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AND PHYSICS  
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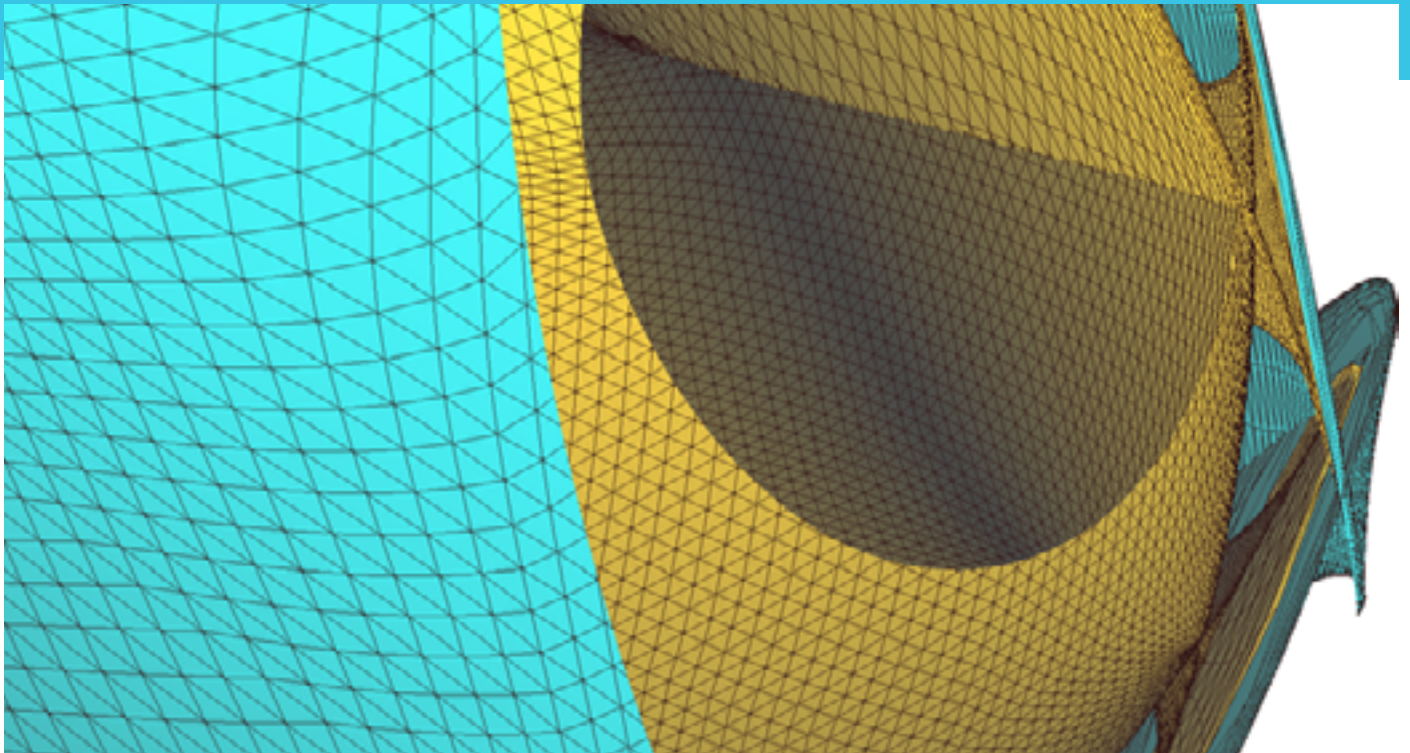
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# MATHEMATICAL MODELING IN GEOPHYSICS



*Illustration of fully 3D seismic ray simulation in triclinic elastic medium*

## RESEARCH AREAS AND EXCELLENCE

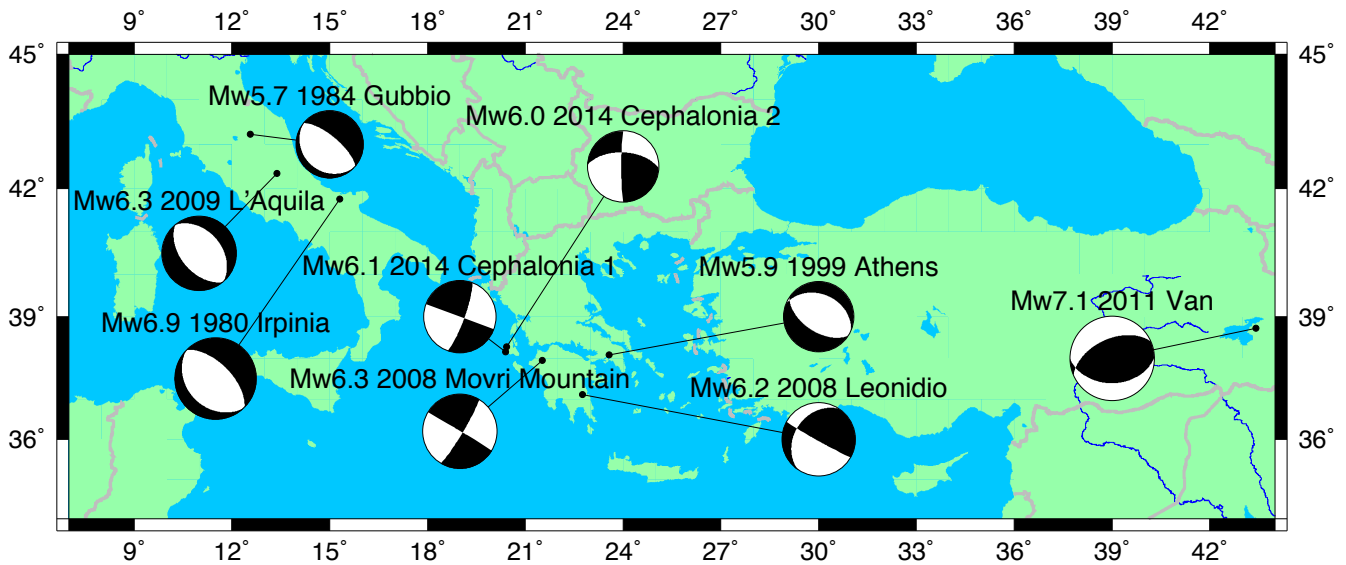
### MISSION

We conduct high-quality research and train students in modeling of wide range of geophysical phenomena, including earthquake source physics, seismic wave propagation, thermal evolution and deformation of the Earth and planets on various scales, gravitational and electromagnetic fields. Our team is experienced in interpreting the data measured at the Earth surface and from satellites using physical models based on continuum mechanics and electrodynamics by means of numerically solving the related partial differential equations and optimizations. Our excellence is also in developing own codes for most efficient performance including parallel supercomputing. We develop advanced seismic instruments. We

deliver worldwide recognized results based on active collaboration with important academic and industry partners.

### EXPERTISE

- Applications of continuum mechanics and electrodynamics on geophysical problems (earthquake physics, seismic exploration, thermal evolution of planets, modeling of their electromagnetic and gravitational fields, two-phase flow in rocks and ice).
- Propagation of elastic and electromagnetic waves in 3-D heterogeneous isotropic and anisotropic media.
- Processing and interpretation of geophysical (including satellite) data.
- Rotational seismology (development of instruments, measurements and interpretations).



*Distribution of processed damaging earthquakes*

- Optimization problems including uncertainty estimation using statistical inference.
- Development of efficient (parallel) codes.

## RESEARCH TOPICS

- Measurement, processing and interpretation of earthquake data (locations, moment tensor and slip inversions) with emphasis on larger events in the Mediterranean.
- Earthquake broadband ground motion modeling.
- Numerical modeling of seismic wave propagation in complex structures using full-wavefield and asymptotic methods.
- Ocean modeling and electromagnetic signatures of ocean flows.
- Processing and interpretation of satellite geomagnetic and gravity data.
- Investigation of electrical conductivity of the Earth at all scales.
- Development of multicomponent seismic sensors (<http://rotaphone.eu/>).

## WHAT WE OFFER

- Mathematical modeling in a wide range of geophysical applications.
- Generation of physics-based seismic input for structural engineering.
- Consulting in seismic hazard assessment.
- Forward and inverse modeling of electromagnetic and seismic wave fields.
- Estimation of accuracy of various wave-propagation modeling methods.

## PARTNERS AND COLLABORATIONS

### ACADEMIC PARTNERS

- University of Patras, Greece
- Czech Academy of Sciences (Geophysical Institute, Institute of Rock Structure and Mechanics), Czech Republic
- California Institute of Technology, USA
- US Geological Survey, USA
- Istituto Nazionale di Geofisica e Vulcanologia, Italy
- Dublin Institute for Advanced Studies (DIAS), Ireland
- Swiss Federal Institute of Technology in Zurich (ETHZ), Switzerland
- National Space Institute (DTU Space), Denmark
- Laboratory of Planetology and Geodynamics Nantes (LPG), France

### INDUSTRY PARTNERS

- State Office for Nuclear Safety
- BP America Production Company
- NORSAR
- Schlumberger Gould Research Center
- European Space Agency
- RS Dynamics



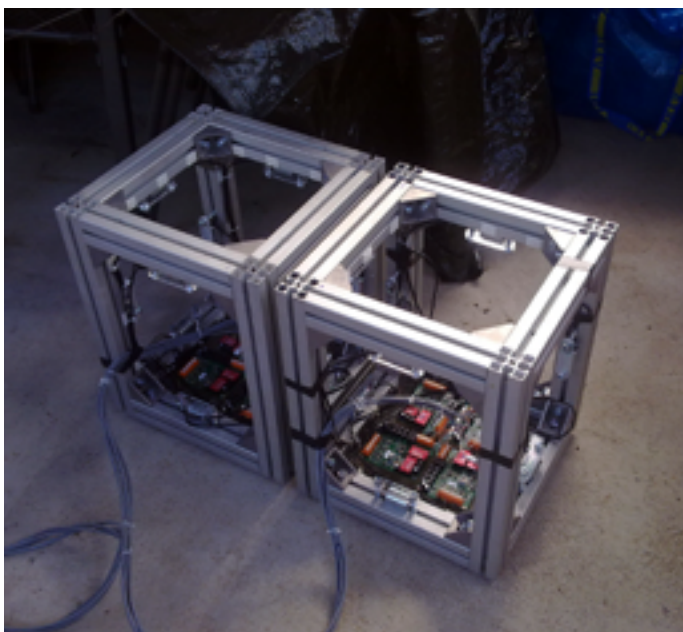
## MAIN RECENT PROJECTS

- Consortium research project Seismic waves in complex 3-D structures (<http://sw3d.cz>).
- Magnetic Signatures of Barotropic and Baroclinic Ocean Flows in Swarm Data, PI Jakub Velímský, ESA funded project within the STSE programme, (<http://geo.mff.cuni.cz/SwarmOceans/>).
- Swarm Expert Support Laboratories, partnership in ESA funded international consortium responsible for production of Level 2 products from the Swarm multisatellite mission.
- Measuring system based on seismic rotations for prospecting mineral and water resources supported by The Technology Agency of the Czech Republic (TAČR) within the Gama Programme (<http://rotaphone.eu/>).
- Software development for electrical impedance tomography of soft tissues for RS Dynamics.

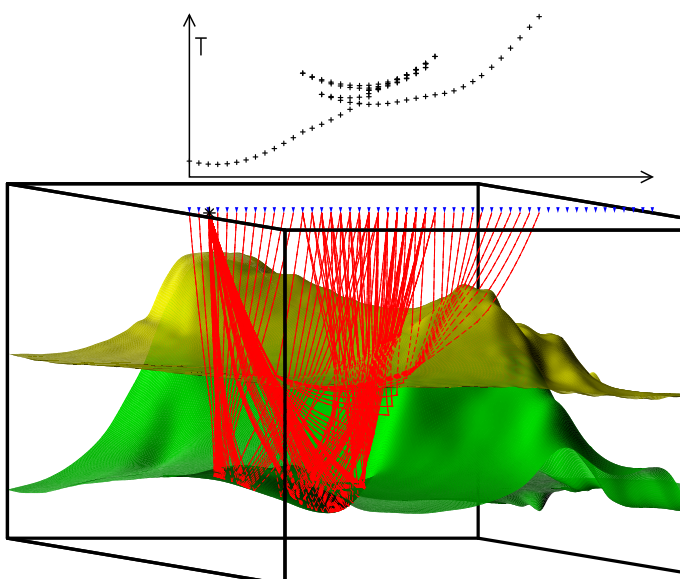
## PATENTS

CZ 3012017 Brokešová J., Málek J., Štrunc J. (2009), Rotational seismic sensor system, Generator of Rotational Seismic Waves and Seismic measuring Set.

CZ 3012018 Brokešová J., Málek J., Štrunc J. (2009), Generator of Rotational Seismic Waves, Rotational Seismic Sensor System and Seismic Measuring Set.



*Rotaphons*



*Two-point rays and travel times in complex velocity model*