



INSTITUTE OF APPLIED & COMPUTATIONAL MATHEMATICS

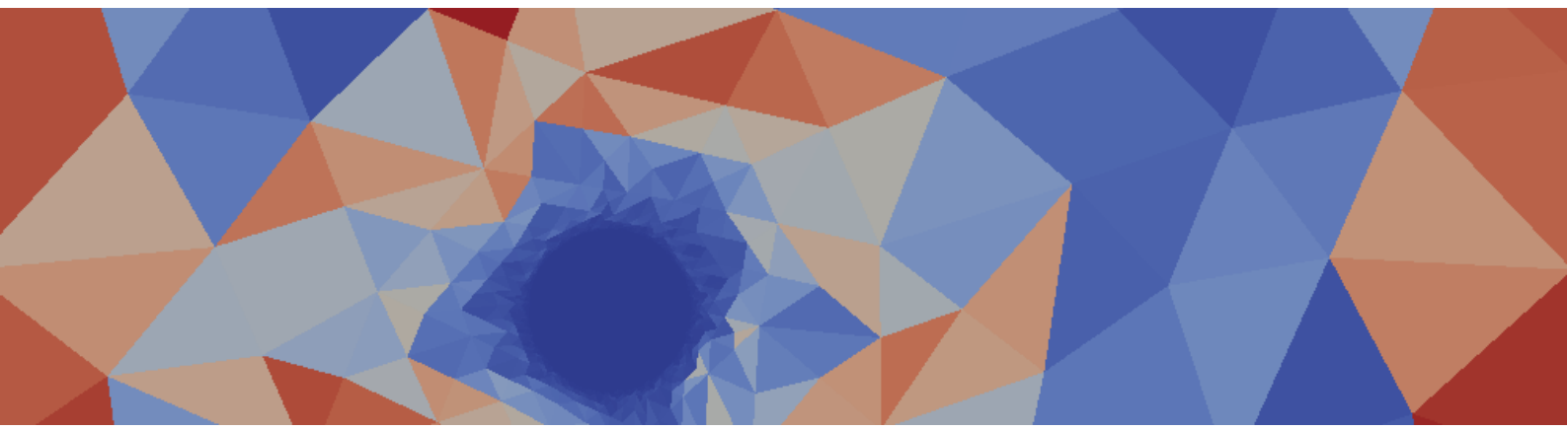
Dissemination Report
2025



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Executive Summary



Executive Summary

The current document presents the activities of the members of the Institute of Applied and Computational Mathematics (IACM) at the Foundation for Research and Technology – Hellas (FORTH), during the 2025 calendar year.

The Institute of Applied and Computational Mathematics (IACM) of the Foundation for Research and Technology – Hellas (FORTH) continued in 2025 to advance its mission of conducting high-level research in *applied mathematics, computational science and their applications* to complex scientific, technological and societal challenges. The Institute combines fundamental mathematical research with advanced computational methodologies, data science and application-driven research, providing a highly interdisciplinary environment in which mathematics, modelling, simulation and computation interact closely with the physical, engineering, life, environmental and social sciences.

In 2025, IACM comprised 30 researchers and associated researchers, produced 161 peer-reviewed publications, participated in 43 externally funded projects with an IACM budget of 11.932.344,34€, and supervised 27 doctoral and postdoctoral researchers.

IACM's scientific activity is organized across three broad Divisions: *Applied Analysis and Modeling, Numerical Analysis and Computational Science, and Applied Science*. Together, these encompass research groups in Applied Analysis, Mesoscale & Continuum Modeling, Molecular Modeling, Data Science, Computational Biomechanics, Scientific Computing and Software Development, Wave Propagation, Regional Analysis, Computational Neurosciences, Computational Pharmacology and Socio-Education Research and Innovation, complemented by dedicated laboratories in Statistical Learning, Coastal and Marine Research, Remote Sensing and Underwater Acoustic Measurements. This breadth constitutes a distinctive strength of IACM, enabling the Institute to address problems that range from fundamental mathematical questions to computationally intensive and application-oriented challenges.

Scientific excellence and interdisciplinary research

During 2025, IACM researchers produced significant results across a remarkably broad scientific spectrum. In fundamental and applied mathematics, research included nonlinear and stochastic partial differential equations, free-boundary problems, mathematical general relativity, nonlinear elasticity and fracture, stochastic processes and multiscale systems. Work on stochastic PDEs addressed, among other topics, stochastic Stefan problems and nonlinear evolution equations, while research in mathematical relativity investigated the stability and formation of singularities and the global dynamics of solutions to the Einstein equations.

Research at the interface of mathematics, physics and engineering included important contributions to nonlinear photonics, statistical wave dynamics, topological structures in magnetic materials, mechanics and materials modelling. Studies of nonlinear multimode photonic systems explored thermalization, energy exchange and statistical optical phenomena, while research on topological magnetic textures addressed the dynamics of skyrmions and antiferromagnetic domain walls, with potential applications in unconventional computing.

A particularly dynamic component of the Institute's scientific portfolio concerns the increasing integration of *artificial intelligence and machine learning with mathematical modelling and scientific computing*. Research activities included scientific machine learning, reduced-order and surrogate modelling, uncertainty quantification, generative approaches for random differential equations, AI-enhanced molecular simulations, machine-learned interaction models and data-driven multiscale methods. The development of predictive, interpretable and computationally efficient models for complex physical systems illustrates the emerging convergence between IACM's traditional strengths in mathematical and computational modelling and rapidly developing AI methodologies.

Multiscale modelling of complex molecular systems and materials similarly combined physics-based simulations, high-performance computing and AI to connect atomistic phenomena with macroscopic behaviour. Research during 2025 addressed polymers, soft matter, biomolecular systems, nanocomposites and functional materials, including active-learning strategies for potential-energy surfaces and deep-learning approaches for bridging molecular resolution levels. These activities exemplify the Institute's broader objective of moving computational modelling beyond description towards predictive frameworks capable of supporting scientific discovery and materials design.

Across the Institute, this methodological expertise was complemented by a strong portfolio of application-driven research spanning biomechanics, neuroscience, pharmacology, environmental and climate sciences, marine and coastal systems, remote sensing, biodiversity, speech technologies, renewable energy and urban systems. This combination of mathematical foundations, computational methodology and real-world applications remains one of IACM's defining characteristics.

Competitive funding, collaboration and impact

IACM maintained a strong and diversified portfolio of externally funded research during 2025, encompassing *European programmes, other international programmes, national funding schemes, industrial and private-sector collaborations, and FORTH Synergy Grants*. The portfolio includes major European initiatives such as the ERC projects *urbisphere* and *SINGinGR*, as well as Horizon Europe projects addressing trustworthy AI, climate and cities, marine ecosystems, biodiversity and public-health challenges. The newly launched *TURING* project, for example, focuses on trustworthy and robust AI-driven models for scientific and engineering applications, while *CLMS-Cities* develops innovative approaches supporting the evolution of the Copernicus Land Monitoring Service for cities participating in the EU Cities Mission.

The Institute's project portfolio also demonstrates its ability to connect mathematical and computational expertise with societal and environmental priorities. Research addresses climate-change adaptation, urban transformation, marine biodiversity, coastal vulnerability, Blue Carbon ecosystems, Arctic observation, health, renewable-energy forecasting and other areas in which quantitative modelling and data analysis can contribute directly to decision-making and technological development.

Equally important is the growing interaction with the private sector and international industry. During 2025, IACM activities included collaborations supported by *Apple, Huawei Technologies, Saudi Aramco and Toyota*, addressing topics ranging from machine learning and speech representation to causal modelling, photovoltaic forecasting and computational studies of polymer–metal systems. The funding portfolio therefore reflects both the Institute's ability to compete successfully for research funding and the relevance of its expertise to industrial and technological challenges.

Collaboration across FORTH remained another important dimension of IACM's activities. Synergy projects connected mathematical and computational expertise with neuroscience, molecular biology, biophysics, materials and biomedical applications. Projects such as *NEUROADAPT, FUSING, Lamia and MorPhase* demonstrate the potential of such cross-institute collaboration, ranging from NeuroAI and adaptive brain stimulation to protein folding, multimodal imaging and mathematical modelling of morphogenetic transitions in living systems.

People, training and scientific environment

IACM continued to contribute actively to the development of the next generation of researchers through the supervision of doctoral candidates, Master's students and postdoctoral researchers, as well as through participation in scientific schools, workshops, conferences and international research networks. The individual research activities documented in this report demonstrate extensive collaborations with universities and research institutions in Greece and internationally and substantial engagement by IACM researchers in scientific committees, editorial activities, international networks and community service.

The Institute also maintained an active programme of scientific events and outreach. Research groups organized and contributed to international workshops, conferences and training schools covering topics including stochastic analysis, mathematical general relativity, topological textures, nonlinear and applied mathematics, and computational science. Such activities reinforce IACM's role not only as a producer of scientific knowledge but also as a meeting point for scientific exchange, interdisciplinary interaction and the training of young researchers.

Research infrastructure

The Institute's research is supported by a diverse computational and experimental infrastructure. Alongside its computing servers and high-performance workstations, IACM operates specialized observational and experimental facilities supporting environmental, marine, remote-sensing and wave-propagation research. These include meteorological and air-quality monitoring networks, flux towers, an AERONET atmospheric monitoring system, a seismological station, an experimental acoustics tank, drones equipped with hyperspectral, optical and thermal imaging systems, remotely operated underwater vehicles, open-sea acoustic infrastructure, marine survey equipment and portable environmental sensing systems.

This combination of computational capability and field/experimental infrastructure enables IACM researchers to integrate mathematical modelling and simulation with real-world observations and experimental data—an increasingly important requirement for modern computational and data-intensive science.

IACM's development & the Future

The year also included important developments in the Institute's personnel. Dr. Angeliki Xenaki joined IACM as Principal Researcher, Dr. Zinovia Mitraka was elected Principal Researcher, and Dr. Yiannis Kamarianakis was elected Research Director. The Institute also marked the retirement of Research Director Dr. Aikaterini Kikis-Papadakis and Technical Scientist Nikolaos Manioudakis. These developments form part of the continuing renewal of IACM's scientific personnel and expertise.

Overall, the activities presented in this report demonstrate an Institute with a *broad scientific base, strong interdisciplinary character and increasing engagement with emerging computational technologies*. IACM's traditional strengths in applied mathematics, mathematical modelling, numerical methods and scientific computing are increasingly complemented by artificial intelligence, machine learning, data-intensive methodologies and advanced computational infrastructure. At the same time, the Institute maintains a strong connection between methodological research and applications in areas of major scientific and societal importance.

Looking forward, an important opportunity for IACM is to further integrate these strengths into a coherent scientific vision centred on **mathematics, modelling, computation, data and AI**. Strengthening scientific excellence, attracting and supporting talented researchers, expanding competitive European and international funding, developing advanced computational infrastructure, enhancing interdisciplinary collaboration within FORTH and with universities and research institutions, and building stronger links with industry and society can further consolidate IACM's position as a leading centre for applied and computational mathematics in Greece and strengthen its presence within the European research landscape.

Structure

The organization structure of the Institute is as follows:

- **Applied Analysis and Modeling Division**

Groups:

- Applied Analysis
- Mesoscale & Continuum Modeling
- Multi-scale modeling of Complex Molecular Systems

- **Numerical Analysis and Computational Science Division**

Groups:

- Data Science
- Computational Biomechanics
- Scientific Computing and Software Development

Laboratory:

- Statistical Learning Laboratory

- **Applied Science Division**

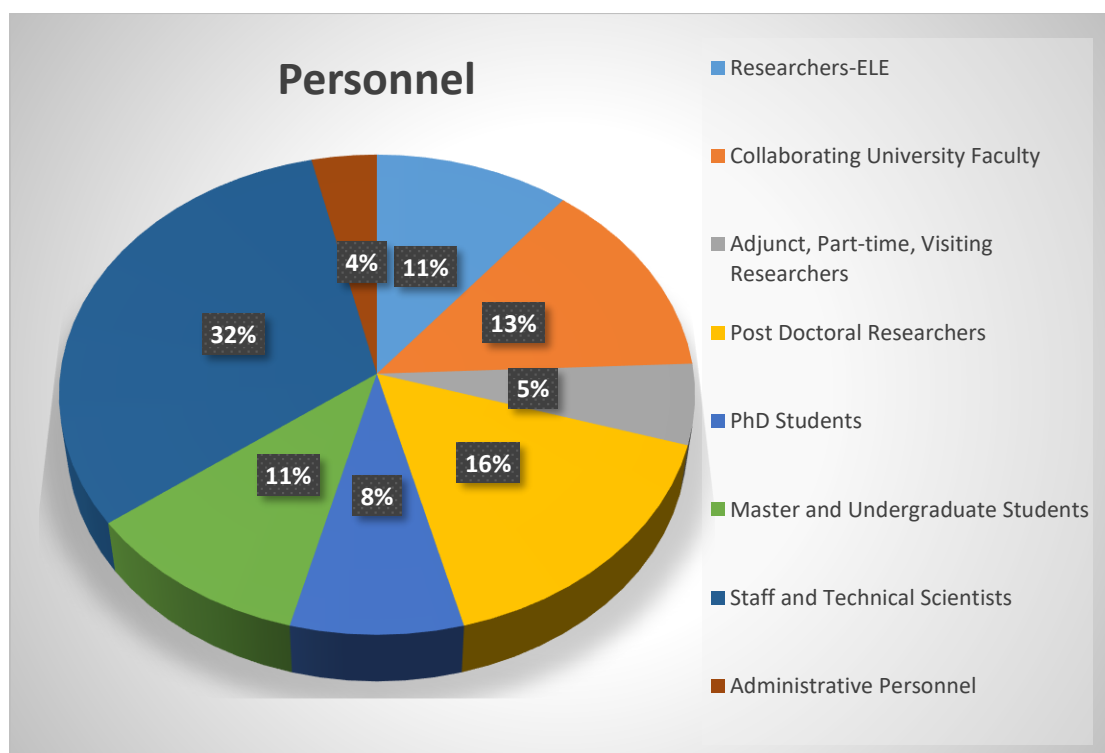
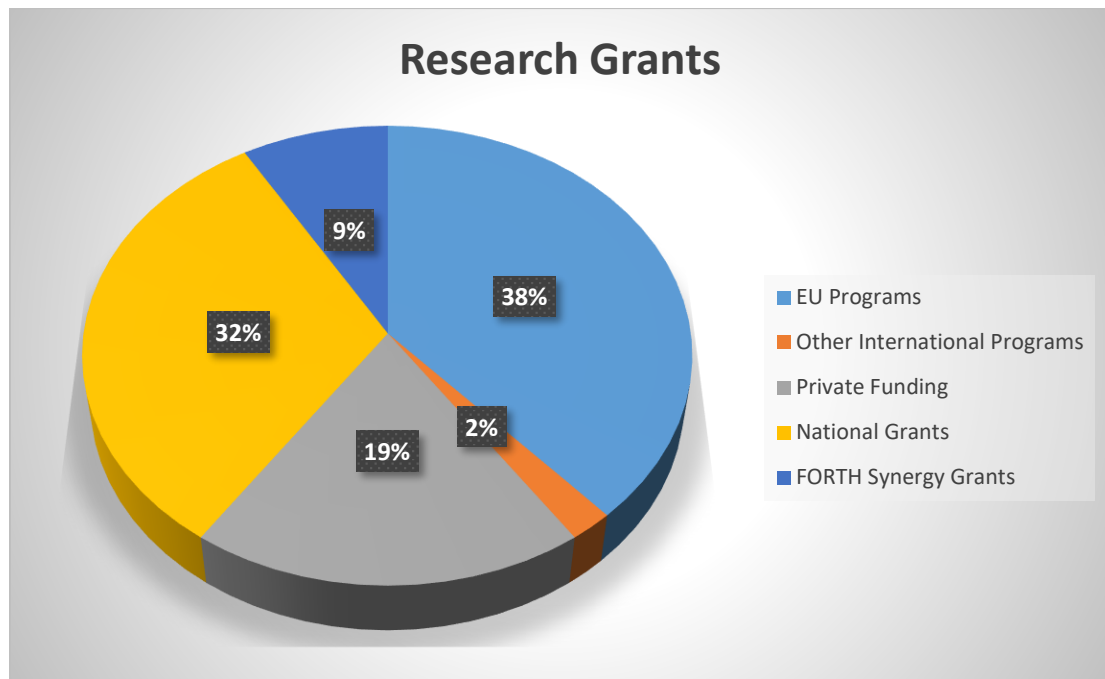
Groups:

- Wave Propagation
- Spatial Analysis
- Computational Neurosciences
- Computational Pharmacology
- Socio-Education Research and Innovation

Laboratories:

- Coastal & Marine Research Laboratory
- Remote Sensing Laboratory
- Underwater Acoustic Measurements Laboratory

Infographics



Research highlights



Applied Analysis

<https://www.iacm.forth.gr/divisions/applied-analysis-modeling/applied-analysis>





SPYRIDON KAMVISSIS

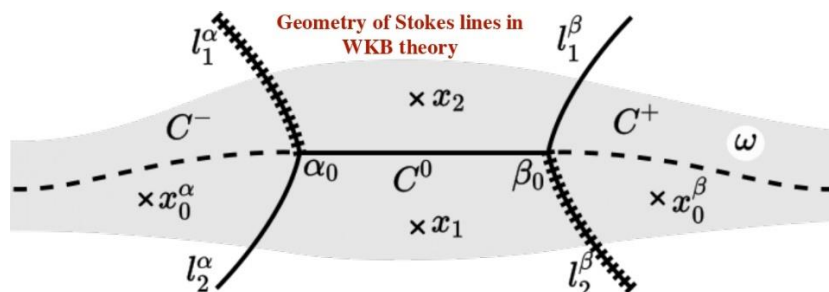
Professor, University of Crete
Associated Researcher

Summary:

My research has focused mostly on infinite dimensional Hamiltonian systems that admit a Lax pair or a zero curvature condition and can be studied via an inverse scattering/spectral method. These systems are often called completely integrable and generalise the finite dimensional Liouville-Arnold integrable systems. They form an important subclass of the general class of nonlinear differential systems; they have special extra structure and can thus be treated in more detail. They are nonetheless ubiquitous and offer a particular window to the understanding of several archetypal phenomena: solitons, dispersive shocks, the modulational instability, breather gases. I have been particularly interested in mathematically rigorous treatments of asymptotic problems like the investigation of long time asymptotics, semiclassical (or small dispersion) high frequency asymptotics and continuum limits of solutions of initial and initial-boundary value problems for nonlinear dispersive partial differential equations and nonlinear lattices, with particular attention to sophisticated "universal" models displaying instabilities.

Research Results during 2025:

- I. Rigorous implementation of the Unified Transform Method for Initial-Boundary Value Problems for PDEs, and application to Asymptotic Problems.
- II. Rigorous semiclassical WKB analysis of non-self-adjoint Dirac operators, and application to the semiclassical analysis of the focusing NLS equation.



Key Publications:

1. A Chatziafratis, S Kamvissis (2025) Infinity of solutions to initial-boundary value problems for linear constant-coefficient evolution PDEs on semi-infinite intervals, Bulletin of the London Mathematical Society, <https://doi.org/10.1112/blms.70179>



GEORGIA KARALI

Associate Professor, National and Kapodistrian University of Athens
Associated Researcher

Summary:

Georgia Karali's research focuses on the rigorous mathematical analysis of partial differential equations (PDEs) and stochastic partial differential equations (SPDEs). She specializes in nonlinear analysis, applied analysis, and the kinetics of phase transitions, particularly investigating deterministic and stochastic problems related to phase change and interface evolution. Much of her work involves the Cahn–Hilliard and Allen–Cahn equations, where she explores existence, regularity of solutions, and front motion under the influence of noise or singular perturbations. Her expertise also extends to mathematical modeling in varied fields, including multi-scale problems, mean curvature flow, and drug absorption kinetics.

Research Results during 2025:

During 2025, my research focused on the analysis of nonlinear and stochastic partial differential equations and free-boundary problems. A main result concerns the FitzHugh–Nagumo system on undulated cylindrical domains, where we studied spontaneous symmetrization and derived an effective reduced system describing the underlying dynamics.

A substantial part was also devoted to stochastic free-boundary problems. We established local existence results for an outer parabolic stochastic Stefan problem on the sphere, addressing the evolution of a moving interface under stochastic forcing. We also proved the existence of maximal solutions for a stochastic Stefan problem arising in a financial model for a volatile asset with bid–ask spread, providing a rigorous framework for the corresponding moving-boundary dynamics. Further results were obtained for higher-order diffusion and Cahn–Hilliard-type equations on the half-line, contributing to the analysis of nonlinear evolution equations in unbounded domains.

Overall, these results contribute to the rigorous analysis of nonlinear evolution partial differential equations, stochastic moving-boundary problems, and reduced models for complex dynamical systems.

Projects: IPMAFIN: Interfacial phenomena in stochastic reaction-diffusion systems & applications to mathematical finance, Funding Agency: Hellenic Foundation for Research and Innovation (H.F.R.I.), Contract number: 14910, Coordinator: Georgia Karali.

Organization of Conferences or Workshops: Stochastic Analysis in Mathematics and Natural Sciences: Theory and Applications, June 5-6 2025, IACM/FORTH, Crete, <https://sites.google.com/view/samans2025/main>

Supervision of Postdocs: Postdocs funded by Hellenic Foundation for Research and Innovation (H.F.R.I.):

1. Andreas Chatziafratis,
2. Dimitris Farazakis,
3. Konstantinos Tzirakis

PhD in progress: Dimitrios Dimitriou

Key Publications:

1. DC Antonopoulou, G Dewhurst, **G Karali**, K Tzirakis (2025) Local existence of the outer parabolic stochastic Stefan problem on the sphere, *Journal of Differential Equations*, 423, 439-475.
2. DC Antonopoulou, D Farazakis, **G Karali** (2025) Existence of maximal solutions for the financial stochastic Stefan problem of a volatile asset with spread, *Stochastic Processes and their Applications*, 179, 104506, <https://www.sciencedirect.com/science/article/pii/S030441492400214X>
3. DC Antonopoulou, **G Karali**, D Li (2025) Optimal Error Estimates of Energy-Stable Runge–Kutta Methods for the ε -dependent Cahn–Hilliard/Allen–Cahn Equation, *Journal of Scientific Computing*, 103, 68.
4. A Chatziafratis, A Miranville, **G Karali**, AS Fokas, EC Aifantis (2025) Higher-order diffusion and Cahn–Hilliard-type models revisited on the half-line, *Mathematical Models and Methods in Applied Sciences*, 35 (5), 1133-1197, <https://doi.org/10.1142/S0218202525500101>

Mesoscale & Continuum Modelling

<https://www.iacm.forth.gr/divisions/applied-analysis-modeling/mesoscale-continuum-modeling>





GRIGORIOS FOURNOHAVLOS

Associate Professor, University of Crete,
Associated Researcher

Summary and Current Aims:

Grigorios Fournodavlos' research lies at the interface of geometric analysis, nonlinear partial differential equations, and mathematical general relativity. He is primarily interested in the analytical and geometric properties of solutions to the Einstein equations, with an emphasis on questions of existence, stability, and singularity formation. His work combines techniques from hyperbolic PDEs, differential geometry, and mathematical physics to study the dynamical behavior of spacetime geometries arising in general relativity.

A central theme of his research is the rigorous analysis of cosmological and black-hole singularities. In particular, he investigates the formation, stability, and asymptotic structure of singular spacetimes, including problems related to strong cosmic censorship, gravitational collapse, and the nature of spacetime boundaries. More broadly, he is interested in understanding how geometric and analytical methods can be used to address fundamental questions concerning the global dynamics of solutions to the Einstein equations and the mathematical foundations of gravitation.

Progress and Key Achievements in 2025:

Grigorios Fournodavlos has made progress on the future stability of tilted fluids in the context of the Einstein-Euler system: (with Elliot Marshall and Todd A. Oliynyk) Future Stability of Tilted Two-Fluid Bianchi I Spacetimes, arXiv:2508.15155

Projects:

- SINGinGR: Singularities in General Relativity, ERCEA (European Research Council Executive Agency), Horizon 2020, Contract number: 101078061, Coordinator: FORTH, Coordinator on the part of IACM: Grigorios Fournodavlos

Organization of Conferences or Workshops:

- 19th Panhellenic Conference on Mathematical Analysis, Geometric Analysis - General Relativity session, 18 – 20 December, 2025. <https://sites.google.com/view/pcma-2025>
- Cretan Stars, a 3-day workshop in Anogia, 1 – 3 November, 2025. <https://users.math.uoc.gr/~gfournodavlos/Workshops/CretanStars2025.html>
- Modern Trends in Gravity and Black Holes, 1 – 7 September, 2025. <https://sites.google.com/view/cretegravity2025>
- Festum-pi Summer School and Research Conference, 14 – 27 July, 2025. <https://www.festum-pi.eu/post/festum-pi-summer-school-and-research-conference-14-27-july-2025-kania-crete-greece>

Supervision of Postdocs:

1. ERC Saeyon Mylvaganam (left academia),
2. Christopher Alexander (now U Rutgers),
3. Grigalius Taujanskas <https://www.dpmms.cam.ac.uk/~gt306/>

Bachelor's Master's & PhD theses completed:

1. Savvas Tsekmezoglou (Master thesis)

Bachelor's, Master's & PhD theses in progress:

1. Filippas Oikonomidis (PhD),

2. Savvas Tsekmezoglou (PhD),
3. Konstantinos Triamatakis (Master),
4. Kalliopi Kakepaki (Master)

Services in local, national and international committees:

HFRI, 4th call to support postdoctoral researchers (math/csd panel)

Other achievements:

- "Timelike boundaries in classical and quantum gravity", Simons Center for Geometry and Physics, Stony Brook, 8-12 December, 2025.
- Workshop in Geometric Analysis, Department of Mathematics, University of Athens, 12-13 September, 2025.
- Public talk, Deskati Mathematical Conference, Municipality of Deskati, 20-22 August, 2025.
- Festum π Summer School and Research Conference, MAICH, Chania, 14-27 July, 2025.
- Boundaries, stability, and singularities in general relativity – A meeting celebrating Helmut 6. Friedrich's 80th birthday, Institut Mittag-Leffler, Stockholm, 9-13 June, 2025.
- Colloquium, Department of Mathematics, University of Patras, 2 April, 2025.
- "Black holes, naked singularities, shocks and implosions", National University of Singapore, 6-10 January, 2025.

Public Outreach:

Public talk about black holes in the municipality of Deskati (Grevena), 20 August, 2025. <https://dimos-deskatis.gr/synedrio-mathimatikon-kai-eklaivevmenis-epistimis-sti-deskati-20-22-8-2025/>

Citation Index: Google Scholar 119 (2025)

Publications:

1. S Alexakis, **G Fournodavlos** (2025) Stable Space-Like Singularity Formation for Axi-symmetric and Polarized Near-Schwarzschild Black Hole Interiors, *Annals of PDE* 11 (1), 10.
2. N Athanasiou, **G Fournodavlos** (2025) A Localized Construction of Kasner-like Singularities, *Communications in Mathematical Physics* 406 (10), 252, <https://doi.org/10.1007/s00220-025-05437-9>
3. **G Fournodavlos**, J Smulevici (2025) On the Initial Boundary Value Problem for the Einstein Vacuum Equations in the Maximal Gauge, *Annales Henri Poincaré*, 1-38, <https://doi.org/10.1007/s00023-025-01645-0>



NIKOLAOS EFREMIDIS

Professor, University of Crete,
Associated Researcher

Summary:

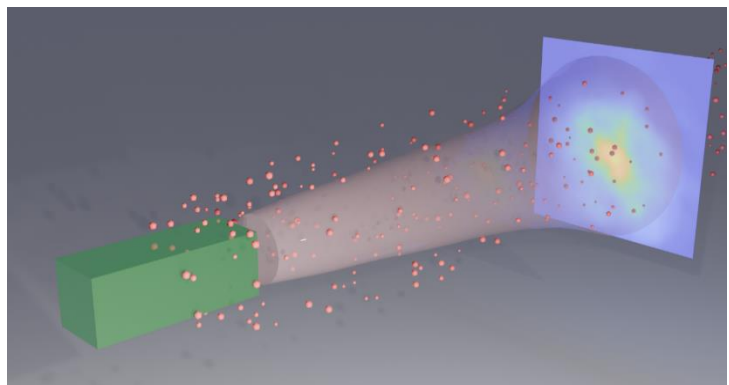
Nikolaos Efremidis' research is centered on the applied and computational mathematics of nonlinear waves, complex optical systems, and statistical wave dynamics. The main objective is to develop mathematical models, analytical methods, and computational approaches for understanding how coherent and incoherent optical fields evolve in high-dimensional nonlinear media. The physical settings include photonic lattices, waveguide arrays, multimode fibers, coupled resonators, and free-space optical systems, while the underlying mathematical themes involve nonlinear dynamical systems, Hamiltonian lattices, modal energy exchange, localization, symmetry, topology, and statistical mechanics.

A major direction of his recent work is optical thermodynamics: the study of thermalization, equilibrium, and entropy-driven evolution in conservative nonlinear optical systems. This includes the emergence of Rayleigh-Jeans distributions, effective temperature and chemical potential, negative-temperature states, prethermalization, and the thermodynamic interaction between coherent localized waves and incoherent optical backgrounds. Within this framework, he investigates how nonlinear mode coupling redistributes power and energy, and how localization, finite-size effects, topology, and discrete symmetries can accelerate, delay, or even suppress thermalization.

The broader aim is to establish predictive principles for controlling nonlinear wave transport and energy flow in complex photonic media. This work combines analytical theory, large-scale numerical simulations, and experimentally relevant modeling, with applications to beam shaping, optical communications, multimode photonics, nonlinear photonic devices, and structured-light propagation in complex or turbulent environments.

Current aims:

1. To develop mathematical and computational frameworks for optical thermodynamics in nonlinear multimode systems, including thermal equilibrium, prethermalization, negative-temperature states, and the role of conserved quantities.
2. To analyze nonlinear modal energy exchange in Hamiltonian optical lattices and wave systems, with emphasis on DNLS-type models, wave turbulence, Rayleigh-Jeans equilibrium, and finite-size effects.
3. To understand the interaction between coherent localized waves and thermalized optical backgrounds, including soliton-thermal-cloud exchange, entropy-driven mechanisms, and thermodynamic control of localized states.
4. To identify mechanisms that control or inhibit thermalization in nonlinear photonic lattices, including symmetry-protected thermal isolation, compact localized modes, topological edge states, and selection rules for nonlinear mode mixing.
5. To design experimentally realistic platforms for observing and controlling statistical wave phenomena, including waveguide arrays, mesh lattices, multimode fibers, coupled resonators, and synthetic photonic lattices.
6. To extend structured-light and nonlinear-wave concepts to applied photonic systems, including free-space optical communication, ground-to-space optical links, and beam-shaping strategies for propagation through complex or turbulent media.



Research Results during 2025:

In 2025, our research focused on the development and application of mathematical models and computational methods for studying nonlinear wave phenomena, with particular emphasis in the field of photonics.

A major research direction concerned the study of the statistical mechanics and thermodynamics of nonlinear multimode photonic systems. Using nonlinear coupled-wave models, we investigated power and energy exchange, entropy maximisation, and relaxation towards thermal equilibrium. Theoretical and computational tools were developed to describe prethermalisation and thermalisation in multiband photonic lattices, as well as to clarify how system topology and associated boundary states affect these processes.

A second research direction addressed the propagation of nonlinear optical beams through random and turbulent media. The analysis combined nonlinear wave equations, stochastic models of refractive-index fluctuations, and extensive numerical simulations. The aim was to achieve a quantitative understanding of the mechanisms governing the spatial coherence, beam spreading, and intensity fluctuations of optical beams, with applications to free-space optical communications and remote sensing.

Projects:

- Using pin beams and complex beam profiles to optimize the performance of free space optical links, Funding agency and funding scheme: Research cooperation between HUAWEI TECHNOLOGIES SWEDEN AB and FORTH, Duration: 14/02/2022-21/12/2025, Coordinator: Nikolaos Efremidis

Supervision of Postdocs:

- Guowen Yang, Nankai University

Bachelor's Master's & PhD theses completed:

1. Guowen Yang, Nankai University (Ph.D. student – co advising with Z. Chen),
2. Jiale Wang, Nankai University (Master student – co advising with Z. Chen)

Bachelor's, Master's & PhD theses in progress:

1. Yichuan Chen, Nankai University (Ph.D. student – co advising with Z. Chen),
2. Jiale Wang, Nankai University (Ph.D. student – co advising with Z. Chen)

External Collaborations:

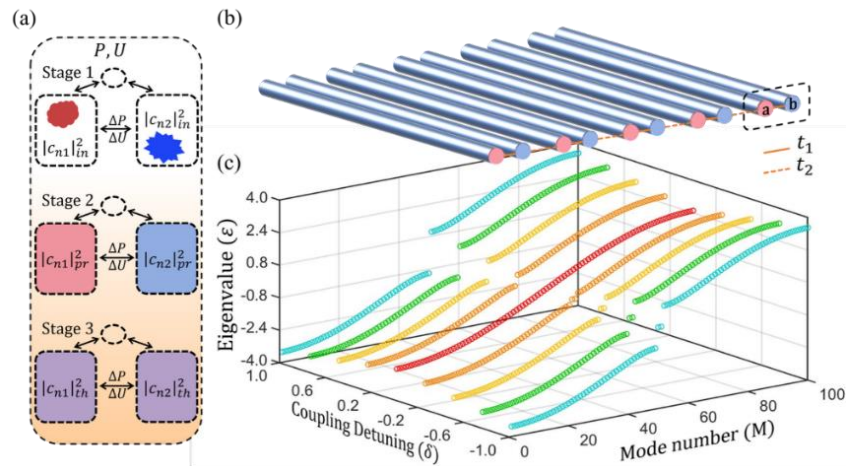
Prof. Zhigang Chen (Nankai Univ.), Prof. Demetri Christodoulides (Univ. of Southern California)

Institutional Collaborations: Stelios Tzortzakos (IESL), Dimitris Papazoglou (IESL)

Citation Index 2025: 756 (total), 753 (without AA)

Key Publications:

1. G Yang, J Wang, Y Chen, L Song, S Xia, D Song, Z Chen, **NK Efremidis** (2025) Unveiling prethermalization and thermal processes through the simplest one-dimensional topological model, *APL Photonics* 10, 076114, <https://doi.org/10.1063/5.0270636>





STAVROS KOMINEAS

Professor, University of Crete,
Associated Researcher

Summary and Current Aims:

The main research focus of Stavros Komineas' group is the mathematics and physics of topological textures in ferromagnetic and antiferromagnetic materials. In particular, they study models (which are nonlinear partial differential equation) that have skyrmion solutions and other topological structures. They seek to derive governing laws for the dynamics of these topological solitons. They also investigate potential applications of such systems in unconventional computing methods.

Research results during 2025:

Topological textures in magnetic materials present a high degree of complexity and they are studied with the tools of topology and of nonlinear differential equations. Ubiquitous experimental observations are available for magnetic skyrmions. These are remarkably robust textures in films and carry a topological number, called the skyrmion number (it is related to the degree of the map from S^2 to S^2).

We have studied the dynamics of skyrmions in two ferromagnetic layers that are antiferromagnetically coupled (the system is called a synthetic antiferromagnet (SAF)). Under an applied magnetic field gradient, the skyrmions move perpendicular to the gradient and the system displays positional memory: when the magnetic field gradient is removed, the skyrmions return to their original positions to a high degree of accuracy. The numerical findings are described using a collective coordinate method, while Hamiltonian methods are used to describe the precise dynamics beyond the numerics. We are further working to use this feature to construct an artificial spiking neuron.

Domain walls in antiferromagnets are solutions of the nonlinear sigma model and they turn dynamical under spin-polarized current. By choosing the spin-current polarization, we obtain propagating walls and oscillatory dynamics. For propagating walls, the profile is found to lack a definite parity and to present power-law tails by perturbation and asymptotic methods.

Projects:

- POLYTOPO: Topological textures in condensed matter, Funding Agency: COST, Program: COST Action, Contract number: CA23134, Coordinator: S. Komineas, Coordinator on the part of IACM: S. Komineas.

Organization of Conferences or Workshops:

- TOPOCOM Workshop, 26-30 May 2025, Heraklion, Crete, Greece.
- Workshop on "Order parameters for topological textures: singularities and dynamics", 22-24 September 2025, Heraklion, Crete, Greece.
- Training School on "Physics and Mathematics of Topological Textures", 12-13 May 2025, Budapest, Hungary

Educational activities within the framework of IACM:

Training School on "Physics and Mathematics of Topological Textures", 12-13 May 2025, Budapest, Hungary (organized by the network POLYTOPO, managed by IACM).

Supervision of Postdocs:

Name: Bruno Barton-Singer.

Scope: Dynamics of topological textures in magnets.

Projects: (a) Paper on “Interaction and collision of skyrmions in chiral antiferromagnets”, 2025. (b) Paper on “Positional memory of skyrmions in magnetic bilayers”, Phys. Rev. B 113, 134448 (2026). (c) now working on “Singularity formation in magnets”.

Bachelor's Master's & PhD theses completed:

1. Under his supervision: Nikos Kalogerakis, (U of Crete) MSc thesis on “Non-Hermitian and reversible systems”, 3/7/2025.
2. Member of three-member panel: Georgiana Charalampous, (U. of Crete) Msc thesis on “The Cauchy problem in general relativity”, Feb 2025.

Bachelor's, Master's & PhD theses in progress:

Under his supervision:

1. George Theodorou, U. of Crete, PhD candidate, “Spin waves and solitons in antiferromagnets” (start May 2023),
2. Anusree Navallur, U. of Crete, PhD candidate, “Framework for skyrmionic dynamics and manipulation” (start May 2024).

Member of three-member panel:

3. Artem Tomilo, U. Crete, PhD candidate

Other achievements:

Journal: Vertex Physics, Member of Editorial Board

Public Outreach:

- Participation in Researchers’ night, FORTH, Heraklion, 9/2025.
- Development of Outreach page within the network POLYTOPO (activity not completed yet).

Citation Index: Current h-index is 27 (from Google scholar)

Key Publications:

1. G Theodorou, **S Komineas** (2025) Traveling antiferromagnetic domain walls in a magnetic field, *Low Temperature Physics* 51 (6), 813-818.
2. G Theodorou, B Barton-Singer, **S Komineas** (2025) Interaction and collision of skyrmions in chiral antiferromagnets, *SciPost Physics* 18 (1), 037.



PHOEBUS ROSAKIS

Professor, University of Crete,
Associated Researcher

Summary and Current Aims:

Modelling, Mathematical Analysis and Computation of nonlinear problems with instabilities and their application to biomechanics, fracture and plasticity. Energy minimization of nonconvex problems for phase transitions with complex microstructure evolution using the Deep Ritz Method (deep neural networks)

Progress and Key Achievements in 2025:

1. Phoebus Rosakis has been developing a new nonlinear theory of brittle fracture together with collaborators from Cornell, KAUST and Pisa. He is the project leader and has developed the mathematical model. Mathematical analysis is done collaboratively with Cornell and Pisa, computations with Cornell (math) and a former KAUST postdoc who is about to start a faculty position in Ioannina (math). This new theory suffers from none of the disadvantages of traditional fracture models including phase field theories and can spontaneously predict nucleation and growth of fracture without extraneous criteria.
2. Phoebus Rosakis has completed and published the first uniqueness theorem of Nonlinear Elasticity for the mixed displacement-traction problem. He is the sole author of this work.

Organization of Conferences or Workshops:

59th Meeting of the Society for Natural Philosophy July 11-13 2025 where Professor Sir John Ball delivered the distinguished Truesdell Lecture.

Supervision of Postdocs:

- Georgios Grekas formerly of KAUST and soon Asst. Prof. of mathematics in U. Of Ioannina, extensive computations testing a novel theory of brittle fracture.

Bachelor's, Master's & PhD theses in progress:

1. Co-supervision of PhD of Arnav Gupta Cornell U. With Prof. T.J. Healey PhD thesis title: Brittle Fracture Using the Inverse Deformation Approach.

External Collaborations:

- Prof. T.J. Healey Math Cornell U., Prof. Roberto Paroni Pisa, Prof. Zhiwen Zhang Hong Kong U., Prof. Rohan Abeyaratne MIT.

Institutional Collaborations:

Co-supervision of PhD of Arnav Gupta Cornell U. with Prof. T.J. Healey

Citation Index: 156 (2025) Google scholar

Key Publications:

- **P Rosakis** (2025) Uniqueness for Some Mixed Problems of Nonlinear Elastostatics, *Mathematics and Mechanics of Solids*, 31(1), 82-95, <https://doi.org/10.1177/10812865251354964>.



DIMITRIS SFYRIS

Principal Researcher

Summary and Current Aims:

1. Universal displacements in elasticity,
2. Existence results in nonlocal nonlinear one dimensional elasticity,
3. Morphogenetic phase transitions in living matter,
4. Implicit theories of constitutive relations,
5. Alternative writing of the momentum equation as a first order system,
6. Theory of multilattices (mechanics and mathematics)

Research Results during 2025: In short terms, within 2025, in three papers we achieved:

- 1) to provide alternative writings of the classical elastodynamic equations as a first order system, both in one, two and three space dimensions; these writings provide unconventional but mechanically reasonable forms of the partial differential equations governing classical elastodynamics.
- 2) for the one dimensional nonlocal elastodynamic equations we found conditions for hyperbolicity and also evaluated Riemann invariants and characteristic direction, which are important when existence and uniqueness results are sought.
- 3) we evaluated universal displacements for all anisotropic classes of linear Cauchy elasticity; these solutions can be used as benchmark problems in computational mechanics, and also provide valuable insights for designing experiments aimed at determining the constitutive response of specific materials.

Progress and Key Achievements in 2025: Established a firm collaboration with Arash Yavari (Georgia, USA), Roger Bustamante (Santiago, Chile), Harold Berjamine (Galway, Ireland), Anastasios Pavlopoulos (IMBB, Greece), K.R. Rajagopal (Texas A-M, USA), Kostas Spiliotis (Xanthi, Greece).

Projects: MorPhase: Morphogenetic Phase transitions in Living Matter, FORTH Synergy grants, Partners: IACM and IMBB, Coordinator on the part of IACM: D. Sfyris.

External Collaborations:

- Arash Yavari (Georgia USA),
- Roger Bustamante (Santiago, Chile),
- Harold Berjamine (Galway, Ireland),
- Anastasios Pavlopoulos (IMBB, Greece),
- K.R. Rajagopal (Texas A-M, USA),
- Kostas Spiliotis (Xanthi, Greece).

Other achievements: Reviewer for many scientific journals in the field of Applied Mathematics-Mechanics.

Citation Index: 72 Scopus (2025 total), 57 (without AA*), 57 (without IA*)

Key Publications:

1. **D Sfyris** (2025) Alternative writings of classical elastodynamics equations as a first order symmetric system. *Mathematics and Mechanics of Solids*, <https://doi.org/10.1177/10812865251348897>
2. **D Sfyris** (2025) One-dimensional nonlocal elastodynamics: constitutive modeling, hyperbolicity, Riemann invariants, characteristic directions, *Zeitschrift für angewandte Mathematik und Physik* 76 (1), 16.
3. A Yavari, **D Sfyris** (2025) Universal Displacements in Anisotropic Linear Cauchy Elasticity, *Journal of Elasticity* 157 (1), 1-15.

Multi-scale modeling of Complex Molecular Systems

<https://www.iacm.forth.gr/divisions/applied-analysis-modeling/molecular-modeling>





VAGELIS HARMANDARIS

Director of IACM

Summary and Current Aims:

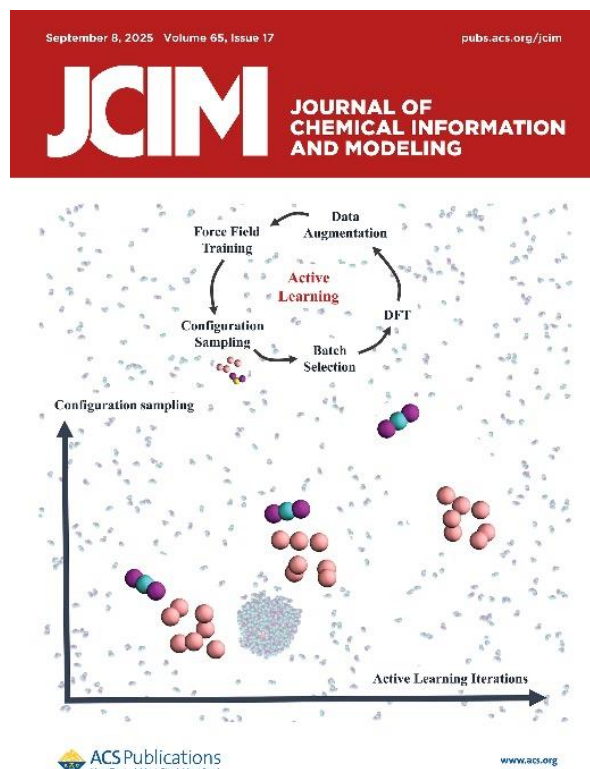
Our research focuses on the development and application of advanced computational methodologies for understanding, predicting, and designing complex molecular systems and materials across multiple length and time scales. By combining physics-based modelling, high-performance computing, machine learning, and artificial intelligence, my work aims to bridge the gap between atomistic phenomena and macroscopic material behavior. Particular emphasis is placed on polymers, soft matter, biomolecular systems, energy materials, and functional nanostructures, with the goal of accelerating scientific discovery and enabling the rational design of next-generation materials and technologies.

A central theme of our research is the integration of multiscale simulations with data-driven approaches to create predictive frameworks for materials innovation. This includes the development of AI-enhanced molecular simulations, machine-learned interatomic potentials, digital twins, and uncertainty-aware computational models capable of guiding experiments and industrial applications. The overarching objective is to transform computational modelling from a descriptive tool into a predictive and actionable technology that can support scientific breakthroughs, industrial innovation, and evidence-based decision making in complex systems.

Progress and Key Achievements in 2025:

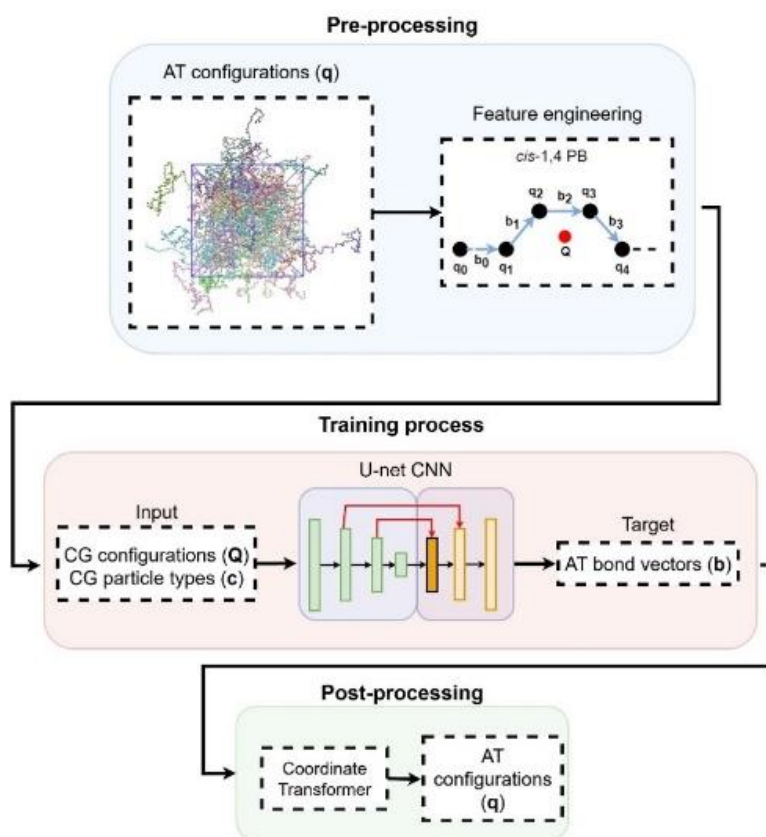
During 2025, our research activities focused on the development of advanced computational methodologies for the modelling of complex molecular systems and materials, combining multiscale simulations, artificial intelligence, and high-performance computing. The year resulted in the publication of about 15 peer-reviewed articles in leading international journals, including *Macromolecules*, *Journal of Chemical Information and Modeling*, *Journal of Physical Chemistry B*, *Soft Matter*, *ACS Applied Polymer Materials*, *Computational Materials Science*, and *Biomolecules*. These publications addressed topics ranging from polymer dynamics and rheology to biomolecular systems, nanocomposites, machine-learning-assisted molecular simulations, active learning for potential energy surfaces, and multiscale modelling of mechanical behavior. Several studies introduced novel AI-driven and physics-informed modelling approaches, strengthening our contributions to the rapidly growing field of AI for Materials Science.

An example of our recent work refers to the development of an active learning (AL) framework for deriving classical atomistic models (force fields) that accurately model the potential energy surfaces of gas/solid atomic-scale complexes. Our approach trains physics-aware potentials, with incorporated flexibility and smoothness, on actively sampled density functional theory data to describe interactions between undercoordinated atomic silver (Ag) clusters and gaseous pollutants (CO_2 , CO , SO_2), relevant for environmental applications like gas sensing. This framework produces atomistic models capable of capturing cohesive, physisorption, and chemisorption interactions with



admirable accuracy, close to ab initio methods, while retaining the efficiency of semiempirical potentials. The proposed methodology is highly versatile, easily accommodating various choices of descriptors, model basis sets, and sampling techniques.

Another example concerns the application of deep learning (DL), to advance multi-scale approaches. In a recent work ([ERCIM, special issue on “AI for Science”, 2025](#)) we introduced a general DL-based approach for back-mapping (re-introducing atomic detail) in coarse-grained multi-component macromolecular systems, based on convolutional neural networks that are trained directly on atomistic descriptors. The new DL model is capable of creating representative well-equilibrated atomistic configurations in a three-dimensional Cartesian space of multi-component polymeric materials of high molecular weight. To improve the accuracy of the deep learning model, the loss function of the neural network is augmented with several penalizing terms based on prior knowledge of the physical properties of the molecular systems under study, such as bond lengths, bond angles, and dihedral angles.



During 2025 our group published **15 articles in peer-reviewed scientific journals (all Q1)** and one chapter entitled “*The Fascinating Behavior of Polymers at Interfaces via Molecular Dynamics Simulations*”, Chapter in Book “[Computational Methods for the Multiscale Modelling of Soft Matter](#)”, Edited by P. Carbone and N. Clarke, Elsevier, 2025. The group also actively participated in major international conferences and workshops, while also contributing to the organization of scientific events, including the 1st International Cyprus Advanced Materials Network Conference. The group's scientific excellence was further recognized through prestigious distinctions, including the Best Poster Award at the European Materials Modelling Council (EMMC) Conference and the Best PhD Thesis Award of the Hellenic Society for Computational Mechanics awarded to members of the research team. At the strategic level, 2025 marked another successful year for the SimEA ERA Chair initiative, which continued to establish Cyprus as a regional hub for advanced materials modelling and AI-driven scientific discovery.

Citations: (Google scholar, till 31/12/2025) - Total: 5378 (577 in 2025); h-index: 42

Key publications:

1. N. Patsalidis, M. D. Mohammadi, S. Bhowmick, G. Biskos, **V. Harmandaris***, “Active Learning of Atomic Size Gas/Solid Potential Energy Surfaces via Physics Aware Models”, *J. Chem. Inf. & Model.*, **2025**, 65, 9009–9021, <https://doi.org/10.1021/acs.jcim.5c01193>.
2. S. Ektirici, A. Rissanou, **V. Harmandaris***, “Investigating the Effects of pH and Temperature on the Interactions and the Properties of Lysozyme-Polyacrylic Acid Complexes”, *ACS Omega*, **2025**, 10, 34787–34800, <https://doi.org/10.1021/acsomega.5c03767>
3. P. Bačová*, **V. Harmandaris**, S. Molina, “Computational investigation of structural properties of poly(lactic acid) and its stereoisomers: shape, size and flexibility”, *Macromolecules*, **2025**, 58, 8572–8580, <https://doi.org/10.1021/acs.macromol.5c00918> (Chosen as back-cover).
4. H. Reda, P. Katsamba, A. Chazirakis, **V. Harmandaris***, “Revealing the role of microstructure and strain heterogeneities in the elastic-plastic transition of glassy polymers”, *Macromolecules*, **2025**, 58, 6994–7004, <https://doi.org/10.1021/acs.macromol.5c00694>

Data Science

<https://www.iacm.forth.gr/divisions/numerical-analysis-computational-systems/data-science>





GEORGIOS ARAMPATZIS

Assistant Professor, University of Crete,
Associated Researcher

Summary:

Georgios Arampatzis' research is centered on the applied and computational mathematics of scientific machine learning for complex physical systems. The main objective is to develop mathematical models, numerical methods, and machine-learning approaches for the reduced-order modeling, surrogate modeling, and uncertainty quantification of high-dimensional dynamical systems and parametric or random partial differential equations. The physical settings include multiscale dynamical systems, fluid flows, molecular and reaction–diffusion systems, and materials, while the underlying mathematical themes involve nonlinear dynamical systems, dimensionality reduction, autoencoders and recurrent latent dynamics, operator learning, probability measures on function spaces, and optimal transport.

A major direction of his recent work is data-driven reduced-order modeling and uncertainty quantification of complex systems. Through the Learn Effective Dynamics (LED) framework, he bridges high-fidelity solvers and fast surrogates by pairing an autoencoder with a recurrent latent time-stepper, alternating between a high-dimensional solver and a learned latent propagator, and adapting the surrogate online with switching governed by its own predicted uncertainty.

In a complementary line, his work on neural measures extends the physics-informed paradigm from single trajectories to whole probability distributions: it constructs parametrized families of probability measures on function spaces and trains them with Wasserstein-based residual losses, supported by universal approximation guarantees, so that the resulting surrogates capture not only the dynamics but also the uncertainty of solutions to random PDEs.

The broader aim is to establish predictive, trustworthy, and interpretable surrogates for complex physical systems, in which the learned low-dimensional representations carry genuine physical meaning. This work combines analytical theory, large-scale numerical simulation on HPC infrastructure, and application-driven modeling, with applications to multiscale simulation, scientific computing, and materials science, including surrogate models for expensive solvers and the classification and forecasting of experimental time series.

Current aims:

1. To advance uncertainty quantification for random and parametric PDEs through neural measures and distributional learning, including optimal-transport losses, approximation guarantees, and extensions toward inverse problems and generative flows of probability measures.
2. To embed physical meaning into low-dimensional representations, propagating physically significant latent variables via the Mori–Zwanzig formalism and the remainder by neural networks, and using multi-task autoencoders that generalize across operating conditions (TURING, Task 3.2).
3. To design fast surrogate and operator-learning models that replace computationally expensive solvers, enabling large-scale parameter exploration, sensitivity analysis, and manyquery design tasks.
4. To apply machine learning to materials, including time-series classification and forecasting from spectroscopic and sensor measurements, with robustness to the distribution shifts that arise across measurement campaigns.
5. To integrate these components into reduced-order models that are simultaneously fast, calibrated in their uncertainty, and physically interpretable, suitable for deployment in scientific and engineering settings.

Projects:

- TURING: Trustworthy Unified Robust Intelligent Generative Systems, EU HORIZON, Contract number: 101215032, Coordinator: NTUA, Coordinator on the part of IACM: Georgios Arampatzis

Supervision of Postdocs:

- Stelios Katsarakis: He is involved in TURING working on Reduced Order Machine Learning Models.

Bachelor's Master's & PhD theses completed:

1. Minas Achladianakis, UoC, MSc, An Expectation-Maximization Interpretation of CMA-ES: Theory and Extensions.

Institutional Collaborations:

- Stelios Tzortzakis (IESL)

Citation Index: 947 (total 2025)

Key Publications:

1. **G Arampatzis**, S Katsarakis, C Makridakis (2025) A generative modeling/Physics-Informed Neural Network approach to random differential equations, arXiv preprint arXiv:2507.01687



AGGELIKI DOXA

Assistant Professor, University of Crete,
Associated Researcher

Summary:

Aggeliki Doxa's main scientific interests lie in the understanding of climate change and land use impacts on population and community dynamics of terrestrial and marine species, with a particular focus on optimizing conservation planning approaches at the local and large scale in the Mediterranean region.

Progress and Key Achievements in 2025:

Co-development of two (2) R packages on systematic conservation planning algorithms:

- prior3D <https://cran.r-project.org/web/packages/prior3D/index.html> and
- priorCON <https://cran.r-project.org/web/packages/priorCON/index.html>

Bachelor's, Master's & PhD theses in progress:

2 PhD and 2 Master theses in progress.

Projects:

- ResTick: "Resilience Enhancement for Ticks and Tick-Borne Diseases in Sub-Saharan Africa", EU HORIZON, Contract number: 101190792, Coordinator: IMBB FORTH, Coordinator on the part of IACM: Y. Kamarianakis.
- Nemo-Tools: "Next-generation monitoring and mapping tools to assess marine ecosystems and biodiversity", Funding Agency: Hellenic Foundation for Research and Innovation, Contract number: 16035, Coordinator on the part of IACM: Y. Pantazis.

Citation Index: 221 (total 2025)

Key Publications:

1. **A Doxa**, C Adam, N Nagkoulis, AD Mazaris, S Katsanevakis (2025) prior3D: An R package for three-dimensional conservation prioritization, *Ecological Modelling* 499, 110919.
2. S Giakoumi, AJ Richardson, **A Doxa**, S Moro, M Andrello, JO Hanson, V Hermoso, T Mazor, J McGowan, H Kujala, E Law, JG Álvarez-Romero, RA Magris, E Gissi, N Arafteh-Dalmau, A Metaxas, EA Virtanen, NC Ban, RM Runya, DC Dunn, S Frascchetti, I Galparsoro, RJ Smith, F Bastardie, V Stelzenmüller, HP Possingham, S Katsanevakis (2025) Advances in systematic conservation planning to meet global biodiversity goals, *Trends in Ecology & Evolution* 40 (4), 395-410.
3. K Konsta, **A Doxa**, S Katsanevakis, AD Mazaris (2025) Projected marine heatwaves over the Mediterranean Sea and the network of marine protected areas: a three-dimensional assessment, *Climatic Change* 178 (2), 1-20.



EVANGELIA KALLIGIANNAKI

Associate Professor, University of the Aegean
Associated Researcher

Summary and Current Aims:

Evangelia Kalligiannaki's research focuses on developing mathematical and computational methods for analyzing complex systems influenced by stochastic effects. She works on stochastic processes, multiscale modeling, and uncertainty quantification, with the goal of transforming detailed microscopic descriptions into efficient and accurate large-scale models. Her approach integrates tools from statistical mechanics, data-driven modeling, and Monte Carlo methods to enhance simulations in areas such as molecular systems, materials science, and energy applications. Currently, her research also emphasizes the development of statistical inference methods at the intersection of statistics and optimal transport, as well as the design of efficient techniques for inference in non-Markovian systems.

Bachelor's, Master's & PhD theses in progress:

PhD:

1. Georgia Baxevasi, Mathematics Department, University of Crete

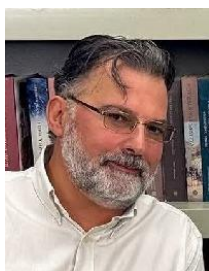
Master:

1. Aikaterini Papahristou, Clustering and Dimension Reduction with Optimal Transport, Department of Statistics and Actuarial-Financial Mathematics, University of the Aegean.
2. Vasileios Tsimpris, Statistical inference approaches of non-Markovian processes described by SDEs with colored noise. Department of Statistics and Actuarial-Financial Mathematics.
3. Vasileios Koutsogiannis, Inference Methods for Lévy-driven Stochastic Differential Equations with Applications in Electricity Price Dynamics. Department of Statistics and Actuarial-Financial Mathematics.

Citation Index: (Source Scopus) 132 (total 2025), 107 (without AA*), 85 (without IA*)

Services in local, national and international committees

- Vice-chair, Department of Statistics and Actuarial-Financial Mathematics, University of the Aegean.
- Undergraduate Committee, Coordinator. Department of Statistics and Actuarial-Financial Mathematics, University of the Aegean.
- Internal Evaluation Team, member, Department of Statistics and Actuarial- Financial Mathematics, University of the Aegean.
- Greek Network for Applied and Industrial Mathematics (GR-Maths-IN), Coordinator.
- EU-Maths-IN, Greek node representative.
- Grant Awarding Coordinator, COST Action STOCHASTICA-(Stochastic Differential Equations: Computation, Inference, Applications), Funding Agency: European Cooperation in Science and Technology.



YIANNIS KAMARIANAKIS

Research Director

Summary and Current aims:

- Development of subsampling-based two-stage adaptive penalized estimators for parametric predictive models. Evaluation of their i) asymptotic properties; ii) small sample properties using Monte Carlo experiments; iii) predictive performance relative to existing methodologies, in motivating applications characterized by high-dimensional data.
- Development and evaluation of novel, shrinkage-prior based, Bayesian estimators for time series models.
- Refinement of the solar forecasting software that has been developed in the last 3 years, within the framework of the collaboration with Saudi Aramco.

Progress and Key Achievements in 2025:

- Development and extensive Monte Carlo evaluation of a novel two-stage adaptive penalized estimator—Subsampling-based Adaptive Ridge (SARIDGE)—for logistic regression models, including a rigorous investigation of its asymptotic properties. The methodology is further validated through two challenging applications: dyslexia screening using eye-tracking data and species distribution modeling.
- Development of a novel modeling framework for multivariate spatio-temporal data that leverages Moran eigenvector filtering to capture complex spatial and temporal dependencies. The methodology has been successfully applied to forecasting mortality rates across the United States.
- Development of software for solar forecasting that integrates Regional Climate Model outputs with advanced statistical downscaling methodologies. The software has been successfully tested using real-world data provided by Saudi Aramco.

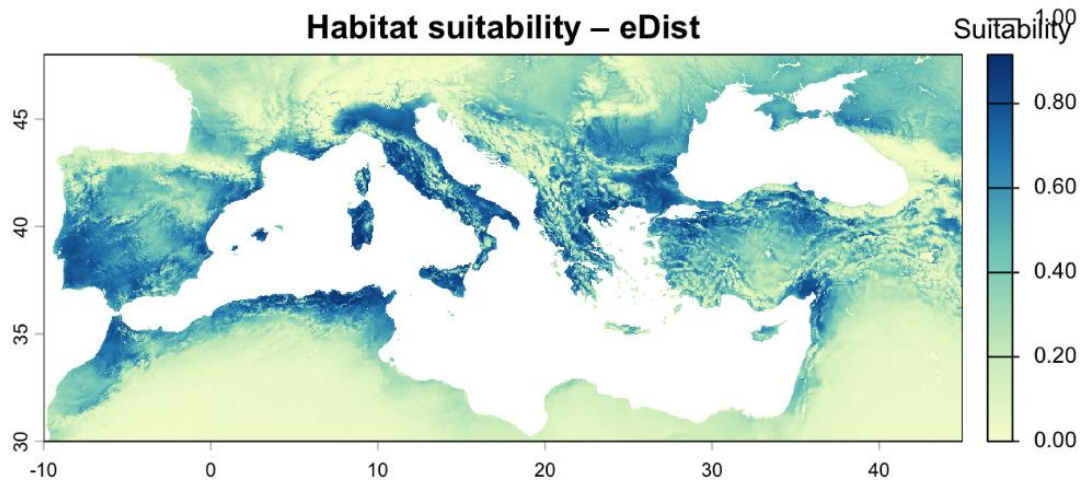
Projects:

- ResTick: “Resilience Enhancement for Ticks and Tick-Borne Diseases in Sub-Saharan Africa”, EU HORIZON, Contract number: 101190792, Coordinator: IMBB FORTH, Coordinator on the part of IACM: Y. Kamarianakis.
- Nemo-Tools: “Next-generation monitoring and mapping tools to assess marine ecosystems and biodiversity”, Funding Agency: Hellenic Foundation for Research and Innovation, Contract number: 16035, Coordinator on the part of IACM: Y. Pantazis.
- smartHEALTH: “European Digital Innovation Hub for smart health”, European Health and Digital Executive Agency, Digital Europe Program Competitiveness 2021-2027 (MIS 6001551), Contract number: 101083630, Coordinator on the part of IACM: Y. Kamarianakis.
- Title: Statistical Machine learning methods for output forecasting in grid connected and off-grid PV systems, Funding Agency: Saudi Aramco, Coordinator on the part of IACM: T. Katsaounis.

Institutional Collaborations:

School of Mathematical and Statistical Sciences, Arizona State University.

School of Environmental Engineering, Cornell University.



Habitat suitability map for Hyalomma marginatum, an important tick species which is the main vector of Crimean–Congo haemorrhagic fever. Habitat suitability is computed using an ensemble of predictive models, including a novel two-stage adaptive penalized estimator (SARIDGE) for logistic regression models.

Citation Index: (Scopus) 1696 (total), 1666 (without AA*), 1551 (without IA*)

Key Publications:

1. P Evangelidakis, **Y Kamarianakis** (2025) A Comparative Analysis of Robust Penalized Estimators for Periodic Time Series, *Greeks in AI Symposium 2025*, Athens, (Abstract only) <https://openreview.net/forum?id=pAfs4ztGG7>
2. K Kostas, S Kar, K Mavridis, E Deligianni, E Roditakis, E Gizeli, J Vontas, **Y. Kamarianakis**, P. Karanis, M. Kotsyfakis (2025) Tick-borne challenges in a changing climate: risks and mitigation strategies for Mediterranean livestock systems, *Entomologia Generalis*, 45 (5), 1259-1269.



NIKOS KOMODAKIS

Associate Professor, University of Crete,
Associated Researcher

Summary:

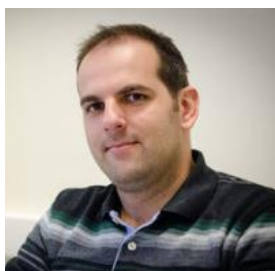
Nikos Komodakis' research spans computer vision, machine learning, and artificial intelligence, focusing on the development of mathematically grounded, scalable algorithms for visual perception and deep learning. His landmark contributions include pioneering neural network architectures like Wide Residual Networks (WideResNets), introducing widely used self-supervised learning techniques (such as predicting image rotations), and advancing knowledge distillation via attention transfer. Additionally, his work encompasses discrete energy minimization and Markov Random Fields (MRFs) using dual decomposition, few-shot visual learning, dynamic graph neural networks, generative AI, and applications in medical image analysis.

Publications in peer-reviewed scientific journals:

1. Q Spinat, B Audelan, X Jiang, B Caba, A Benichoux, D Ioannidou, O Teboul, **N Komodakis**, W Huijbers, R Gabr, A Gafson, C Elliott, D Arnold, N Paragios, S Belachew (2025) Deep learning detection of acute and sub-acute lesion activity from single-timepoint conventional brain MRI in multiple sclerosis, *Medical Image Analysis* 105, 103619, <https://doi.org/10.1016/j.media.2025.103619>

Publications in proceedings of international scientific conferences:

1. A Gerontopoulos, S Gidaris, **N Komodakis** (2025) Multi-Token Prediction Needs Registers, *NeurIPS 2025*.
2. E Karypidis, I Kakogeorgiou, S Gidaris, **N Komodakis** (2025) Advancing Semantic Future Prediction through Multimodal Visual Sequence Transformers, *Proceedings of the Computer Vision and Pattern Recognition Conference*, 3793-3803.
3. E Karypidis, I Kakogeorgiou, S Gidaris, **N Komodakis** (2025) DINO-Foresight: Looking into the Future with DINO, *NeurIPS 2025*.
4. T Kouzelis, I Kakogeorgiou, S Gidaris, **N Komodakis** (2025) EQ-VAE: Equivariance Regularized Latent Space for Improved Generative Image Modeling, *ICML 2025*.
5. T Kouzelis, E Karypidis, I Kakogeorgiou, S Gidaris, **N Komodakis** (2025) Boosting Generative Image Modeling via Joint Image-Feature Synthesis, *NeurIPS 2025*.
6. D Shopkoev, A Ali, M Zhussip, V Malykh, S Lefkimmiatis, **N Komodakis**, S Zagoruyko (2025) ReplaceMe: Network Simplification Depth Pruning and Transformer Block Linearization, *NeurIPS 2025*.
7. Q Spinat, A Duran, O Teboul, N Paragios, **N Komodakis** (2025) Diffusing Boundaries: CBCT-to-CT Translation with Extended Field of View, *MICCAI 2025*.



YANNIS PANTAZIS

Principal Researcher

Summary and Current Aims:

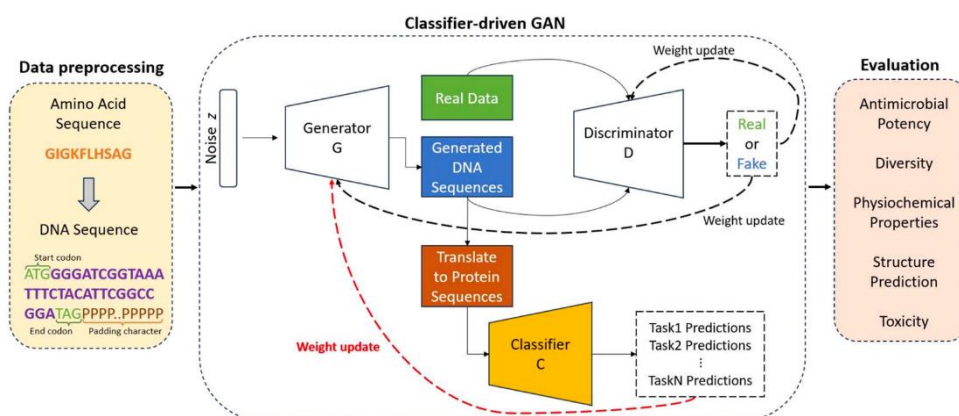
Yannis Pantazis' research focuses on the development of Machine Learning (ML) and Artificial Intelligence (AI) methodologies, with a recent emphasis on transfer learning, generative modeling applied in protein engineering, computational biology, and speech technologies. During 2025, his research activities converged around a common objective: the development of principled, mathematically grounded AI methods that are both theoretically sound and broadly applicable across a wide range of scientific and engineering domains.

A major research direction revolves around the transfer learning and adaptation of foundation models. Building on previous work in deep generative modeling, representation learning, and information-theoretic ML, he investigated how large pretrained models can be efficiently adapted to diverse scientific domains, including protein engineering and biodiversity monitoring. This effort resulted in highly accurate methods for antimicrobial peptide classification and laid the foundations for subsequent work on vision foundation models for underwater image classification.

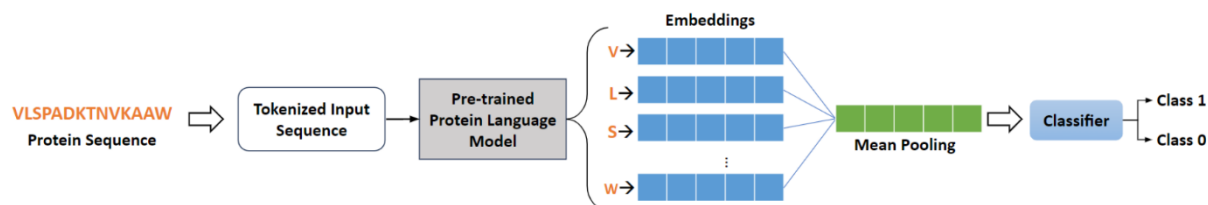
A second major research direction concerns generative AI for scientific design. His work explored the use of generative adversarial networks and preference-guided optimization strategies for de novo antimicrobial peptide generation, while continuing a broader research agenda on divergences, information theory, and generative learning. In parallel, he advanced research in speech synthesis through disentangled representation learning, mutual-information optimization, expressive speech generation, and neural vocoding. Finally, through a rapidly expanding collaboration with the Nephrology Clinic of PAGNI Hospital, they contributed computational and data-driven perspectives to the study of kidney and cardiovascular diseases, establishing the foundations for future research in predictive modeling and clinical decision support.

His current research aims include:

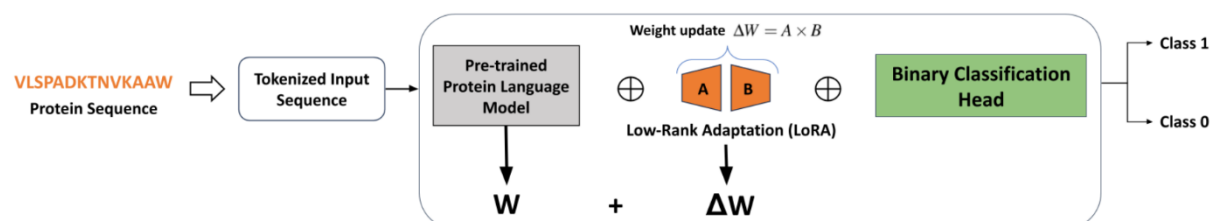
1. Transfer learning and parameter-efficient adaptation methods for foundation models under limited-data regimes.
2. Generative AI methodologies for biological sequence design and, more broadly, for scientific discovery.
3. Information-theoretic learning principles for robust representation learning and uncertainty quantification.
4. Speech synthesis and speech representation learning for expressive, controllable, and intelligible speech generation.
5. Development of ML methodologies for clinical decision support and predictive modeling in nephrology and cardiovascular medicine.



a) Embeddings-based Transfer Learning



b) Fine-Tuning with Low-rank Adaptation (LoRA)



Progress and Key Achievements in 2025:

Yannis Pantazis' research activities consolidated around the broader theme of AI and Deep Learning for Scientific Discovery, with a particular emphasis on foundation models, generative AI applied in protein engineering, speech technologies, and biomedical applications. A major achievement was the development and evaluation of transfer learning methodologies on foundation models. In protein engineering, he demonstrated that adapting large protein language models significantly improves antimicrobial peptide classification, providing a systematic assessment of transfer learning strategies across multiple pretrained biological models. Complementing this effort, he advanced generative AI approaches for biological design through the development of feedback-driven generative adversarial networks for de novo antimicrobial peptide generation, establishing a closed-loop framework that integrates predictive and generative models. These contributions strengthened a coherent research program spanning representation learning, generative modeling, optimization, and AI-driven biological discovery.

Significant progress was also achieved in speech and biomedical AI. Through the STOMA project, they developed novel methodologies for disentangled speech representation learning, expressive speech synthesis, neural vocoding, and speech intelligibility enhancement, further strengthening IACM's Data Science Group expertise in speech processing and speech generation. In parallel, a rapidly expanding collaboration with the Nephrology Clinic of PAGNI Hospital led to multiple publications on cardiorenal syndrome, acute heart failure, and renal dysfunction, establishing the foundations for future research in predictive modeling and AI-assisted clinical decision support. The year also marked the successful completion of the STOMA and NEMO-Tools projects, delivering new methodologies and analytical tools for speech technologies, marine ecosystem monitoring, and biodiversity assessment.

Citation Index: (Google Scholar 2025) 152 (total), 140 (without AA), 127 (without IA).

Key Publications:

1. G Aletras, M Bachlitzanaki, M Stratinaki, E Lamprogiannakis, I Petrakis, E Foukarakis, **Y Pantazis**, M Hamilos, K Stylianos (2025) Integrating Novel Biomarkers into Clinical Practice: A Practical Framework for Diagnosis and Management of Cardiorenal Syndrome, *Life* 15 (10), 1540, <https://doi.org/10.3390/life15101540>
2. E Georgoulis, MA Zervou, **Y Pantazis** (2025) Transfer Learning on Protein Language Models Improves Antimicrobial Peptide Classification, *Scientific Reports*, <https://doi.org/10.21203/rs.3.rs-5768912/v1>
3. MA Zervou, E Doutsis, **Y Pantazis**, P Tsakalides (2025) Classifier-driven generative adversarial networks for enhanced antimicrobial peptide design, *Briefings in Bioinformatics* 26 (5), bba500, <https://doi.org/10.1093/bib/bba500>



ANTONIS PAPAPANTOLEON

Professor, TU Delft

Affiliated Scientist

Summary:

Antonis Papapantoleon's research lies at the interface of stochastic analysis, mathematical finance, and scientific machine learning, with a central focus on three interconnected themes: the rigorous theory of backward stochastic differential equations (BSDEs) and their mean-field extensions; the quantification of model uncertainty and derivation of model-free bounds for derivative prices; and the development of deep learning and gradient flow methods for option pricing and hedging. In 2025, these directions produced several published/accepted papers and new preprints establishing both theoretical foundations and practical algorithms, as detailed below.

Current aims:

1. *Mean-field BSDEs and McKean–Vlasov equations*: Establish existence, uniqueness, and stability results for mean-field BSDEs in full generality, and develop a rigorous theory of propagation of chaos for the corresponding particle systems.
2. *Model uncertainty and model-free bounds*: Derivation of model-free bounds for multi-asset derivatives using option-implied market information and deep learning, and study the role of dependence uncertainty in risk management.
3. *Deep and machine learning methods for option pricing*: Develop and analyze deep gradient flow methods and implicit-explicit time-stepping schemes for solving PDEs and BSDEs arising in option pricing, with rigorous convergence guarantees. Investigate the performance and reliability of neural network architectures for option pricing, model calibration, and hedging in realistic market settings.

Research results during 2025:

My main scientific publication in 2025 concerns a novel deep learning approach for pricing European options in diffusion models, that can efficiently handle high-dimensional problems resulting from Markovian approximations of rough volatility models. The option pricing partial differential equation is reformulated as an energy minimization problem, which is approximated in a time-stepping fashion by deep artificial neural networks. The proposed scheme respects the asymptotic behavior of option prices for large levels of moneyness, and adheres to a priori known bounds for option prices. The accuracy and efficiency of the proposed method is assessed in a series of numerical examples, with particular focus in the lifted Heston model.

Progress and Key Achievements in 2025:

Machine learning in finance

- Paper on empirical comparison of neural network architectures for option pricing accepted in *European Journal of Finance*
- Deep implicit-explicit minimizing movement method for option pricing in jump-diffusion models accepted in *Communications in Nonlinear Science and Numerical Simulation*
- Time-stepping deep gradient flow method for rough diffusion models published in *Quantitative Finance*
- New preprint establishing convergence of the generalization error for deep gradient flow methods applied to high-dimensional PDEs

Mean-field BSDEs

- Preprint establishing existence, uniqueness, and propagation of chaos for general McKean–Vlasov and mean-field BSDEs
- Companion preprint on stability of backward propagation of chaos

Model uncertainty

- Updated preprint on model-free bounds for multi-asset options using option-implied information and deep learning submitted for journal review

Organization of Conferences or Workshops

- New Challenges in Financial and Energy Markets: Math, Data & AI, Athens, Greece, 31 October 2025.
- YES XIII | Dependence Modeling, Eurandom, Eindhoven, The Netherlands, 30 June–2 July 2025.
- Advances in Mathematical Finance, Freiburg, Germany, 21–23 May 2025.
- Minisymposium: Stochastic Analysis, at the 19th Panhellenic Conference on Mathematical Analysis, Athens, Greece, 18–20 December 2025.
- Minisymposium: Modeling, Prediction, and Trading in Energy Markets, at the SIAM Conference on Financial Mathematics and Engineering (FM23), Miami, Florida, USA, 15–18 July 2025.

Bachelor's Master's & PhD theses completed

Integrated MSc theses, supervised:

1. E. Kokkinou: Measuring financial risk and uncertainty, NTU Athens, 2025
2. G. Andronikou: Option pricing using machine learning methods. NTU Athens, 2025.

MSc theses, supervised:

1. M.H. Chang: A Reinforcement Learning Approach to Backtesting for Options Trading. TU Delft, 2025. (with A. Kolarijani)
2. I.E. Klein: Optimising Dispatch Strategies for Grid-Connected Green Hydrogen Systems with Wind PPAs, Battery Storage and Day-Ahead Market Participation. TU Delft, 2025. (with T. Nane)
3. K. Papadopoulos: The least-squares Monte Carlo method and applications in financial mathematics. NTU Athens, 2025.

PhD theses, committee member:

1. T. Lardy: Optimal test statistics for anytime-valid hypothesis tests. Univ. Leiden, 2025.
2. B. Negeysi: Modern machine learning methods for high-dimensional forward-backward SDEs with applications in mathematical finance. TU Delft, 2025.
3. J. Willems: Fractional stochastic partial differential equations in space and time. TU Delft, 2025.
4. M. Yang: Learning on simplicial complexes. TU Delft, 2025.

Bachelor's, Master's & PhD theses in progress

PhD students, supervisor: E. Dragazi: Model-uncertainty and applications in mathematical finance. NTU Athens.

Citation Index: (Google Scholar 2025) 118 (total)

Key Publications:

- **A. Papapantoleon**, J. Rou: A time-stepping deep gradient flow method for option pricing in (rough) diffusion models. *Quantitative Finance* 25, 2009–2020, 2025.



SOFIA TRIANTAFYLLOU

Assistant Professor, University of Crete,
Associated Researcher

Summary and Current aims:

Sofia Triantafyllou's research focuses on causal inference for multiple treatments and the integration of observational and experimental data, including the identifiability and transportability of causal effects across data sources and populations. A current aim is extending these methods to clinical and electronic health record (EHR) settings, in collaboration with colleagues at the University of Pittsburgh and international partners.

Progress and Key Achievements in 2025:

Continued work on data-driven adjustment for multiple treatments, and on identifiability and transportability with combined observational and experimental data (see Publications below).

Research Results during 2025:

My research focuses on causal inference, the branch of statistics that asks not just "what is correlated with what," but "what causes what," using real-world data. In 2025, I worked on the following projects:

First, together with collaborators from the University of Washington, we developed new methods for identifying which variables must be accounted for to correctly estimate the effect of multiple treatments given simultaneously - a common challenge in medicine and public health.

Second, I collaborated on a large multicenter clinical study of sepsis patients, showing that even within patient subgroups defined by shared clinical or biological traits, individuals can respond very differently to the same treatment: some benefiting greatly, others being harmed. This challenges the idea that grouping patients into "types" is enough to safely personalize treatment.

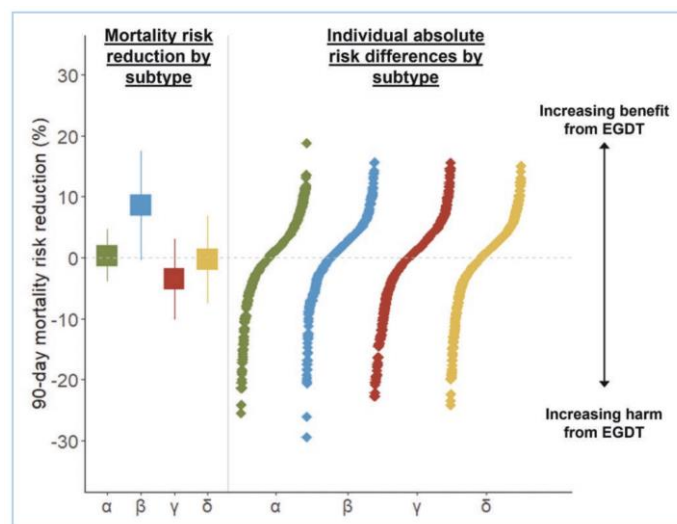


Figure 1 Predicted individual response to early goal-directed therapy (EGDT) for septic shock patients, grouped by clinical subtype (α , β , γ , δ). While each subtype shows a different average effect (left panel), individual patients within every subtype range from substantial benefit to substantial harm (right panel), showing that subtype alone is not enough to safely guide treatment decisions.

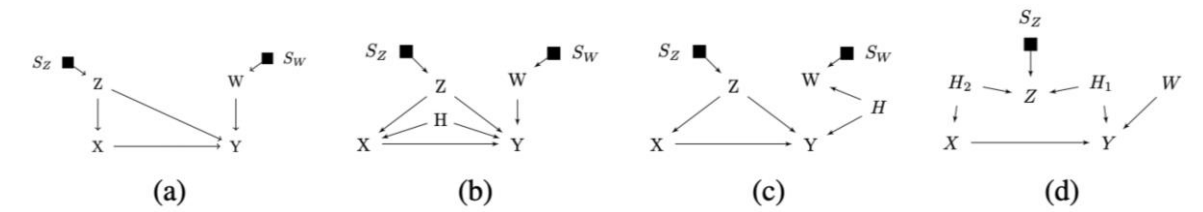


Figure 2. Four example scenarios illustrating when it is (and isn't) possible to combine data from two different patient populations to estimate a treatment effect. In cases (a), (c), and (d), a valid set of variables exists that allows results from one population be safely transferred to another; in case (b), no such set exists. Our method, now published in the AI and Statistics Conference, identifies exactly when "evidence transfer" between populations is trustworthy.

Third, together with FORTH PhD Konstantina Lelova, and our collaborator at the University of Pittsburgh, we developed a Bayesian method for determining when results from a clinical trial conducted in one population can be safely applied to a different population, without requiring full knowledge of the underlying causal structure. This is a key step toward more reliable "evidence transfer" in medicine.

Together, these projects advance tools for making trustworthy causal conclusions from imperfect, real-world data.

Bachelor's Master's & PhD theses completed:

- Georgios Vlachonatsios – BSc thesis, "Predicting Missing-Not-At-Random Samples Using Experimental Data," Department of Mathematics and Applied Mathematics, University of Crete. (Supervisor)
- Argyri Makromichelaki – BSc thesis, "Machine Learning and Matrix Factorization Models in Environmental Sciences: Optimizing the Interpretation of Aerosol Mass Spectrometry Data," Department of Mathematics and Applied Mathematics, University of Crete. (Supervisor)
- Maria-Eleni Papadaki – MSc thesis, "Modeling Photovoltaic Efficiency Dynamics Using Time Series Data," Department of Mathematics and Applied Mathematics, University of Crete. (Panel Member)
- Minas Achladianakis – MSc thesis, "An Expectation-Maximization Interpretation of CMA-ES: Theory and Extensions," Department of Applied Mathematics, University of Crete. (Panel Member)

Bachelor's, Master's & PhD theses in progress:

- Konstantina (Nadia) Lelova – PhD candidate, Department of Mathematics and Applied Mathematics, University of Crete (since 2024). Thesis on statistical methods combining large-scale observational data (e.g. electronic health records) with smaller, more reliable experimental data for causal inference.

External Collaborations:

- Prof. Gregory F. Cooper, Department of Biomedical Informatics, University of Pittsburgh – collaboration on causal identifiability/transportability methods and clinical applications, including work with the University of Pittsburgh Medical Center (UPMC).
- Asst. Professor Ema Percovic, Department of Statistics, University of Washington)

Citation Index: 169 (total 2025), 166 (without AA* 2025)

Key Publications:

1. LaPlante, S., Perković, E., & **Triantafillou, S.** (2025). Data-Driven Adjustment for Multiple Treatments. arXiv e-prints, arXiv-2503. (currently under review in the *Journal of Causal Inference*)
2. Lelova, K., Cooper, G.F., & **Triantafillou, S.** (2025). Testing Identifiability and Transportability with Observational and Experimental Data. arXiv preprint arXiv:2505.12801. (accepted in *AISTATS 2026*)



IOANNIS TSAMARDINOS

Professor, University of Crete,
Associated Researcher

Summary and Current aims:

Research in Machine Learning and Artificial Intelligence with emphasis on:

- (a) causal discovery and automated causal discovery,
- (b) agentic AI,
- (c) automated machine learning (including time-series),
- (d) feature selection (including time-series) and knowledge discovery,
- (e) applications to biomedical informatics.

Research Results during 2025:

In 2025 I published 4 papers in journals and 1 in conferences. One of these papers is with The Cancer Genome Atlas Consortium and was published in the journal Cell Cancer with an impact factor of about 56 and already has 40 citations in about a year. Also, I was invited to the 2025 Global Software Technology Summit of the Huawei company. Also, I successfully completed my research project funded by Huawei managed by IACM-FORTH. And in 2025 I was included in the list by Stanford University of the 2% most influential scientists. My research activities focused on variable selection, automatic machine learning, and automatic causal discovery. In 2025 I submitted the EIC Transition grant which was funded the following year.

Scientific Distinctions:

Included in the Stanford list of top 2% of most impactful scientists. (<https://topresearcherslist.com/>) since its inception.

Projects:

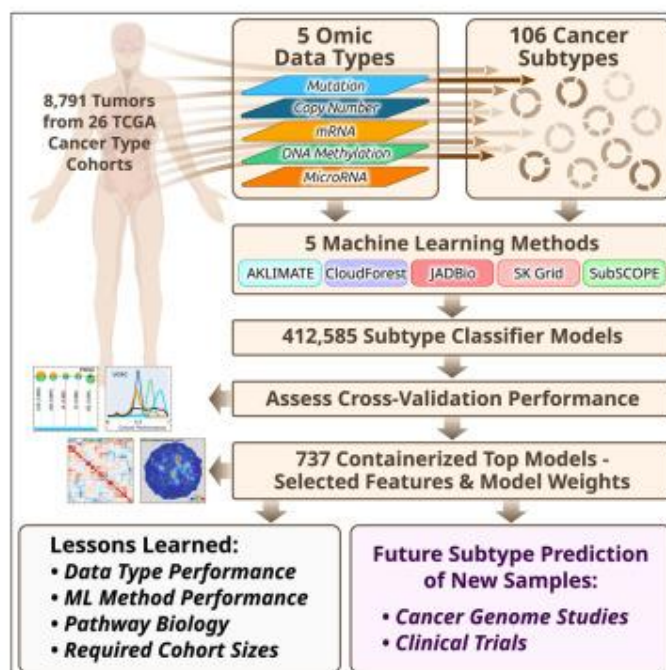
- “Causal discovery and inference for surrogate-assisted optimization”, Funding Agency: Huawei Technologies (Ireland) CO, Coordinator: IACM, Coordinator on the part of IACM: Ioannis Tsamardinos
- “Large Causal Models for AIOps”, Funding Agency: Huawei Technologies (Ireland) CO, Coordinator: IACM, Coordinator on the part of IACM: Ioannis Tsamardinos

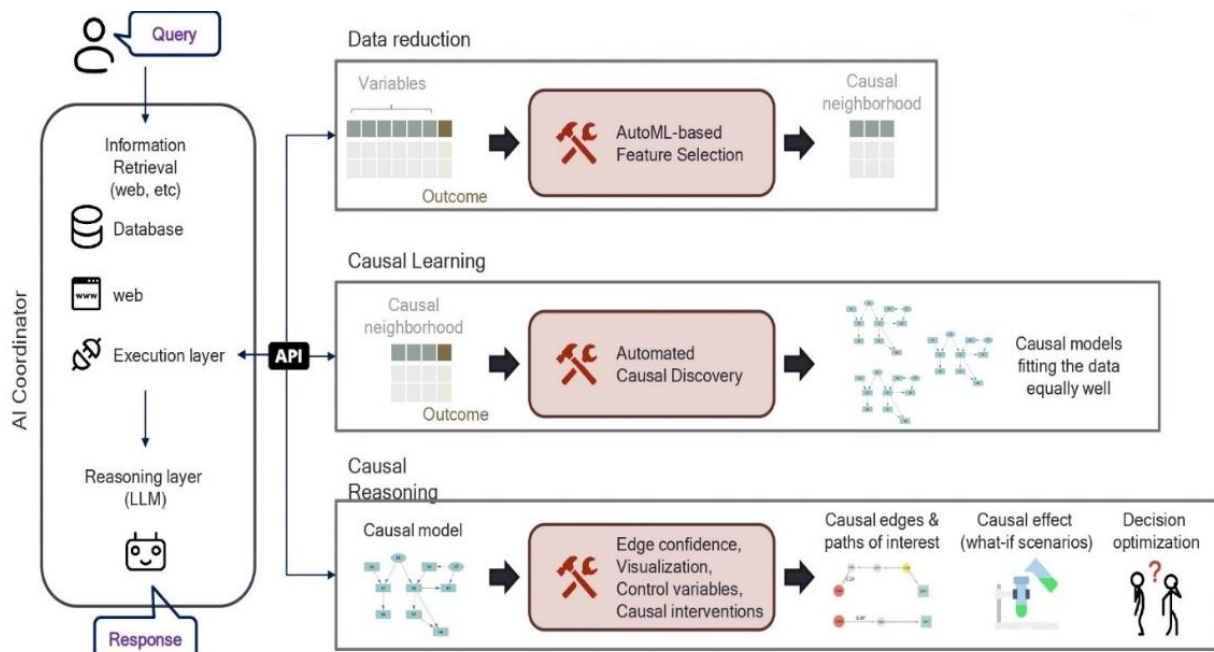
Supervision of Postdocs:

- Nikolaos Gkorgkolis, post doc, working on Causality in Huawei projects

Participation in the foundation and development of spin-offs:

CEO and founder of JADBio Gnosis DA S.A., a university of Crete spin off company. JADBio is an AI/ML deep tech company that has been awarded the “Spin Off of the Year 2021” award by the Greek ministry.





ETIA Causal AI Agent

Revenue from sales of services, products, patent rights:

JADBio has declared about 200K revenues from 2025. The actual numbers are submitted at the TEMH and are publicly available.

Other achievements:

- Invited talk by Huawei, title: "Advances in Automated Machine Learning and Automated Causal discovery", in Florence during 1-2 September 2025, during the "Global Software Technology summit" organized by Huawei.
- Invited talk by Prof. Grigorios Tsoumakas, title: "An Introduction to Automated Machine Learning (ML), Causal-Based Multiple Feature Selection, and Automated Causal Discovery (AutoCD) with Use Cases, School of Informatics, Aristotle University of Thessaloniki, 16/05/2025.
- Panel member in conference "Innovation Crete 6.0 AI the day after", held in Heraklion in 20/03/2025 organized by the local Chamber of Commerce.

Citation Index: Google scholar 16267 as of 25/6/2026 (includes self-references).

Publications in peer-reviewed scientific journals:

1. K Ellrott, CK Wong, C Yau, MAA Castro, JA Lee, BJ Karlberg, JK Grewal, V Lagani, B Tercan, V Friedl, T Hinoue, V Uzunangelov, L Westlake, X Loinaz, I Felau, PI Wang, A Kemal, SJ Caesar-Johnson, I Shmulevich, AJ Lazar, I **Tsamardinos**, KA Hoadley, AG Robertson, TA Knijnenburg, CC Benz, JM Stuart, JC Zenklusen, AD Cherniack, PW Laird (2025) Classification of non-TCGA cancer samples to TCGA molecular subtypes using compact feature sets, *Cancer Cell* 43 (2), 195-212. e11.
2. OP Leary, H Hwang, MD Pizzagalli, V Voong, L Tran, M Duffy, J Arditi, A Choi, J Zepecki, G Papoutsoglou, I **Tsamardinos**, PL Zadnik Sullivan, PM Klinge, N Tapinos (2025) BIOM-67. A MIRNA-BASED LIQUID BIOPSY FOR BRAIN TUMOR DIAGNOSIS AND IN VITRO EFFECTS OF MIRNA INHIBITION ON GLIOBLASTOMA STEM CELL GROWTH, VIABILITY, AND SELF-RENEWAL, *Neuro-Oncology* 27 (Supplement_5), v39-v39.
3. C Papadaki, M Mortoglou, AE Boukouris, K Gourlia, M Markaki, E Lagoudaki, A Koutsopoulos, I **Tsamardinos**, D Mavroudis, S Agelaki (2025) MicroRNA Expression Analysis and Biological Pathways in Chemoresistant Non-Small Cell Lung Cancer, *Cancers* 17 (15), 2504.
4. G Tsaknakis, AM Perantonaki, S Papadakis, A Komodromou, I Mavroudi, C Pontikoglou, Z Papadovasilakis, G Papoutsoglou, I **Tsamardinos**, H Papadaki (2025) Novel diagnostic and prognostic tools for patients with chronic idiopathic neutropenia: Data on a cohort of 266 patients, *Blood* 146, 623, <https://doi.org/10.1182/blood-2025-623>

Computational Biomechanics

<https://www.iacm.forth.gr/divisions/numerical-analysis-computational-systems/computational-biomechanics>



biomarkers, patient-specific hemodynamic parameters derived from medical imaging and computational fluid dynamics, and indicators of aneurysm wall instability. The integration of biological and hemodynamic information is expected to improve risk stratification beyond currently used clinical and morphological criteria. Ultimately, the study aims to establish a foundation for personalized management strategies for patients with unruptured intracranial aneurysms.

Progress and Key Achievements in 2025:

- Cardiovascular diseases are the leading cause of morbidity and mortality worldwide. Symptoms related to atherosclerosis disease are typically only noted in its advanced state (even decades after its initiation) making its manifestation in the coronary arteries the most common cause of sudden death. This observation emphasizes the need to improve early detection and therapy of atherosclerosis. In collaboration with the functional nanocrystals and tissue engineering labs at IESL a multifunctional nanoparticle assembly system was designed to offer early targeted diagnosis and treatment of atherosclerosis. Papaharilaou's results demonstrated that the designed system has the potential to target the endothelium under physiological flow conditions. The affinity and targeting specificity of functionalized colloidal nanocrystal clusters (CNCs) for injured endothelium associated with atherosclerotic lesions were investigated in vitro under physiological and disturbed flow conditions and complemented by numerical simulations. The computational analysis provided a detailed description of the complex local flow field and the hemodynamic stresses experienced by the functionalized CNCs, enabling interpretation of the experimentally observed targeting behavior.

Projects:

- Lamia: Functional Nanoclusters for Multimodal Imaging of Atherosclerosis, Funding Agency: FORTH, Program: FORTH Synergy Grant, Coordinator on the part of IACM: Y Papaharilaou.

Educational activities within the framework of IACM

- Coordinator of the "Biofluid Mechanics" Module in Biomedical Engineering MSc Program co-organized by UOC, FORTH and TUC

Bachelor's Master's & PhD theses completed:

- Stylianos Perrakis, MSc Thesis Advisory Committee, UOC, Computer Science Department, 'Generative Models for Super-Resolution in Medical Imaging'

Bachelor's, Master's & PhD theses in progress:

- Konstantinos Ntotsikas: PhD Thesis Advisory Committee, Medical School UOC, 'Prospective observational study of the relationship between circulating biomarkers, hemodynamic parameters, and intracranial aneurysm wall instability'
- George Grammatikakis: MSc Thesis Advisor: Biomedical Engineering MSc Program co-organized by UOC, FORTH and TUC, 'Cerebral Aneurysm Hemodynamics, Resolving Flow Instabilities with Reduced Order Models'

Citation Index (Scopus): 72 (2025 total), 72 (2025 without AA*), 70 (2025 without IA*)

Key Publications:

1. L Papadimitriou, M Graigkioti, E Koutsouroubi, K Pagonidis, **Y Papaharilaou**, A Ranella, A Lappas (2025) VCAM-1-Functionalized Iron Oxide Nanoclusters for Targeted MRI-Based Diagnosis of Atherosclerosis, *MedComm-Biomaterials and Applications* 4(4), e70030.

Scientific Computing & Software Development

<https://www.iacm.forth.gr/divisions/numerical-analysis-computational-systems/scientific-computing-software-development>





GEORGIOS AKRIVIS

Professor Emeritus, University of Ioannina
Honorary Fellow

Summary and Current Aims:

Georgios Akrivis' research focuses on time stepping methods, such as multistep methods, Runge-Kutta methods, and Galerkin methods for evolution p.d.e.'s. Currently, he is particularly interested in numerical methods for the approximation of harmonic maps into spheres as well as in discontinuous Galerkin methods for nonlinear parabolic equations.

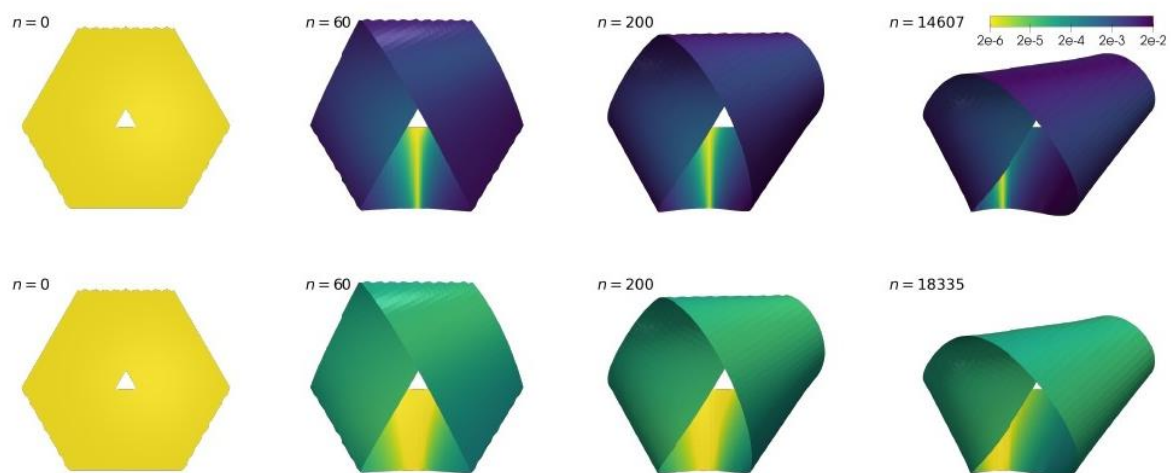
Research Results during 2025:

We constructed fully discrete numerical methods that preserve at the discrete level the three most important invariants of the nonlinear Schrödinger equation, namely, mass, energy, and momentum.

We devised and studied a linearized two-step BDF method for the approximation of harmonic maps into spheres, that is, unit-length harmonic vector fields. This was the first projection-free, second order consistent method with respect to the unit-length constraint.

We constructed and studied Physics-informed neural networks, based on Runge-Kutta methods and related Galerkin time-stepping methods, for parabolic equations in Hilbert spaces. We established maximal L2 parabolic regularity for B-stable Runge-Kutta as well as for continuous and discontinuous Galerkin time-stepping methods by the energy technique, allowing variable time steps.

Both the standard seven-step BDF method as well as a "shifted" variant thereof are unstable, even for o.d.e.'s. We showed that suitable linear combinations of these two unstable methods are stable even for parabolic equations.



Evolution of an initially flat Möbius strip using the implicit Euler (top row) and two-step BDF methods (bottom row) realizing discrete H^2 -gradient flows with step sizes $\tau = 2^{-7}$. The coloring represents the unit-length constraint violation.

Progress and Key Achievements in 2025:

His main result was the construction and analysis of a linearly implicit two-step BDF method for harmonic maps. The paper was published in Mathematics of Computation.

Other achievements:

Georgios Akrivis is Associate Editor of *SIAM J. Numerical Analysis*.

Publications in peer-reviewed scientific journals:

- **G Akrivis**, S Bartels, C Palus (2025) Quadratic constraint consistency in the projection-free approximation of harmonic maps and bending isometries, *Mathematics of Computation* 94, 2251-2269, DOI: <https://doi.org/10.1090/mcom/4035>
- **G Akrivis**, M Chen, F Yu (2025) The weighted and shifted seven-step BDF method for parabolic equations, *IMA Journal of Numerical Analysis*, Vol. 45 (6), pp. 3207–3234, <https://doi.org/10.1093/imanum/drae089>
- **G Akrivis**, S Larsson (2025) A priori and a posteriori error estimates for discontinuous Galerkin time-discrete methods via maximal regularity, *BIT Numerical Mathematics* (2026) 66:1, <https://doi.org/10.1007/s10543-025-01094-5>
- **G Akrivis**, B Li, R Tang, H Zhang (2025) High-order mass-, energy- and momentum-conserving methods for the nonlinear Schrödinger equation, *Journal of Computational Physics* 532, 113974, <https://doi.org/10.1016/j.jcp.2025.113974>
- **G. Akrivis**, C.G. Makridakis, C. Smaragdakis (2025) Runge–Kutta physics informed neural networks: formulation and analysis. *Numerische Mathematik*, <https://doi.org/10.1007/s00211-025-01501-7>

Other publications:

- **G Akrivis**, S Bartels, M Ruggeri, J Wang (2025) Projection-free approximation of flows of harmonic maps with quadratic constraint accuracy and variable step sizes, arXiv preprint arXiv:2505.05655
- **G Akrivis**, J Bona, A Durán, O Karakashian, D Mitsotakis, B Pelloni, J-C Saut (2025) Preface: Modeling Wave Propagation: Mathematical Theory and Numerical Analysis, in Memory of Prof. Vassilios Dougalis, *Studies in Applied Mathematics*, Special Issue, <https://doi.org/10.1111/sapm.70082>



PANAGIOTIS CHATZIPANTELIDIS

Associate Professor, University of Crete
Associated Researcher

Summary and Current Aims:

Recent research activity involves the error analysis of positive preserving fully discrete schemes, using a local extremum diminishing flux limiter, for a Keller–Segel chemotaxis model in two spatial dimensions.

The interaction between nonlinear stabilization mechanisms and genuine chemotactic singularity formation remains largely unexplored. In particular, it is still unclear whether positivity-preserving flux limiting and Algebraic Flux Correction-type stabilization preserve the correct Keller–Segel blow-up dynamics, critical mass thresholds, and singularity formation times.

Research Results during 2025:

The chemotaxis model describes the aggregation of slime molds resulting from their chemotactic features. The function u is the cell density of cellular slime molds, c is the concentration of the chemical substance secreted by molds themselves, $c-u$ is the ratio of generation or extinction.

It is known that the solution u may blow-up in finite time and satisfies the conservation of total mass with respect to the cell density. In addition, for positive initial function $u^0 > 0$, the cell density remains positive. It is well-known that the solution of $\$u\$$ may blow up in finite time. However, for sufficiently small initial data the solution (u,c) exists for all time and is bounded.

The main difficulty in constructing suitable numerical schemes is to preserve several essential properties of the Keller–Segel equations such as positivity, mass conservation, and energy dissipation.

Algebraic Flux Correction (AFC) schemes, are a stabilized method that works on the algebraic level and manipulate the matrix and the right-hand side of the algebraic system of equations. in order to preserve mass conservation and satisfy the discrete maximum principle.

For a Keller–Segel model for chemotaxis in two spatial dimensions, we discretize space using piecewise linear finite elements on a quasiuniform triangulation of acute type and time by the backward Euler method. We assume that initial data are sufficiently small in order not to have a blow-up of the solution. Under appropriate assumptions on the regularity of the exact solution and the time step parameter we show existence of the fully discrete approximation and derive error bounds for the cell density and for the chemical concentration.

Citation Index (Scopus): 732 (2025 total), 713 (2025 without AA*), 688 (2025 without IA*)

KONSTANTINOS CHRYSAFINOS

Professor, NTUA
Associated Researcher

Summary and Current Aims:

Konstantinos Chrysafinos' current research aims are related to the analysis of numerical algorithms for partial differential equations. In particular, his research concerns analysis and numerical analysis of PDE constrained optimal control problems. Optimal control problems related to coupled PDE nonlinear reaction-diffusion systems arising Mathematical Biology is the targeted application for the upcoming years. The emphasis will be placed on the development of first and second order optimality conditions that are necessary for the numerical analysis of fully-discrete approximation schemes. Issues related to the stability and error estimation will be also examined, as well as convergence properties of suitable nonlinear solvers.

Research Results during 2025:

The main results of our research program during the last year include:

1. Fully-discrete schemes for the parabolic p-Laplacian ([1]): In particular, we analyzed schemes of arbitrary order that combine the discontinuous Galerkin time-stepping with classical conforming finite elements in space. The main emphasis of our research was the development of a symmetric –Cèa's Lemma type- error estimates in a suitable quasi-norm, under minimal regularity assumptions on the data.
2. Semi-smooth Newton methods for control-constrained bilinear control problems of semilinear elliptic PDEs ([2]): We have proved results regarding existence, uniqueness and regularity for the solution of the state equation, as well as differentiability properties of the control to state mapping. These results allow the development of first and second order optimality conditions, and the superlinear convergence of the semi-smooth Newton method to local solutions satisfying no-gap second order sufficient optimality conditions under a strict complementarity condition.
3. Error estimates for finite element discretizations of bilinear optimal control problems related to semi-linear elliptic equations ([3]): The discretization is carried out by using the finite element method, with piecewise constant functions for the control and continuous piecewise linear functions for the state and the adjoint state. We proved convergence of the solutions of the discrete problems to solutions of the continuous problem and we demonstrated that strict local solutions of the continuous problem can be approximated by local solutions of the discrete problems.

Organization of Conferences or Workshops:

- “Numerical Analysis and Scientific Computing Session” 19th Panhellenic Conference of Mathematical Analysis.

Bachelor's Master's & PhD theses completed:

P. Paraschis, PhD Thesis at National Technical University of Athens. co-advisor

Bachelor's, Master's & PhD theses in progress:

C. Korosidis, PhD Thesis at National Technical University of Athens, co-advisor

Citation Index (Scopus): 35 (2025 total), 33 (2025 without AA*), 32 (2025 without IA*)

Key Publications:

1. E Casas, **K Chrysafinos**, M Mateos (2025) Bilinear control of semilinear elliptic PDEs: Convergence of a semismooth Newton method, *Numerische Mathematik* 157 (1), 143-163.
2. E. Casas, **K. Chrysafinos** and M. Mateos, “Error estimates for the discretization of bilinear control problems governed by semilinear elliptic PDEs”, *Math. Cont. and Related Fields*, (15) 2025, pp 1320-1345
3. **K Chrysafinos**, P Paraschis (2025) Error estimates for discontinuous Galerkin time-stepping schemes for the parabolic p-Laplacian: a quasi-norm approach, *ESAIM: Mathematical Modelling and Numerical Analysis* 59 (1), 449-485.



EMMANUIL GEORGOULIS

Professor, National Technical University of Athens
Associated Researcher

Summary:

Emmanuil Georgoulis' research focuses on numerical analysis, scientific computing, and approximation theory, specifically targeting the mathematical analysis and computational modeling of partial differential equations (PDEs). He is widely recognized for his work on high-order discontinuous Galerkin finite element methods, particularly on complex, polytopic meshes and arbitrarily shaped domains. His contributions encompass rigorous a posteriori error estimation and adaptive refinement strategies, space-time finite element formulations for hyperbolic and parabolic equations, and numerical methods preserving structural properties like hypocoercivity and maximum principles. Additionally, his research extends to multiscale methods, virtual element methods, high-dimensional approximation theory, and applications across fluid dynamics, mathematical biology, and quantitative finance.

Research Results during 2025:

We have developed an adaptive discontinuous finite element methodology the energy/temperature equation of the Boussinesq system arising from the modelling of Mantle convection of the Earth. The adaptivity is driven by mathematically rigorous a posteriori error estimators. The key mathematical challenge of mitigating the effects of exponential factors with respect to the final time, arising from the use of Grönwall-type arguments, is addressed by an exponential fitting technique. We showcase the superior performance of the new class of a posteriori error estimators in driving mesh adaptivity in Earth's Mantle convection simulations, in a setting where the energy/temperature discretised by the discontinuous Galerkin method, coupled with the Taylor-Hood finite element for the momentum and mass conservation equations.

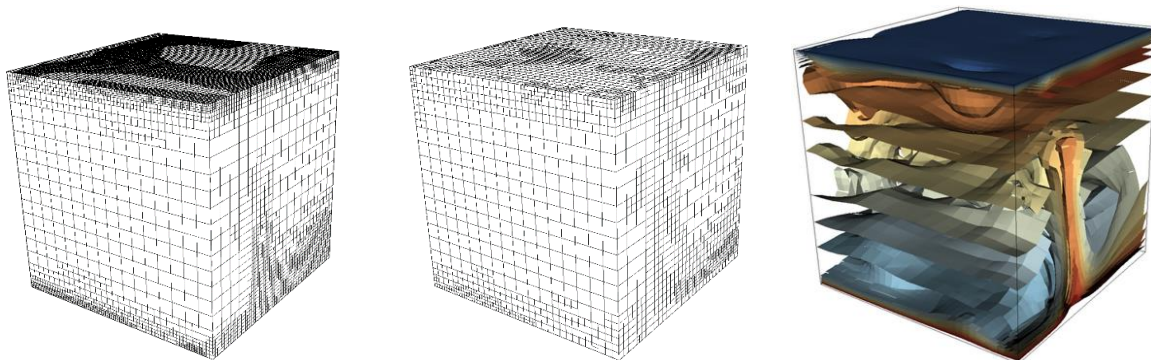
In the figure we see a instance of adapted mesh with a heuristic estimator (left), and with the new rigorous a posteriori error estimator (centre) to deliver a solution of comparable accuracy (right). The mesh is considerably coarser showcasing the added benefit of the approach.

Organization of Conferences or Workshops: 23rd European Finite Element Fair 2026 at NTU Athens.

Bachelor's Master's & PhD theses completed: Two Master's Theses at NTU Athens and one PhD thesis (Dr Panagiotis Paraschis) completed at NTUA in 2025.

Services in local, national and international committees:

European Finite Element Fair, Member of the Organising Committee (2022 – pres.)



Other activities interconnecting research and production, contributing to regional development, other public benefit work:

He coordinated the launch and he serves as founding Director of the Mathematics-Driven Innovation Centre (M-DICE) at Heriot-Watt University in Edinburgh. M-DICE, established in 2024, is a nationally (to the UK) leading centre for interdisciplinary research in the Mathematical Sciences, which has received national, regional (Scotland) and local (Edinburgh) funding.

Other achievements (for instance editorial duties, invited lectures etc):

SIAM Journal on Numerical Analysis, Associate Editor (2018 – pres.)

Institutional Collaborations:

- NTU Athens (Professor)
- Heriot-Watt University (Chaired Professor in Computational Mathematics, p/t)

Citation Index (Google Scholar): 384 (2025)

Key Publications:

1. Z Dong, **EH Georgoulis**, PJ Herbert (2025) A Hypocoercivity-Exploiting Stabilized Finite Element Method for Kolmogorov Equation, *SIAM Journal on Numerical Analysis* 63 (3), 1105-1127.
2. R. E. Fernandes, **E. H. Georgoulis**, and A. Paganini (2025) Level-set shape optimization via polytopic discontinuous Galerkin methods, *SIAM Journal on Scientific Computing* 47(5) B1293-B1315.



THEODOROS KATSAOUNIS

Professor, University of Crete

Associated Researcher

Summary:

Theodoros Katsaounis' research focuses on applied mathematics, numerical analysis, and computational partial differential equations (PDEs), with a strong emphasis on developing efficient, structure-preserving numerical schemes for time-dependent physical systems. His work spans finite element and finite volume methods, particularly discontinuous Galerkin and relaxation techniques, for solving hyperbolic conservation laws, incompressible Navier–Stokes equations, and nonlinear wave models. A major thread of his research involves rigorous a posteriori error estimation and adaptive mesh algorithms for nonlinear evolution problems (such as the Schrödinger equation and systems exhibiting finite-time blow-up), alongside high-frequency wave propagation and multi-physics applications including mathematical modeling of solar cells.

Projects:

- TRANS-MOD: Modeling Transcription: an integrated approach to understand cancer-specific gene expression programs, Funding Agency: ELIDEK, Program: Greece 2.0 National Recovery and Resilience Plan “Basic Research Financing”, Contract number: 015276, Coordinator on the part of IACM: Theodoros Katsaounis.
- Statistical Machine learning methods for output forecasting in grid connected and off-grid PV systems, Funding Agency: Saudi Aramco Technologies, Contract number: SATC 2025-022, Coordinator on the part of IACM: Theodoros Katsaounis

Supervision of Postdocs:

- Konstantina Xarmpi, working in collaboration with the biologists on modelling the RNA transcription. (Project: TRANS-MOD).

Bachelor's, Master's & PhD theses in progress:

- Iakovos Christodoulou (MSc. Thesis) working on the lottery ticket idea for neural networks, (expected to finish June 2026)

External Collaborations:

- Athanasios Tzavaras, CEMSE, KAUST, Saudi Arabia
- Dimitrios Mitsotakis, Univ. of Wellington, New Zealand
- Eirini Kyza, Univ. of St. Andrews, Scotland, UK
- Agis Athanassoulis, Univ. of Dundee, Scotland, UK

Citation Index: Google Scholar: 1040, Scopus: 528(Total), 493(without AA), 388(without IA)



CHARALAMBOS MAKRIDAKIS

Research Director

Summary:

During recent years, significant progress has been made on understanding the approximation properties of neural network functions. Foundational results have shown that neural networks with various architectures are capable of efficiently approximating both smooth and singular functions. These advances alone, however, do not provide sufficient insight into the behaviour of machine learning algorithms themselves, particularly in applications involving PDE solvers, uncertainty quantification, and complex systems such as generative models. Our work has focused on developing a mathematical understanding of ML algorithms by analysing their underlying minimisation problems and the properties dictated by the chosen loss functional. Adopting a variational perspective, we study a broad range of ML methods—including function learning, PDE solvers, and probability-measure approximation—and connect classical numerical-analysis notions of stability with the behaviour of the associated loss functionals. This viewpoint has led to new results on stability and convergence, which in turn have motivated the design of new algorithms.

A systematic study of the influence of Loss Functional. Our first step is to interpret these algorithms as minimisation problems over suitable discrete or continuous spaces. Introducing appropriate layers of abstraction in the discretisation process—from deterministic or probabilistic quadrature, to functionals involving integrals or appropriate distances, and further to problems posed in infinite-dimensional spaces—provides a unified and transparent framework for analysing a broad class of modern algorithms and explaining their behaviour through rigorous analysis. This variational perspective has led to new convergence results and error bounds for function learning Loulakis and Makridakis [2023], as well as new stability notions for PDE solvers Gazoulis, Gkanis, and Makridakis [2025]. These ideas further reveal connections between training procedures and classical finite-element or time-discrete methods Akrivis, Makridakis, and Smaragdakis [2025], Grekas and Makridakis [2024], Grekas, Makridakis, and Pryer [2025c]. Additional developments include a systematic ML framework for random differential equations Arampatzis, Katsarakis, and Makridakis [2025] and new minimisation-based algorithms for saddle-point problems Makridakis, Pim, and Pryer [2024a, b], Makridakis, Pim, Pryer, and Rekatsinas [2025]. Although the minimisation problem over neural network functions is inherently non-convex, our work has shown that algorithms driven by strongly coercive functionals (in the continuous, infinite-dimensional setting) inherit good stability and performance properties at the discrete level. This observation motivates the introduction, already at the PDE level, of alternative variational principles with enhanced characteristics. A recent successful application of this viewpoint is Makrakis, Makridakis, Mitsoudis, Plexousakis, and Pryer [2025], where Morawetz identities were used to derive novel variational principles for the Helmholtz equation, leading to efficient neural network solvers.

Classical numerical analysis stability and PDE neural solvers. Our work Gazoulis et al. [2025] shows that the training process—i.e., evaluating the loss functional through quadrature or other approximations—plays a decisive role in determining its stability (coercivity). This establishes a new link between ML training procedures and classical stability concepts from numerical PDE analysis. We also demonstrate the necessity of coercivity through time-discrete training examples where its failure leads to instability and lack of convergence. These insights motivated the development of several hybrid algorithms Akrivis et al. [2025], Grekas and Makridakis [2024], Grekas et al. [2025c]. In Akrivis et al. [2025], we systematically connect Runge–Kutta (RK) time-discrete schemes to neural solvers via the training mechanism, showing that the resulting methods inherit the stability and computational behaviour of the underlying RK schemes. This leads to the first energy-conservative neural network solvers for the wave equation. From a theoretical standpoint, the stability of the parabolic case is established using new maximal-regularity estimates for classical RK schemes, developed as well in Akrivis et al. [2025]. In Grekas and Makridakis [2024], Grekas et al. [2025c], we propose using finite element techniques for training neural solvers of elliptic problems in dimensions where meshes can be efficiently constructed. In such cases, the resulting methods possess strong stability properties and improved memory and computational efficiency.

Link of nonlinear PDE tools to the analysis of ML algorithms. In our work, we have observed that analysing the minimisers of ML algorithms is closely related to classical problems in the Calculus of Variations. Tools from this field help not only

in establishing convergence properties but also in formulating new stability notions essential for algorithm design Loulakis and Makridakis [2023], Gazoulis et al. [2025]. Since linear theory is often insufficient in the ML setting, methods from nonlinear PDEs and the Calculus of Variations provide a more suitable framework. A key methodological ingredient in our approach is the use of Γ -convergence and the liminf–limsup framework of De Giorgi Loulakis and Makridakis [2023], Gazoulis et al. [2025], Akrivis et al. [2025], Grekas and Makridakis [2024], Grekas et al. [2025c]. This perspective also appears promising for probabilistic problems. Furthermore, establishing lower semicontinuity of the loss functional yields useful information on the behaviour of local minimisers Loulakis and Makridakis [2023].

Projects:

- SUMMER GRADUATE SCHOOL 2020, Founding Agency: Stavros Niarchos Foundation, Duration: 01/01/2020 - 31/12/2025, Coordinator: Charalambos Makridakis

Supervision of Postdocs:

- Nikolaos Rekatsinas
- Stelios Katsarakis

Publications in peer-reviewed scientific journals:

1. G. Akrivis, **C.G. Makridakis**, C. Smaragdakis (2025) Runge–Kutta physics informed neural networks: formulation and analysis. *Numerische Mathematik*, <https://doi.org/10.1007/s00211-025-01501-7>
2. G. Grekas, K. Koumatos, **C. Makridakis**, A. Vekelis (2025) A class of discontinuous Galerkin methods for nonlinear variational problems, *Mathematics of Computation* 94 (355), 2221–2250.
3. G. Grekas, **CG Makridakis** (2025) Deep Ritz - Finite element methods: Neural network methods trained with finite elements, *Computer Methods in Applied Mechanics and Engineering*, Vol. 437, 117798, <https://doi.org/10.1016/j.cma.2025.117798>
4. **C.G. Makridakis**, A. Pim, T. Pryer (2025) A Deep Uzawa-Lagrange Multiplier Approach for Boundary Conditions in PINNs and Deep Ritz Methods, *Journal of Machine Learning*, Vol. 4 (3), 166–191.

Other publications:

1. G. Arampatzis, S. Katsarakis, **C. Makridakis** (2025) A generative modeling/Physics-Informed Neural Network approach to random differential equations, arXiv preprint arXiv:2507.01687
2. D. Gazoulis, I. Gkanis, **CG Makridakis** (2025) On the Stability and Convergence of Physics Informed Neural Networks, arXiv preprint arXiv:2308.05423
3. G. Grekas, K. Koumatos, **C. Makridakis**, A. Vekelis (2025) Convergence of Discontinuous Galerkin Methods for Quasiconvex and Relaxed Variational Problems, arXiv preprint arXiv:2501.11944
4. G. Grekas, **CG Makridakis**, T. Pryer (2025) PINN-DG: Residual neural network methods trained with Finite Elements, arXiv preprint arXiv:2507.03521
5. G. Makrakis, **C. Makridakis**, D. Mitsoudis, M. Plexousakis, T. Pryer (2025) Variational Principles for the Helmholtz equation: application to Finite Element and Neural Network approximations, arXiv preprint arXiv:2511.13217
6. **C. Makridakis**, A. Pim, T. Pryer, N. Rekatsinas (2025) Deep Uzawa for Kinetic Transport with Lagrange-Enforced Boundaries, arXiv preprint arXiv:2507.19907



DIMITRIOS MITSOUDIS

Associate Professor, University of West Attica

Associated Researcher

Summary:

Dimitrios Mitsoudis' current research focuses on numerical and mathematical modelling, with an emphasis on wave propagation phenomena. Specifically, he is interested in:

- numerical methods for the Helmholtz equation and for problems in unbounded domains;
- finite element methods for problems in underwater acoustics;
- variational principles and coercive formulations for the Helmholtz equation;
- function approximation and PDEs on complex domains.

The Helmholtz equation models time-harmonic wave propagation and scattering, and is often posed on unbounded or very large domains, as in underwater acoustics where the marine environment is treated as an infinite waveguide. He develops efficient finite element methods that handle realistic geometries and Dirichlet-to-Neumann-type boundary conditions, incorporate point sources outside the computational domain through their effect on the boundary, and remain stable with wavenumber-explicit constants.

A second line studies variational principles for the Helmholtz equation with impedance (absorbing) boundary conditions, asking whether physically meaningful energy functionals exist whose stationary points solve the problem. Starting from Hamilton's principle, he derives time-harmonic energies that are generally indefinite and construct strongly coercive augmentations of them, which he aims to turn into practical numerical methods based on finite element spaces and neural-network architectures.

A third line develops the Domain-Adapted Functions (DAFs), a new family of basis functions for approximation and the solution of PDEs on complex domains. Built by embedding a physical domain Ω into a simpler fictitious domain D with analytic Dirichlet-Laplacian eigenpairs, they are doubly orthogonal and maximally concentrated in Ω ; on this basis he has developed an approximation theory and a semidiscrete Galerkin scheme demonstrated on the heat equation.

Current Aims:

1. Complete the well-posedness and stability analysis of the proposed models with wavenumber-explicit constants, and extend the methods to more realistic underwater-acoustics scenarios (e.g. range-dependent or non-uniform waveguides), validating them against benchmark problems.
2. Turn the coercive variational principles into practical finite-element and neural-network methods, and assess their accuracy and robustness at high wavenumbers.
3. Finalise the DAF approximation theory and clarify how the optimal parameters (the fictitious domain D , the number of eigenfunctions, and the truncation rank) depend on the geometry of Ω and the spectral content of the target function; benchmark the DAFs against alternative methods on complex geometries; and extend the framework to further PDEs.

Research Results during 2025:

My research this year focused on numerical and mathematical modelling of wave propagation phenomena, developed with collaborators along three main lines.

The first concerns finite element methods for the Helmholtz equation in underwater acoustics, where the marine environment is modelled as an unbounded waveguide. We worked on formulations that handle realistic geometries and Dirichlet-to-Neumann boundary conditions, incorporate external point sources through their boundary effect, and aim for wavenumber-explicit stability.

The second line investigates variational principles for the Helmholtz equation with impedance boundary conditions. Starting from Hamilton's principle, we derived time-harmonic energy functionals that are generally indefinite, and constructed coercive augmentations of them intended to underpin new finite element and neural-network-based numerical methods. A paper on this topic was submitted in 2025.

The third line concerns Domain-Adapted Functions (DAFs), a new family of basis functions for function approximation and the solution of PDEs on complex domains, built by embedding the physical domain into a simpler fictitious domain with known Dirichlet-Laplacian eigenpairs. These functions are doubly orthogonal and concentrated in the domain of interest; we developed an approximation theory and a semidiscrete Galerkin scheme, tested on the heat equation.

These three directions continue to define our ongoing work and set the aims for the coming year.

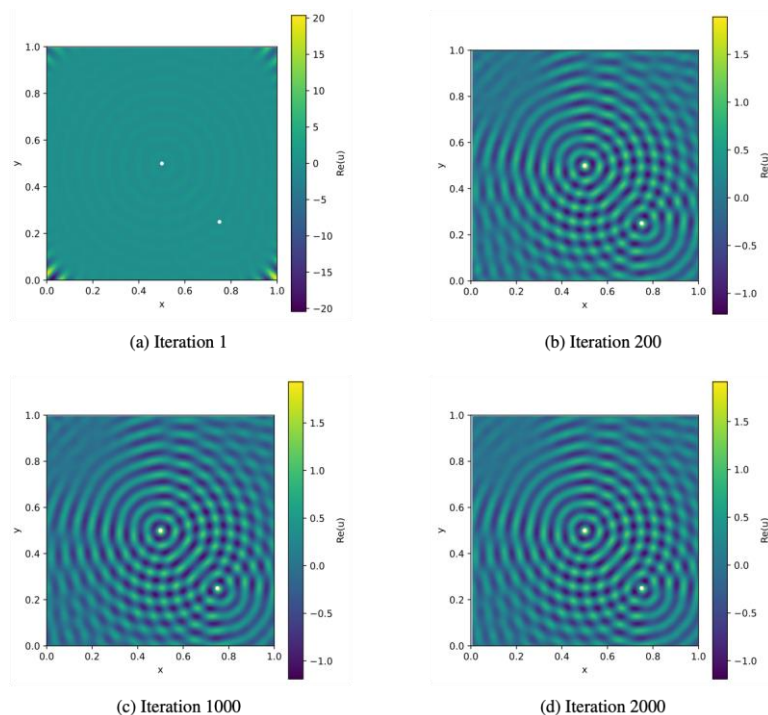


Figure: Plane-wave neural network approximation of the solution u of the Helmholtz equation on $\Omega=[0,1]^2$ at $k=100$ with two Gaussian sources. Panels show the real part of u at early, mid and late training iterations.

External Collaborations:

- Prof. Chrysoula Tsogka, University of California, Merced
- Dr. Symeon Papadimitropoulos, University of California, Merced

Citation Index (SCOPUS): 9 (2025 total), 6 (2025 without AA*), 5 (2025 without IA*)

Key Publications:

1. S. Papadimitropoulos, **D.A. Mitsoudis**, C. Tsogka, Imaging in three-dimensional waveguides with partial-aperture data, in: Advances in Underwater Acoustics, Structural Acoustics, and Computational Methodologies. Volume 1: Underwater Acoustics, Sean F Wu and Steffen Marburg (eds.), World Scientific, 2025, 615–644.



COSTAS SMARAGDAKIS

Assistant Professor, University of the Aegean
Associated Researcher

Summary:

Costas Smaragdakis' research connects numerical analysis with artificial neural networks to develop reliable, high-performance solvers for complex partial differential equations (PDEs) and functional minimisation problems. A primary motivation is to ensure that deep learning frameworks, such as Physics-Informed Neural Networks (PINNs), inherit the stability, higher-order accuracy, and qualitative guarantees of classical numerical analysis methods. An important aspect of his current work comprises addressing bottlenecks in mesh-free solvers. He is developing ANN architectures that learn optimal, permutation-invariant quadrature weights directly from unstructured point clouds. This ensures that the numerical integration required for functional minimisation remains highly accurate without relying on traditional computational grids. Concurrently, he continues to advance classical numerical methods, such as implicit-explicit (IMEX) minimising movement schemes for partial integro-differential equations. His overarching aim is to translate those theoretical formulations into robust, scalable software optimised for high-performance parallel computing environments. A central focus of this effort is the active development of an open-source library that implements 2D Discontinuous Galerkin solvers on agglomerated elements, utilising C++ and Python bindings. Moving forward, his goal is to continue to synthesise the rigorous error bounds of classical numerical analysis with the flexibility of deep learning, ultimately delivering reliable, optimised computational tools.

Bachelor's Master's & PhD theses completed:

1. Charalampos Passalidis, Master's, University of the Aegean, Heavy Tailed Distributions: Closedness and Dependence (three-member panel)
2. Theodora Soniadou, Master's, University of the Aegean, Συσχέτιση Στοχαστικών Διαφορικών Εξισώσεων και Μερικών Διαφορικών Εξισώσεων (three-member panel)

Bachelor's, Master's & PhD theses in progress:

1. Sofia Vlami, University of the Aegean. Μαθηματικά Θεμέλια, Υπολογιστικές Προσεγγίσεις και Αβεβαιότητα στην Αξιολόγηση των Οικονομικών και Κλιματικών Επιπτώσεων
2. Alvertos Poronidis, University of Crete, Μελέτη της επίλυσης διαφορικών εξισώσεων με νευρωνικά δίκτυα
3. Maria Leivadiotou, Master's, University of the Aegean, Development for Portofolio Construction using the R programming language (three-member panel)
4. Vasileios Koutsogiannis, University of the Aegean, Inference Methods for Levy-Driven Stochastic Differential Equations with Applications in Electricity Price Dynamics (three-member panel)
5. Konstantinos Tsintzilonis, Master's, Univ. of the Aegean, Applications to Finance - Credit Risk (three-member panel)
6. Vasileios Tsimpris, Master's, University of the Aegean, Statistical Inference Approaches of Non-Markovian Processes Described by SDEs with Colored Noise (three-member panel)
7. Stefanos Pappas, Master's, University of the Aegean, Numerical Solution of Stochastic Differential Equations Using Python (three-member panel)
8. Angeliki Moschopoulou, Master's, Univ. of the Aegean, Methods of Statistical Inference for Stochastic Differential Equations with Applications in the Valuation and Risk Assessment of Bonds and Portfolios (three-member panel)
9. Alexandros Korolis, Master's, University of the Aegean, Decision Trees Optimization Using Alternative Splitting Functions (three-member panel)

Citation Index (Google scholar): 17 (2025)

Publications in peer-reviewed scientific journals: G. Akrivis, C.G. Makridakis, **C. Smaragdakis** (2025) Runge–Kutta physics informed neural networks: formulation and analysis. *Numerische Mathematik*, <https://doi.org/10.1007/s00211-025-01501-7>

MEMBERS OF THE SCIENTIFIC COMPUTING AND SOFTWARE DEVELOPMENT GROUP



NIKOLAOS REKATSINAS

Postdoctoral Researcher

MARIOS G. STAMATAKIS

Postdoctoral Researcher

Wave Propagation

<https://www.iacm.forth.gr/divisions/applied-science/wave-propagation>





GEORGE MAKRAKIS

Professor, University of Crete
Associated Researcher

Summary and Current Aims:

- (a) Variational approximations of the Helmholtz equation (waveguide and impedance problems) via non-local boundary conditions,
- (b) Asymptotic approximations of phase-space equations for linear wave equations

Research Results during 2025:

The research activity carried out in 2025 developed along two closely related directions, both concerned with the mathematical and computational analysis of wave phenomena.

The first direction focused on exploiting previously developed asymptotic solutions of the phase-space Schrödinger equation to construct a Van Vleck-type semiclassical propagator directly from phase-space considerations, rather than through the traditional configuration-space approach. The resulting formulation is, in principle, applicable to general Hamiltonians and therefore provides a framework suitable for the study of systems exhibiting wave chaos. The results have been published in “The Anisotropic Gaussian Semi-Classical Schrödinger Propagator,” *Mod. Math. Phys.* 2(1), 2 (2026), co-authored with P. D. Karageorge.

The second direction concerned the solution of the Helmholtz equation with impedance boundary conditions using Physics-Informed Neural Networks (PINNs). The approach combines physically motivated variational principles for wave fields with Morawetz-type identities, with the aim of improving the coercivity of the resulting formulations and providing a rigorous foundation for both finite element and neural network approximations. The results are to appear in “Variational Principles for the Helmholtz Equation: Application to Finite Element and Neural Network Approximations,” *Proceedings of the Royal Society A* (2026), co-authored with C. Makridakis, D. Mitsoudis, M. Plexousakis, and T. Pryer.

In parallel, a fundamental research programme was continued on the physical interpretation and systematic design of geometry-adapted Morawetz multipliers. This work supports the ongoing study of Helmholtz scattering in non-uniform waveguides, including configurations with different asymptotic behaviours at the exits towards infinity.

Bachelor's, Master's & PhD theses in progress:

- V. Christakakis, Master thesis: Wignerization of the Helmholtz equation with point source, Dept. Math. Appl. Math., University of Crete.

Citation Index: 13 (total 2025), 13 (2025 without AA*), 13 (2025 without IA*)



PANAGIOTIS PAPADAKIS

Senior Scientist

Projects:

- WHALES'25 – FORTH Mission, Funding Agency: OCEAN CARE (NGO - CH), Coordinator: FORTH-IACM, Coordinator on the part of IACM: Emmanuel Skarsoulis

Educational activities within the framework of IACM:

Hosting two students from the French Maritime Academy (ECOLE NAVALE) for their three-month internship under my supervision. The task of Ms Jade LEMARCHAND and Mr Théo RAILLOT was to calculate the eigenfrequencies of the IACM experimental water tank and compare them with the theoretical eigenfrequencies.

Citation Index: 12 (total 2025),

Publications in proceedings of international scientific conferences:

1. A Prospathopoulos, E Skarsoulis, G Piperakis, D Makropoulos, P Drakopoulou, D Kassis, D Ballas, E Orfanakis, **P Papadakis**, M Taroudakis (2025) Assessment of shipping noise in Greek marine waters under the 2018-2023 Marine Strategy Framework Directive (MSFD) monitoring programme, *8th Underwater Acoustics Conference and Exhibition, UACE2025*, 15-20 June 2025, Halkidiki, Greece



EMMANUEL SKARSOULIS

Research Director

Summary and Current Aims:

Development of analysis methods for ocean acoustic thermometry in the Arctic. Dispersion analysis of low-frequency, long-range acoustic transmissions in polar environments. Calculation of wave-theoretic travel-time sensitivity kernels for range-dependent reference environments. Analysis of transarctic propagation experiments such as the Coordinated Arctic Acoustic Thermometry Experiment (2019-20) and the HiAOOS (High Arctic Ocean Observation System) experiment (2024-26).

Development of a permanent ocean acoustic observatory for the detection of sperm whales in the Strait of Kythira. Conduct of underwater acoustic measurements at selected locations between Kythira and Cape Tainaron to establish baseline knowledge on sperm-whale presence, ambient noise characteristics, propagation conditions and telemetry.

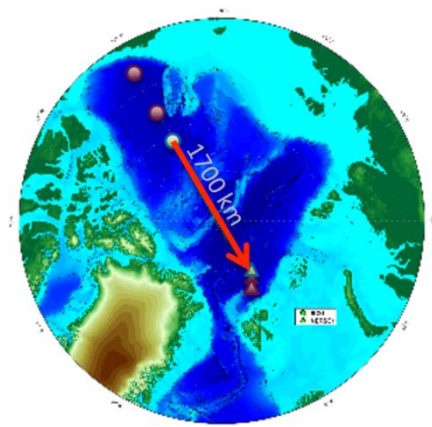
Development of an operational environment for calculation of shipping noise in the Eastern Mediterranean Basin in the framework of the EU Marine strategy Framework Directive (MSFD) using a coupled-mode approach and AIS data.

Research Results during 2025:

In 2025 the activities of the Underwater Acoustics Group included both methodological advancements and field work. The first focused on the further development of methods for the analysis of ocean acoustic tomography experiments in Arctic environments, in the framework of the HiOOS (EU-Horizon Europe) project. The new methods accounting for excessive dispersion were tested on previous large-scale experiments and will be applied for the analysis of an ongoing tomography experiment in the central Arctic. The field work was related to cetacean acoustics, as well as to acoustic monitoring of earthquake activity. Regarding the first, an acoustic station – one of the stations developed by the group in previous years - was deployed in summer 2025 west of the island of Kythira to carry out sperm-whale detections in real time and collect data for the development of a permanent acoustic observatory for the detection of sperm whales (SAVe Whales project). In a parallel effort, following the intense seismic activity in Santorini in February 2025, the group set up, deployed and operated from March to October 2025 an underwater acoustic observatory in the Caldera of Santorini, in the Bay of Armeni, to acoustically monitor the volcanic and seismic activity.

Progress and Key Achievements in 2025:

- First temperature estimates from the analysis of a series of transarctic low-frequency acoustic transmissions along a 1700-km long path in 2019-20.
- Deployment and operation for 1 month (July 2025) of an acoustic station for real-time detection of sperm whales in the sea area west of Kythira island.
- Underwater acoustic measurements of seismic activity in the Caldera of Santorini for 7 months (March-October 2025).



Transarctic Underwater Acoustic Propagation



Deployment/recovery (with the support of the Hellenic Coast Guard) of an underwater acoustic observatory in the Caldera of Santorini (March-October 2025).



Deployment of acoustic station for sperm-whale detection west of Kythira island (late June 2025).

Projects:

1. HiAOOS: High Arctic Ocean Observation System, Funding Agency: European Commission, Program: Horizon Europe, Contract number: 101094621, Coordinator on the part of IACM: Emmanuel Skarsoulis
2. WHALES'25 – FORTH Mission, Funding Agency: OCEAN CARE (NGO - CH), Coordinator: FORTH-IACM, Coordinator on the part of IACM: Emmanuel Skarsoulis

Other activities interconnecting research and production:

Development and deployment in the Caldera of Santorini (port of Armeni) from 1 March to 15 October 2025 of an underwater acoustic observatory for monitoring the seismic activity in near real time. This activity took place in collaboration with the Hellenic Coast Guard following the intense seismic activity in the area in February 2025.

Key Publications:

1. A Prospathopoulos, **E Skarsoulis**, G Piperakis, D Makropoulos, P Drakopoulou, D Kassis, D Ballas, E Orfanakis, P Papadakis, M Taroudakis (2025) Assessment of shipping noise in Greek marine waters under the 2018-2023 Marine Strategy Framework Directive (MSFD) monitoring programme, *8th Underwater Acoustics Conference and Exhibition, UACE2025*, 15-20 June 2025, Halkidiki, Greece
2. **E Skarsoulis**, G Piperakis (2025) Acoustic observables and inversions in long-range polar transmissions, *8th Underwater Acoustics Conference and Exhibition, UACE2025*, 15-20 June 2025, Halkidiki, Greece (abstract).



MICHAEL TAROUDAKIS

Professor Emeritus, University of Crete
Honorary Fellow

Summary and Current Aims:

Michael Taroudakis' research interests include Marine Technology issues related to Physical and Acoustical Oceanography. In particular, digital twins applications, machine learning techniques and acoustic signal processing. With regards underwater acoustics, which is his main field of research, emphasis is given to Ambient Noise issues as well as to inverse problems, such as sea-bed classification and ocean acoustic tomography.

In addition, machine learning techniques are applied to data handling and analysis of problems related to social and political sciences which is another direction of research.

Research Results during 2025:

In relation to underwater acoustics, which is my main field of research, the outcome of my research efforts during 2025 were related to acoustic classification of the marine environment. Two different approaches were studied:

1. **Use of fiber optics cables (DAS) for sea-bed classification.** Together with Prof. Hefeng Dong we studied the character of the signals recorded in FO arrays. We showed that primary and secondary microseisms due to surface gravity waves are detected and separated by frequency-wavenumber decomposition due to the excellent low-frequency performance of the DAS system. Greens' functions are retrieved by performing passive seismic interferometry (PSI) to the continuous strain data, which contains Scholte wave. The shear-wave velocities of the upper sediments are estimated by a non-linear geoacoustic inversion algorithm using the dispersion property of the Scholte wave.

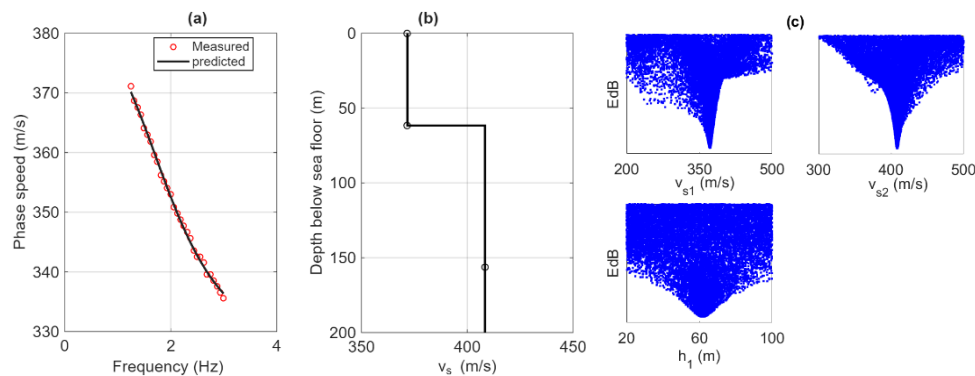


Figure 1. Inversion results for a sea-bed consisting of one sediment layer over a halfspace. Inversions concern estimations of shear velocity. (a) Estimated and predicted dispersion curve. (b) Estimated shear wave speed profile. (c) Scatter plot of the objective function values for sediment layer thickness and the shear wave speed in the sediment layer and the layer beneath).

2. **Use of typical hydrophones in the water column for ocean acoustic tomography and sea-bed classification.** I supervised the MSc thesis of Dinitris Synanis who studied the use of a Convolutional Neural Network (CNN) for the inversion of broadband acoustic signals recorded at the marine environment aiming at the estimation of the water

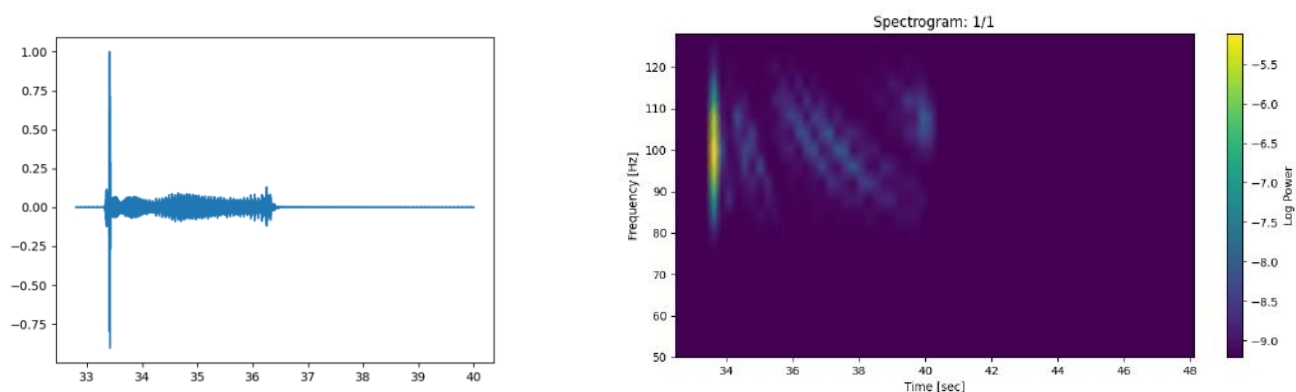


Figure 2. A signal and its spectrogram used to estimate the environmental parameters of a shallow water environment (water column and sea-bed).

column properties (sound speed) and/or the basic features of the sea-bed (compressional velocity and density) using time-frequency analysis quantified through their spectrograms. It was shown by systematic studies of simulated environments that very good results can be obtained in shallow waveguides for both cases.

Projects:

1. EFFECTIVE: Enhancing social well-being and economic prosperity by reinforcing the effectiveness of protection and restoration management in Mediterranean MPAs, Funding Agency: EC, Program: Horizon -Blue Parks, Contract number: EYZ00097 EFFECTIVE, Coordinator on the part of IACM: Michael Taroudakis
2. UACE 2025: Underwater Acoustics Conference and Exhibition 2025, Funding Agency: Office of Naval Research, Coordinator: FORTH, Coordinator on the part of IACM: Michael Taroudakis

Organization of Conferences or Workshops:

During 2025, he organized the *8th International Underwater Conference and Exhibition (UACE 2025)* held in Halkidiki, June 2025 and he is in the preparation phase of the next one to be held in Volos, June 2027.

Educational activities within the framework of IACM:

He participates in the organization of the *Post Graduate Program in Cutting Edge Technologies in Vision Sciences*, in which IACM is a partner. Also, he continued the supervision of the thesis of a Masters' program student in a subject of Acoustical Oceanography.

Citation Index: 22 (total 2025), 22 (without AA* 2025), 22 (without IA* 2025)

Key Publications:

1. E Vergis, S Triliva, M Genius, M Taroudakis, N Papadakis (2025) A mixed-methods approach to understanding dual insecurity: examining Crete's labour market, *Quality & Quantity*, 1-26, <https://doi.org/10.1007/s11135-025-02249-w>
2. Dong H. and **Taroudakis M.**: "Analysis of passive DAS data for observation of microseisms and extracting Scholte wave dispersion in shallow water" in *UACE 2025 Conference Proceedings* edited by M. Taroudakis pp 61-66 (2025). *Acceptance from abstract.*
3. UACE 2025 Conference Proceedings (M.I. Taroudakis editor) ISSN: 2408-0195, on-line edition, FORTH Heraklion (2025).



ANGELIKI XENAKI

Principal Researcher

Summary:

Angeliki Xenaki's current research focuses on Distributed Acoustic Sensing (DAS) for ocean acoustic applications. DAS turns a fiber-optic cable into a long, dense array of sensors for passive acoustic monitoring, which is well-suited for ocean acoustic measurements. DAS has gained popularity as an alternative method for passive measurements as it offers unprecedented sensing coverage over hundreds of kilometers with high-resolution and high-sensitivity and is robust to harsh environmental conditions. Moreover, DAS can utilize existing infrastructure of fiber optic cable networks installed for telecommunications. Considering the extensive and expanding submarine fiber-optic telecommunication network, DAS is a practical technology for monitoring the underwater soundscape.

Current Aims:

- Develop the mathematical framework that explains the underlying physics and the transduction mechanism from optical to mechanical and eventually acoustic quantities
- Explain the effect of DAS acquisition parameters in signal processing
- Propose signal processing and machine learning methods for DAS data analysis
- Validate experimentally the theoretical findings.

Research Results during 2025:

Extensive monitoring of acoustic activities is important for many fields, including biology, security, oceanography, and Earth science. Distributed acoustic sensing (DAS) is an evolving technique for continuous, wide-coverage measurements of mechanical vibrations, which is suited to ocean applications. DAS illuminates an optical fiber with laser pulses and measures the backscattered wave due to small random variations in the refractive index of the material. External stimuli, such as mechanical strain due to acoustic wavefields impinging on the fiber-optic cable, modulate the backscattered wave. Continuous measurement of the backscattered signal provides a distributed sensing modality of the impinging wavefield. Considering the potential use of existing telecommunication fiber-optic cables deployed across the oceans, DAS has emerged as a promising technology for monitoring the underwater soundscape.

The research conducted in 2025 developed the mathematical framework to explain the DAS transduction mechanism from electromagnetic to mechanical and eventually acoustic quantities; see Fig.1. The theoretical development was applied on signal processing of a publicly available dataset to show that DAS enables real-time, high-resolution monitoring of the underwater soundscape capturing seismic, oceanographic and acoustic signals simultaneously; see Fig.2.

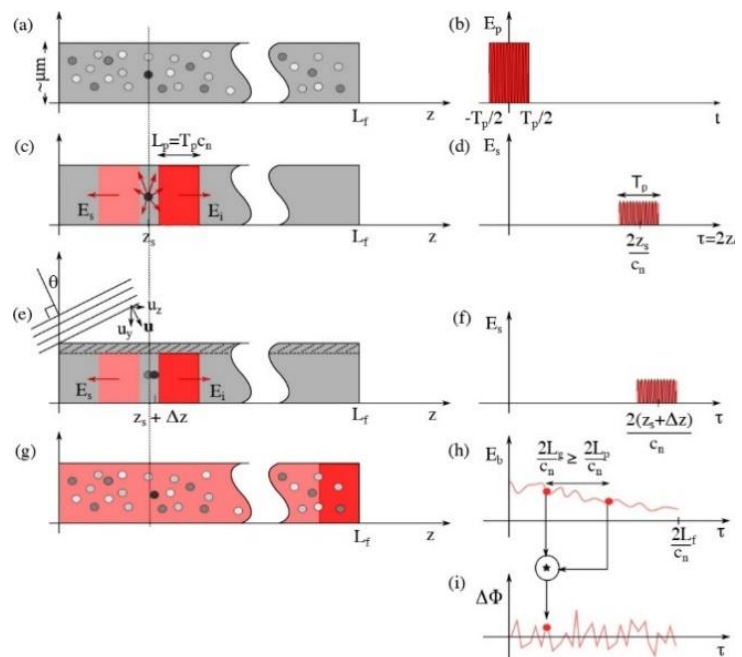


Figure 1: Schematic representation of active optical sensing for passive monitoring of external vibrational fields.

Progress and Key Achievements in 2025:

- The ongoing research on DAS provided a characterization of the system's response and the spatial coherence of DAS measurements in the presence of diffuse noise.
- Her review paper on DAS which details the mathematical foundation of the method has remained the most read journal item since its publication on July 2025, <https://www.altmetric.com/details/174564892>
- Her application to the Geo-INQUIRE project for Transnational Access of research infrastructures was successful, granting access to conduct a DAS experiment at-sea at the research infrastructure of INFN-LNS in Eastern Sicily (realized in March 2026).

External Collaborations:

- INFN – LNS, Italy - <https://www.lns.infn.it/en/>
- DTU, Denmark - <https://electro.dtu.dk/research/research-areas/electro-technology/acoustic-technology>

Services in local, national and international committees:

IEEE Signal Processing Society – Sensor Array and Multichannel Technical Committee (member).

Other achievements: Associate Editor for the Journal of Acoustical Society of America

Public Outreach: Outreach responsible for IACM – assisting FORTH's outreach activities (e.g. “Ηρθαν τα αύρια”)

Citation Index: h-index 14 (Google Scholar), 217 (2025 total), 217 (2025 without AA*), 205 (2025 without IA*)

Key Publications:

1. **A Xenaki**, P Gerstoft, E Williams, S Abadi (2025) Overview of distributed acoustic sensing: Theory and ocean applications, *The Journal of the Acoustical Society of America* 158 (1), 801-825.
2. **A Xenaki**, (2025) Distributed acoustic sensing for ocean applications, *8th Underwater Acoustics Conference and Exhibition, UACE2025*, 15-20 June 2025, Halkidiki, Greece (abstract only)

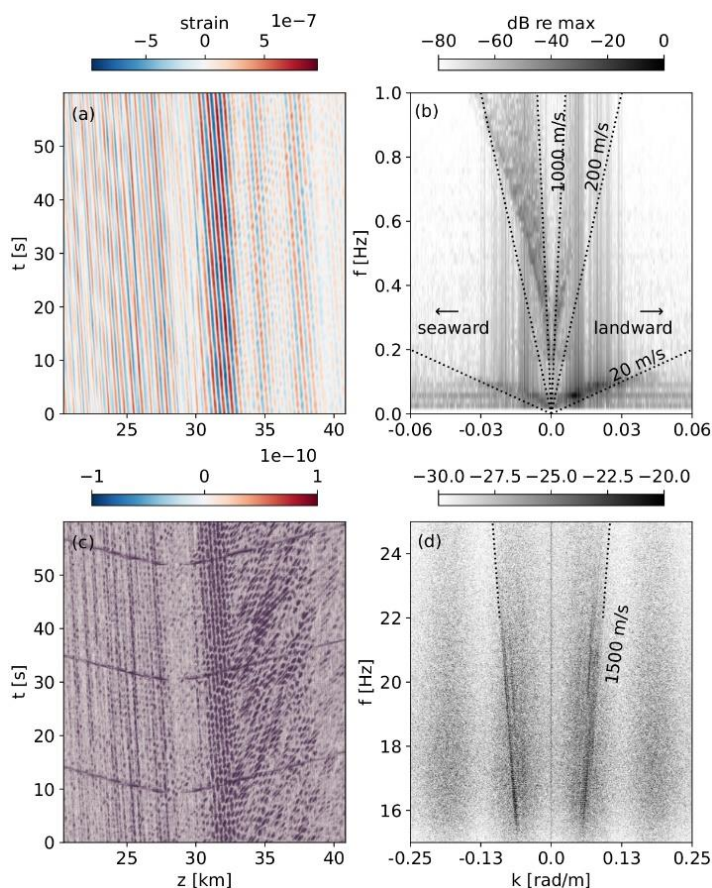


Figure 2: (a) Recorded data in strain units as a function of distance z from the interrogator and recording time t and (b) corresponding frequency-wavenumber (f - k) representation indicating the dominant very low-frequency energy of ocean and seismic waves. (c) The same data after high-pass filtering featuring acoustic wavefronts propagating along the fiber and (d) the corresponding f - k representation.

MEMBERS OF WAVE PROPAGATION GROUP



GEORGE PIPERAKIS

Technical Scientist

Summary:

George Piperakis' research focuses on Wave propagation theory, Underwater acoustics and Bio-acoustics.

Projects:

- HiAOOS: High Arctic Ocean Observation System, Funding Agency: European Commission, Program: Horizon Europe, Contract number: 101094621, Coordinator on the part of IACM: Emmanuel Skarsoulis
- WHALES'25 – FORTH Mission, Funding Agency: OCEAN CARE (NGO - CH), Coordinator: FORTH-IACM, Coordinator on the part of IACM: Emmanuel Skarsoulis

Publications in proceedings of international scientific conferences:

1. A Prospathopoulos, **E Skarsoulis**, G Piperakis, D Makropoulos, P Drakopoulou, D Kassis, D Ballas, E Orfanakis, P Papadakis, M Taroudakis (2025) Assessment of shipping noise in Greek marine waters under the 2018-2023 Marine Strategy Framework Directive (MSFD) monitoring programme, *8th Underwater Acoustics Conference and Exhibition, UACE2025*, 15-20 June 2025, Halkidiki, Greece
2. **E Skarsoulis**, G Piperakis (2025) Acoustic observables and inversions in long-range polar transmissions, *8th Underwater Acoustics Conference and Exhibition, UACE2025*, 15-20 June 2025, Halkidiki, Greece (abstract).

Computational Neurosciences

<https://www.iacm.forth.gr/divisions/applied-science/computational-neurosciences>





GEORGIA GREGORIOU

Professor, University of Crete

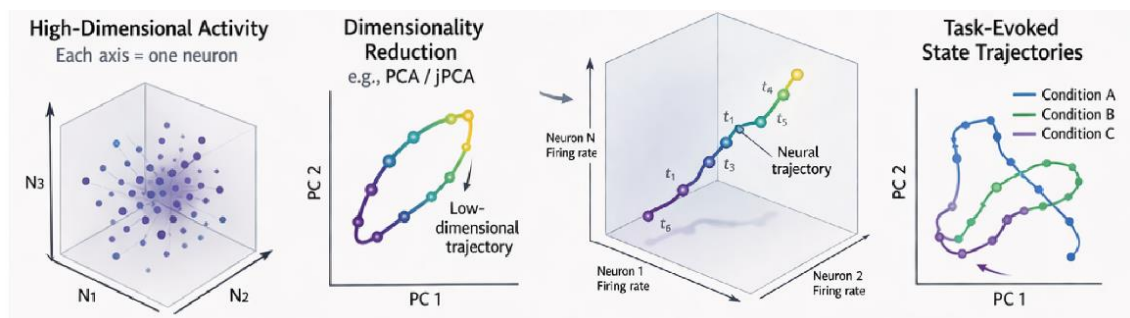
Associated Researcher

Summary

The main interests of Georgia Grigoriou's group lie at the intersection of systems and computational neuroscience, with a focus on the neural mechanisms underlying perceptual and cognitive functions. A major goal of their work is to understand how representations of sensory and cognitive variables change according to behavioral goals, and how flexible behavior is implemented in the brain despite relatively fixed anatomical connections. To address these questions, their research has focused on how visual attention and working memory modulate the activity of single neurons and neuronal ensembles across prefrontal, parietal, and visual brain areas.

They use intracranial multi-electrode recordings in non-human primates performing cognitive tasks, and computational analyses of neuronal signals, to address two main questions. First, what circuit-level mechanisms support large-scale integration across brain areas during attention and working memory? To investigate this, they apply signal-processing methods to examine how oscillatory synchronization contributes to the formation of functional networks according to behavioral demands, and they assess the anatomical and functional specificity of frequency-specific oscillatory activity in the brain.

Second, how are visual features and cognitive variables encoded by neuronal ensembles, and how does this neural code change with task demands? They use machine-learning algorithms to decode task-relevant information from population activity patterns and to characterize the spatiotemporal structure of the neural code. In addition, they investigate how a stable perception of the world is maintained despite rich, variable, and high-dimensional neural representations of sensory and cognitive variables. To this end, they use dimensionality-reduction approaches to examine the geometry of neural representations in activity space and how this geometry changes as a function of behavioral demands.



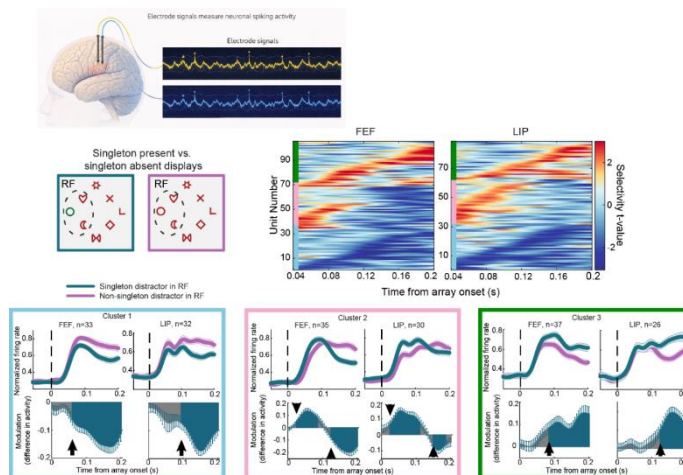
Neuronal Population Responses in High-Dimensional Neural State Space.

Current Aims:

1. Investigate the contribution of neurons in different cortical layers in prefrontal and visual areas to the mechanisms of attention and memory.
2. Understand the role of brain rhythms in local processing and inter-areal communication and information flow.
3. Identify measures of neural activity and long-range neuronal interactions that predict behavioral responses in cognitive task.
4. Investigate the structure of neural population representations (manifolds) of cognitive variables and the temporal characteristics of the neural code.
5. Exploit state-of-the-art artificial neural networks to elucidate circuit mechanisms of cognitive functions.
6. Explore and develop invasive and non-invasive closed loop neuromodulation applications to enhance cognitive functions.

Progress and Key Achievements in 2025:

1) They made significant progress in understanding how the brain controls distraction during goal-directed visual search. Using simultaneous neuronal recordings in two key brain regions, the frontal eye field (FEF) and lateral intraparietal area (LIP), they showed that salient, but irrelevant distractors are not processed uniformly: distinct neuronal subpopulations in both regions either enhance or suppress responses to distractors. They further demonstrated that FEF plays a particularly important role in active distractor suppression, with a larger proportion of suppressive neurons than LIP and suppression strength correlating with faster target search behavior. Moreover, by employing population analyses and dimensionality reduction approaches they found that target and distractor location representations occupy overlapping rather than fully independent neural subspaces, suggesting that salient distractors can interfere with priority-map coding even when behaviorally irrelevant. Overall, the work advances the field by clarifying the heterogeneous and region-specific neural mechanisms through which prefrontal and parietal circuits balance salience-driven capture with top-down attentional control.



Neuronal populations in prefrontal and parietal cortices display heterogeneous firing patterns to encode targets and distractors

2) They contributed to a study which showed that spontaneous single-neuron activity is not random background noise but carries structured, area-specific information about cortical organization. Recording neurons from seven different cortical areas—V1, V4, DP, 7A, M1, PMd, and PFC they showed that firing rate, inter-spike interval variability, neuronal timescales, and pairwise correlations together define distinctive “fingerprints” for each area. These spontaneous spiking fingerprints were tightly linked to anatomical cortical hierarchy: areas that are closer in the hierarchy show more similar spiking profiles, while more distant areas are more distinct. The work also confirms that neuronal timescales tend to increase along the hierarchy and finds that hierarchical relationships are especially evident during eyes-closed rest, suggesting that spontaneous cortical dynamics reflect intrinsic anatomical organization most clearly when external visual input is reduced. Overall, the study advances understanding of resting-state brain activity by demonstrating that local single-neuron dynamics mirror large-scale cortical hierarchy and provide a bridge between microscopic spiking activity and macroscale cortical organization.

3) They implemented high count/ high density recordings across cortical layers to investigate how hierarchical transfer of information across the brain is mapped onto distinct neural circuits and how these representations are modulated by behavior. Ongoing work focuses on characterizing these circuits during attention and memory.

Projects:

- NEUROADAPT: Advancing Personalized Neuromodulation: Integrating NeuroAI into Real-Time Adaptive Brain Stimulation, Funding Agency: FORTH, FORTH Synergy Grants, Coordinator on the part of IACM: Georgia Gregoriou.
- In2PrimateBrains: Intra- and Inter-Areal Communication in Primate Brain Networks, Founding Agency: European Union, H2020-MSCA-IT, Coordinator on the part of IACM: Georgia Gregoriou

Supervision of Postdocs: Panagiotis Sapountzis, Sofia Paneri

Citation Index: (Google Scholar 2025) 194 (total), 190 (without AA*), 189 (without IA*)

Key Publications:

1. A Morales-Gregorio, R Gutzen, S Paneri, P Sapountzis, A Kleinjohann, S Grün, A Riehle, X Chen, T Brochier, **GG Gregoriou**, BE Kilavik, SJ van Albada (2025) Spontaneous spiking statistics form unique area-specific fingerprints and reflect the hierarchy of cerebral cortex, bioRxiv, doi: 10.1101/2025.05.13.653871
2. P. Sapountzis, A. Antoniadou, **G.G. Gregoriou** (2025) Diverse neuronal activity patterns contribute to the control of distraction in the prefrontal and parietal cortex, *PLoS Biology* 23 (1), e3003008.



RAOS VASSILIS

Professor, University of Crete
Associated Researcher

Summary:

To disentangle the role of the dorsal and ventral premotor cortex in the control of hand grasping actions. In particular, to assess the intra- and inter-areal dynamics and examine the causality in the premotor grasping network.

To reveal the way the brain processes observed actions and the mechanisms whereby we assign meaning to the actions of other subjects, by investigating the underlying neural dynamics at the micro, meso, and macroscopic scales.

To develop decoders for the real-time control of a dexterous hand able to manipulate objects in a versatile fashion using neural signals recorded from the forelimb representations of the dorsal and ventral premotor cortical areas.

Progress and Key Achievements of your research in 2025:

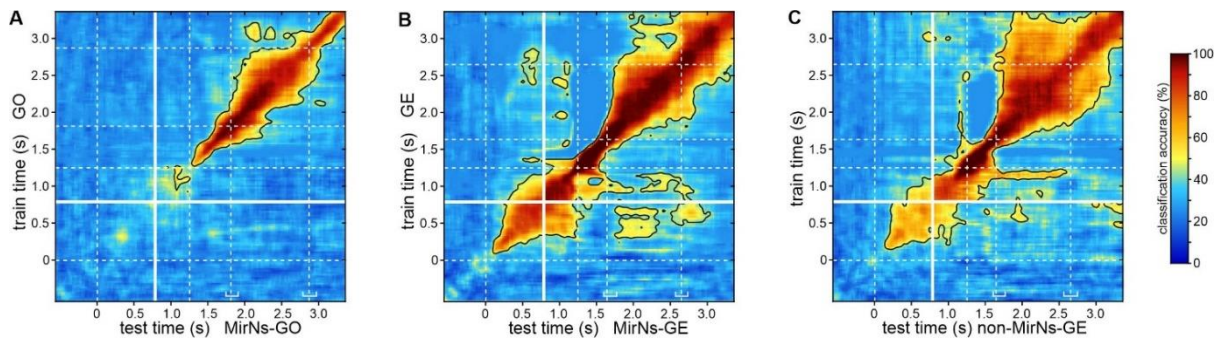
During 2025, the team worked to understand how the premotor cortex dynamically represents grasping movements. We analysed the activity of neurons recorded from the brains of macaques while they either performed reach-to-grasp movements or observed an experimenter performing them. The results showed that information about grip type and its evolving kinematics is distributed across neuronal populations and continuously reorganised over time. Furthermore, action execution and observation are linked through shared, partially overlapping neural representations.

These findings are particularly relevant to the development of brain–machine interfaces. They suggest that decoders that exploit collective, time-varying neural activity can identify not only the intended grip but also the continuous kinematic trajectory of the hand. Harnessing the shared representations of action observation and execution could contribute to systems with improved generalisation and reduced calibration requirements, enabling more accurate and natural control of prosthetic limbs and robotic assistive devices.

Research Results during 2025:

During 2025, the team worked to understand how the premotor cortex dynamically represents grasping movements. We analysed the activity of neurons recorded from the brains of macaques while they either performed reach-to-grasp movements or observed an experimenter performing them. The results showed that information about grip type and its evolving kinematics is distributed across neuronal populations and continuously reorganised over time. Furthermore, action execution and observation are linked through shared, partially overlapping neural representations.

These findings are particularly relevant to the development of brain–machine interfaces. They suggest that decoders that exploit collective, time-varying neural activity can identify not only the intended grip but also the continuous kinematic trajectory of the hand. Harnessing the shared representations of action observation and execution could contribute to systems with improved generalisation and reduced calibration requirements, enabling more accurate and natural control of prosthetic limbs and robotic assistive devices.



Grasp configurations are classified through a distributed and dynamic neural population code. Decoding was performed on pseudopopulations constructed across recording sessions using a Poisson naïve Bayes classifier. A-C: Cross-temporal classification matrices for MirNs (A: grasping observation, GO; B: grasping execution, GE) and non-MirNs in grasping execution (C). Classifiers were trained at each time bin and tested across all bins. Color scale indicates classification accuracy. Black contours mark significant classification (non-parametric permutation test; 500 label shuffles; one-sided $p < 0.002$). Contours were smoothed for visualization only. Thick white lines denote alignment discontinuities.

Educational activities within the framework of IACM:

Director of the Postgraduate Programme in the “Brain & Mind Sciences

Services in local, national and international committees:

- Elected President of the “Hellenic Neuroscience Society”
- Member of the Governing Council of the “Federation of European Neuroscience Society”

Public Outreach:

Brain Awareness Week events.

Citation Index: (Google Scholar 2025) 107 (total), 107 (without AA*), 107 (without IA*)

Computational Pharmacology

<https://www.iacm.forth.gr/divisions/applied-science/computational-pharmacology>





VANGELIS KARALIS

Professor, University of Athens
Associated Researcher

Summary:

Vangelis Karalis works at the intersection of biomedical sciences, artificial intelligence, data science, and mathematical modeling, with applications in clinical research, pharmacometrics, and computational medicine. His interdisciplinary research integrates quantitative, computational, and clinical approaches to advance modern healthcare, pharmaceutical sciences, and fundamental scientific understanding.

His research activities focus on the development and application of computational and mathematical methodologies for the analysis of pharmacokinetic, pharmacodynamic, clinical, and biomedical data. Particular emphasis is placed on artificial intelligence, machine learning, modeling and simulation, in silico clinical studies, and digital methodologies that support drug development, personalized medicine, and clinical decision-making.

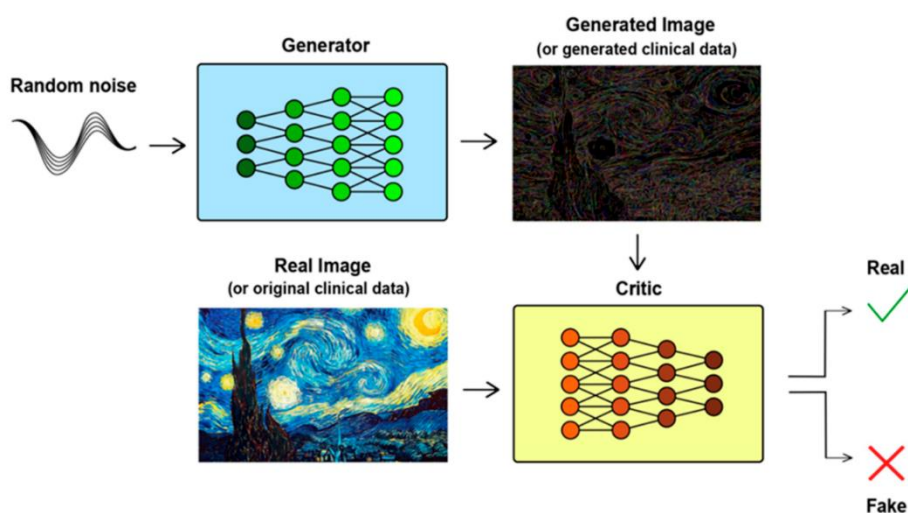


Figure 1. Schematic representation of WGAN operation for the generation of synthetic clinical data.

Research Results during 2025:

During 2025, the main research focus was the generation of synthetic data for clinical studies using advanced artificial intelligence techniques. Wasserstein Generative Adversarial Networks (WGANs) were developed to create virtual participants for bioequivalence studies based on a limited number of real clinical observations (Figure 1). In simulated 2x2 crossover studies, the synthetic populations successfully reproduced both the bioequivalence acceptance rates and the statistical distribution of the original populations, even when model training relied on very small samples. This approach may substantially expand available datasets, reduce the number of participants required, and contribute to faster, more efficient, and cost-effective clinical studies. For highly variable drugs, WGANs also outperformed the scaled FDA/EMA approaches. Threefold data augmentation achieved acceptance rates above 89% across all evaluated criteria, while 10 of the 18 scenarios reached 100%, supporting the proposed use of WGAN-based data augmentation in highly variable drug bioequivalence studies (Figure 2). In parallel, pharmacometric research combined population pharmacokinetics, machine learning, and simulation methods to support individualized treatment. For pirfenidone, dose

adjustments were proposed for adverse events, hepatic impairment, and CYP1A2 interactions. For mycophenolic acid, dose and time after transplantation emerged as key predictors, with boosting models achieving predictive accuracy of $R^2 > 0.91$.

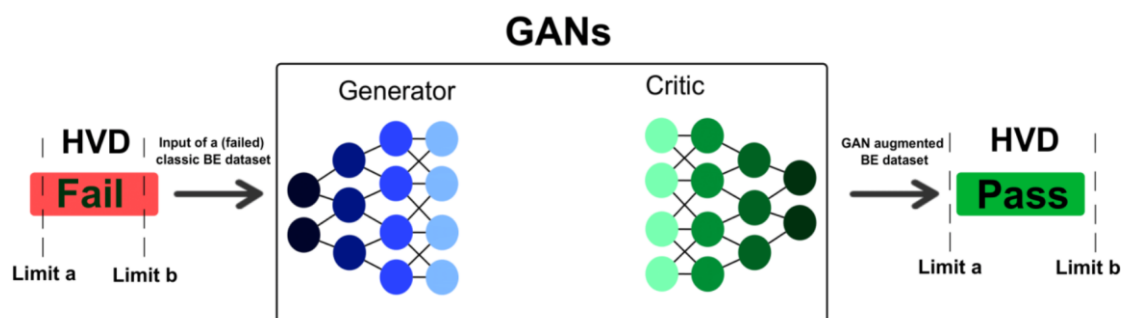


Figure 2. Proposed application of WGANs for data augmentation in bioequivalence studies of highly variable drugs.

Current Aims:

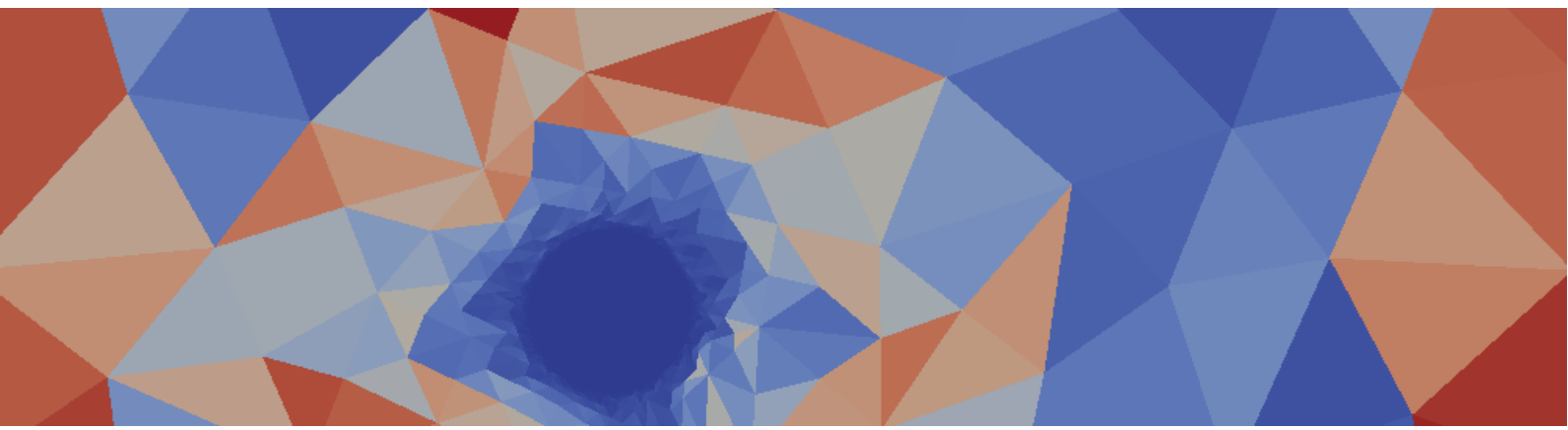
- Development of artificial intelligence methodologies for biomedical and clinical applications.
- Advancement of computational pharmacology and pharmacometric modeling approaches.
- Integration of machine learning and mathematical modeling into clinical research and healthcare.
- Development of in silico clinical studies and simulation-based methodologies for drug development.
- Application of data science and computational methods to personalized medicine and translational research.

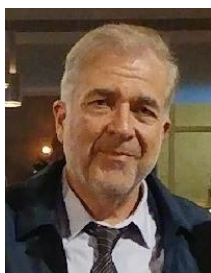
Key Publications:

1. A Nikolopoulos, **VD Karalis** (2025) Artificial Intelligence Meets Bioequivalence: Using Generative Adversarial Networks for Smarter, Smaller Trials, *Machine Learning and Knowledge Extraction* 7 (2), 47, <https://doi.org/10.3390/make7020047>
2. A Nikolopoulos, **VD Karalis** (2025) Generative Neural Networks for Addressing the Bioequivalence of Highly Variable Drugs, *Algorithms* 18 (5), 266, <https://doi.org/10.3390/a18050266>

Coastal and Marine Research

<https://crl.iacm.forth.gr/>





NIKOLAOS KAMPANIS

Research Director

Summary and Current Aims:

Current aims of research include

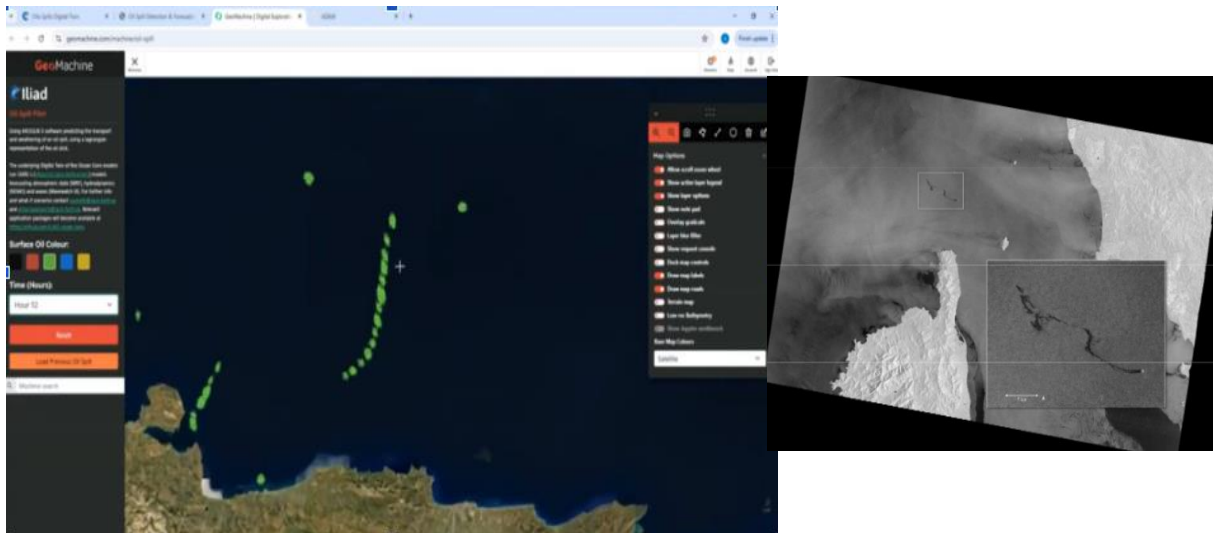
1. Digital twin of the ocean advancements for the applications created during the Iliad project, development of improvements on the operational models predicting sea state and atmosphere
2. AI models environmental studies and prediction of extreme events.
3. AI for pollution identification, mainly oil spills and plastics.
4. Computational Fluid dynamics
5. Data analytics (big data, assimilation).

Research Results during 2025:

2025 was a year of significant research achievements for the Coastal & Marine Research Laboratory (CMRL) of IACM/FORTH. The ILIAD project (Horizon 2020) was successfully completed, having developed an integrated digital framework for marine data and the Digital Twin of the Ocean for the Cretan Sea. The laboratory's research output included 6 publications in international journals and 8 in conference proceedings. Notable among these is the paper "Marine heatwaves in the Mediterranean Sea: a convolutional neural network study for extreme event prediction" (Ocean Science, 2025), which applies deep learning models to the prediction of marine heatwaves, as well as the two IEEE OCEANS 2025 papers on the "Coastal Crete" Digital Twin, covering applications in maritime safety/ship routing and in the detection and forecasting of oil spill deposition and drift. Other publications addressed Aegean Sea turbidity, the vulnerability of coastal archaeological monuments, and sustainable coastal tourism. The laboratory also took on the direction of the Cretan Coastal Observatory for the Region of Crete, strengthening operational services for marine pollution forecasting, coastal safety, and coastal erosion.

Projects:

- ILIAD: INTEGRATED Digital Framework FOR Comprehensive MARITIME DATA AND INFORMATION SERVICES, Funding Agency: European Commission, Coordinator on the part of IACM: Nikolaos Kampanis.
- EFFECTIVE: Enhancing social well-being and economic prosperity by reinforcing the eFFECTIVEness of protection and restoration management in Mediterranean MPAs, Funding Agency: European Commission, Program: HORIZON-MISS-2022-OCEAN-01, Coordinator on the part of IACM: Michael Taroudakis.
- NECCA: Coastal Vulnerability Assessment in Selected Coasts of Crete and Northern Peloponnese Against Flood Hazards, Funding Agency: Public Procurement.
- Development of an Innovative Coastal Monitoring and Forecasting System to Serve Maritime Sports Activities in Kouremenos, Sitia, Funding Agency: Region of Crete.
- Investigation of the Development of Tourist Coastal Interventions in the Less Developed Areas of Lasithi, Funding Agency: Region of Crete.
- TECTONIC: TEchnological Consortium TO develop sustaiNability of underwater Cultural heritage, Funding Agency: European Commission, Program: Horizon 2020, Coordinator: Nikolaos Kampanis.
- Crete Coastal Observatory: Establishment of the Crete Coastal Observatory under the Climate Change Observatory of the Region of Crete, Funding Agency: Region of Crete and the Green Fund, Coordinator: Nikolaos Kampanis



Supervision of PostDocs:

- George Alexandrakis,
- Sofia Darmaraki
- Vassiliki Metheniti,
- Antonis Parasyris

Citation Index: h-index: 24 (Google scholar); citations (2025): 211, i10-index 34

Key Publications:

1. G Alexandrakis, V Metheniti, A Parasyris, G Kozyrakis, **N Kampanis**, K Lampropoulos, A Vythoulka, A Moropoulou (2025) Enhancing Remote Area Tourism through Sustainable Maritime Infrastructure Development, *Technical Annals* 1 (9).
2. Metheniti, V., Parasyris, A., Alexandrakis, G., Kozyrakis, G., & **Kampanis, N.** (2024). Local scale wave forecasting aiding harbor safety; A case study in Heraklion Port. *Technical Annals*, 1(7). <https://doi.org/10.12681/ta.40368>
3. A Parasyris, V Metheniti, **N Kampanis**, S Darmaraki (2025) Marine heatwaves in the Mediterranean Sea: a convolutional neural network study for extreme event prediction, *Ocean Science* 21 (3), 897-912, <https://doi.org/10.5194/os-21-897-2025>
4. V Metheniti, V Vervatis, **N Kampanis**, S Sofianos (2025) Turbidity effects on the Aegean sea surface properties using numerical simulations, *Ocean Dynamics* 75 (1), 4, <https://doi.org/10.1007/s10236-024-01654-3>
5. A Vythoulka, F Kaliakmanis, E Delegou, A Giannikouris, **N Kampanis**, G Alexandrakis, A Moropoulou, S Chlorokostas, E Magkoulis, C Kontopoulos, V Charalampopoulou (2025) Agritourism as a strategy of remote island's development: The case study of Kasos, *ACM Journal on Computing and Cultural Heritage* 18 (4), 1-17, <https://doi.org/10.1145/3691347>





GEORGIOS KOZYRAKIS

Technical Scientist

Summary and Current Aims:

1. Digital twin of the ocean advancements for the applications created during the Iliad project, development of improvements on the operational models predicting sea state and atmosphere
2. Continued research of Wind Resource Assessment with applications on Atmospheric/Oceanic interaction and Wind Energy Research.

Projects: Dr Kozyrakis participated in all research projects of the group during 2025.

Public Outreach:

- Participation/Presentation in Researcher's Night 2025
- Participation/Presentation in InnoDays2025

Publications in Peer-Reviewed Scientific Journals:

1. G Alexandrakis, V Metheniti, A Parasyris, **G Kozyrakis**, N Kampanis, K Lampropoulos, A Vythoulka, A Moropoulou (2025) Enhancing Remote Area Tourism through Sustainable Maritime Infrastructure Development, *Technical Annals* 1 (9).
2. C Condaxakis, **GV Kozyrakis** (2025) Application of Measure–Correlate–Predict (MCP) Methodology for Long-Term Evaluation of Wind Potential and Energy Production on a Terrestrial Wind Farm Siting Position in the Hellenic Region, *Energies* 19 (1), 103, MDPI.
3. **Kozyrakis, G.V.**, Nikolaidis, A., Gauci, A., Zodiatis, G., Azzopardi, J., Galanis, G., Zammit, A., D'Amico, S., Alexandrakis, G., Metheniti, V., Parasyris, A., & Kampanis, N.A. (2024). Comparison of Malta HF Radar Currents with CMEMS Mediterranean MFC Data. *Technical Annals*, 1(7). <https://doi.org/10.12681/ta.40415>
4. **Kozyrakis, G.V.**, Nikolaidis, A., Zodiatis, G., Galanis, G., Alexandrakis, G., Metheniti, V., Parasyris, A., & Kampanis, N.A. (2024). Wave climate conditions of the MUSAN underwater park in Ayia Napa with emphasis in extreme events. *Technical Annals*, 1(7). <https://doi.org/10.12681/ta.40032>
5. Metheniti, V., Parasyris, A., Alexandrakis, G., **Kozyrakis, G.**, & Kampanis, N. (2024). Local scale wave forecasting aiding harbor safety; A case study in Heraklion Port. *Technical Annals*, 1(7). <https://doi.org/10.12681/ta.40368>

Publications in Proceedings of International Scientific Conferences:

1. G Alexandrakis, J Karagiorgos, V Metheniti, **G Kozyrakis**, V Vervatis, S Sarantis, N Kampanis (2025) Investigation of marine plastic pollution and socioeconomic impacts in the area of Pachia Ammos, Crete, *EGU General Assembly 2025*, Vienna, Austria, 27 Apr–2 May 2025, EGU25-15976, Copernicus Meetings. <https://doi.org/10.5194/egusphere-egu25-15976>
2. G Alexandrakis, A Parasyris, V Metheniti, **GV Kozyrakis**, N Kampanis (2025) Coastal Vulnerability Monitoring of Coastal Archaeological Sites, Crete, Greece, *International Conference on Transdisciplinary Multispectral Modeling and Cooperation for the Preservation of Cultural Heritage*, 491-502.
3. V Metheniti, S Outmani, G Alexandrakis, S Keeble, et al. (2025) Coastal Crete: A Digital Twin of the Ocean for Oil Spill Identification and Forecasting, *IEEE OCEANS 2025*, Brest, 1-8.
4. A Parasyris, V Metheniti, L Vettorello, J Ribeiro, M Delgado, J Goddard, J Rebane, M Egerer, G Alexandrakis, **GV Kozyrakis**, S Keeble, ML Quarta, A Ristolainen, A Silva, E Agorogiannis, K Papachristopoulou, C Ipektsidis, H Santos, N Kampanis (2025) Coastal Crete: The Ship Routing/Harbor Safety Digital Twin of the Ocean, *IEEE OCEANS 2025*, Brest, 1-6.

Citation index (Google Scholar): 67 (2025), 354 (total), h-index:8, i10-index 7

MEMBERS OF THE COASTAL AND MARINE RESEARCH LABORATORY



GEORGE ALEXANDRAKIS

Postdoctoral Researcher



SOFIA DARMARAKI

Postdoctoral Researcher



VASSILIKI METHENITI

Postdoctoral Researcher

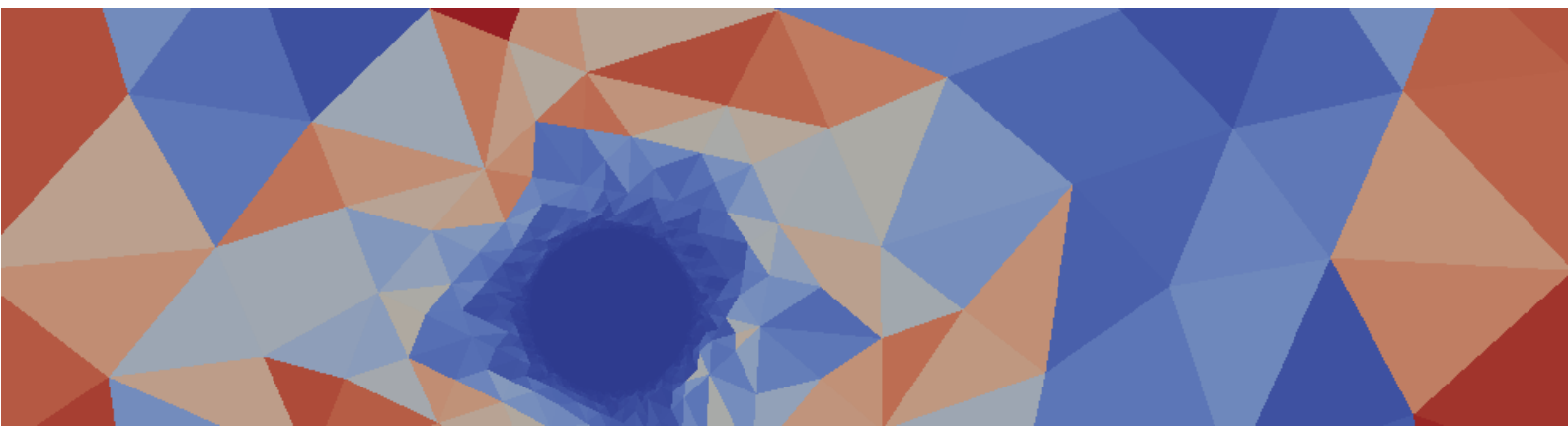


ANTONIS PARASYRIS

Postdoctoral Researcher

Remote Sensing

<http://rslab.gr>





NEKTARIOS CHRYSOULAKIS

Research Director

Summary:

Current research focuses on the global challenges posed by urbanization and climate change. A fundamental disconnect persists between the methods used in climate science and those used in urban systems science to study the dynamic links and feedbacks between climate and cities. Developing Earth Observation (EO) based approaches to quantify these interlinkages represents a strategic research frontier.

Current aims of the research:

a) **Understanding the interactions between urban systems and atmospheric processes across spatial scales** that remains a significant scientific challenge. Although it is well established that socio-economic dynamics influence urban - atmosphere interactions, the challenge lies in understanding the interactions at neighbourhood and smaller scales, where decision-making typically occurs (supported by the project urbisphere).

b) **Dynamic coupling urban form with urban function:** there is a large temporal mismatch between form and function that to date is not considered in a dynamic framework in urban climate models, urban risk assessment and urban change scenarios. EO methods can be used to analyse both urban form and function, as well as to support multiscale methods related to climate impacts (supported by the project urbisphere).

c) **Robust estimation of heat and CO2 emissions in cities:** development of new EO-based methods and exploiting new technologies to estimate urban heat and CO2 fluxes. Recently, new research questions have been raised related to the EO-based estimation of turbulent fluxes in urban settings, where the inherent uncertainties in aerodynamic resistance make it challenging. Furthermore, based on urban function quantification, EO-based approaches can be used to upscale urban CO2 flux towers observations, as well as in emission source attribution (supported by the projects CLMS-Cities and e-Genesis).

d) **Development of new EO-based methods for urban resilience and urban planning:** mainly related to climate change adaptation and mitigation at local scale in cities. EO has a key role and the concept is relevant to the evolution of the European initiative Copernicus, as well as to the exploitation of observations of the Greek Microsatellites constellation (supported by the projects SAT4GAIA, e-Genesis and EUROASIS).

Research Results during 2025:

Examples of 2025 results:

- Bridging of different spatial scales of thermal infrared observations towards understanding the interactions between urban systems and atmospheric processes across spatial scales (Fig. 1).

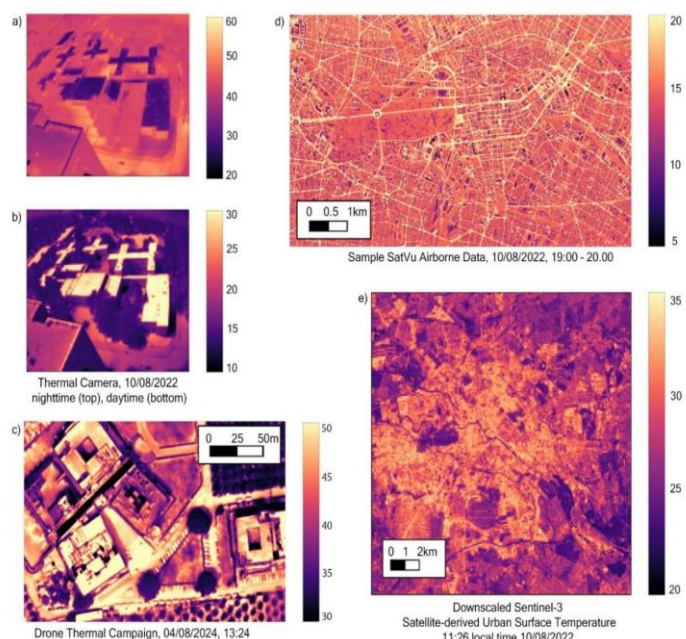


Figure. 1. Illustrative example of how EO can provide data across spatial scales using multiscale urban surface temperature observations: a, b) thermal cameras deployed on a roof provide very high resolution (0.15 m x 0.15 m) thermal observations during a campaign in Berlin; c) drone acquisition in Heraklion provides a resolution of 0.5 m x 0.5 m; d) airborne acquisition in Berlin at 3 m x 3 m; and e) downscaled satellite acquisition in Berlin at 100 m x 100 m.

- Development of urban CO₂ emissions profiles based on flux tower observations towards dynamic coupling urban form with urban function. In Heraklion, the central business district emissions have a distinct daily bi-modal shape throughout the year, linked to traffic. Whereas, in a typical residential area, emissions are primarily from buildings with an afternoon maxima and greater space heating in winter linked to increasing fuel consumption.
- Development of a spectral library of urban materials, based on field campaigns in several European cities, towards supporting the development of new EO-based methods for urban resilience and urban planning. Monitoring and evaluation of climate adaptation and mitigation efforts in cities often lack standardized metrics and evaluation indicators, especially for large scale implementations. EO is a usable, promising solution for long term monitoring and for spatial evaluations, such as mapping large scale deployment of solar panels on building roofs.

Projects:

- Urbisphere: Coupling dynamic cities and climate, European Union, Program: ERC, Coordinator: FORTH (Nektarios Chrysoulakis - cPI), Coordinator on the part of IACM: Nektarios Chrysoulakis.
- CLMS-Cities: Copernicus responding to EU Cities Mission, European Union, Program: Horizon Europe, Coordinator: FORTH (Nektarios Chrysoulakis).
- SAT4GAIA: Copernicus responding to EU Cities Mission, Funding Agency: European Space Agency, Program: Greek Microsatellites, Coordinator on the part of IACM: Nektarios Chrysoulakis.
- ClimaCrete: Mission Climate Change Adaptation Observatory of the Region of Crete, Funding Agency: Region of Crete, Program: Green Fund, Coordinator on the part of IACM: Nektarios Chrysoulakis.
- EUSPA/OP/21/21/Lot 3/SC4: Technical support for the creation of Copernicus story maps and dashboards, Funding Agency: European Union, Program: EUSPA - Lot 3 - Professional applications, Coordinator on the part of IACM: Nektarios Chrysoulakis.
- CLIMPACT II: National Research Network for Climate Change and Its Effects, Funding Agency: GSRI, Program: National Public Investment Programme (PIP) – Operational Programme ‘Strengthening Research, Innovation and Technology, Coordinator on the part of IACM: Nektarios Chrysoulakis.
- Life IGIC: Improvement of Green Infrastructure in agroecosystems: reconnecting natural areas by countering habitat fragmentation, Founding Agency: Hellenic Foundation for Research and Innovation (HFRI), Coordinator on the part of IACM: Nektarios Chrysoulakis
- HARMONIA, Founding Agency: European Union, H2020, Coordinator on the part of IACM: Nektarios Chrysoulakis

Citation Index 2025: (Scopus) 652 (total), 639 (without AA*), 594 (without IA*).

Key Publications:

1. **Chrysoulakis, N.**, Somarakis, G., Kuffer, M., Mallet, C. and Taubenböck, H., 2025. Foreword to the Special Issue “Exploring the Potential of Urban Remote Sensing”. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 18, 11323-11329.
2. Reek, J.E., Crowther, T.W., Lauber, T., Schemm, S., Parastatidis, D., **Chrysoulakis, N.**, Huang, M., Piao, S., Zohner, C.M. and Smith, G.R., 2025. Forest edges are globally warmer than interiors and exceed optimal temperatures for vegetation productivity. *Communications Earth & Environment*, 6, 635.
3. Mitraka, Z., Lantzanakis, G., Panagiotakis, E. **Chrysoulakis, N.**, Somarakis, G., Marconcini, M., Feigenwinter, C. and Lauwaet, D., 2025. Prototypes for enhanced urban heat monitoring leveraging Copernicus services and satellite data. *Discover Cities*, 2, 14.
4. Iqbal, N., Ravan, M., Mitraka, Z., Birkmann, J., Grimmond, S., Hertwig, D., **Chrysoulakis, N.**, Somarakis, G., Wendnagel-Beck, A. and Panagiotakis, E., 2025. How does perceived heat stress differ between urban forms and human vulnerability profiles? Case study Berlin. *Natural Hazards and Earth System Sciences*, 25, 2481–2502.
5. **Chrysoulakis, N.**, 2025. Earth observation for urban climate. Proc. SPIE 13672, Remote Sensing Technologies and Applications in Urban Environments X, 1367202, <https://doi.org/10.1117/12.3077252>
6. Kyriakidis, I., Pavlidis, V., Gkolemi, M., Mitraka, Z., **Chrysoulakis, N.** and Katragkou, E., 2025. Assessing the Sensitivity of WRF to Surface Urban Physics. *Environmental and Earth Sciences Proceedings*, 35, 67.
7. Mitraka, Z., Lantzanakis, G., Gkolemi, M., and **Chrysoulakis, N.**, 2025. Large scale exploitation of satellite data for the assessment of urban surface temperatures. In *Proceeding of Joint Urban Remote Sensing Event (JURSE2025)*, held in Tunis, Tunisia, May 4 - 7, pp. 1-4, IEEE Xplore doi: 10.1109/JURSE60372.2025.11076004



ZINOVIA (ZINA) MITRAKA
Principal Researcher

Summary and Current aims of the research:

My scientific interests lie at the intersection of urban climate and urban remote sensing, with a particular focus on supporting cities' adaptation to and mitigation of climate change. My research focuses on developing Earth Observation data-fusion methods to improve the representation of urban form and function, as well as integrated approaches for incorporating fused datasets into urban climate models and decision-support applications.

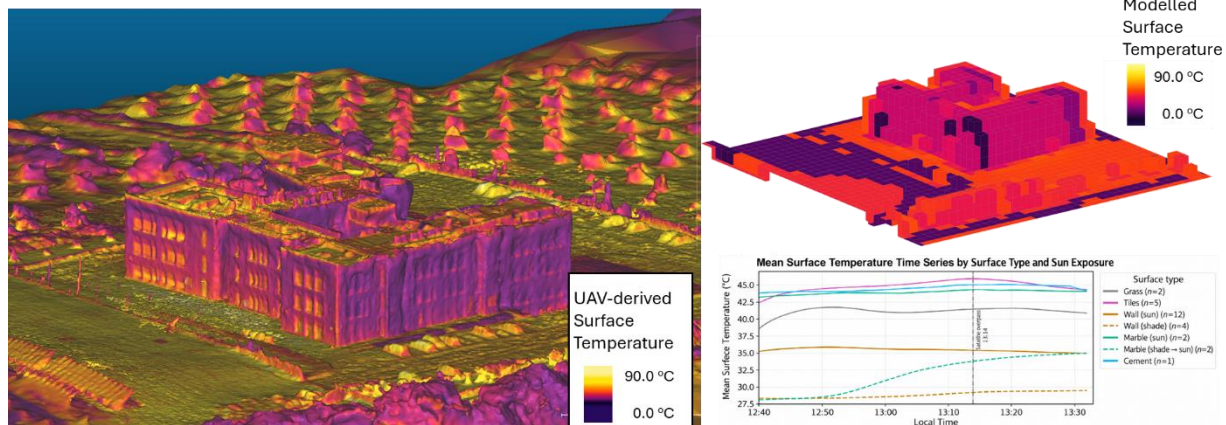
My current aims include integrating satellite, airborne, UAV-derived (Unmanned Aerial Vehicle) and field observations to characterise urban surface properties and associated energy and carbon exchanges. Through collaboration with urban climate modellers, local authorities and planners, I aim to develop and validate methods for assessing urban heat exposure and evaluating adaptation solutions.

My research seeks to enhance the exploitation of current and next-generation Earth Observation missions for operational urban monitoring and the assessment of climate adaptation and mitigation strategies at neighborhood to regional scales.

Projects:

- Urbisphere: Coupling dynamic cities and climate, European Union, Program: ERC, Contract number: 855005, Coordinator: FORTH (N. Chrysoulakis - cPI), Coordinator on the part of IACM: N. Chrysoulakis.
- CLMS-Cities: Copernicus responding to EU Cities Mission, European Union, Program: Horizon Europe, Contract number: 101188032, Coordinator: FORTH (N. Chrysoulakis), Coordinator on the part of IACM: N. Chrysoulakis.
- SAT4GAIA: Copernicus responding to EU Cities Mission, Funding Agency: European Space Agency, Program: Greek Microsatellites, Contract number: 1000040488, Coordinator on the part of IACM: N. Chrysoulakis.
- ClimaCrete: Mission Climate Change Adaptation Observatory of the Region of Crete, Funding Agency: Region of Crete, Program: Green Fund, Contract number: Programmatic Agreement 262477, Coordinator on the part of IACM: N. Chrysoulakis.
- EUSPA/OP/21/21/Lot 3/SC4: Technical support for the creation of Copernicus story maps and dashboards, Funding Agency: European Union, Program: EUSPA -Lot 3 - Professional applications, Contract number: EUSPA/OP/21/21/Lot3, Coordinator on the part of IACM: N. Chrysoulakis.
- Life IGIC: Improvement of Green Infrastructure in agroecosystems: reconnecting natural areas by countering

Three-Dimensional Representation of the Surface Temperature | August 18, 2025 13:00



habitat fragmentation, Founding Agency: Hellenic Foundation for Research and Innovation (HFRI), Coordinator on the part of IACM: Nektarios Chrysoulakis

- HARMONIA, Founding Agency: European Union, H2020, Coordinator on the part of IACM: Nektarios Chrysoulakis
- CLIMPACT II: National Research Network for Climate Change and Its Effects, Funding Agency: GSRI, Program: National Public Investment Programme (PIP) – Operational Programme ‘Strengthening Research, Innovation and Technology, Coordinator on the part of IACM: N. Chrysoulakis.
- UpClim, Founding Agency: Hellenic Foundation for Research and Innovation (HFRI), Coordinator on the part of IACM: Zina Mitraka

Citations: (Google Scholar) total: 2111 (225 in 2025), h-index: 19, i10-index: 32

Publications in peer-reviewed scientific journals:

1. N Iqbal, M Ravan, **Z Mitraka**, J Birkmann, S Grimmond, D Hertwig, N Chrysoulakis, G Somarakis, A Wendnagel- Beck, E Panagiotakis (2025) How does perceived heat stress differ between urban forms and human vulnerability profiles? Case study Berlin, *Natural Hazards and Earth System Sciences*, 25 (7), 2481-2502. <https://doi.org/10.5194/nhess-25-2481-2025>
2. **Z Mitraka**, G Lantzanakis, E Panagiotakis, N Chrysoulakis, G Somarakis, M Marconcini, C Feigenwinter, D Lauwaet (2025) Prototypes for enhanced urban heat monitoring leveraging Copernicus services and satellite data, *Discover Cities*, 2 (1), 1-13, <https://link.springer.com/article/10.1007/s44327-025-00059-1>

Publications in proceedings of international scientific conferences:

1. C Feigenwinter, **Z Mitraka**, N Chrysoulakis and S Stagakis (2025) Urban heat emissions monitoring using Copernicus services – a cross-cutting application from the CURE project. *Beat the Heat Conference 2025*, held in at the Swiss TPH, Basel, Switzerland, 28 August.
2. M Gkolemi, **Z Mitraka**, D Hertwig, W Morrison, D Fenner, N Chrysoulakis, S Grimmond, A Christen, J Birkmann (2025) Comparison of urban surface temperatures derived from in-situ and satellite TIR data with modeled 3D urban surface temperatures, *12th International Conference on Urban Climate*, Rotterdam, The Netherlands, 7–11 Jul 2025, ICUC12-602, <https://doi.org/10.5194/icuc12-602>
3. I Kyriakidis, V Pavlidis, M Gkolemi, **Z Mitraka**, N Chrysoulakis, E Katragkou (2025) Assessing the Sensitivity of WRF to Surface Urban Physics, *Environmental and Earth Sciences Proceedings* 35 (1), 67, <https://doi.org/10.3390/eesp2025035067>
4. **Z Mitraka**, G Lantzanakis, M Gkolemi, N Chrysoulakis (2025) Large scale exploitation of satellite data for the assessment of urban surface temperatures. In *Proceedings of Joint Urban Remote Sensing Event (JURSE2025)*, 1-4. <https://ieeexplore.ieee.org/abstract/document/11076004>
5. **Z Mitraka**, G. Lantzanakis, M Gkolemi, N Chrysoulakis (2025) Large scale exploitation of satellite data for the assessment of urban surface temperatures. Abstracts of the European Space Agency *Living Planet Symposium LPS2025*, held in Vienna, Austria, June 23 – 27, 2025.
6. **Z Mitraka**, G Lantzanakis, M Gkolemi, D Tsirantonakis, N Chrysoulakis, W Morrison, D Fenner, A Christen, T Reinicke, S Grimmond, J Birkmann, M Abrams (2025) "Analysis of urban surface temperatures from ground- based and airborne sensors: Berlin, Germany", *12th International Conference on Urban Climate*, Rotterdam, The Netherlands, 7–11 Jul 2025, ICUC12-450, <https://doi.org/10.5194/icuc12-450>
7. V Pavlidis, I Kyriakidis, M Fiseki-Papadimitriou, M Gkolemi, **Z Mitraka**, N Chrysoulakis, E Katragkou (2025) Investigating the impact of WRF urban parameterizations on Paris urban climate, *12th International Conference on Urban Climate*, Rotterdam, The Netherlands, 7 - 11 July, 2025, ICUC12-897, <https://doi.org/10.5194/icuc12-897>



DIMITRIS POURSANIDIS

Technical Scientist

Summary and Current Aims:

My research focuses on the integration of marine ecology, Earth Observation, field-based monitoring, and spatial modelling to support the conservation, restoration, and climate-relevant assessment of coastal marine ecosystems. During 2025, research activities focused on developing the spatial and methodological basis for assessing Blue Carbon Ecosystems, with particular emphasis on seagrass meadows. The work included the use of Earth Observation data and existing geospatial datasets to characterise habitat extent across different spatial scales. The current aim of my research is to strengthen the scientific and operational basis for seagrass conservation, restoration, and blue carbon accounting in the Mediterranean and beyond. This includes developing integrated workflows that combine high-quality field data, sediment carbon measurements, Earth Observation, and machine-learning models to estimate habitat extent, condition, carbon stocks, and restoration potential.

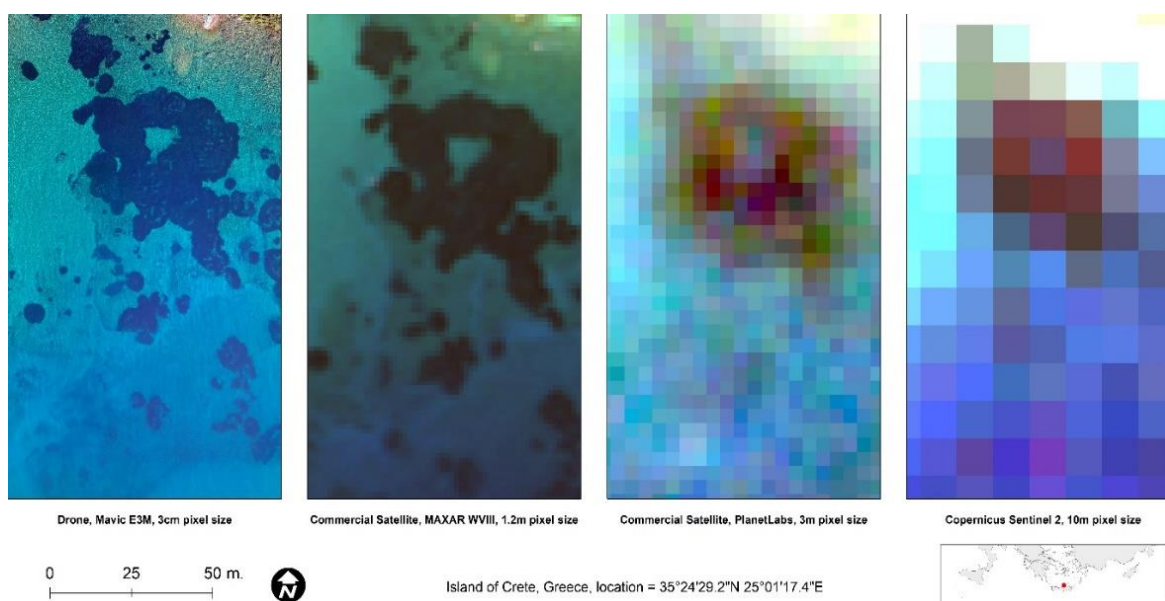
Projects:

- C-BLUES: Carbon sequestration in BLUE EcoSystems, Horizon Europe, HORIZON-CL5-2023-D1-02, Coordinator on the part of IACM: Dimitris Poursanidis

Key Publications:

1. JC Baez, O Akyol, E Azzurro, P Battaglia, A Belmonte-Gallegos, G Christidis, F Crocetta, C Dalyan, Y Gönül, F Grati, S Greco, C Gubili, NB Kesici, L Lipej, E Mancini, B Mavrič, V Orenes-Salazar, JA Ortega Ceacero, C Pipitone, **D Poursanidis**, et al. (2025) New records of rarely reported species in the Mediterranean Sea (March 2025), *Mediterranean Marine Science* 26 (1), 256-276, <https://doi.org/10.12681/mms.40675>
2. C Beierkuhnlein, B Pugh, S Justice, F Schrodtt, G El Serafy, A Karnieli, I Manakos, L Nietsch, J Peñas de Giles, A Peterek, **D Poursanidis**, et al. (2025) Towards a comprehensive geodiversity-Biodiversity nexus in terrestrial ecosystems, *Earth-Science Reviews*, 264, 105075, <https://doi.org/10.1016/j.earscirev.2025.105075>
3. **D Poursanidis**, S Katsanevakis (2025) Mapping Subtidal Marine Forests in the Mediterranean Sea Using Copernicus Contributing Mission, *Remote Sensing*, 17 (14), 2398, <https://doi.org/10.3390/rs17142398>

Citation Index from SCOPUS: 39 (2025 total), 38 (2025 without AA*), 31 (2025 without IA**)



MEMBERS OF THE REMOTE SENSING LABORATORY



GIANNIS LANTZAKIS

Research Assistant



DAVID PARASTATIDIS

Research Assistant



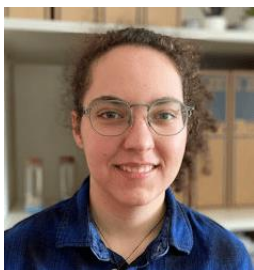
MANOLIS PANAGIOTAKIS

Research Assistant



KONSTANTINOS POLITAKOS

Research Assistant



MARIA GKOLEMI

Research Assistant



DIMITRIS TSIRANTONAKIS

Research Assistant



VASILEIOS GELADARIS

Research Assistant



AGATHI BANTISOULI

Research Assistant



MARIOS TSEREPIS

Research Assistant



NIKOS AL-SHEIKH ALY

Research Assistant



ARGYRO GATI

Research Assistant

Facilities/Infrastructures



COMPUTING FACILITIES

Servers:

- Dell PowerEdge R730xd
- Dell Server PowerEdge R640 with RAID Controller, NL-SAS disks, VMware 7
- Fujitsu Primergy RX2540 M6
- Fujitsu Primergy RX 200 S6, 2 x Intel(R) Xeon(R) CPU E5606 @ 2.13GHz, 8 cores total, 12 GB RAM, DDR3 1066 MHz, 1.4 TB HDD RAID Array

Workstations:

- Dell Precision T3500, T3600, T3610, T5810, T5820, 3640, 3650, 3660, 3665, 3666
- Dell Precision 7920
- Lenovo ThinkStation P620 CTO
- Lenovo ThinkStation P7
- Lenovo ThinkStation P3 Tower Gen 2
- Apple Mac Studio M2 Max (512GB/64GB) & Mac Studio M4 Max (2TB/128GB)
- Apple iMac 24" M1 (x2), iMac 24" M3 (x3), iMac 24" M4
- Kernel PC / Turbo-X / Power PC (i7-8700, i9-9900K, i9-10900K, i9-13900, Ryzen 9 3950X, Ryzen 9 5950X, Ryzen 7 3800X, i7-11700 etc.)
- CUSTOM PC AMD Ryzen 9 7900 (x3)
- H/Y Ergo i7-8700K (x3)
- 1 Infiniband Switch, FUJITSU PY CB IB Switch 40Gb 18/18 (Mellanox)
- 2 Ethernet Switches, FUJITSU PY CB Eth Switch/IBP 1Gb 36/12
- 4 Compute Nodes, FUJITSU PRIMERGY BX920 S2, 2 x Intel(R) Xeon(R) CPU X5650 @ 2.67GHz, 12 cores total, 16 GB RAM, DDR3 1333 MHz
- 2 Compute Nodes, FUJITSU PRIMERGY BX920 S3, 2 x Intel Xeon CPU @ 2.2 GHz, 12 cores total, 16 GB RAM, DDR3 1333 MHz
- 2 Compute Nodes, FUJITSU PRIMERGY BX924 S4, 2 x Intel Xeon CPU @ 2.6 GHz, 12 cores total, 32 GB RAM, DDR3 1600 MHz
- 5 Compute Nodes, FUJITSU PRIMERGY BX2560 M1, 2 x Intel(R) Xeon(R) CPU E5-2680 v3 @ 2.50GHz, 24 cores total, 32 GB RAM, DDR4 2133 MHz
- 1 Storage Server, Supermicro SSG-6027R-E1R12N, 2 x Intel(R) Xeon(R) CPU E5-2620 v2 @ 2.10GHz, 12 cores total, 32 GB RAM, DDR3 1600 MHz, 40 TB HDD RAID Array

FIXED STATIONS

Wireless Network of Meteorological Stations: The Remote Sensing Lab of IACM has installed a Wireless Weather Meteorological Network of 14 stations covering the wider area of the city of Heraklion. All Stations are equipped with Air Temperature (TAir)/ Relative Humidity (RH) Sensors, 7 Stations are equipped with Wind Speed / Wind Direction Sensors and 1 Station is equipped with a Rain Bucket and a Total Solar Radiation Sensor, providing on-line intra-urban meteorological measurements. For more information see <https://rslab.gr/equipment/wnms.html>



Flux Towers: The Remote Sensing Lab of IACM has installed two Flux Towers in the city of Heraklion monitoring turbulent sensible and latent heat fluxes, net all-wave radiation flux and CO2 flux. Both are equipped with IRGASON Integrated CO2/H2O Open-Path Gas Analysers, 3D Sonic Anemometers and CNR1/CNR4 Net Radiometers. For more information see <https://rslab.gr/equipment/fluxtowers.html>



Air Quality Network Stations: The Remote Sensing Lab of IACM operates Air Quality Network Stations installed in Athens, in Thessaloniki and in Heraklion. For more see <https://rslab.gr/equipment/airqualitystations.html>

PhenoCams: The Remote Sensing Lab of IACM operates phenocams installed in Berlin, Heraklion and Paris in the framework of the urbisphere ERC Synergy Grant. For more information see <https://rslab.gr/equipment/phenocams.html>

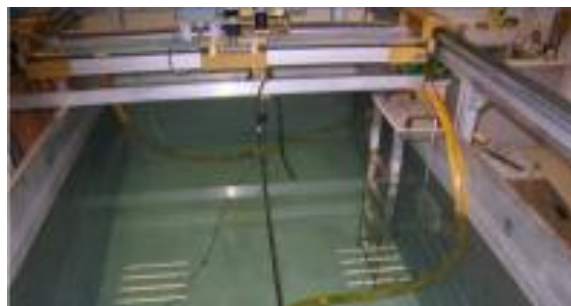


Aerosol Robotic Network (AERONET) System: AERONET deploys ground-based remote sensing providing observations of spectral aerosol optical depth (AOD), inversion products, and precipitable water in diverse aerosol regimes and adopts Sun and Lunar scenarios for collecting spectral measurements of the atmosphere. The Remote Sensing Lab of IACM has installed and operates an AERONET System including a Cimel Multiband Photometer at Heraklion city center. For more information see <https://rslab.gr/equipment/aeronet.html>

Rain Gauge: The Remote Sensing Lab of IACM has installed a HD2015 rain gauge at the HECMAS-ICOS Associated flux tower. The gauge, with direct online data delivery, enhances real-time analysis and supports the research on urban fluxes. For more information see <https://rslab.gr/equipment/aeronet.html>

Seismological Station: The Wave propagation group of IACM has installed a seismological station at IACM-FORTH campus for continuous monitoring of the seismicity in the area of Heraklion. The station is linked to the Hellenic Seismological Broadband Network of the National Observatory of Athens (NOA_HL). For more information see <https://www.iacm.forth.gr/divisions/applied-science/wave-propagation>

Experimental tank: IACM owns and operates an experimental tank (2,5m x 1,5m x 1,3m) with electronically controlled system of axes with two independent arms and four degrees of freedom, a pulser-receiver, a waveform generator, oscilloscopes, Signal and Power Amplifiers, Data Acquisition cards (on board and USB), Ultrasonic transducers (200-700kHz) and laboratory omnidirectional hydrophones (10Hz -120kHz). For more information see <https://www.iacm.forth.gr/divisions/applied-science/uamlaboratory>



DRONES & ROBOTS

Unmanned Aerial System (UAS) with Hyperspectral Camera: The Remote Sensing Lab of IACM owns/operates a Drone equipped with the HySpex Mjolnir Hyperspectral Imaging System for Unmanned Aerial Vehicle. Its Hyperspectral Camera covers a wide spectrum of ultraviolet/visible/near infrared measurements (400-2500nm). For more information see <https://rslab.gr>



Unmanned Aerial Systems (UAS) with Optical and Thermal Cameras: The Remote Sensing Lab of IACM owns/operates two Unmanned Aerial Systems with optical and thermal cameras. The T-Drone M-1000 is equipped with two cameras: one optical and one thermal. The Parrot ANAFI Thermal is equipped with RGB/Thermal Camera. For more information see <https://rslab.gr/equipment/uas.html>

Unmanned Aerial System with Thermal Camera: The Remote Sensing Lab of IACM owns/operates a Parrot ANAFI Thermal equipped with RGB/Thermal Camera, suitable for use in the collection of surface temperature data and the creation of ultra-high resolution topographic and orthomosaic products in the visible spectrum. For more information see <https://rslab.gr/equipment/uas.html>

Drone DJI Phantom 4 Pro V2: The Coastal and Marine Research Lab of IACM owns/operates one portable marine survey equipment Drone with 7km Radius equipped with high definition camera. For more information see <https://crl.iacm.forth.gr/drone/>



Mini-ROV Guardian robot: The Coastal and Marine Research Lab of IACM owns/operates one ROV mini Guardian with 150m operational depth, equipped with onboard cameras LYNN, Laser and Cygnus sensors, and also water and sediment samplers. For more information see <https://crl.iacm.forth.gr/mini-rov/>



PORTABLE EQUIPMENT

Aspirated Radiation Shield and UV & Solar Radiation sensors: The Coastal and Marine Research Lab of IACM owns/operates three Davis Vantage Pro2 Plus, 24-hr Fan-Aspirated Radiation Shield and UV & Solar Radiation sensors, meteorological stations, currently deployed in various areas. The sensor suite combines an anemometer measuring wind speed, a direction vane measuring wind direction, a rain collector, a temperature and a humidity sensor. The particular Met. Stations, are very versatile and easily installed in a variety of climatic conditions and different terrains and makes them ideal for accurate measuring campaigns. For more information see <https://crl.iacm.forth.gr/>

HySpex hyperspectral camera: The Remote Sensing Lab of IACM owns/operates a HySpex Mjolnir VS-620 hyperspectral camera. In addition to the high-quality hyperspectral data cube, double resolution data in the VNIR range is always readily available. Ground-based operations are possible using proper tripod, whereas flight campaigns are also possible using proper UAS (Hercules X8 - HySpex Edition) available in RSLab. For more information see <https://rslab.gr>



Area Heat Stress Monitors: The Remote Sensing Lab of IACM owns/operates QUESTemp° 36 Area Heat Stress Monitors are designed to evaluate potential heat stress in the environment. These instruments deliver monitoring through Wet Bulb Globe Temperature (WBGT) sensing technology and the calculation of a WBGT index value. For more information see https://rslab.gr/equipment/questemp_heat_stress_monitors.html

Optris Infrared camera: The Remote Sensing Lab of IACM owns/operates a thermal imager Optris PI 640i which is the smallest measuring VGA infrared camera worldwide and delivers pin-sharp radiometric pictures and videos in real time. Ground-based operations are possible using proper tripod, whereas flight campaigns are also possible using proper UAS available in RSLab. For more information see https://rslab.gr/equipment/infrared_camera.html

Surface Thermometers: The Remote Sensing Lab of IACM possesses a number of iButton Thermochron devices and two high accuracy Rotronic HygroPalm HP32 sensors. For more information see <https://rslab.gr/>

Field Spectroradiometer: The Remote Sensing Lab of IACM owns a Field Portable Spectroradiometer (RS-3500) covers the full-spectrum of ultraviolet/visible/near infrared measurements (350-2500 nm) with just one scan. It can be operated by one person and is accompanied with a handheld Computer. For more information see <https://rslab.gr>

Telraam S2: The Remote Sensing Lab of IACM owns/operates a device that has been designed and built from scratch for the specific purpose of counting traffic. It operates completely autonomously thanks to the built-in mobile data connection, and the remote device management tools. For more information see <https://rslab.gr>

Open Sea Experiment infrastructure: The Laboratory of Underwater Acoustic Measurements of IACM owns/operates open sea experiment infrastructure including one low frequency sound source, two towed array systems with three and two hydrophones, omni-directional hydrophones (10Hz -280kHz), pingers, transponders, and temperature, depth and underwater noise recorders. For more information see <https://www.iacm.forth.gr/divisions/applied-science/uamlaboratory>

Wave & tide sensors and side scan sonars: The Coastal and Marine Research Lab of IACM owns/operates portable wave & tide sensors and side scan sonars. For more information see <https://crl.iacm.forth.gr/>

Diving equipment: The Coastal and Marine Research Lab of IACM owns full diving equipment.

VHR Satellite Imagery: The Remote Sensing Lab of IACM owns a series of Very High Spatial Resolution Satellite Imagery acquired from commercial satellite platforms. Most of them cover urban areas providing the spatiotemporal evolution of several cities. For more information see <https://rslab.gr/equipment/hiresimagery.html>

Grants



Grants

EU PROGRAMMES

Title: **Coupling dynamic cities and climate**

Acronym: **urbisphere**

Funding Agency: European Union, Program: ERC

Coordinator: FORTH (Nektarios Chrysoulakis - cPI), Coordinator on the part of IACM: **Nektarios Chrysoulakis**

Duration: 2020 – 2028, Total budget: 12.720.90€4, IACM Budget: 2.892.250€

Short Description: Understanding, forecasting, and projecting feedbacks between climate change and drivers of urban transformation, and aims to change how the scientific community conceptualises, classifies and predicts the climate system and urban planning.

Title: **Singularities in General Relativity**

Acronym: **SINGinGR**

Funding Agency: ERC, Program: Horizon 2020, Coordinator: FORTH

Coordinator on the part of IACM: **Grigorios Fournodavlos**

Duration: 4 years (01/03/2024-31/03/2028), Total budget: 1 312 180.00€, IACM Budget:

Short Description: Gravitational singularities (points where density and spacetime curvature become infinite and standard laws of physics break down) are often found inside black holes and at the Big Bang. How they are formed remains one of the most important unsolved problems. The ERC-funded SINGinGR project will found a research group in Greece to address this. The group will develop novel mathematical tools to prove singularity formation in new settings and test long-standing conjectures. It aims to construct Big Bang singularities beyond the simplified symmetric and analytical cases studied so far. Furthermore, it aims to demonstrate that black hole interiors can develop spacelike singularities in scenarios outside of spherical symmetry.

Title: **HARMONIA**

Founding Agency: European Union, Program: H2020

Duration: 01/06/2021 – 31/01/2025

Coordinator on the part of IACM: **Nektarios Chrysoulakis**

Short description: The project leverages existing tools, services and novel technologies to develop a platform supporting local policy-makers and citizens to understand the effects of Climate Change, and providing actionable data for smarter development strategies as well as generating opportunities for business growth and urban sustainability.

Title: **Copernicus responding to EU Cities Mission**

Acronym: **CLMS-Cities**

Funding Agency: European Union, Program: Horizon Europe, Coordinator: FORTH (N. Chrysoulakis)

Coordinator on the part of IACM: **Nektarios Chrysoulakis**

Duration: 2025 – 2028, Total budget: 2.863.930€, IACM Budget: 647.500€

Short Description: Contributing to CLMS (Copernicus Land Monitoring Service) evolution, by developing innovative methods to monitor climate change mitigation activities in cities that have joined the EU Cities Mission.

Title: **Trustworthy Unified Robust Intelligent Generative Systems**

Acronym: **TURING**

Funding Agency: European Union, Program: HORIZON, Coordinator on the part of IACM: **Georgios Arampatzis**

Duration: 3 years (01/09/2025-31/08/2028), Total budget: 7 497 790€, IACM Budget: 200,000€

Short Description: AI models for scientific and engineering applications

The complexity and importance of advances in science and engineering have increased the need for intricate physical systems in critical operations and simulations. However, this approach is resource-intensive and costly. While AI offers a promising alternative, it remains limited in terms of generalisation, accuracy, and ethical considerations. The EU funded TURING project will develop innovative and robust AI-driven solutions to overcome these challenges. To achieve this, it will integrate a plethora of multidisciplinary advancements from related fields to pre-train generative and multimodal

foundation models capable of capturing the physics of dynamic systems sharing common properties. These models will progressively incorporate more complex physical systems to ensure robustness, ultimately becoming specialised in their respective fields.

Title: Enhancing social well-being and economic prosperity by reinforcing the eFFECTIVENess of protection and restoration management in Mediterranean MPAs

Acronym: **EFFECTIVE**

Funding Agency: EC, Program: Horizon -Blue Parks, Coordinator on the part of IACM: **Michael Taroudakis**

Duration: 48 months (1/06/2023 – 31/05/2027, IACM Budget: 399875€

Short Description: The project is related to the core ambition of the Integrated Maritime Policy (IMP) of the EU to coordinate and establish coherent decision-making in order to maximize sustainable development, economic growth and social cohesion of EU Member States in the marine domain. The EFFECTIVE main objective is to develop a comprehensive scientific knowledge base and practical guidance, combining science, technological nature-based solution and digitalization, for the application of the Ecosystem-Based management to the protection and restoration management of the EU's Mediterranean Blue Natural Capital.

Title: Resilience Enhancement for Ticks and Tick-Borne Diseases in Sub-Saharan Africa

Acronym: **ResTick**

Funding Agency: Horizon Europe, Coordinator: IMBB, Coordinator on the part of IACM: **Yiannis Kamarianakis**

Duration: 36 months, Total budget: 6.1€M, IACM Budget: 95000€

Short Description: ResTick addresses urgent issues surrounding ticks as disease vectors, focusing on Crimean-Congo Haemorrhagic Fever (CCHF), within the Sub-Saharan Africa (SSA) and Crete, Greece. Ticks pose significant challenges to ecosystems, economies, and public health, particularly as climate change exacerbates environmental dynamics. Therefore, tackling ticks' impact becomes crucial, including the development of early warning and monitoring systems and the creation of affordable, user-friendly diagnostics. Proactive actions are necessitated as climate-driven shifts are reshaping disease landscape. The project aims to enhance resilience against these challenges by establishing a dedicated network focused on understanding tick species, pathogens, and their interactions within the SSA context. Leveraging advanced molecular ecology methodologies, statistics, and cutting-edge technologies, the initiative will establish baseline data for early warning systems and develop point-of-care devices, integrating them into One Health approaches. Additionally, it endeavours to create predictive models for both tick abundance and disease prevalence. ResTick underscores the critical role of interdisciplinary collaboration in addressing these challenges. IACM leads the work package that focuses on the statistical analysis (Species Distributions Models; Risk Maps) of the tick-presence data collected from ResTick partners.

Title: Technical support for the creation of Copernicus story maps and dashboards

Acronym: **EUSPA/OP/21/21/Lot 3/SC4**

Funding Agency: European Union, Program: EUSP -Lot 3-Professional applications, Coordinator: Evenflow,

Coordinator on the part of IACM: **Nektarios Chrysoulakis**

Duration: 2025 – 2026, Total budget: 300.000€, IACM Budget: 53.100€ (for the current slot)

Short Description: Provision of technical and business support for downstream space market development, including Renewable Energy and Raw Materials, Agriculture and Forestry, Insurance and Finance, and Urban Development.

Title: TEchnological Consortium TO develop sustainAbillity of underwater Cultural heritage

Acronym: **TECTONIC**

Funding Agency: European Commission, Program: Horizon 2020 – MSCA-RISE-2019

Coordinator: **Nikolaos Kampanis**

Duration: 01/01/2020-30/11/2025, Budget for IACM: 46,000€

Short Description: TECTONIC promotes interdisciplinary collaboration among researchers, engineers, archaeologists, conservators, geologists, and industry professionals to develop innovative solutions for the documentation, conservation, restoration, and management of Underwater Cultural Heritage (UCH). The project focuses on 3D reconstruction of underwater sites, risk assessment under changing environmental conditions, conservation protocols, low-cost robotic monitoring systems, and public awareness activities. Its ultimate goal is to generate innovative methodologies and marketable products that support the preservation and sustainable management of underwater cultural assets.

Title: High Arctic Ocean Observation System

Acronym: **HiAOOS**

Funding Agency: European Commission, Program: Horizon Europe (HORIZON)

Coordinator on the part of IACM: **Emmanuel Skarsoulis**

Duration: 5 YEARS (1 January 2023 – 31 December 2027), Total budget: 9.500.358€, IACM Budget: 295.000€

Short Description: Development, implementation and validation of several ocean observing technologies to improve data collection in the ice-covered Arctic Ocean.

Title: Intra- and Inter-Areal Communication in Primate Brain Networks

Acronym: **In2PrimateBrains**

Founding Agency: European Union, H2020-MSCA-IT

Coordinator on the part of IACM: **Gregoriou Georgia**

Duration: 01/03/2021 - 28/02/2025

Short description: A Marie Skłodowska-Curie Innovative Training Network (ITN) coordinated by Aix-Marseille University with the aim to train a 15 early-stage researchers across different European labs in Germany, France, Greece, United Kingdom, Belgium and Italy to study how neurons and neuronal populations communicate within and between areas of the primate brain. The work combined neurophysiology, imaging and computational modelling to explain how these network interactions support cognition and behaviour.

Title: Carbon sequestration in BLUE EcoSystems

Acronym: **C-BLUES**

Funding Agency: Horizon Europe, Program: HORIZON-CL5-2023-D1-02

Coordinator on the part of IACM: **Dimitris Poursanidis**

Duration: 48 months (01/04/2024-31/03/2028), Total budget: 5 000 000€, IACM Budget: 164018.75€

Short Description: C-BLUES seeks to enhance knowledge and understanding of Blue Carbon Ecosystems (BCEs), including emerging BCEs like natural and farmed kelp systems, and increase BCE inclusion in national greenhouse gas inventories and reporting under the United Nations Framework Convention on Climate Change.

Title: INTEGRATED Digital Framework FOR Comprehensive MARITIME DATA AND INFORMATION SERVICES

Acronym: **ILIAD**

Funding Agency: European Commission, Program: LC-GD-9-3-2020

Coordinator on the part of IACM: **Nikolaos Kampanis**

Duration: 02/2022 – 01/2025, Budget for IACM: 402,000€

Short Description: ILIAD developed an integrated digital framework for comprehensive maritime data and information services. The project aimed to enhance access to marine data and support the development of advanced digital solutions for maritime monitoring, management, and decision-making through innovative digital twin technologies.

Title: Topological textures in Condensed Matter

Acronym: **POLYTOPO**

Funding Agency: COST, Program: COST Action, Chair: **Stavros Komineas**

Duration: 1/11/2024 - 31/10/2028, Total budget: ~ 650.000 €, IACM Budget: 650.000 €

Short Description: The mathematical concept of Topology has become a key concept in condensed matter physics, offering new insights into physical phenomena. This COST action focuses on techniques for the creation and annihilation of topological textures and on their static and dynamic properties that form a vibrant field of research.

Title: Improvement of Green Infrastructure in agroecosystems: reconnecting natural areas by countering habitat fragmentation

Acronym: **Life IGIC**

Founding Agency: Hellenic Foundation for Research and Innovation (HFRI)

Duration: 01/09/2017 – 31/12/2025

Coordinator on the part of IACM: **Nektarios Chrysoulakis**

Short description: The project develops Green Infrastructure (GI) and supporting Sustainable Farming Methods in olive orchards, in Western Messara plain, south Crete, Greece.

Title: **European Digital Innovation Hub for smart health**

Acronym: **smartHEALTH**

Funding Agency: European Health and Digital Executive Agency

Program: Digital Europe Program Competitiveness 2021-2027 (MIS 6001551),

Coordinator: D. Katehakis, ICS FORTH

Coordinator on the part of IACM: **Yiannis Kamarianakis**

Duration: 12 months (IACM's participation), Total budget: 6.1€M, IACM Budget: 20000€

Short Description: Collaboration with Optotech Ltd. for the development of statistical predictive models and machine learning algorithms for Dyslexia screening, based on explanatory variables derived with eye-tracking. Within the framework of this collaboration I i) participated in one conference in Greece; ii) submitted a joint research proposal; and iii) submitted a manuscript in a Statistics journal.

Title: **Copernicus responding to EU Cities Mission**

Acronym: **SAT4GAIA**

Funding Agency: European Space Agency, Program: Greek Microsatellites

Coordinator: GSH

Coordinator on the part of IACM: **Nektarios Chrysoulakis**

Duration: 2024 – 2026, Total budget: 1.764.931€, IACM Budget: 390.000€

Short Description: Design, development, validation, integration, and delivery of the Land Monitoring Service, which includes the following Modules: a) Land Use/Land Cover Mapping; b) Deformation Monitoring; c) Urban Analytics Services.

Title: **Enabling the Next-Generation of Computational Physicists and Engineers**

Acronym: **ENGAGE**

Founding Agency: FORTH TRANSFER FUNDING TO CyL

Coordinator on the part of IACM: **Vagelis Harmandaris**

Duration: 01/01/2022 - 31/12/2026

Short description: A European Doctoral Network concerning the training young computational scientists on advanced High Performance Computing & multi-scale modeling of complex physical systems.

OTHER INTERNATIONAL PROGRAMMES

Title: **Underwater Acoustics Conference and Exhibition 2025**

Acronym: **UACE 2025**

Funding Agency: Office of Naval Research, Contract number: ΔΕΘ00 UACE 2025 ONR N000142512193

Coordinator: FORTH

Coordinator on the part of IACM: **Michael Taroudakis**

Duration: 13 months 1/03/2025-30/06/2026, Total budget: 22600€, IACM Budget: 22600€

Short Description: Support of the International Underwater Acoustics Conference and Exhibition 2027 organized by FORTH.

PRIVATE FUNDING

Title: **Disentangled Representation Learning via Mutual Information Optimization with Application in Speech Representation Learning**

Acronym: **DISENTANGLE-SPEECH**

Funding Agency: Apple Inc., Program: Apple University Research Partnerships (direct industry funding)

Coordinator: **Yannis Pantazis**

Duration: 12 months, Total budget: \$70,000 USD, IACM Budget: \$70,000 USD

Short Description: This project develops a robust framework for disentangled representation learning by placing Mutual Information (MI) estimation at its core, with application to speech representation learning. Speech signals can be disentangled into linguistic, speaker identity, and style features. The project will: (1) develop a software library of existing and novel MI estimators; (2) enhance neural network architectures and expand training databases for speech processing; (3) iteratively train and evaluate new disentangled speech representation models; and (4) assess the generalization of the new MI estimators beyond speech to other problem domains.

Title: Causal discovery and inference for surrogate-assisted optimization

Funding Agency: Huawei Technologies (Ireland) CO

Coordinator: **Ioannis Tsamardinos**

Duration: Dec 2021-Dec 2027

Title: Large Causal Models for AIOps

Funding Agency: Huawei Technologies (Ireland) CO

Coordinator: **Ioannis Tsamardinos**

Duration: Mar 2024-Dec 2027, Total budget: 292.879,00 €, IACM Budget: 292.879,00 €

Title: Statistical Machine learning methods for output forecasting in grid connected and off-grid PV systems

Funding Agency: Saudi Aramco Technologies

Coordinator: **Theodoros Katsaounis**

Duration: Six (6) Months, Total budget: 130,000.00 \$ (USD), IACM Budget: 130,000.00 \$ (USD)

Short Description: Develop mathematical & statistical learning models for forecasting power output in PV systems.

Title: Computational Studies of Polymer-Metal Systems

Funding Agency: Industry Funding, Toyota Japan

Coordinator on the part of IACM: **Vagelis Harmandaris**

Duration: 01/10/2025-30/09/2026, Total budget: 120.000 €, IACM Budget: 120.000€.

Short Description: An industrial collaboration, fully funded by Toyota, targeting on the development of advanced models and simulations across multiple scales (ab-initio and atomistic) for complex polymer-metal interfacial systems with applications in fuel cells and organic electronics.

Title: Using pin beams and complex beam profiles to optimize the performance of free space optical links

Funding agency and funding scheme: Research cooperation between HUAWEI TECHNOLOGIES SWEDEN AB and FORTH

Coordinator: **Nikolaos Efremidis**

Duration: 14/02/2022-21/12/2025

Short Description: We studied the propagation of optical pin beams through atmospheric turbulence. Our theoretical, numerical, and experimental results demonstrate that this form of light structuring significantly reduces the scintillation index at the receiver compared with conventional Gaussian beams. Taken also into account that optical pin beams can be generated using an additional phase mask, they can be considered as promising candidates for improving the performance of free-space optical communication systems.

Title: WHALES'25 – FORTH Mission

Acronym: **WHALES'25**

Funding Agency: OCEAN CARE (NGO - CH)

Coordinator: **Emmanuel Skarsoulis**

Duration: 14 MONTHS (1 March 2025 to 31 May 2026), Total budget: 117.120€, IACM Budget: 117.120€

Short Description: Detection of sperm whales in the Kythira Strait.

Title: SUMMER GRADUATE SCHOOL 2020

Founding Agency: Stavros Niarchos Foundation

Coordinator: **Charalambos Makridakis**

Duration: 01/01/2020 - 31/12/2025

Title: **Development of Molecular Simulation Methods for Polymer Nanocomposite Materials**

Founding Agency: THE GOODYEAR TIRE & RUBBER COMPANY

Coordinator on the part of IACM: **Vagelis Harmandaris**

Duration: 01/07/2017 - 31/08/2027

Short description: A long-standing industrial collaboration, fully funded by Goodyear, focused on the development of advanced, high-fidelity chemical models across multiple scales and large-scale simulations of complex materials for tire applications.

NATIONAL PROGRAMMES

Title: **National Research Network for Climate Change and Its Effects**

Acronym: **CLIMPACT II**

Funding Agency: GSRI, Program: National Public Investment Programme (PIP) – Operational Programme ‘Strengthening Research, Innovation and Technology, Contract number: 2023NA11900001 (ΟΠΣ 5201588)

Coordinator: NOA, Coordinator on the part of IACM: **Nektarios Chrysoulakis**

Duration: 2023 – 2026, Total budget: 3.148.100€, IACM Budget: 31.900€ (for the current slot)

Short Description: Addressing issues related to Climate Change and the associated climate risks, natural disasters, as well as social and economic impacts

Title: **UpClim**

Founding Agency: Hellenic Foundation for Research and Innovation (HFRI)

Duration: 2024 – 2025

Coordinator on the part of IACM: **Zina Mitraka**

Short description: The project contributes to the ongoing regional climate activities of CMIP6/EURO-CORDEX and dedicated CORDEX Flagship Pilot Studies, operating under the auspices of the World Climate Research Project. Additional simulations investigate the sensitivity of aerosol and urban parameterizations on regional climate.

Title: **Interfacial phenomena in stochastic reaction-diffusion systems & applications to mathematical finance**

Acronym: **IPMAFIN**

Funding Agency: Hellenic Foundation for Research and Innovation (H.F.R.I. / ΕΛ.ΙΔ.Ε.Κ.)

Coordinator: **Georgia Karali**

Duration: 24 months (14/11/2023-13/11/2025), Total budget: 166.000€, IACM Budget: 166.000€

Short Description: The project is devoted to the study of interfacial phenomena in stochastic reaction-diffusion equations and applications to mathematical finance. The simultaneous use of techniques from probability, and nonlinear partial differential equations in order to explore such interfacial phenomena in stochastic reaction-diffusion systems and applications to mathematical finance, which is a cornerstone of this proposal, is an emerging, highly active field of activity. The proposal mainly focuses on the following four working packages that we plan to investigate in detail: 1) Existence of the stochastic unbounded obstacle problem; 2) Rigorous derivation of the equations for the multi-dimensional stochastic Stefan financial model for a portfolio of assets; 3) Regularity, density and rigorous asymptotics for the financial stochastic Stefan problem of a volatile asset with spread; 4) Long time asymptotics of stochastic motion by mean curvature. All these are novel and challenging problems that cross the boundaries between the mathematical disciplines of applied analysis, probability theory, stochastic partial differential equations and mathematical finance. The proposed approaches are very new and necessary for mathematics in order to keep up with the demands from applied areas and open new horizons for scientific research.

Title: **Towards Real-Time, Enhanced Text-To-Speech Synthesis on the Device**

Acronym: **STOMA**

Funding Agency: Hellenic Foundation for Research and Innovation (H.F.R.I. / ΕΛ.ΙΔ.Ε.Κ.)

Program: 2nd Call for H.F.R.I. Research Projects to support Faculty Members and Researchers

Coordinator: **Yannis Pantazis**

Duration: 36 months, Total budget: 198,000.00 €, IACM Budget: 198,000.00 €

Short Description: STOMA targets the design and implementation of novel, lighter Text-to-Speech (TTS) synthesis systems that combine deep learning with classical signal processing, exploiting the quasi-periodic nature of speech. Unlike existing neural TTS systems, which have tens of millions of parameters and require server-side (cloud) computation, STOMA aims to reduce neural network size by approximately 5-fold and accelerate inference 10-fold, enabling real-time speech generation directly on mobile devices. The project also addresses speech intelligibility enhancement by adaptively adjusting speaking style (Lombard effect) to improve speech clarity in noisy environments through transfer learning, and by integrating the Spectral Shaping and Dynamic Range Compression (SSDRC) algorithm into the TTS pipeline.

Title: **Thermal stimuli-responsive 3D printed electroactive polymer nanocomposites towards 4D “programmable” geometries**

Acronym: **THUNDER**

Founding Agency: Hellenic Foundation for Research and Innovation (HFRI)

Coordinator on the part of IACM: **Vagelis Harmandaris**

Duration: 01/02/2024 - 31/12/2025

Short description: Multi-scale modeling and simulations of complex polymeric nanocomposites with applications on thermal stimuli-responsive 3D printed electroactive materials.

Title: **Modeling Transcription: an integrated approach to understand cancer-specific gene expression programs**

Acronym: **TRANS-MOD**

Funding Agency: Hellenic Foundation for Research and Innovation (H.F.R.I. / ΕΛ.ΙΔ.Ε.Κ.)

Program: Greece 2.0 National Recovery and Resilience Plan “Basic Research Financing”, Coordinator: I. Talianidis, IMBB

Coordinator on the part of IACM: **Theodoros Katsaounis**

Duration: 23 months (01/02/2024-31/12/2025), Total budget: 400,000.00€, IACM Budget: 130,000.00€

Short Description: Experimental and Mathematical Modelling of some parts of RNA Transcription

Title: **Next-generation monitoring and mapping tools to assess marine ecosystems and biodiversity**

Acronym: **NEMO-Tools**

Funding Agency: Hellenic Foundation for Research and Innovation (H.F.R.I. / ΕΛ.ΙΔ.Ε.Κ.)

Program: Basic Research Financing (Horizontal support for all Sciences), National Recovery and Resilience Plan (Greece 2.0) — Sub-action 2: Funding Projects in Leading-Edge Sectors

Coordinator: Aristotle University of Thessaloniki (AUTH)

Coordinators on the part of IACM: **Yannis Pantazis, Yiannis Kamarianakis**

Duration: 23 months, Total budget: 400,000.00 €, IACM Budget: 50,000.00 €

Short Description: NEMO-Tools aims to advance the state of the art in marine ecosystem observation, mapping, and monitoring in support of the EU Green Deal and Biodiversity Strategy 2030. The project pursues three main objectives: (1) developing next-generation, affordable, user-friendly marine biodiversity monitoring tools including satellite and drone mapping, optimized eDNA protocols, AI-based species identification tools, low-cost citizen-science hydrophones, and upgraded autonomous/remotely operated vehicles; (2) supporting the EU Biodiversity Strategy by developing operational guidelines for effective monitoring and conservation planning; and (3) empowering ocean observation by engaging citizens in science.

Title: **Adaptive Methods for Solving Partial Differential Equations**

Acronym: **AdaptSol**

Founding Agency: Hellenic Foundation for Research and Innovation (H.F.R.I.)

Coordinator on the part of IACM: **Nikolaos Rekatsinas**

Duration: 15/06/2021 - 14/02/2025

Acronym: **HYDRODYNAMIC**

Founding Agency: Hellenic Foundation for Research and Innovation (H.F.R.I.)

Coordinator on the part of IACM: **Marios Georgios Stamatakis**

Duration: 01/08/2021 - 31/03/2025

Title: **Temperature Extremes in the Mediterranean Sea and adjacent regions**

Acronym: **TEXMED**

Founding Agency: Hellenic Foundation for Research and Innovation (H.F.R.I.)

Coordinator on the part of IACM: **Sofia Darmaraki**

Duration: 01/01/2023 - 30/06/2025, Budget: 117,942.00€

Title: **Development of an Innovative Coastal Monitoring and Forecasting System to Serve Maritime Sports Activities in Kouremenos, Sitia**

Funding Agency: Region of Crete

Budget for IACM: 68,000€

Short Description: The project develops an advanced coastal monitoring and forecasting system to support maritime sports activities in Kouremenos, Sitia. The system provides environmental observations and forecasting capabilities to improve safety, operational planning, and user experience for coastal and marine recreation activities.

Title: **Investigation of the Development of Tourist Coastal Interventions in the Less Developed Areas of Lasithi**

Funding Agency: Region of Crete

Budget for IACM: 62,000€

Short Description: This project evaluates opportunities for sustainable coastal tourism development in less developed areas of Lasithi. It investigates potential interventions, assesses environmental and socioeconomic impacts, and provides recommendations for balanced coastal development strategies.

Title: **Establishment of the Crete Coastal Observatory under the Climate Change Observatory of the Region of Crete**

Acronym: **Crete Coastal Observatory**

Funding Agency: Region of Crete and the Green Fund

Program: Green Fund: Natural Environment and Climate Neutrality (2024)

Coordinator: **Nikolaos Kampanis**

Budget for IACM: 70,000€

Short Description: The proposed observatory, linked to the "Crete Coastal Monitoring Mechanism" within the framework of the Regional Climate Change Adaptation Plan focuses on the systematic observation and recording of coastal zone evolution and shoreline erosion indicators, the assessment of beach vulnerability to sea-level rise and anthropogenic pressures, supporting evidence-based decision-making and the development of environmentally sustainable solutions and management plans aimed at protecting coastal infrastructure, assets, and ecosystems from erosion and climate-related hazards.

Title: **Coastal Vulnerability Assessment in Selected Coasts of Crete and Northern Peloponnese Against Flood Hazards**

Acronym: **NECCA**

Funding Agency: Public Procurement, Coordinator: OIKOM – FORTH, Duration: 2024 – 2026

Budget for IACM: 159,755 €

Short Description: NECCA focuses on assessing coastal vulnerability to flooding in selected coastal areas of Crete and Northern Peloponnese. The project supports risk evaluation and adaptation planning through scientific analysis of coastal hazards and climate-related impacts.

Title: **Mission Climate Change Adaptation Observatory of the Region of Crete**

Acronym: **ClimaCrete**

Funding Agency: Region of Crete, Program: Green Fund, Contract number: Programmatic Agreement 262477

Coordinator on the part of IACM: **Nektarios Chrysoulakis**

Duration: 2025 – 2028

Total budget: 1.000.000€, IACM Budget: 89.474€ (for both N. Kampanis and N. Chrysoulakis Labs)

Short Description: Climate Change Adaptation Observatory of the Region of Crete.

FORTH SYNERGY GRANTS

Title: **Advancing Personalized Neuromodulation: Integrating NeuroAI into Real-Time Adaptive Brain Stimulation**

Acronym: **NEUROADAPT**

Funding Agency: FORTH, Program: "Theodore Papazoglou" FORTH Synergy Grants 7th call

Coordinator: **Georgia Gregoriou**

Duration: 24 months (01/09/2025-31/08/2027), Total budget: 80,000€, IACM Budget: 40,000€

Short Description: The project aims to develop an adaptive closed-loop system that integrates multi-electrode recordings with electrical stimulation to generate specific patterns of neuronal activity. Since the stimulation motifs required to achieve the target activity patterns are not known in advance, a machine learning algorithm will be employed to minimize the error between the evoked and target neuronal activities.

Title: **Biophysical tools FUSed via integrative computational approaches to decode protein foldING**

Acronym: **FUSING**

Funding Agency: FORTH, Program: Theodore Papazoglou FORTH Synergy Grants (4th Cycle)

Coordinator: IMBB/FORTH; Principal Investigator: Dr. Giorgos Gouridis, Partners: IMBB/FORTH

Coordinator on the part of IACM: **Yannis Pantazis**

Duration: 24 months originally (01/07/2022 – 30/06/2024), extended to 30/06/2025

Total budget: 80,000.00€, IACM Budget: 40,000.00€

Short Description: FUSING couples cutting-edge biophysical tools with computational approaches to deduce protein folding funnels: the energetic landscape that governs how an unfolded protein transitions through intermediate states to reach its native structure. The project uses single-molecule FRET (smFRET) at both equilibrium and non-equilibrium conditions to observe individual protein molecules at high resolution. Computational and machine learning methods developed at IACM are used to model and infer structural state transitions from these experimental datasets. The project is organized in three interconnected objectives: (1) identifying structural states during protein folding with single-molecule resolution; (2) generating and inferring folding dynamics from immobilized single-molecules; and (3) integrating structural and dynamic data for comparative analysis across perturbed systems and structural homologs.

Title: **Functional Nanoclusters for Multimodal Imaging of Atherosclerosis**

Acronym: **Lamia**

Funding Agency: FORTH, Program: Synergy Grant

Coordinator: A. Lappas, A. Ranella, Y. Papaharilaou, Partners: IACM, IESL

Coordinator on the part of IACM: **Y Papaharilaou**

Duration: 01/07/2021-31/12/2026, Total budget: 80000€, IACM Budget: 40000€

Short Description: The project aims to develop new multimodal assemblies of Maghemite Nanoparticles that will serve as Contrast Agents to increase sensitivity and specificity in the early detection of atherosclerotic lesions by exploiting MRI. The outcome of the proposed study will be an effective, safe, and innovative system that when manipulated for Magnetomotive photoacoustic imaging and sensitised by targeting VCAM-1 will provide compositional information for advanced plaque characterization, overall, improving the quality of Cardiovascular Disease patient management.

Title: **Morphogenetic Phase transitions in Living Matter**

Acronym: **MorPhase**

Funding Agency: FORTH Synergy grants

Coordinator: Sfyris and Pavlopoulos, Partners: IACM and IMBB

Coordinator on the part of IACM: **Dimitrios Sfyris**

Duration: 2 years (01/09/2025-31/08/2027), Total budget: 80000€, IACM Budget: 40000€

Short Description: We study morphogenetic phase transitions in animal epithelia. We target to lay down a non-convex energy capable of describing tetragonal to hexagonal phase transitions during Parhyale embryogenesis.

Administration/Support



Administration



MARIA PAPADAKI

Head Secretary

YIOTA RIGOPOULOU

Administration Officer



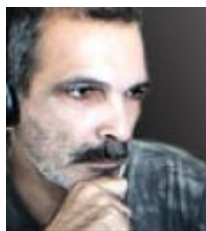
KALLIA KRASSA

Administrative Assistant

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Support



GEORGE ANDROULAKIS

Technical Scientist



EVANGELIA FLOURI

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