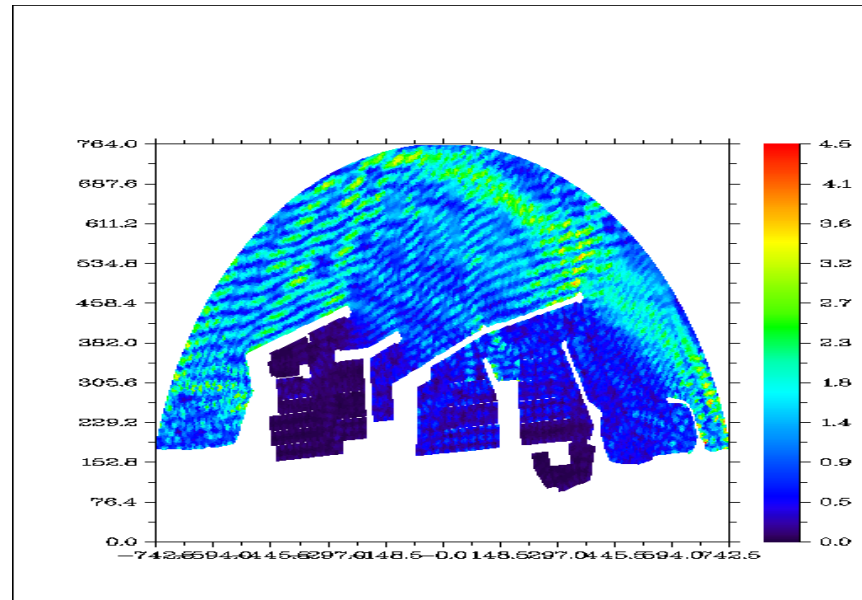
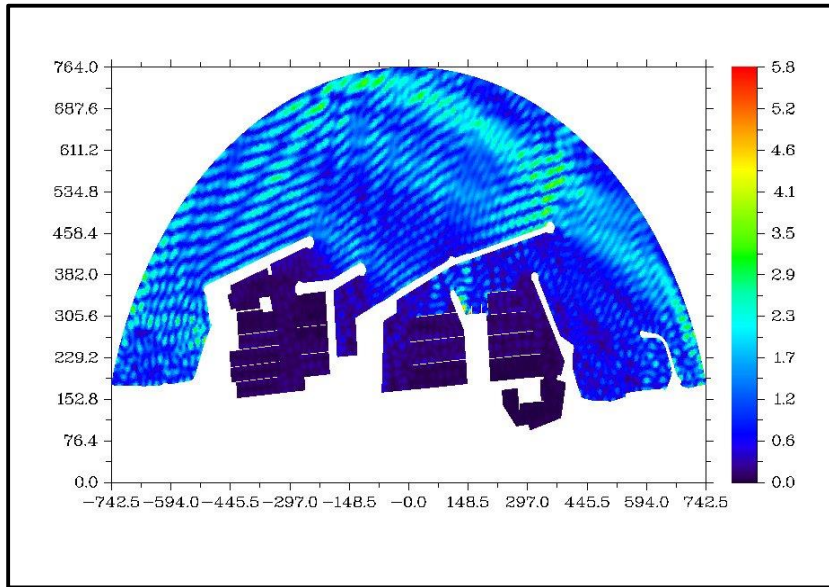
Period : 6s

Incidence angle : South-East

Fully Reflecting at coastline



Waves in Hyeres Harbor



a) Chandrasekera model

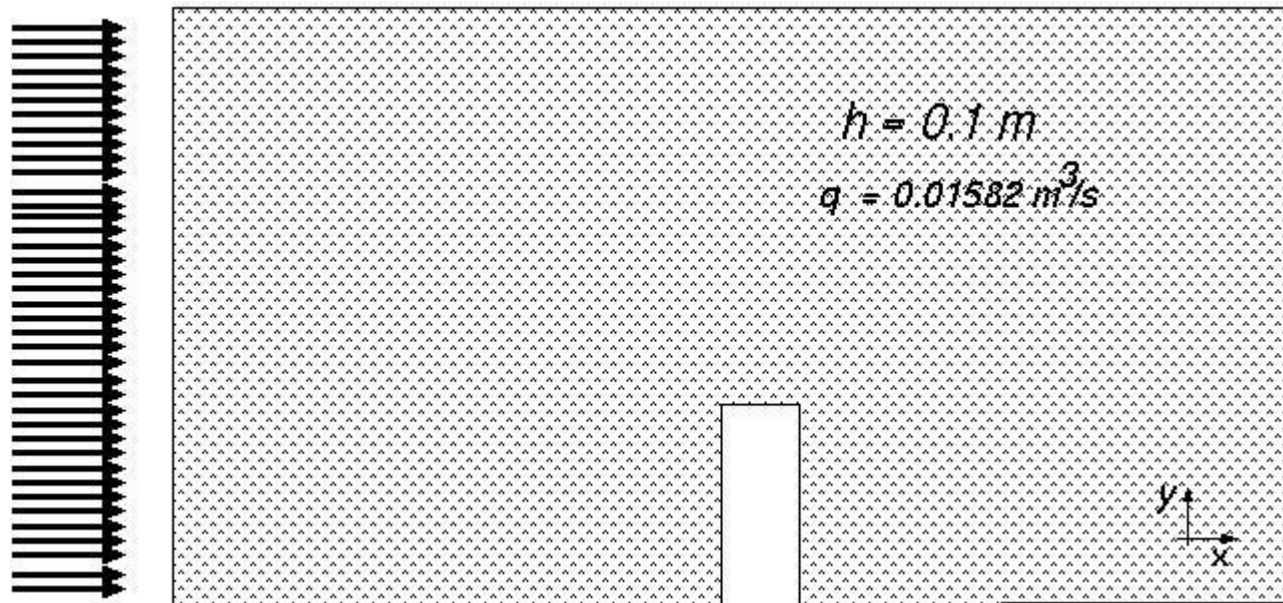
b) Chamberlain model

30114 nodes

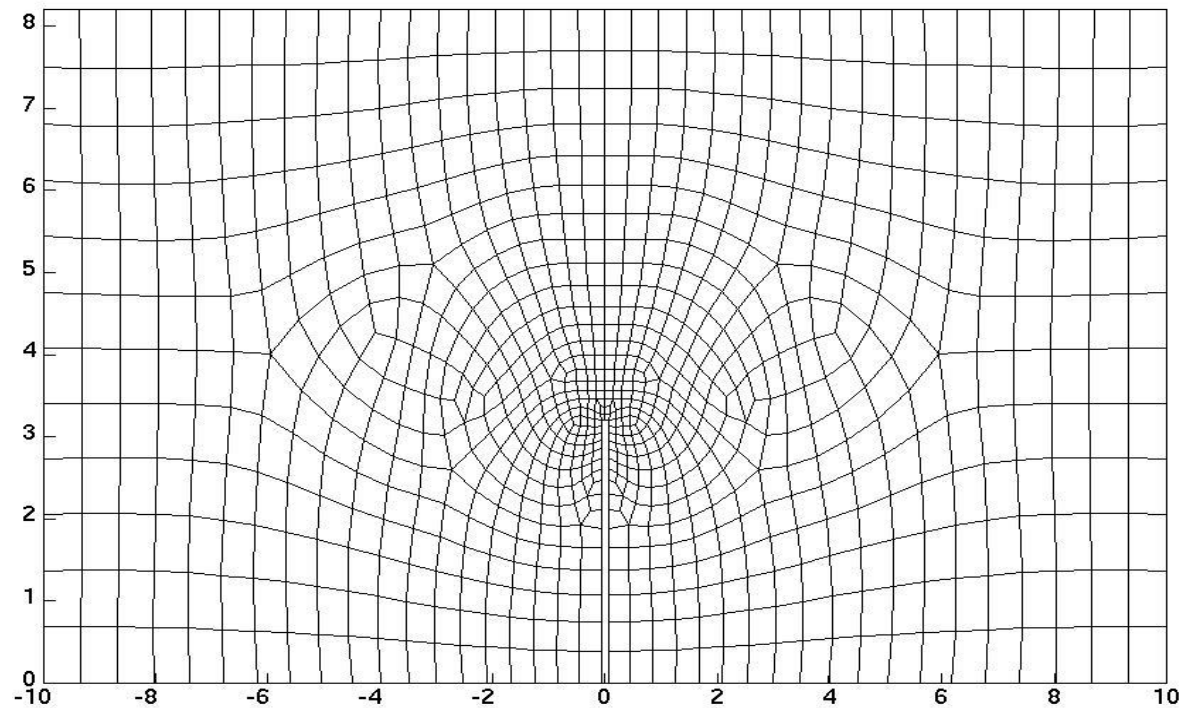
57283 triangular elements

SPECIFIC PHYSICAL PROBLEMS

INVISCID FLOW IN OPEN CHANNELS WITH LATERAL CONTRACTION

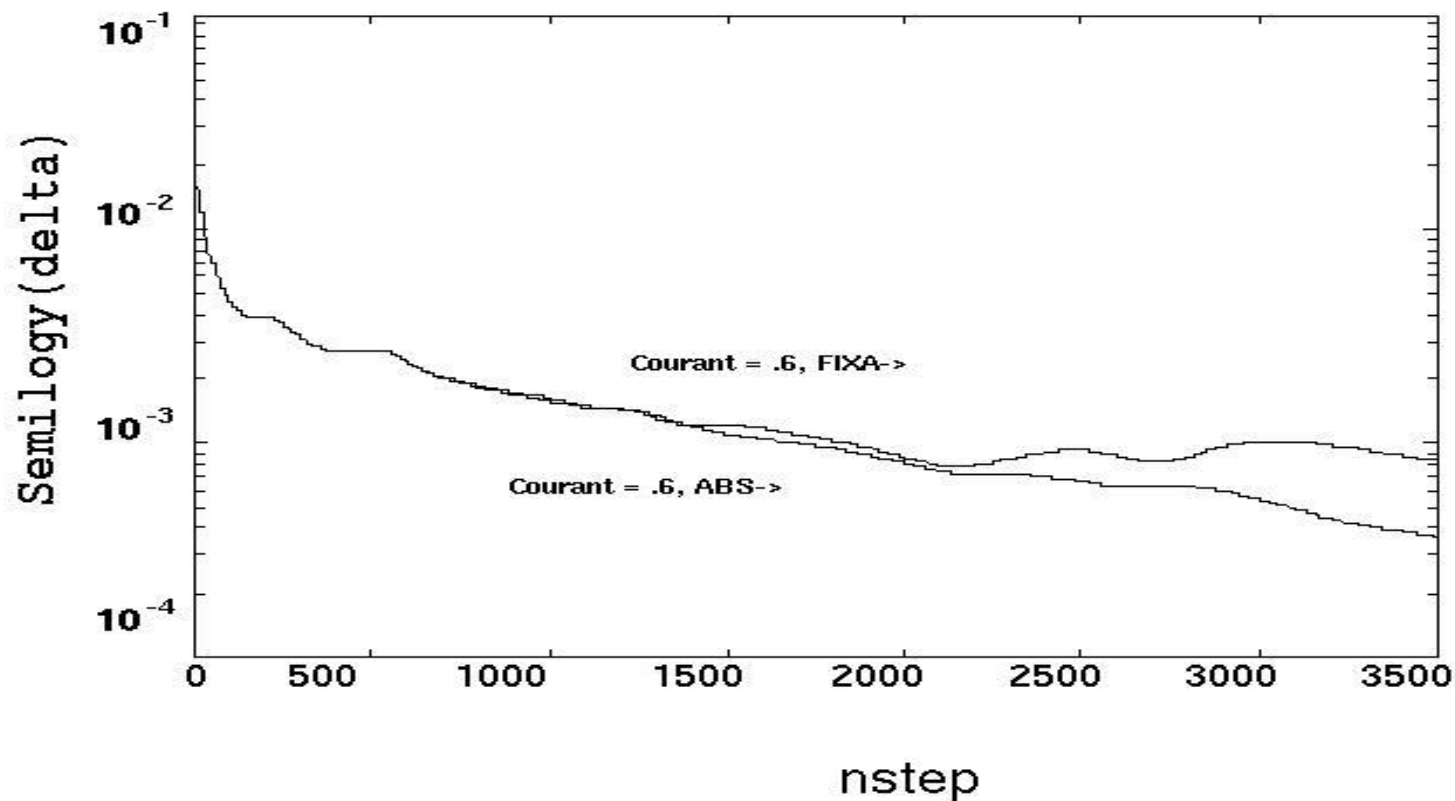


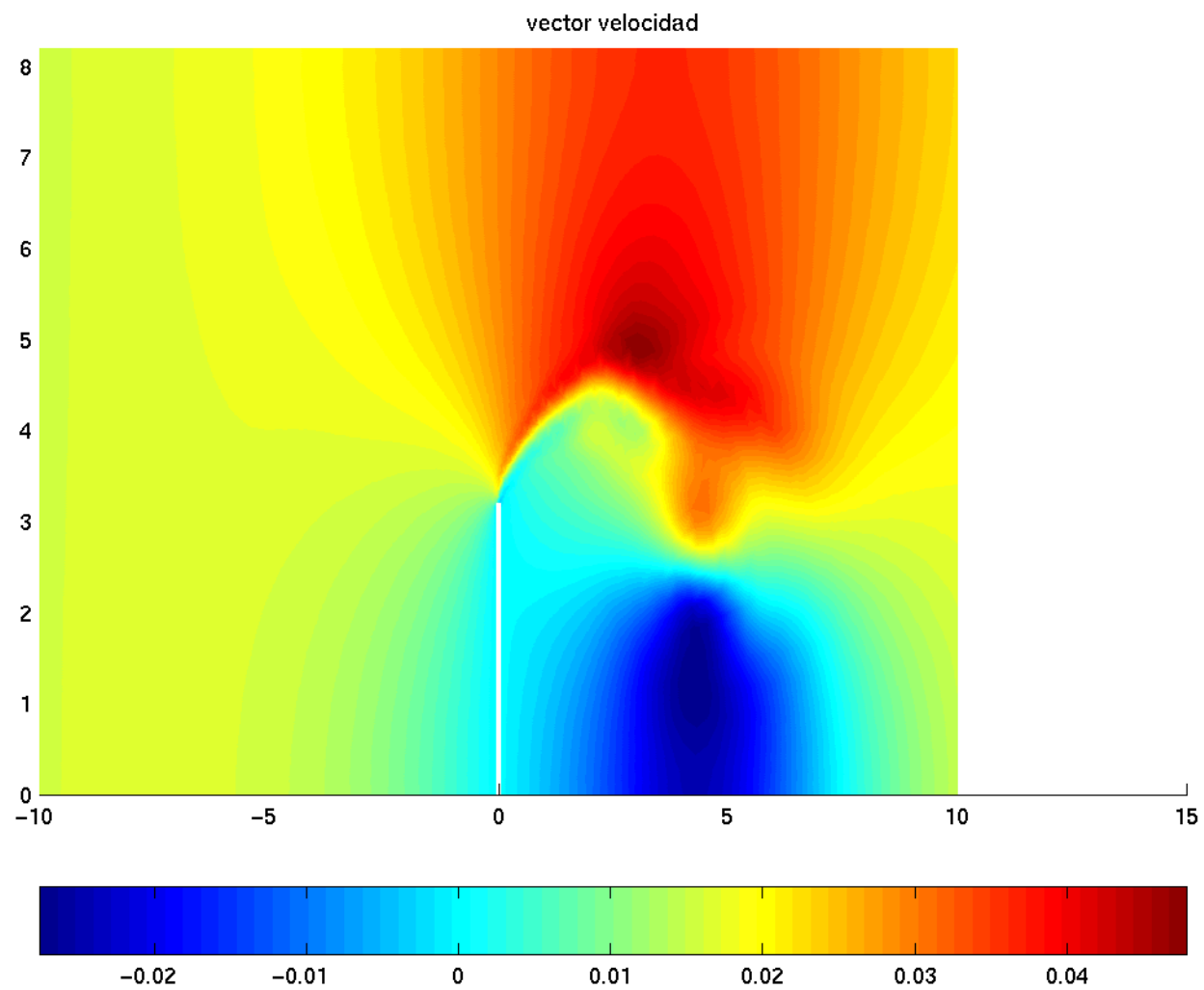
FINITE ELEMENT METHOD (SUPG)



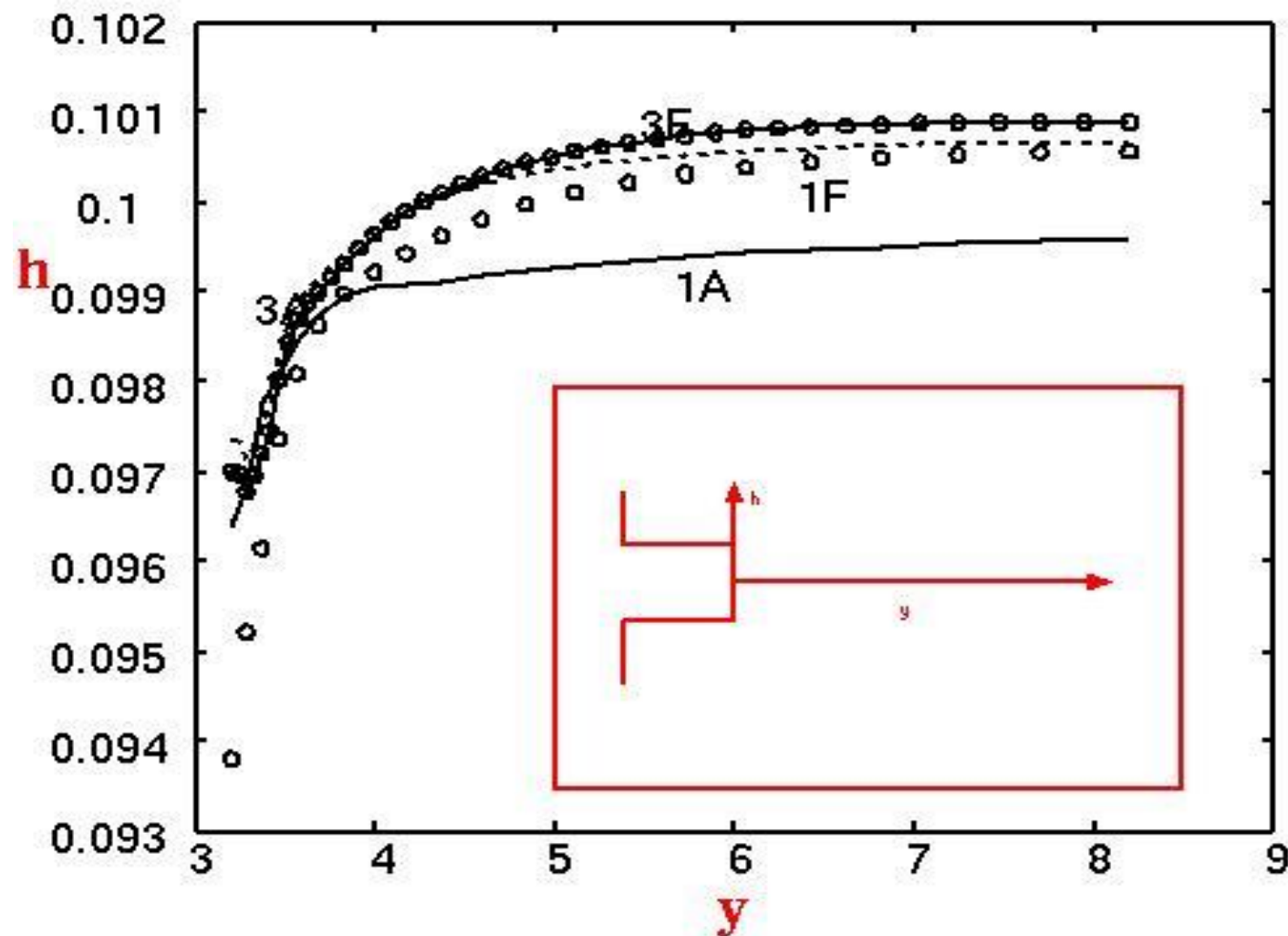
MESH WITH 818 ELEMENTS

AN EXPLICIT METHOD. CONVERGENCE

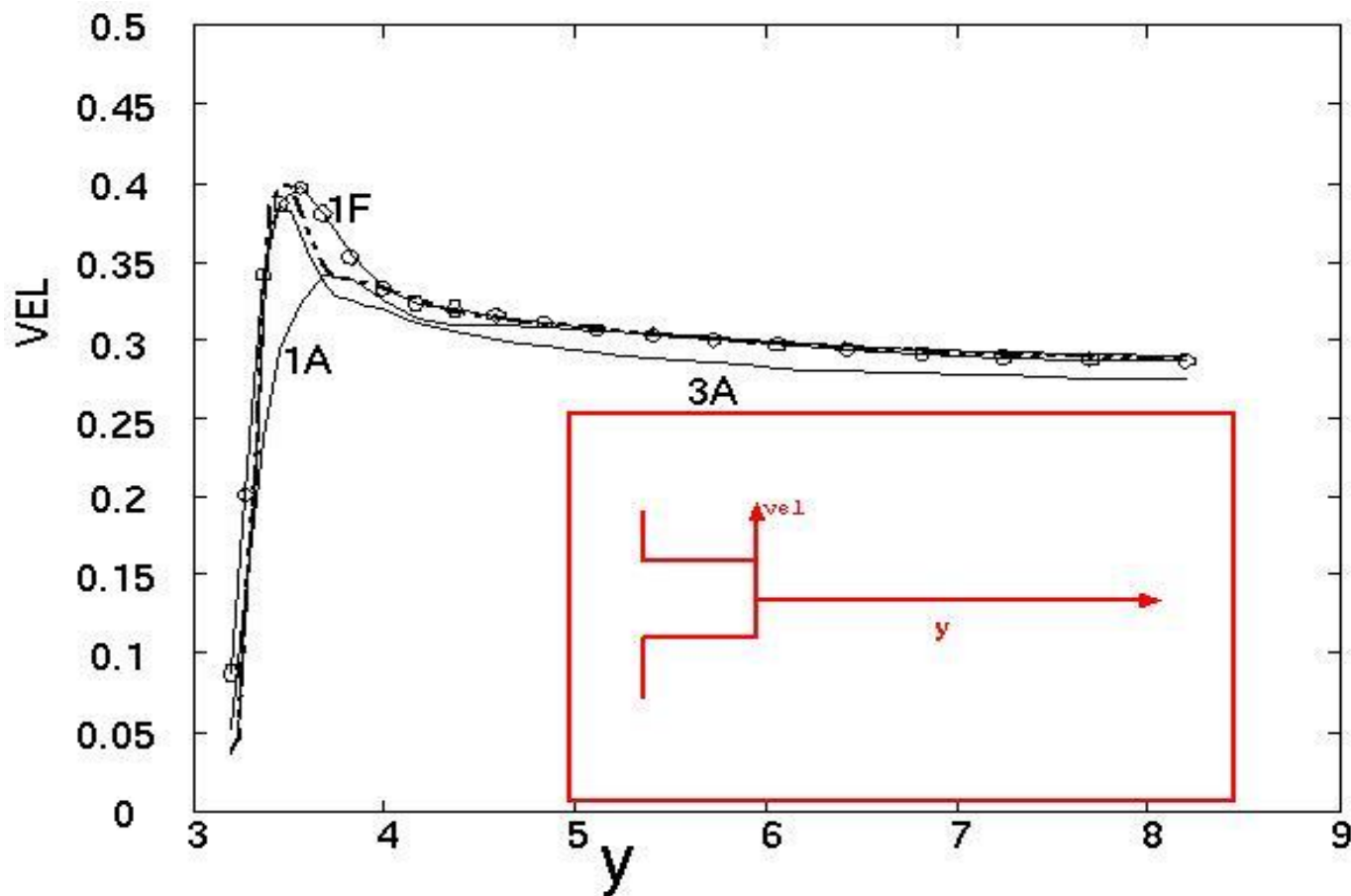




WATER DEPTH ALONG THE LATERAL CONTRACTION



MAGNITUDE OF VELOCITY ALONG THE LATERAL CONTRACTION



MATHEMATICAL SKILLS

**BOUNDARY PROBLEMS IN AN UNBOUNDED
DOMAIN**

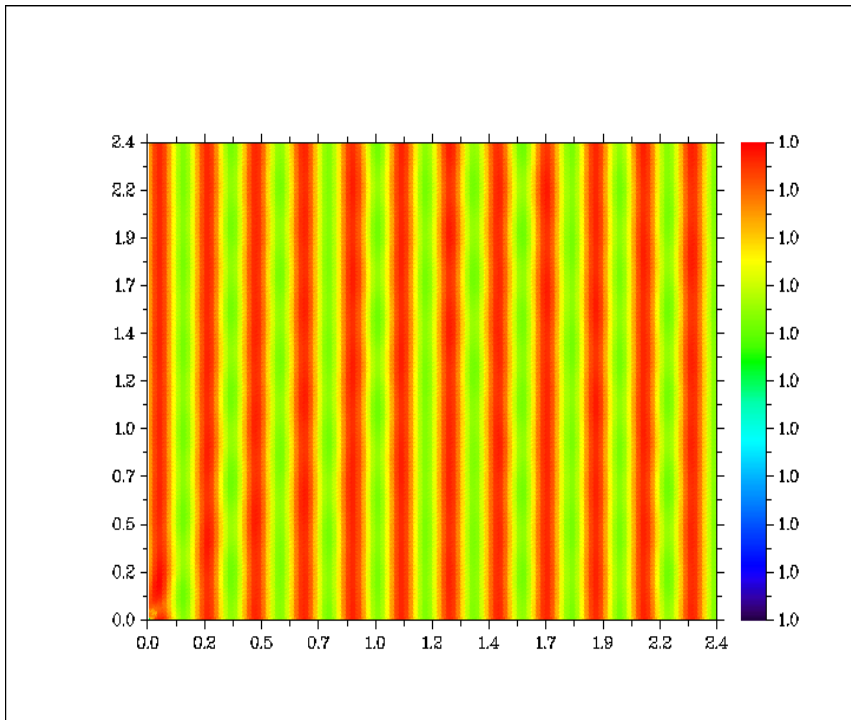
**STABILIZATION OF ADVECTION-DIFFUSION-
REACTION EQUATION**

OPEN BOUNDARY CONDITIONS TO HELMHOLTZ EQUATION

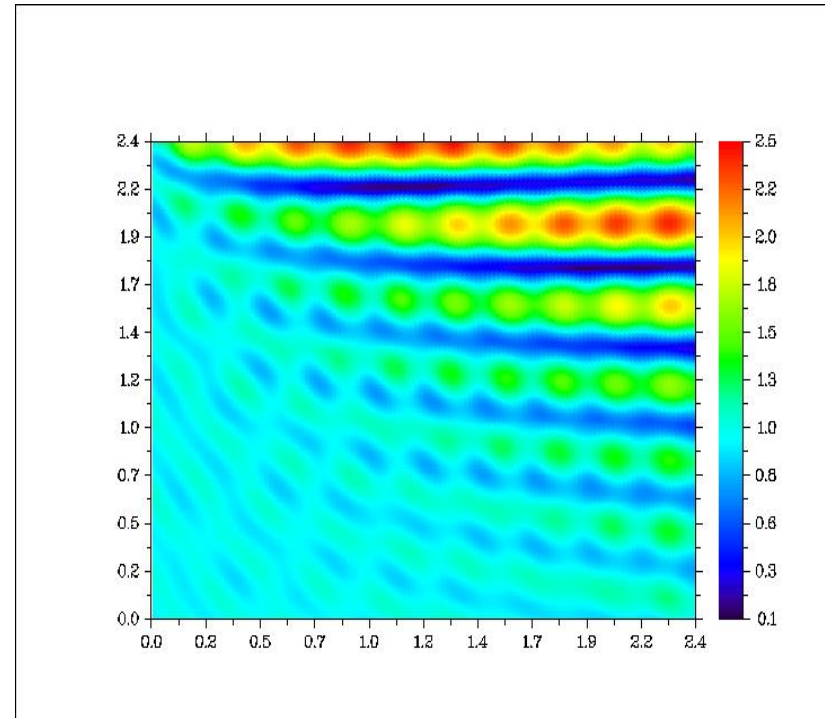
Ruperto P. Bonet

ruperto.bonet@upc.edu

Numerical Example with $k = \text{cte}$

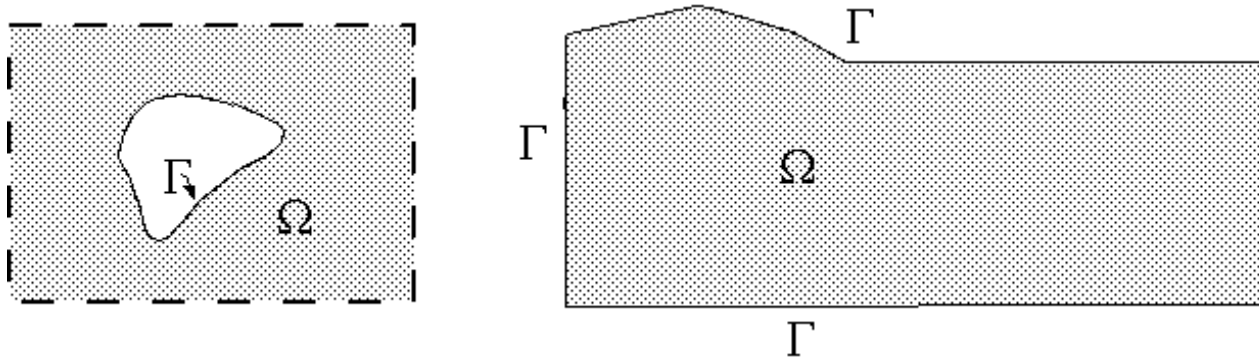


a) $g = \exp(ikx)$

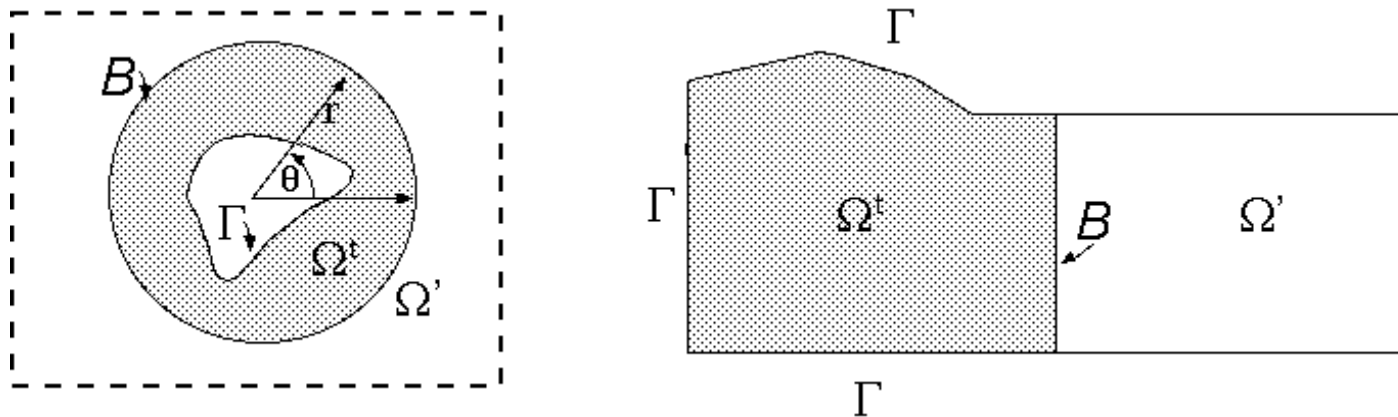


b) $g = \exp(ik \cos(x/6) x) \pi$

AN UNBOUNDED PROBLEM GOVERNED BY HELMHOLTZ EQUATION



A BOUNDED PROBLEM GOVERNED BY HELMHOLTZ EQUATION



NUMERICAL SKILLS

- *DESIGN OF SEVERAL TECHNIQUES TO IMPOSE OPEN BOUNDARY CONDITIONS*
- *DEVELOP OF AN OWN CODE NAMED “**PDEN**” TO SOLVE PARTIAL DIFFERENTIAL EQUATIONS NUMERICALLY*

FUTURE PROJECTS

SIMULATION OF WOUND HEALING PROCESS
(IN COLABORATION WITH DELFT UNIVERSITY)

DYNAMICAL SYSTEMS TO SOLVE ELLIPTIC INTEGRALS
(IN COLABORATION WITH DMA1-UPC, SPAIN)

DEVELOPING AND COMPARISON OF COUPLING
ALGORITHMS TO INTERACTION OCEAN-ATMOSPHERE

SPECIFIC PHYSICAL PROBLEMS

TUMOR GROWTH

- **WOUND CONTRACTION**
- **ANGIOGENESIS**
- **WOUND CLOSURE**