



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

19

# ANNUAL REPORT 2024



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of the Academy of Athens

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## Staff Members in 2024

RCAAM in the year 2024 continued its multiple activities with notable scientific results published in internationally renowned journals, international collaborations, missions to institutions abroad, and weekly seminars with speakers from Greece and abroad. This issue of the proceedings records all the activities of the members of RCAAM during the year.

**Supervisor** of the Center is Academician Pr. George Contopoulos.

The composition of the personnel in 2024 was:

- Patsis Panos, **Researcher A, Director**
- Contopoulos Ioannis, **Researcher A**
- Basilakos Spiros, **Researcher A** (Since September 2018 also Director of the Institute of Astronomy, Astrophysics, Space Applications, and Remote Sensing of the National Observatory of Athens)
- Georgoulis Manolis, **Researcher A** (on leave)
- Gontikakis Konstantinos, **Researcher A**
- Harsoula Mirella, **Researcher B**
- Tsokaros Antonios, **Researcher B** (on leave)
- Katsanikas Matthaios, **Researcher C**
- Nathanail Antonios, **Researcher C**
- Tzemos Athanasios, **Researcher C**
- **Scientific Collaborators, former researchers of RCAAM:** Dara Eleni, Efthymiopoulos Christos (University of Padova, Italy), Zachariadis Theodosios, Tritakis Vasilis
- **Scientific Collaborator, Visiting Researcher:** Papadopoulos Pantelis (AUTH)
- **Technical Manager:** Zoulias Manolis (on leave)
- **Secretary:** Karnavas Konstantinos (part-time up to August)
- **PhD Candidates conducting their thesis at RCAAM:** Dimitropoulos Ioannis, University of Patras (supervised by I. Contopoulos), Koleti Myrto, NKUA (supervised by K. Gontikakis), Zouloumi Konstantina, NKUA (supervised by Ch. Efthymiopoulos and M. Harsoula), Antonopoulou Eleni, NKUA (supervised by A. Nathanail)

- **Master's Students conducting their thesis at RCAAM:** Michailidis Aggelos, NKUA (supervised by C. Gontikakis), Psomas Iason, Univ. of Patras (supervised by A. Nathanail), Zanias Foivos, Univ. of Amsterdam (supervised by A.C. Tzemos)
- **Undergraduate Students conducting their thesis at RCAAM:** Kavalagios Theodosios, NTUA (supervised by M. Harsoula), Karyofyllis Xenophon, NKUA (supervised by A.C. Tzemos)
- **Undergraduate Students who conducted their practical training at the RCAAM:** Oikonomou Eleni, NKUA (supervised by I. Contopoulos), Kontogianni Eugenia, Univ. of Ioannina (supervised by C. Gontikakis), Kalogeropoulou Chrysoula, Univ. of Ioannina (supervised by M. Harsoula)

- **Collaborations of the Center with other resesarch institutions:**<sup>1</sup>

The RCAAM collaborates with researchers at the following institutions:

Max Planck Institute for Extraterrestrial Physics (MPE), Max Planck Institute for Astrophysics (MPA), Munich, Germany (programs “1, 5”), Laboratoire d’Astrophysique de Marseille (LAM), Aix-Marseille University, Marseille, France (program “5”), University of Cape Town, South Africa (program “6”), National Observatory of Athens (IAADET) (program “5”), Aristotle University of Thessaloniki (program “5”), University of Patras (programs “7”, “8”, “9”), Jagiellonian University, Poland (program “10”), University of Barcelona, Spain (program “12”), University of Naples, Italy (program “12”), University of São Paulo, Brazil (program “12”), King’s College London, UK (program “12”), Royal Belgian Institute of Space Aeronomy, Belgium (program “13”), Cyprus Space Exploration Organization, Cyprus (program “14”), University of Helsinki, Finland (program “15”), University of Bristol, UK (program “16”), Department of Mathematics, United States Naval Academy, USA (program “16”).

A memorandum of cooperation was signed between RCAAM and the Department of Physics of the University of Patras (December 2024).

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<sup>1</sup>The numbers in parentheses refer to the serial numbers of the programs in the Center’s program list.

**The research of RCAAM focused mainly on the following five scientific fields:**

- Theoretical and Observational Galactic Dynamics
- Nonlinear Dynamics and Chaos
- Solar Physics
- Magnetohydrodynamics
- Cosmology
- Study of electromagnetic waves of extremely low frequency (Extremely Low Frequency, ELF) in the range 2-50 Hz

## About us

The Research Center for Astronomy and Applied Mathematics (RCAAM), is one of the Research Institutes of the Academy of Athens.

The main competences of RCAAM are Galactic Dynamics and Galactic Morphology, Nonlinear Dynamics and Chaos Theory, Solar Physics, Magnetohydrodynamics, Cosmology and Gravitation.

We are working towards comparing theoretical results with observational data from ground based as well as from space observatories (VLT, Solar Dynamics Observatory, etc.). The main scientific goals for the period 2022-2024 include the study of the role of Chaos in supporting structures in Nbody simulations, the Dynamics of the Milky Way and other galaxies, the investigation of Chaos in quantum systems, the study of the magnetic connectivity in the active-regions of the solar atmosphere, the investigation of particle acceleration in the pulsar magnetosphere and the time profiles of the resulting high energy radiation, the formation and evolution of Structures in Cosmology as well as the nature of dark matter and dark energy.

A number of young researchers are coming to our Institute and successfully complete their PhD and Masters Theses. The researchers of our institute participate in fourteen (14) supervising committees of PhD and MSc theses. RCAAM members participated in the teaching of the courses “Galactic and Extragalactic Astronomy”, “Dynamical Astronomy” and “Cosmology” at the Department of Physics of University of Athens.

RCAAM organizes since 1997 a seminar on a weekly basis, during the whole year, with speakers leading scientists from Greece and abroad. The talks are attended by many researchers, university professors and young scientists. RCAAM has organized in 2002 and 2007 international conferences on “Galaxies and Chaos” and on “Chaos in Astronomy” respectively. This series of conferences is planned to be continued during the next years. Another conference organized with great success by our Institute was the conference “Classical and Quantum Gravity”, Crete 2009. Members of RCAAM participated also in the organization of several more conferences in Greece and abroad. Many other talks for the broad public are given every year by the researchers of RCAAM.



## History

The Research Center for Astronomy and Applied Mathematics was established in 1959 initially as “Office for Research and Calculations”, to promote scientific research in Astronomy and Applied Mathematics and to perform calculations related to these topics. In 1966 has been renamed “Research Center for Astronomy and Applied Mathematics”. Since then scientific research has been conducted in the following fields, which are also the current working areas:

- Dynamical Astronomy, Nonlinear phenomena and applications of Chaos Theory in Astronomy
- Galactic Dynamics and Galactic Morphology
- Solar Physics and Relations between Solar and Terrestrial Phenomena
- Magnetohydrodynamics
- Cosmology and Gravitation
- A recently added research field is the study of electromagnetic waves of extremely low frequency (ELF) at 2-50 Hz.

The first supervisor of the “Office for Research and Calculations”, and later of the “Research Center for Astronomy and Applied Mathematics”, was Academician Prof. I. Xanthakis, until his death on 10 July 1994. During the years 1994-1997 the Research Center was supervised by Academician Prof. N. Artemiadis. After 1997 the supervisor is Academician Prof. G. Contopoulos.

As directors have served in the past Dr. L. Mavridis (1960-1966), Dr. K. Makris (1971-1979), Dr. K. Poulakos (1981-2001), Dr. N. Voglis (2001-2007), Dr. V. Tritakis (2007), Dr. E. Dara (2008). Since 2009 acting director of the Center is Dr. P.A. Patsis. Researchers who have worked in the past in the Research Center were Dr. I. Lyritzis, Dr. V. Petropoulos and Dr. Th. Zachariadis.

## Our Research

### **Nonlinear & Chaotic Dynamics**

The research that is carried out in Nonlinear and Chaotic Dynamics has as goal the investigation in depth of chaotic phenomena and the application of Chaos theory in solving astronomical problems as well as problems in dynamics that are encountered in other science disciplines. The term "Chaos" means that the laws of Physics allow limited predictability, despite the fact that these laws are expressed by rigorous mathematical equations. Although the Theory of Chaos was first applied in astronomical dynamical systems, today it finds applications to various phenomena of interest for everyday life (for example: earth and space weather forecasting, earthquakes, development of complex digital networks etc.).

### **Galactic Dynamics & Galactic Morphology**

Galactic Dynamics is the tool to understand the observed Morphology of disk and elliptical galaxies. Our research combines Orbital Theory, N-body Simulations and Hydrodynamics with Observations in large telescopes. The orbital analysis of bars and spirals in 2D and 3D models has revealed the dynamical phenomena that shape the forms of elliptical galactic systems, the spirals of normal and barred-spiral galaxies, as well as the edge-on profiles of galactic disks. In the last years research in this field in our Institute has underlined the role of chaotic orbits in reinforcing the spiral structure in barred-spiral systems and in the dynamics of disk galaxies in general.

### **Solar Physics**

The members of RCAAM working in solar physics possess significant skills and experience in the study and analysis of (1) magnetic loops in the solar corona, (2) particle acceleration processes in reconnecting magnetic configurations, (3) small-scale phenomena in the solar atmosphere, including micro-flares and jets, (4) solar magnetography and related diagnostics, (5) solar eruptions and their connections with the Earth, including eruption prediction, and (6) fundamental properties and complexity of solar magnetism. RCAAM solar physicists perform both data analysis and modeling, routinely analysing data from multiple ground- and space-based instruments and actively collaborating with fellow solar and heliospheric physicists worldwide.

RCAAM solar physicists are active members of multiple international professional organizations and routinely attend and contribute to International Conferences, Workshops, Symposia, as well as to Public Outreach activities aiming to inform and educate the general public on aspects of heliophysics. They participate and organize multiple conferences and convene sessions within wider conferences. They interact and collaborate with colleagues in Greece, Europe in general, the Unites States, and Asia (China, Japan).

## **Astrophysical Magnetohydrodynamics**

We are investigating the dynamics of electrically conducting magnetized fluids in various systems of astrophysical interest. Over the years, we have developed pioneering semi-analytical solutions of the non-linear equations of Magnetohydrodynamics (MHD) in non-relativistic protostellar winds, relativistic galactic and extragalactic jets, magnetized protostellar collapse, the axisymmetric pulsar magnetosphere, and the magnetosphere of rotating black holes. More recently, we have been working on a particular regime of MHD, namely Force-Free Electrodynamics (FFE), and developed a numerical code that we implement in the study of the structure and high energy radiation of the three-dimensional pulsar magnetosphere and the solar corona. We are investigating accretion disk magnetic winds as the origin of Warm Absorbers (WA) and Ultra Fast Outflows (UFO) in Active Galactic Nuclei (AGN). We are also actively investigating the role of a novel astrophysical mechanism, the Cosmic Battery, in the origin of astrophysical magnetic fields and in the dynamics of X-ray binaries and astrophysical jets.

## **Cosmology & Gravitation**

In the field of Cosmology, research ranges from observational to fully theoretical aspects of Cosmological physics. In particular RCAAM is interested in: (a) statistical properties of the large scale structures as well as the geometry and topology of the distribution of matter in the Universe, (b) constraints on the cosmological parameters from cosmological data, (c) evolution of perturbations and structure formation in different cosmological models, (d) the nature of dark energy and the possible interaction between dark matter and dark energy, (e) alternative theories (except dark energy) for the accelerated expansion of the universe, and (f) classical and quantum cosmology of scalar fields.

In the field of Gravitation, research is pursued in the following thematic areas: (a) classical problems in General Relativity, (b) alternative theories of gravity, (c) black hole physics and in particular on the computation of Hawking radiation, black hole entropy and the possible solutions of the Black Hole Information Paradox, (d) quantum fields in curved spacetime, and (e) quantum gravity phenomenology.

## Scientific Projects

The research scientific staff of RCAAM participated in the following research programs in 2024:

1. **“Nonlinear phenomena in galactic disks”** (2024-2025). Program of the Research Committee of the Academy of Athens (200/1022). (G. Contopoulos, P. Patsis, M. Harsoula, M. Katsanikas, A. C. Tzemos, and P. Okalidis). External collaborators: T. Naab and P. Grosbol. Total budget: €19,270. Scientific Coordinator: G. Contopoulos.

Results:

- Participation of P. Patsis in the European Astronomical Society – Annual Meeting” conference and presentation of the invited talk “2”.
- Publications in peer-reviewed conference proceedings: “1”.
- Visit of P. Patsis to the Max-Planck Institute for Astrophysics (MPA) in Munich for program-related work (December 8–15).
- N-body simulation calculations were performed at the RZG Computing Center in Munich.

2. **“Study of the dynamical evolution of entanglement and coherence in quantum systems”** (2018-2024). (G. Contopoulos, A. C. Tzemos). (Non-funded). Scientific Coordinator: G. Contopoulos.

Results:

- Publications in peer-reviewed journals: “2” and 4”.

3. **“Study of order and chaos in quantum dynamical systems”** (2024-2025). Program of the Research Committee of the Academy of Athens (200/1026) (A. C. Tzemos, G. Contopoulos, F. Zaniias). Total budget: €14,140. Scientific Coordinator: A. C. Tzemos.

Results:

- Publications in peer-reviewed journals: “1” and “3”.
- Talks: **AT-1** and **AT-2**.

4. **Dissemination of results in Galactic Dynamics”** (06/15/2023-12/31/2024). Program managed by the Research Committee of the Academy of Athens (200/1006), fully funded by the European Astronomical Society (EAS) through the Wilhelm and Else Heraeus” foundation with an amount of €50,000. The purpose of the program was the organization of the conference “HERA24: The Nature and the Dynamics of Structures Observed in Galactic Disks,” aimed at young scientists and held from September 15-20, 2024, at the Academy of Athens. Scientific Coordinator: P. Patsis.

Results:

- The organization of the conference was successfully completed. (<http://astro.academyofathens.gr/hera24.html>).

5. **Gas flow and star formation in galactic bars** (07/2024-12/2025). Program of the Research Committee of the Academy of Athens (200/1025), replacing the previous RCAAM programs “Gas flow in the centers of galaxies” and “Morphological features of disk galaxies due to nonlinear phenomena.” (G. Contopoulos, P. Patsis (RCAAM), E. Athanassoula, Laboratoire d’Astrophysique de Marseille (LAM), Aix-Marseille University, Marseille, France; S. Pastras, Max-Planck Institute for Extraterrestrial Physics (MPE), Munich, Germany; P. Papadopoulos, Aristotle University of Thessaloniki; I. Alikakos, contract researcher). Total budget: €18,060. Scientific Coordinator: P. Patsis.

Results:

- Publications in peer-reviewed journals: one paper has been submitted.
  - Publications in peer-reviewed conference proceedings: **“2”**.
  - Hydrodynamical code RAMSES calculations were performed at the RZG Computing Center in Munich.
  - Talks: **PP-4**.
6. **“Numerical investigation of the impact of complex instability on the phase space structure of dynamical systems with emphasis on barred galaxy models”**. (P. Patsis, M. Katsanikas, RCAAM; H. Skokos, H. Moges, University of Cape Town, South Africa; M. Hillebrand, Max Planck Institute for the Physics of Complex Systems, Germany) (2019-2024). The program is funded by the University of Cape Town, supporting researchers’ travel for collaborations within the project.

Results:

- Publication in peer-reviewed journals: **“6”**.
7. **“Study of current sheets and high-energy radiation from compact astrophysical objects”** (2023-2026). (I. Dimitropoulos, I. Contopoulos). A PhD research program of I. Dimitropoulos, funded by HFRI. Duration: 3 years. Total budget: €31,500.
  8. **“500,000 CPU core hours on ARIS HPC”**. Principal Investigator: K. Gourgouliatos (University of Patras). Co-Principal Investigator: I. Contopoulos.
  9. **“100,000 hours of Machine Learning Node (Cuda GPU) on ARIS HPC”**. Principal Investigator: I. Contopoulos. Co-Principal Investigator: K. Gourgouliatos (University of Patras).

10. **“Support for the operation and development of the International Station for the Study of Schumann Electromagnetic Waves”** (2024-2025). Program of the Research Committee of the Academy of Athens (200/1023). Budget: €19,440. Scientific Coordinator: I. Contopoulos. Participation, supervision: V. Tritakis. Collaboration with the University of Krakow, Poland. Replaced a previous program with the same topic.

Results:

- Supervision, maintenance, and operation of the Schumann wave measurement station located at the summit of Mount Parnon in Laconia.

11. **“Study of solar atmosphere regions where the solar wind originates”** (2024-2025) (C. Gontikakis, I. Contopoulos). Program of the ELKE of the Academy of Athens, code 200/1021. Scientific Coordinator: C. Gontikakis.

Results:

- Publications in peer-reviewed journals: **“31”**.
- Talks: **CG-1**.
- Other relevant activities: **CG-2**.

12. **“The nature of dark energy”** (duration: 2011-2018, but publications based on project results continue). A research program on the nature of dark energy in collaboration with multiple universities: S. Basilakos, M. Plionis (AUTH), J. Sola (University of Barcelona, Spain), S. Capozziello (University of Naples, Italy), A. Lima (University of São Paulo, Brazil), and N. Mavromatos (King’s College London, UK). Financially supported by the Universities of Barcelona, Naples, and São Paulo.

Results:

- Publications in peer-reviewed journals: **“16”-23”**.

13. **“ESA / Space Weather Expert Service Network (SWESNET)”** (2015-2024). A program of the European Space Agency (ESA), coordinated by the Royal Belgian Institute of Space Aeronomy, Belgium. Ongoing since 2015. Internal project code: 200/902. RCAAM participation: M. Georgoulis. Due to M. Georgoulis’ leave of absence, the program was transferred to the research team of IAASARS of the National Observatory of Athens in September 2024.

Results:

- Participation in collaborative flare and space weather event campaigns within the ESA Space Safety Network.

14. **“Cyprus Space Research and Innovation Centre (C-SpaRC)”**. International program co-funded by the European Space Agency (ESA), the European

Union, and the Republic of Cyprus, supervised by the International Committee for Space Research (COSPAR). Coordinator: Dr. Georgios Danos, President of the Cyprus Space Exploration Organization, Cyprus. M. Georgoulis participates as an external expert, without funding.

15. **“Marie Curie Innovation and Training Network SWATNET: Space Weather Awareness Training Network”** (2021-2025). International program of the European Commission coordinated by the University of Helsinki (Finland), managed by the Research Committee of the Academy of Athens (200/963). Sponsor: European Union, Horizon 2020 Programme, National Science Foundation. 3,128,225€ (486,035€ for the Academy of Athens). Principal Investigator: Dr. E. Kilpua, University of Helsinki, Finland. Scientific supervisor for the Academy of Athens, Acad. Prof. L. Christoforou. Participation from the RCAAM, M. Georgoulis.

Results:

- Publications in peer-reviewed journals: **“28”**, **“30”**, and three papers under preparation.
- Talks: **MG-5**, **MG-11**.

16. **“Methods of Dynamical Astronomy and Hamiltonian Chaos in Chemical Dynamics.”** (2022-). International collaboration with the Department of Mathematics at the University of Bristol and the Department of Mathematics at the United States Naval Academy (S. Wiggins). Participation from the RCAAM, M. Katsanikas. The University of Bristol funds the researchers’ travel for the program’s needs.

Results:

- Publications in peer-reviewed journals: **“36-47”**.
- Talks: **MK-1**.

17. **“Artificial Intelligence and Machine Learning in Hamiltonian Dynamics”** (01/07/2024-31/12/2025). Program of the Research Committee of the Academy of Athens (code 200/1020). Budget: 18,100 Euros. Scientific supervisor: M. Katsanikas.

Results:

- Publications in peer-reviewed journals: One publication under preparation.

18. **“Magneto-hydrodynamics of Compact Objects.”** (2024-2025). Research program of the Research Committee of the Academy of Athens (code 200/1024). Scientific Supervisor: A. Nathanail.

Results:

- Talks: **AN-1, AN-2, AN-3.**

19. **Advancing Understanding of Black Hole Accretion”** 3 Million core Hours” of computational time on ARIS HPC” within the framework of the 16th Call for Project Proposal Submissions”. Scientific Supervisor: A. Nathanail.

## Publications in 2024

### Special Editions

1. Dr. P.A. Patsis edited the publication of the detailed annual report of the Center for 2023, in a special issue.

### Publications in International Journals with Referees

(Published or accepted for publication in 2024 (69 papers in total))

1. Contopoulos G. and Tzemos A.C., 2024, “Classical and Bohmian Trajectories in Integrable and Nonintegrable Systems”, *Particles* 7(4), 1062.
2. Tzemos A.C. and Contopoulos G., 2024, “Formal Integrals of Motion in Time Periodic Hamiltonian Systems”, *Maple Trans.*, Article 17296.
3. Tzemos A.C. and Contopoulos G., 2024, “A Comparison Between Classical and Bohmian Quantum Chaos”, *Chaos Solit. Fractals* 188, 115524.
4. Tzemos A.C. and Contopoulos G., 2024, “Dynamics of Quantum Observables and Born’s Rule in Bohmian Quantum Mechanics”, *Chaos Solit. Fractals* 185, 115075.
5. Harsoula M. and Contopoulos G., 2024, “Periodic Orbits in a Galactic Potential”, *Cel. Mech. Dyn. Astron.* 136, 20.
6. Moges H., Katsanikas M., Patsis P.A., Hillebrand M. and Skokos Ch., 2024, “The Evolution of the Phase Space Structure along Pitchfork and Period-Doubling Bifurcations in a 3D Galactic Bar Potential”, *Int. Journal. Bif. Chaos*, 34, 2430013.
7. Contopoulos I., Ntotsikas D. and Gourgouliatos K.N., 2024, “On the Pulsar Y-Point”, *Mon. Not. R. Astron. Soc.* 527L, 127.
8. Contopoulos I., Kazanas D. and Papadopoulos D.V., 2024, “Gravitational Waves from the Pulsar Magnetosphere”, *Mon. Not. R. Astron. Soc.* 527, 11198.
9. Contopoulos I., Dimitropoulos I., Ntotsikas D. and Gourgouliatos K.N., 2024, “A New Solution of the Pulsar Equation”, *Universe* 10, 178.



10. Contopoulos I., Mlynarczyk J., Kubisz J. and Tritakis V., 2024, “Possible Identification of Precursor ELF Signals on Recent EQs That Occurred Close to the Recording Station”, *Atmosphere* 15, 1134.
11. Nathanail A., Contopoulos I. and Rezzolla L., 2024, “The Impact of Resistivity on the Variability of Black Hole Accretion Flows”, *Astron. Astroph.*, (in press).
12. Dimitropoulos I., Contopoulos I., Mpisketzis V. and Chaniadakis E., 2024, “The Pulsar Magnetosphere with Machine Learning: Methodology”, *Mon. Not. R. Astron. Soc.* 528, 3141.
13. Soudais A., Cerutti B. and Contopoulos I., 2024, “Scaling Up Global Kinetic Models of Pulsar Magnetospheres Using a Hybrid Force-Free-PIC Numerical Approach”, *Astron. Astroph.* 690, 170.
14. Ntotsikas D., Gourgouliatos K.N., Lander S.K. and Contopoulos I., 2024, “Twisted Magnetar Magnetospheres”, *Mon. Not. R. Astron. Soc.* 527, 6691.
15. Tritakis V., Mlynarczyk J., Contopoulos I. et al., 2024, “Extremely Low Frequency (ELF) Electromagnetic Signals as a Possible Precursory Warning of Incoming Seismic Activity”, *Atmosphere* 15, 457.
16. Basilakos S. et al., 2024, “Observable Signatures of No-Scale Supergravity in NANOGrav”, *Int. J. Mod. Phys. D*, 2441014.
17. Basilakos S., Lympers A., Petronikolou M., and Saridakis E.N., 2024, “Alleviating Both ( $\sigma_8$ ) and ( $H_0$ ) Tensions in Tsallis Cosmology”, *Eur. Phys. J. C*, 84(3), 297.
18. Basilakos S., Nanopoulos D.V., Papanikolaou T., Saridakis E.N., and Tzerefos C., 2024, “Induced Gravitational Waves from Flipped SU(5) Superstring Theory at nHz”, *Phys. Lett. B*, 849, 138446.
19. Basilakos S., Nanopoulos D.V., Papanikolaou T., Saridakis E.N., and Tzerefos C., 2024, “Gravitational Wave Signatures of No-Scale Supergravity in NANOGrav and Beyond”, *Phys. Lett. B*, 850, 138507.
20. Asimakis P., Basilakos S., and Saridakis E.N., 2024, “Building Cubic Gravity with Healthy and Viable Scalar and Tensor Perturbations”, *Eur. Phys. J. C*, 84(2), 1.
21. Papageorgiou A., Plionis M., Basilakos S., and Abdullah M.H., 2024, “The Cluster Mass Function and the  $\sigma_8$  Tension”, *Mon. Not. R. Astron. Soc.*, 527(3), 5559.
22. Papanikolaou Th., Tzerefos Ch., Basilakos S., et al., 2024, “Revisiting String-Inspired Running-Vacuum Models under the Lens of Light Primordial Black Holes”, *Phys. Rev. D*, 110(2), 024055.
23. Karnesis N. et al. (including Basilakos S.), 2024, “The Laser Interferometer Space Antenna mission in Greece White Paper” *Int. J. Mod. Phys. D*, 33, 7n08, id. 2450027.

24. Georgoulis M.K., 2024, “A Treatment of the All-Clear Problem for Solar Energetic Particle Events and Subsequent Decision Making”, *Acta Astronaut.*, 225, 615.
25. Georgoulis M. et al, 2024, “Prediction of Solar Energetic Events Impacting Space Weather Conditions”, *Adv. Space Res* (in press).
26. Kontogiannis I. and Georgoulis M.K., 2024, “The Temporal Evolution of Non-neutralized Electric Currents and the Complexity of Solar Active Regions”, *Astroph. J.*, 970(2), 162.
27. Aparna V., Georgoulis M.K., and Martens P.C., 2024, “Magnetic Helicity Signs and Flaring Propensity: Comparing the Force-free Parameter with the Helicity Signs of H Filaments and X-Ray Sigmoids”, *Astroph. J.*, 967(2), 134.
28. Koya S., Patsourakos S. and Georgoulis M.K., 2024, “Assessment of the Near-Sun Magnetic Field of the 10 March 2022 Coronal Mass Ejection Observed by Solar Orbiter”, *Astron. Astroph.*, 690, A233.
29. Nindos A. et al. (including Georgoulis M.), 2024, “Magnetic Helicity and Energy Budgets of Jet Events from an Emerging Solar Active Region”, *Astron. Astroph.*, 689, L11.
30. Biswal S. et al. (including Georgoulis M.), 2024, “Case Studies on Pre-eruptive X-class Flares Using R-value in the Lower Solar Atmosphere”, *Astroph. J.*, 974(2), 259.
31. Koletti M., Gontikakis C., Patsourakos S. and Tsinganos K., 2024, “Multiwavelength Study of On-Disk Coronal-Hole Jets with IRIS and SDO Observations”, *Astron. Astroph.* 690, 11.
32. Harsoula M. and Tzemos A.C., 2024, “The Building Blocks of the Spiral Arms in Galaxies”, *J. Vibr. Test. Sys. Dyn.* 8, 155.
33. Zouloumi K., Harsoula M. and Efthymiopoulos C., 2024, “Multiple Pattern Speeds and the Manifold Spirals in a Simulation of a Barred Spiral Galaxy”, *Mon. Not. R. Astron. Soc.* 529, 1941.
34. Bamber J., Tsokaros A., Ruiz M. and Shapiro, S. L., 2024, “Jetlike structures in low-mass binary neutron star merger remnants”, *Phys. Rev. D* 110, 024046.
35. Joshi R. K., Chattopadhyay I., Tsokaros A. and Tripathi P. K., 2024, “Numerical Simulation of Radiatively Driven Transonic Relativistic Jets”, *Astroph. J.* 971 (13), 1.
36. Katsanikas M. and Wiggins S., 2024, “2D Generating Surfaces and Dividing Surfaces in Hamiltonian Systems with Three Degrees of Freedom”, *Int. Journal. Bif. Chaos*, 34(01), 2430002.

37. Katsanikas M. and Wiggins S., 2024, “3D Generating Surfaces in Hamiltonian Systems with Three Degrees of Freedom - I”, *Int. Journal. Bif. Chaos*, 34(02), 2430004.
38. Katsanikas M. and Wiggins S., 2024, “3D Generating Surfaces in Hamiltonian Systems with Three Degrees of Freedom - II”, *Int. Journal. Bif. Chaos*, 34(02), 2430005.
39. Katsanikas M. and Wiggins S., 2024, “Periodic Orbit Dividing Surfaces in Rotating Hamiltonian Systems with Two Degrees of Freedom”, *Int. Journal. Bif. Chaos*, 34, 2450130.
40. Katsanikas M. and Wiggins S., 2024, “Periodic Orbit Dividing Surfaces in Rotating Hamiltonian Systems with Three Degrees of Freedom - I”, *Int. Journal Bif. Chaos*, 34, 2450143.
41. Katsanikas M. and Wiggins S., 2024, “Periodic Orbit Dividing Surfaces in Rotating Hamiltonian Systems with Three Degrees of Freedom - II”, *Int. Journal Bif. Chaos*, 34, 2430025.
42. Katsanikas M., Gonzalez Montoya F. and Wiggins S., 2024, “2D Generating Surfaces in a Quartic Hamiltonian System with Three Degrees of Freedom - I”, *Int. Journal Bif. Chaos*, 34, 2450166.
43. Katsanikas M., Gonzalez Montoya F. and Wiggins S., 2024, “2D Generating Surfaces in a Quartic Hamiltonian System with Three Degrees of Freedom - II”, *Int. Journal Bif. Chaos*, 34, 2450180.
44. Katsanikas M., Gonzalez Montoya F. and Wiggins S., 2024, “3D Generating Surfaces in a Quartic Hamiltonian System with Three Degrees of Freedom - I”, *Int. Journal Bif. Chaos*, (in press).
45. Katsanikas M., Gonzalez Montoya F. and Wiggins S., 2024, “3D Generating Surfaces in a Quartic Hamiltonian System with Three Degrees of Freedom - II”, *Int. Journal Bif. Chaos*, (in press).
46. Gonzalez Montoya F., Katsanikas M. and Wiggins S., 2024, “Periodic Orbit Dividing Surfaces in a Quartic Hamiltonian System with Three Degrees of Freedom - I”, *Int. Journal. Bif. Chaos*, 34, 2430011.
47. Gonzalez Montoya F., Katsanikas M. and Wiggins S., 2024, “Periodic Orbit Dividing Surfaces in a Quartic Hamiltonian System with Three Degrees of Freedom - II”, *Int. Journal Bif. Chaos*, 34, 2450131.
48. Antonopoulou E. and Nathanail A., 2024, “Parameter Study for Hot Spot Trajectories Around SgrA\*”, *Astron. Astroph.* 690(A240), 10.

49. Mpisketzis V. and Nathanail A., 2024, “Disk Mass After a Binary Neutron Star Merger as a Constraining Parameter for Short Gamma-Ray Bursts”, *Astron. Astroph.* 690(L9), 8.
50. Kazunori A. et al. (including Nathanail A.), Event Horizon Telescope Collaboration, 2024, “VizieR Online Data Catalog: M87\* EHT Image”, VizieR On-line Data Catalog: J/A+A/681/A79, Originally published in: 2024A *Astron. Astroph.* 681, A79.
51. Mpisketzis V. et al. (including Nathanail A.), 2024, “Impact of Anisotropic Ejection on Jet Dynamics and Afterglow Emission in Binary Neutron-Star Mergers”, *Mon. Not. R. Astron. Soc.* 527(3), 9159.
52. Moriyama K. et al. (including Nathanail A.), 2024, “Future Prospects for Constraining Black Hole Spacetime: Horizon-scale Variability of Astrophysical Jets”, *Astroph. J.* 960(2), 106.
53. Akiyama K. et al. (including Nathanail A.), Event Horizon Telescope Collaboration, 2024, “The Persistent Shadow of the Supermassive Black Hole of M87. I. Observations, Calibration, Imaging, and Analysis”, *Astron. Astroph.* 681(A79), 63.
54. Paraschos G. F. et al. (including Nathanail A.), 2024, “Ordered Magnetic Fields Around the 3C 84 Central Black Hole”, *Astron. Astroph.* 682(L3), 15.
55. Kazunori A. et al. (including Nathanail A.), Event Horizon Telescope Collaboration, 2024, “First Sagittarius A\* Event Horizon Telescope Results. VII. Polarization of the Ring”, *Astroph. J. Lett.* 964(2), L25, 25.
56. Kazunori A. et al. (including Nathanail A.), Event Horizon Telescope Collaboration, 2024, “First Sagittarius A\* Event Horizon Telescope Results. VIII. Physical Interpretation of the Polarized Ring”, *Astroph. J. Lett.* 964(2), L26, 37.
57. Raymond A. W. et al. (including Nathanail A.), 2024, “First Very Long Baseline Interferometry Detections at 870 m”, *Astron. J.* 168(3), 19.
58. Jiang H. X. et al. (including Nathanail A.), 2024, “Dynamics and Emission Properties of Flux Ropes from Two-Temperature GRMHD Simulations with Multiple Magnetic Loops”, *Astron. Astroph.* 688(A82), 15.
59. Lin L. et al. (including Papadopoulos P.), 2024, “Inadequate Turbulent Support in Low-Metallicity Molecular Clouds”, *Nat. Astr.* (in press).

**Publications in conference proceedings and other publications with referees:**

1. Patsis P., 2024, “Determining the angular speeds of Bar and Spiral patterns: Commonalities and noteworthy distinctions”, EAS2024/, European Astronomical Society Annual Meeting, held 1-5 July, 2024 in Padova, Italy.  
Online at <https://eas.unige.ch/EAS2024/>. Session SS40 : BAR AND SPIRAL PATTERN SPEEDS ACROSS GALACTIC DISCS, Invited talk, id. 2528.
2. Grosboel P. and Patsis P., 2024, “Determining the phase of spiral arms in grand-design spiral galaxies using power spectra of stellar clusters”, EAS2024/, European Astronomical Society Annual Meeting, held 1-5 July, 2024 in Padova, Italy. Online at <https://eas.unige.ch/EAS2024/>. Session SS40 : BAR AND SPIRAL PATTERN SPEEDS ACROSS GALACTIC DISCS, ePoster, id. 186.
3. Petronikolou M., Basilakos, S., Lymperis A. and Saridakis E., 2024, “Alleviating both  $H_0$  and  $\sigma_8$  tensions through Tsallis entropy”, Corfu Summer Institute 2023 School and Workshops on Elementary Particle Physics and Gravity, 23 April-6 May and 27 August-1 October, 2023 in Corfu, Greece. <https://pos.sissa.it/cgi-bin/reader/conf.cgi?confid=463>, id.174.
4. Efthymiopoulos Ch., Zouloumi K. and Harsoula M., 2024, “Manifold spirals in barred-spiral galaxies with two pattern speeds: N-body and Milky Way models” EAS2024/, European Astronomical Society Annual Meeting, held 1-5 July, 2024 in Padova, Italy. Online at <https://eas.unige.ch/EAS2024/>. Session SS40 : BAR AND SPIRAL PATTERN SPEEDS ACROSS GALACTIC DISCS, Contributed talk, id. 292.
5. Antonopoulou E. and Nathanail A., 2024, “Black Hole Imaging: Tackling the SgrA\* Orbital Motion Riddle”, EAS2024, Presentation, id. 956.

**Publications in Greek**

1. Contopoulos I., 2024, “Artificial General Intelligence: The New Challenge of Humanity”, Aktines Journal, 802, 245-256.

**Publications in conference proceedings and other publications without referees:**

1. Mandrini et al. (including Georgoulis M.), 2024, “Division E: Sun and Heliosphere. Triennial Report 2021-2024”, Trans. Int. Astron. Union, Ser. A, 31, E4.

2. Georgoulis M. et al., 2024, Transactions IAU, 31:3, 2024IAU Commission E2 (Solar Activity / Activite Solaire) Triennial Report 2018 - 2021.
3. F. P. Ramunno et al. (including Georgoulis M.), 2024, “Magnetogram-to-Magnetogram: Generative Forecasting of Solar Evolution”, ESA SP (in press).
4. Mendoza Zambrano L. et al. (including Georgoulis M.), 2024, “Fuel-Optimal Trajectories of the Perturbed Cislunar Three-Body Problem for Lunar Occultation Applications”, Int. Astronaut. Congress (IAC) 2024, Milan (in press).

## Distinctions

- S. Vasilakos is an Adjunct Professor (2022-2024) at the European University Cyprus.
- Dr. Manolis Georgoulis was awarded an honorary plaque for his contribution to the popularization of Astronomy and Space Physics by the Chios Astronomy Society on August 4th.
- Dr. Manolis Georgoulis was also awarded the diploma of his election as a Corresponding Member of the International Academy of Astronautics (International Academy of Astronautics – IAA) during an IAA conference at Embry-Riddle Aeronautical University, Daytona Beach, Florida, on May 8th.
- Dr. M. Katsanikas had six distinguished publications (feature articles) in the journal International Journal of Bifurcation and Chaos.

## Participation in Conferences and Talks

### G. Contopoulos

- GC-1. Lecture at the Academy of Athens titled “Artificial Intelligence and Science” (February).

### P. Patsis

- PP-1. Invited talk in the Astrophysics Department at the Physics Faculty of the National and Kapodistrian University of Athens, titled: “Why should we care about how fast spiral arms and bars of galaxies rotate? - Understanding the significance of determining their pattern speeds” (April 24).
- PP-2. Participation in the conference “European Astronomical Society – Annual Meeting” and presentation of an invited talk titled “Determining the angular speeds of Bar and Spiral Patterns: Commonalities and noteworthy distinctions”, in Padova, Italy (July 1-5).

- PP-3. Member of the Scientific Organizing Committee (SOC) and main organizer of the conference “HERA24: The Nature and the Dynamics of Structures Observed in Galactic Disks”, Academy of Athens, September 15-20. Delivered one of the keynote talks on “Orbital theory and the structure of galactic disks”.
- PP-4. Invited talk at the Max-Planck Institute for Astronomy, Munich, Germany titled “Morphologies arising from the gas flow in the innermost kpc of barred spiral galaxies” (December 9).

## **I. Contopoulos**

- IC-1. Lecture on “Pulsar Magnetospheres with Machine Learning”, NASA/Goddard Space Flight Center, Greenbelt, Maryland, USA (invited talk, May 7).
- IC-2. Lecture on “Pulsars with PINNs”, 5th Workshop on Relativistic Plasma Astrophysics, Purdue University, West Lafayette, Indiana, USA (invited talk, May 8).
- IC-3. Lecture on “Black Hole Magnetospheres”, NASA/Goddard Space Flight Center, Greenbelt, Maryland, USA (Relativity Group Lunch Seminar, May 9).
- IC-4. Lecture on “MHD with Physics Informed Neural Networks (PINNs)”, course for graduate students as part of the 5th Summer School “Magnetohydrodynamics in Astrophysics” organized by the Hellenic Astronomical Society (ELASET), Ioannina (September 16).
- IC-5. Lecture on “Solution of a Simple Physics Problem with Physics Informed Neural Networks (PINNs)”, design and coordination of a computer lab session as part of the 5th Summer School “Magnetohydrodynamics in Astrophysics” organized by the Hellenic Astronomical Society (ELASET), Ioannina, September 16-20 (in collaboration with I. Dimitropoulos, September 16).
- IC-6. Participation in the International Scientific Conference on “Transhumanism and Artificial Intelligence”, Athens (November 18-21).
- IC-7. Lecture on “2 years with ChatGPT: the greatest bubble in human history?”, invited talk at the conference “Physics Enchants...” organized by the Union of Greek Physicists, University of Western Attica (December 13).

## **M. Georgoulis**

- MG-1. Working meeting for the recognition of the distinguished career of Dr. Spyros Antiokhos, SpiroFest 2024, High Altitude Observatory Boulder, Colorado. Lecture titled “How do Coronal Mass Ejections Originate in Solar Active Regions?” (February 29 – March 1).

- MG-2. Poster presentation titled “Reliable Magnetic Energy Release Estimation in Individual Flux-Changing Events in the Solar Photosphere and Above” at the Solar Orbiter / Parker Solar Probe / DKIST Workshop, San Antonio, Texas (April 7-12).
- MG-3. Lecture titled “Toward Energy Partitioning of Small-Scale Magnetic Reconnection Events from the Photosphere to the PSP Spacecraft” at the Parker Solar Probe Science Working Group (SWG), Smithsonian Astrophysical Observatory, Harvard University, Massachusetts (April 29 – May 1).
- MG-4. Lecture titled “A Treatment of the All-Clear Problem for SEP Events and Subsequent Decision Making” at the 4th IAA Conference on Space Situational Awareness (ICSSA), Embry-Riddle Aeronautical University, Daytona Beach, Florida (May 8-10).
- MG-5. Invited talk titled “Flares and CMEs and their Forecasting” at the Operational Space Weather Fundamentals, International School of Space Science (ISSS), L’Aquila, Italy (May 13-17).
- MG-6. Two invited talks titled
- (a) “PSP Literature Resources: Current Status in the PSP Science Gateway”
  - (b) “Flow Tracking on WISPR Images: Objectives and Possible Approaches”
- at the Parker Solar Probe WISPR Consortium Meeting, Applied Physics Laboratory, Maryland (June 27-28).
- MG-7. Three invited talks titled:
- (a) “Low-Atmospheric Morphological and Topological Imprints of Eruptive Solar Magnetic Configurations”
  - (b) “Next-Generation Solar Observations: The Sun Beyond the Sun-Earth Line and the Ecliptic Plane”
  - (c) “Prediction of Solar Energetic Events Impacting Space Weather Conditions: A Roadmap of Findings and Recommendations”
- at the 45th COSPAR Scientific Assembly, Busan, South Korea (July 13-21).
- MG-8. Lecture titled “Energetics of Low-Coronal Magnetic Flux Cancellation and its Impact on Solar Wind Observations During PSP Solar Encounters: Preliminary Results” at the Parker Solar Probe Science Working Group (SWG), Applied Physics Laboratory, Maryland (September 30 – October 2).
- MG-9. Invited talk titled “A Consistent Treatment and Discussion on All Clear for Solar Energetic Particle Events” at the Operational and Exploration Requirements and Research Capabilities for SEP Environment Modeling and Forecasting, Georgia State University, Atlanta, Georgia (October 16-19).



- MG-10. Invited talk titled “The Carrington-Level, Cycle-Defining NOAA Active Region 13664: A Preliminary Study” at the May 2024 Solar & Geospace Superstorm Workshop, Applied Physics Laboratory, Maryland (October 28 – November 1).
- MG-11. Invited talk (given online) titled “The Unexpectedly Intriguing Case for Predicting Solar Flares” at the European Space Weather Week (ESWW) 2024: 20 years of expanding horizons, from fundamental science to protecting society, Coimbra, Portugal (November 4–8).
- MG-12. Two lectures titled:
- (a) “Optical Flow Diagnostics in Parker Solar Probe/WISPR Images”.
  - (b) “Fractality, Multifractality and Turbulence in Parker Solar Probe Data”.
- at the 2024 Fall Meeting of the American Geophysical Union (AGU), Washington, D.C. (December 9-13).

### **C. Gontikakis**

- CG-1. Lecture at the European Astronomical Society Meeting titled “The transition region of solar flare loops” (Padova, July 1-5).
- CG-2. Poster presentation at the European Astronomical Society Meeting titled “Analysis of a coronal hole jet using SDO and IRIS data” (Padova, July 1-5).

### **M. Harsoula**

- MH-1. Lecture at the “3rd Annual Workshop in Space Science & Complexity at Princeton Athens Center” titled “Chaos and Order in Galaxies: The building blocks of the spiral arms in galaxies” (Athens, July 1-2).
- MH-2. Member of the local organizing committee for HERA 24 “The Nature and the Dynamics of Structures Observed in Galactic Disks”. WE Heraus-EAS Early Career Researchers in Astronomy Workshop. Academy of Athens (September 15-20).

### **M. Katsanikas**

- MK-1. Invited talk at the conference “Applied Nonlinear Dynamical Systems and Chaos - Celebrating Stephen Wiggins 65th Birthday”, Royal Academy of Sciences, Madrid, Spain titled: “Phase Space Geometry and Periodic Orbit Dividing Surfaces in 2D and 3D Caldera-type Hamiltonian Dynamical Systems” (July 2).
- MK-2. Member of the local organizing committee for HERA 24 “The Nature and the Dynamics of Structures Observed in Galactic Disks”. WE Heraus-EAS Early Career Researchers in Astronomy Workshop, Academy of Athens (September 15-20).

## A. Nathanail

- AN-1. Lecture at the GRBForum conference, Athens, Greece (July 8-12).
- AN-2. Invited to the Annual Conference of AnalytiX-2024, Dublin, Ireland (October 16-18).
- AN-3. Invited to the GRB+CE2024 conference, A workshop on GRBs and central engine powered transients, Playa De Carmen, Mexico (December 2-6).

## A. Tzemos

- AT-1. Presentation at the 13th International Conference on Mathematical Modeling in Physical Sciences titled “Introduction to Bohmian Quantum Chaos”, Kalamata (September 30 – October 3, online).
- AT-2. Lecture at the Maple Conference 2024, Waterloo Canada, titled “Partial Ergodicity in 2d Bohmian trajectories”, (October 24-25, online).
- AT-3. Member of the local organizing committee for HERA 24 “The Nature and the Dynamics of Structures Observed in Galactic Disks”. WE Heraus-EAS Early Career Researchers in Astronomy Workshop, Academy of Athens (September 15-20).
- AT-4. Participation in the 20th National Physics Conference. Lecture titled “Chaos and Born’s Rule in entangled Bohmian qubits”, Lamia (March 8-10).

## Organisation of Conferences and Meetings

1. PP-1: Dr. P. Patsis was the chairman of the Scientific and Local Organizing Committee of the conference “HERA24: The Nature and the Dynamics of Structures Observed in Galactic Disks” which was held successfully from September 15-20 at the Academy of Athens. The conference was funded by the European Astronomical Society (EAS) through the “Wilhelm and Else Heraeus” foundation.
2. PP-2: Dr. P. Patsis was responsible for organizing the weekly seminars of the RCAAM at the seminar room of the Center.
3. SB-1: Dr. Basilakos was a member of the organizing committee of the international conference in Cosmology, “Tensions in Cosmology”, Corfu, September, with the participation of many prominent scientists.
4. MG-1: Dr. M. Georgoulis participated in organizing the Parker Solar Probe Science Working Group Meeting held at Johns Hopkins Applied Physics Laboratory from September 30 to October 2.

5. MG-2: Dr. M. Georgoulis participated in the Scientific Organizing Committee (SOC) of the Working Meeting “Operational and Exploration Requirements and Research Capabilities for SEP Environment Monitoring and Forecasting”, Georgia State University, Atlanta, Georgia (October 16-19).
6. CG-1: Dr. C. Gontikakis participated in organizing a seminar on “Solar Eclipses from Yesterday to Today and the Contribution of Serge Koutchmy” held in Athens, NKUA, on October 17.

## Seminars

RCAAM, aiming at the continuous effort of informing both researchers and postgraduate students on contemporary research topics in the field of Astronomy-Astrophysics and nonlinear dynamical systems, organizes weekly seminars. Often, researchers from foreign institutions are funded by their institutes to come and speak at RCAAM seminars and interact with our center's researchers. In 2024, 15 seminars were held at the Center, covering topics in Astronomy, Astrophysics, and nonlinear Dynamics. In addition to the researchers and postgraduate students of the Center, the seminars also featured academics, professors, and distinguished scientists from various Universities and Research Centers from Greece and abroad.

Furthermore, in 2024, 26 seminars were held at RCAAM by students from the Physics Departments of the University of Athens and the University of Patras, focusing on high-energy Astrophysics/Magnetohydrodynamics, under the supervision of Professors I. Contopoulos and A. Nathanail.

The following is the list of seminars.

2024 SPEAKERS TABLE

<b>Antonios Nathanail</b> RCAAM Academy of Athens	Short Gamma-ray bursts as binary neutron star mergers, or not?	09/01/2024
<b>Andreas Burkert</b> University of Munich, Germany	The turbulent dynamics of high-redshift disk galaxies	16/01/2024
<b>Janusz Mlynarczyk</b> Jagiellonian University, Poland	Extremely low frequency electromagnetic waves in the Earth-ionosphere waveguide	23/01/2024
<b>Henrique Santos Lima</b> Brazilian Center for Research in Physics, Rio de Janeiro, Brazil	First-principle validation of Fourier's law: a brief study of classical inertial n-vector models	30/01/2024
<b>Matheus M. A. Paixão</b> Brazilian Center for Research in Physics, Rio de Janeiro, Brazil	Bohmian Mechanics, chaos, and the Unruh effect	06/02/2024
<b>Francisco Gonzalez Montoya</b> University of Leeds, UK	Normally Hyperbolic Invariant Manifolds in the Stormer problem: A generalization of the Unstable Periodic Orbits and its role in the transport in phase space	12/03/2024

2024 SPEAKERS TABLE

<b>Francesco Sylos Labini</b> Enrico Fermi Research Center Rome, Italy	Rotation curves of the Milky Way and of external galaxies and a new mass model	09/04/2024
<b>Eugene Vasiliev</b> University of Cambridge, UK	Dynamical modelling of barred galaxies	24/04/2024
<b>Ioannis Dandouras</b> University of Toulouse, France	Space plasma physics from Moon orbit and from the Moon surface: opportunities provided by the Lunar Gateway programme	28/04/2024
<b>Athanasios C. Tzemos</b> RCAAM Academy of Athens	Advances in Bohmian Chaos	04/06/2024
<b>Francesca Fragkoudi</b> University of Durham, UK	Barred galaxies in $\Lambda$ CDM: Uncovering the formation history and dark matter content of Milky Way-type galaxies	18/06/2024
<b>Diego Valencia-Enrquez</b> Mariana University, Colombia	Orbital Dynamics and Structural Evolution in Barred and Unbarred Disc Galaxy Models	25/06/2024
<b>George Loukes-Gerakopoulos</b> Astronomical Institute, Czech Academy of Sciences, Prague	The center of mass issue of an extended body moving in a curved spacetime	9/07/2024
<b>Ewa L. Lokas</b> Astronomical Institute University of Warsaw, Poland	Buckling instability in galactic bars	16/07/2024
<b>Moise Bonilla-Licea</b> CINVESTAV, Mexico City, Mexico	A simple design of quantum gates in quantum computer	3/12/2024

SPEAKERS TABLE AT ASTROPHYSICS/MAGNETOHYDRODYNAMICS  
SEMINARS 2024

<b>Eugenia Koutsoumbou</b> University of Athens	Infrared Observations of the Interstellar Medium of Galaxy NGC 253	12/1/2024
<b>Iasonas Psomas</b> University of Patras	Determining the Mass of Ejected Material and the Accretion Disks in Neutron Star Mergers	19/1/2024
<b>Ioannis Dimitropoulos</b> University of Patras	A New Explanation of the Origin of Fast Radio Bursts	1/2/2024
<b>Argyris Loules</b> University of Athens	The History of GRMHD Simulations	9/2/2024
<b>Elena Antonopoulou</b> University of Athens	Accretion Simulations on Neutron Stars	16/2/2024
<b>Eugenia Koutsoumbou</b> University of Athens	Low Energy Cosmic Rays	23/2/2024
<b>Iasonas Psomas</b> University of Patras	Mass Estimates of Disks and Ejected Material in Compact Object Mergers	1/3/2024
<b>Ioannis Dimitropoulos</b> University of Patras	The Asymmetric Magnetosphere of Pulsars (Part A)	15/3/2024
<b>Ioannis Dimitropoulos</b> University of Patras	The Asymmetric Magnetosphere of Pulsars (Part B)	22/3/2024
<b>Argyris Loules</b> University of Athens	The Effect of Spin of Black Holes on the Power and Geometry of Jets	30/3/2024
<b>Eugenia Koutsoumbou</b> University of Athens	Ionization Rate Calculation due to Cosmic Rays via Non-Thermal Galaxy Emissions	12/4/2024
<b>Iasonas Psomas</b> University of Patras	Low Mass Neutron Star Mergers	19/4/2024
<b>Argyris Loules</b> University of Athens	Hybrid Simulations of Matter Accretion onto Black Holes	30/5/2024

2024 SPEAKERS TABLE AT ASTROPHYSICS/MAGNETOHYDRODYNAMICS  
SEMINARS

<b>Elena Antonopoulou</b> University of Athens	Sagittarius A* Flares via GRMHD Simulations	7/6/2024
<b>Eugenia Koutsoubou</b> University of Athens	Determination of Accretion States in Active Galactic Nuclei via Infrared Emission Line Study	14/6/2024
<b>Ioannis Dimitropoulos</b> University of Patras	Slowdown of Pulsar Rotation Interacting with Winds	3/10/2024
<b>Elena Antonopoulou</b> University of Athens	Creation of Vertical Magnetic Field in Accretion Disks via the Dynamo Mechanism	10/10/2024
<b>Ioannis Contopoulos</b> Academy of Athens	Solving the Pulsar Equation in Three Dimensions Using Neural Networks	17/10/2024
<b>Argyris Loules</b> University of Athens	Modeling Relativistic Astrophysical Jets with Finite Conductivity Plasma	24/10/2024
<b>Elena Antonopoulou</b> University of Athens	Particle Acceleration in Magnetized Accretion Disks via GR(R)PIC Simulations	7/11/2024
<b>Ioannis Dimitropoulos</b> University of Patras	The Fundamental Level of $\gamma$ -ray Pulsars	14/11/2024
<b>Angelos Michailidis</b> University of Athens	The Solar Magnetic Field	22/11/2024
<b>Argyris Loules</b> University of Athens	Two-Temperature Fluids in GRMHD Simulations	28/11/2024
<b>Eugenia Koutsoubou</b> University of Athens	Ionization of Emission Lines via Cosmic Rays in Active Galactic Nuclei and Star-Forming Galaxies	5/12/2024
<b>Elpida Oikonomou</b> University of Athens	The Zeltron Code and the Magnetospheres of Pulsars	12/12/2024
<b>Iasonas Psomas</b> University of Patras	Formation of Black Holes via Neutron Star Mergers	19/12/2024

## Teaching

The researchers of the RCAAM gave a series of lectures in university departments, seminars for students and researchers, and in schools organized by scientific societies.

- Dr. **S. Basilakos** taught, upon assignment, the course in Cosmology in the Departments of Mathematics and Physics at the University of Athens.
- Dr. **C. Gontikakis** participated in the teaching of the postgraduate course in Solar Physics in the Department of Physics at the University of Athens, in collaboration with Professors I. Dagklis, Dr. A. Heilaris, and Dr. Ch. Katsavrias, during the period (March-June).
- Dr. **M. Katsanikas** taught the course in Dynamical Astronomy in the postgraduate program in Astrophysics at the Department of Physics of EKPA (academic year 2023-2024, spring semester).

## PhDs and Masters

At RCAAM, doctoral candidates and graduate students working on their theses for the acquisition of specialization diplomas (Masters), as well as senior university students preparing their bachelor's theses, are employed. Additionally, the researchers of RCAAM participate in committees overseeing dissertations and bachelor's theses, which are mainly conducted outside of RCAAM.

Specifically, in 2024, the members of RCAAM supervised the following doctoral dissertations and master's and bachelor's theses:

- Dr. **I. Contopoulos** is the main supervisor of the doctoral dissertation
  - of Mr. I. Dimitropoulos titled: “Origin of high-energy radiation from compact objects (black holes, pulsars)” (Department of Physics, University of Patras).

Furthermore, he is a member of the three-member committee for the doctoral dissertations of:

- Dr. H. Sinnis titled: “Relativistic Instabilities in Astrophysical Jets” (Department of Physics, National and Kapodistrian University of Athens, completed successfully).
- Mr. V. Bisketzis titled: “Plasma Dynamics in the Environment of a Rotating Black Hole” (Department of Physics, National and Kapodistrian University of Athens).
- Mr. D. Dotsikas titled: “Study of the Magnetospheres of Pulsars” (Department of Physics, University of Patras).
- Mr. A. Loules titled: “Modeling of Astrophysical Accretion Disks” (Department of Physics, National and Kapodistrian University of Athens).



Finally, he supervised the internship of:

- Ms. E. Oikonomou titled: “Study of the Magnetospheres of Pulsars” (Department of Physics, National and Kapodistrian University of Athens).
- Dr. **S. Basilakos** is a member of the three-member committee for the doctoral dissertations of:
  - Mr. M. Kapsambelis at the National and Kapodistrian University of Athens titled: “Generalized Geometrical Theories in Gravity and Cosmology”.
  - Mr. H. Tzerefos at the National and Kapodistrian University of Athens titled: “Modified Gravity: Applications in Cosmology, Black Holes, and Gravitational Waves”.
- Dr. **M. Georgoulis** is a member of the three-member committee for the following doctoral dissertations:
  - Mr. Augustin André-Hoffmann, University of Ioannina and University of Sheffield, UK, titled “Pre-Eruption Magnetic Configuration and Eruption Forecasting”.
  - Ms. Shifana Koya, University of Ioannina and Marie-Curie Skłodowska University, Lublin, Poland, titled “Assessment of the Near-Sun CME Magnetic Field”.
  - Mr. Shreeyesh Biswal, University of Ioannina and University of Sheffield, UK, titled “Three-dimensional Solar Flare Forecasting”.
- Dr. **K. Gontikakis** is the main supervisor of the doctoral dissertation
  - Ms. M. Koletti titled: “Study of Outflow Regions from the Solar Atmosphere” (Department of Physics, National and Kapodistrian University of Athens). Co-supervisors: N. Vlachakis, Department of Physics, National and Kapodistrian University of Athens, S. Patsourakos, Department of Physics, University of Ioannina.

He also supervised the Master’s thesis of:

- Mr. Angelos Michailidis titled: “Study of Radiation and the Magnetic Field of Plasma Outflow Jets in the Solar Atmosphere”.

Finally, he supervised the internship of the student from the University of Ioannina:

- Ms. Evgenia Kontogianni, from July 1st to September 15th, 2024, titled “Study of Coronal Loops During a Flare from Observations in the Ultraviolet Radiation”.
- Dr. **M. Harsoula** was a member of the three-member advisory committee for the doctoral dissertation

- Ms. K. Zouloumi titled: “Spiral Structure of Galaxies and Chaos in N-body Models of Galactic Disks” (Main supervisor: X. Efthymiopoulos). Ms. Zouloumi successfully defended her doctoral dissertation in July.

She is also a co-supervisor (with main supervisor Professor K. Anagnostopoulos) of:

- Mr. Theodosios Kavalagios Master’s thesis from the Department of Mathematics, School of Applied Mathematical and Physical Sciences, National Technical University of Athens, titled “Study of the Role of Angular Velocity in Density Spiral Waves in Galaxies”.

Finally, she was the main supervisor of the internship of:

- Ms. Chrysoula Kalogeropoulou from the Department of Physics, University of Ioannina, as part of the project “Internship in Higher Education at the University of Ioannina”, funded by the European Social Fund (ESF) and co-financed by National Resources through the Operational Program “Human Resource Development & Social Cohesion” (PP 2021-2027). The subject of the internship was: “Density Spiral Waves in Galaxies”, July-September 2024.

- Dr. **A. Nathanail** is the supervisor of the doctoral dissertation
  - Ms. E. Antonopoulou at the Department of Physics, National and Kapodistrian University of Athens, titled: “Exploring the Hidden Aspects of Black Holes: Magnetohydrodynamic Simulations and Flares in Regions of Extreme Gravitational Influence”.

and the supervisor of the Master’s thesis

- Mr. I. Psomas (Department of Physics, University of Patras), titled: “Exploring the Parameter Space in Mergers of Double Neutron Star Systems”.

- Dr. **A.C. Tzemos** is the supervisor of the Master’s thesis of
  - Mr. Phoibos Zaniias, Master’s student at the Department of Physics, University of Amsterdam, titled: “Study of Order and Chaos in Quantum Dynamical Systems”, part of the corresponding program of the Research Committee of the Academy of Athens (200/1026).
  - The Bachelor’s thesis of Mr. X. Karyofyllis (Department of Physics, National and Kapodistrian University of Athens), titled: “Order and Chaos in the de Broglie-Bohm Interpretation of Quantum Mechanics”.

## Participation in Committees

The members of RCAAM are active members in many national and international scientific committees for the promotion of researchers and university professors in Greece and abroad. They serve also as referees in the main research astronomical journals.

## Promotion of Astronomy and Public Outreach

The researchers of RCAAM, upon invitation, gave several outreach talks at educational institutions and events for the public. They also wrote popular science articles and contributed to the dissemination of the research results of the Center through their interventions.

- **P. Patsis**

- Interview on the program “Open Pages”, “ACHELOOS TV” (June 2).
- Article in the newspaper “Naftemporiki” titled “The importance of passing knowledge and techniques from one generation of researchers to the next” (September 17).

- **I. Contopoulos**

- “Artificial General Intelligence”, Christian Student Union, Athens, January 20.
- “Faith and Science”, General Lyceum of Kapandriti “Kallistratos”, February 13.
- Presentation, discussion, and answers to questions related to Artificial Intelligence, Piraeus Lighthouse, Piraeus, March 3.
- “The storm of Artificial Intelligence—how will it affect us and our children”, Parents’ School of the Holy Island of Tinos, Tinos, March 9.
- “Images from Space”, 1st Lyceum, Rizarios Ecclesiastical School, March 19.
- “The end of Physics?” and discussion, Physics Club of Lyceum, Rizarios Ecclesiastical School, March 19.
- “Artificial General Intelligence: The new challenge for humanity”, Piraeus Lighthouse, Piraeus, April 2.
- “The storm of Artificial Intelligence”, Holy Monastery of All Saints, Spetses, August 4.
- “Is there God in the Universe?”, Christian Student Union, December 11.
- “Man and his place in the universe”, Sunday Meetings: study of the ecology of the person, Institute of Agricultural Sciences Hall, Syngrou Estate, December 15.

- A series of 4 interviews titled “The Limits of Science” on Pemptousia TV by journalist and astrophysicist Christos Dimopoulos.
- **S. Basilakos**
- Throughout the year, S. Vassilakos gave over 30 interviews to print and electronic media (ERT, MEGA, OPEN, ALPHA, SKAI, ONE, Naftemporiki, Kathimerini, VIMA, etc.).
- **M. Georgoulis**
- Popular presentation titled “The present and future of heliophysics: Remote sensing and in-situ measurements from space”, 12th Astronomy Festival of Chios, August 2.
- Brief intervention in a documentary in preparation on climate change, directed by Giannis Vamvakis, August.
- Participation and brief greeting at the evening event “Seafaring and Space” held on August 4 in Chios, honoring Academic Dr. Stamatios Krimigis with the screening of the movie about his life and work titled “Stamatios Krimigis: Hunting Planets for 60 Years”, directed by Giannis Vamvakis.
- “The challenge of the first Greek astronaut’s mission”. Joint interview with Dr. Adriano Golemi (ESA) with journalist Dimitris Mallas on CNN.gr, August 11.
- Invited lectures on the Parker Solar Probe mission, as follows:
  - Hayden Planetarium, American Museum of Natural History, New York, October 7.
  - Fiske Planetarium, University of Colorado at Boulder, November 15.
  - Chilchimbeto Community School of the Navajo tribe, Kayenta, Arizona, December 18. Online presentation.
- **M. Harsoula** Invited talk titled “Exploring the Near and Far Universe”, 3rd Year of the 3rd Lyceum of Vyronas (November 22).
- **M. Katsanikas**
- Invited talk titled “Artificial Intelligence and Machine Learning”, April 6. Teacher training, 6th Lyceum and 5th Gymnasium of Marousi.