HORIZON EUROPE
MSCA 2025 Calls Conference

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Computational Science and Engineering

Institute of Graduate Education

Piri Reis University

PÎRÎ REIS ÜNİVERSİTESİ 2008

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Dynamical Systems and Reaction Kinetics Networks

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113F383-Lotka-Volterra Systems and Some of Their Applications in Biology, Chemistry, and Physics (2014-2016)

119F017-Dynamic Analysis of Biochemical Systems Using Computational Algebra Methods (2019-2022)

Dynamical Systems and Reaction Kinetics Networks

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- CONSIGLIO NAZIONALE DELLE RICERCHE CNR (Italy)
- HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT BERLIN - HTW BERLIN (Germany)
- MEDIZINISCHE UNIVERSITAET WIEN (Austria)
- PIRI REIS UNIVERSITY (Türkiye)
- YEDITEPE UNIVERSITY VAKIF (Türkiye)
- UNIVERSITATEA DIN CRAIOVA UCV (Romania)
- SVEUCILISTE U ZAGREBU FAKULTET ELEKTROTEHNIKE I RACUNARSTVA UNIVERSITYOF ZAGREB FACULTY OF ELECTRICAL ENGINEERING (Crotia)

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- SICHUAN UNIVERSITY (CHINA)
- OBUDAI EGYETEM (HUNGARY)
- SHANGHAI JIAO TONG UNIVERSITY (CHINA)

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Motivation:Understanding Complex Systems in Nature

- Real-world phenomena often involve complex interactions and change over time.
- Biochemical systems, in particular, exhibit non-linear, multi-parameter behaviors that are hard to predict.
- Our goal: use dynamical systems theory to analyze and control these behaviors.

Research Objectives: Main Aims of the Project

- Advance theory of multi-parameter differential systems.
- Study structure, solution behavior, stability, and bifurcations.
- Apply findings to biochemical reaction networks.
- Develop tools for stability analysis and prediction.

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Methodological Framework

Our Approach: Symbolic and Numerical Computation

- Symbolic computation (e.g., algebraic methods) with numerical tools.
- Tailored algorithms to detect multi-stability and bifurcations.
- Analyze how systems behave under different parameter conditions.

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Application to Biochemical Networks
Why Reaction Kinetics?

- Biochemical reactions = critical for life processes.
- Our models focus on networks with complex feedback and control mechanisms.
- Goal: Understand how small changes lead to large-scale effects (gene regulation, drug responses).

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Stability & Bifurcation Analysis: What We Uncover

- Conditions under which systems switch between different stable states.
- Detect tipping points and predict transitions.
- Essential for interpreting real biological behaviors.

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Control & Parameter Estimation
Bringing Control Theory into Biology

- Develop tools to control and steer system behavior.
- Focus on positive control and impulsive control - new areas in biomedical applications.
- Parameter estimation from experimental data to make models realistic.

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Sustainability & the Green Charter
Environmentally Responsible Modeling

- Align research with Green Charter principles.
- Use simulations to reduce the need for physical experiments.
- Explore sustainable design of chemical and biomedical processes.

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Training & Interdisciplinary Impact
Building Skills & Crossing Fields

- Interdisciplinary approach: math, biology, computer science.
- Contributes to training of early-stage researchers.
- Bridges theoretical research with practical applications.

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Dynamic Modeling of Infectious Transmission

DyModIT

Mathematical modeling is useful for understanding and mitigating infectious diseases. The DyModIT (Dynamic Modeling of Infectious Transmission) project employs state-of-the-art mathematical techniques to study systematically the dynamics of disease transmission.

An up-to-date version of ordinary differential equations implemented within the DyModIT modeling suite enables the analyst to study in a robust framework how variations in the rates of transmission and recovery bear upon epidemic trajectories in making accurate predictions of epidemic outcomes. DyModIT provides a means for realism through stochasticity and the articulation of network theory in modeling social contact. This data-driven approach allows sensitivity to be rigorously tested and optimized using extensive sensitivity analysis of factors such as the duration of immunity, vaccination strategies, and transmissibility; and, in turn, the insights from DyModIT directly translate into optimal strategic decisions regarding, among others, vaccination policies, nonpharmaceutical interventions (e.g., lockdown), and resource allocation during an epidemic, thereby significantly increasing the management capacity for infectious disease hazards.

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- YEDITEPE UNIVERSITY VAKIF (Türkiye)
- SABANCI UNIVERSITY (Türkiye)
- UNIVERZITA KARLOVA CU(CZU)
- CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE (CZU)
- MOLDOVA STATE UNIVERSITY
- UNIVERSITY OF MARIBOR (Slovenia)
- CAMTP-CENTER FOR APPLIED MATHEMATICS AND THEORETICAL PHYSICS (Slovenia)
- BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS (Hungary)
- UNIVERSITYOF ZAGREB FACULTY OF ELECTRICAL ENGINEERING (Crotia)
- OBUDAI EGYETEM (HUNGARY)
- GDANSKI UNIWERSYTET MEDYCZNY GUMed (POLAND)
- SZEGEDI TUDOMANYEGYETEM USZ (HUNGARY)
- NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE NUBIP
- V. N. Karazin Kharkiv National University KKNU
- UNIVERSITEIT GENT Ugent (BELGIUM)
- University Center Abdelhafid Boussouf of Mila (ALGERIA)
- UNIVERSITE DE CONSTANTINE 3 (ALGERIA)
- ECOLE NATIONALE D'INGENIEURS DE TUNIS ENIT (TUNISIA)
- Southwest Petroleum University Southwest Petroleum University (China)

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What are our next MSCA Projects in 2025?

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Thank you
Any Questions ?

Please contact
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