



OSCAR

Open Science Clusters' Action
for Research & Society

Funded Project

Open modeling pipelines to Make Extreme Astrophysical Events NICER

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Implemented by the



**Research Center for Astronomy
and Applied Mathematics
of the Academy of Athens**



**Funded by
the European Union**

What problem(s) are you going to solve?

- Fragmented and inaccessible modeling tools for X-ray data.
 - Advanced physical models (e.g., GRMHD, kinetic plasma simulations) are not easily translatable into observable quantities.
 - No integrated framework combines physical equations with real-time fitting of observational data.
 - Existing implementations are often non-FAIR and difficult to reuse or reproduce.
 - Researchers without large computing infrastructures cannot easily perform state-of-the-art inference on neutron stars and black holes.
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What are you planning to do to solve the problem?

- Develop an AI-accelerated modeling pipeline with Physics-Informed Neural Networks (PINNs) combined with MCMC and genetic algorithms.
- Fit NICER and other X-ray mission data dynamically while solving physical models.
- Deliver open-source code, interactive notebooks, test datasets, and training materials via Zenodo and EOSC resources.
- Reduce computational barriers: high-fidelity simulations run on a single GPU in hours instead of HPC clusters.
- Framework adaptable to other compact objects like Black holes, future missions (Athena, LISA), and cross-domain applications like hydrodynamics and aerospace.
- Workshops, tutorials, and documentation for researchers at all levels to foster broad, reproducible scientific use.

What will be the results and how do you plan to make them available to the broader community?

- AI-powered, modular framework connecting theoretical models with real data
- Enables realistic modeling of neutron star and black hole environments on modest hardware, democratizing high-fidelity astrophysical simulations.
- Reanalyze past datasets with modern physics-informed tools, uncovering previously hidden phenomena.
- Researchers can input new physical equations, explore different scenarios, and extend to future missions (Athena, LISA).
- All software, notebooks, test datasets, and training materials released...
- Public workshops, interactive notebooks, and demos empower students, early-career researchers, and citizen scientists.
- Methodology applicable beyond astrophysics

Who is doing it?

- Dr Ioannis Contopoulos
 - Dr Ioannis Dimitropoulos
 - Dr Dimitrios Skiathas
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