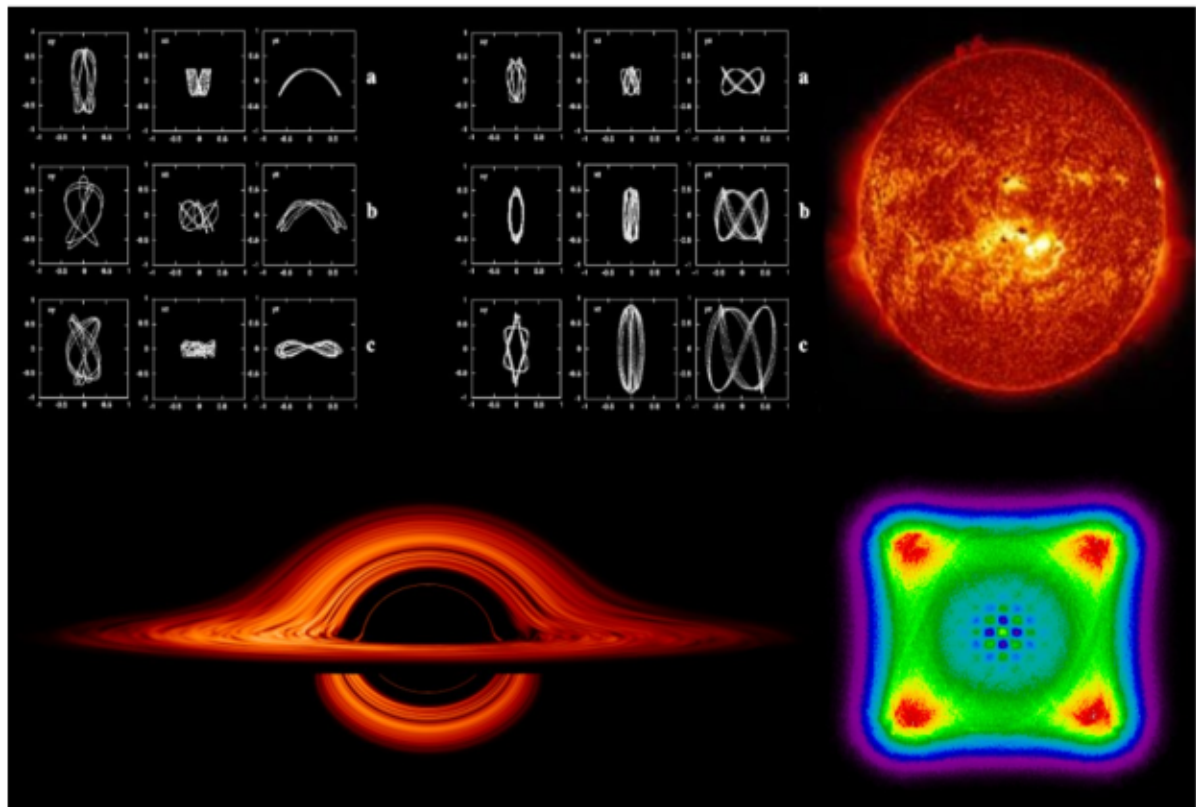




**Research Center for Astronomy  
and Applied Mathematics**  
of the Academy of Athens

# ANNUAL REPORT 2019



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# Contents

Contact Address . . . . .	2
Staff Members in 2019 . . . . .	2
Associate Members and Visitors . . . . .	2
About us . . . . .	4
History . . . . .	5
Our Research . . . . .	6
Scientific Projects . . . . .	8
Publications in 2019 . . . . .	11
Distinctions . . . . .	16
Participation in Conferences and Talks . . . . .	16
G. Contopoulos . . . . .	16
P. Patsis . . . . .	17
C. Efthymiopoulos . . . . .	17
I. Contopoulos . . . . .	18
M. Georgoulis . . . . .	18
C. Gontikakis . . . . .	19
M. Harsoula . . . . .	19
V. Tritakis . . . . .	19
A. Tzemos . . . . .	19
Organisation of Conferences and Meetings . . . . .	19
Seminars . . . . .	21
Teaching . . . . .	25
Phds and Masters . . . . .	26
Missions – Visits to other Research Institutions . . . . .	27
Incoming Visitors . . . . .	28
Participation in Committees . . . . .	28
Promotion of Astronomy and Public Outreach . . . . .	29

## Staff Members in 2019

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## 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 2018-19 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

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 United 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 scientific staff of RCAAM participated during 2019 in the following programs:

1. **“Non-linear phenomena in galactic discs”**. Program of the Research Committee of Academy of Athens (200/895). (G. Contopoulos, P.A. Patsis, C. Efthymiopoulos, M. Harsoula, R. Paez).  
Publications in journals with referees No: “4”, “4”, “6”, “9”,  
Publications in conference proceedings without referees No: “1”  
Talks, presentations: PP-2, CE-4, CE-5.
2. **“Dissemination of research results”** Program funded from the general bequests for education of the Academy of Athens (200/915) (G. Contopoulos, A.C Tzemos). 46 seminars at the RCAAM and a special volume of RCAAM (see catalog in the paragraph “Seminars”).
3. **“Analytic Computation of Invariant Manifolds and the structure of Chaos”** (G. Contopoulos, C. Efthymiopoulos, M. Harsoula, R. Paez (not funded).  
Publications in journals with referees No: “11”  
Talks: CE-1,CE-2.
4. **“Galactic Dynamics”** (2018-2019). Program of the Research Committee of the Academy of Athens (200/885). (G. Contopoulos, P.A. Patsis., S. Chatzopoulos). A paper in preparation. Talks: PP-1.
5. **“Study of the dynamical evolution of the entanglement and coherence in quantum systems”** (G. Contopoulos, C. Efthymiopoulos, A. Tzemos) (not funded).  
Publications in journals with referees No “3”  
Talks: GC-1, AT-1
6. **“Dimensionality in Physics and Astronomy”** (G. Contopoulos, E. Chaliasos). Study of a 4th space dimension for the explanation of the rotation curves of the galaxies. One paper in preparation.
7. **“Study of the stellar orbits and the gravitational potentials in galaxies with theoretical, numerical and observational methods”**. Program of Instituto Nacional de Astrofisica Optica y Electronica, Mexico, funded by the National Council for Research and Technology of Mexico (SEP-Conacyt). Coordinator: I. Puerari. Participation (P. Patsis). Duration: 2015-2018. The program is extended in 2019 and included the supervision of a PhD thesis (L.Chavez). The PhD thesis was successfully defended in February 25.  
Publication in journal with referees: No “7”.  
Talk: PP-3
8. **“Total mass estimates in unrelaxed disks in the Universe”** (P. Patsis, C. Efthymiopoulos). Collaboration with professors of the Astrophysics, Astronomy

and Mechanics division of the Physics department of the university of Thessaloniki (K. Tsiganis, P. Papadopoulos) and students. The program will investigate new methods for the estimation of the total mass of disks (galactic or protoplanetary) which have not yet relaxed and in which the Virial theorem is not applicable. Such objects are e.g. galaxies in the early Universe ( $z > 1$ ). (Not funded). Prof. Papadopoulos is a visitor in RCAAM for the last three years.

9. **“Orbital content of galactic bars”** (2019-2021). Program of the Laboratoire d’Astrophysique de Marseille, of the university Aix-Marseille (AMU) in collaboration with RCAAM (E. Athanassoula, LAM, P. Patsis, Y. Wang, National Astronomical Observatories, Chinese Academy of Sciences, Beijing). LAM supported two visits of E. Athanassoula in RCAAM during 2019).  
Μια εργασία υπό προετοιμασία.  
Talks, presentations: PP-4.
10. **“Numerical investigation of the impact of Complex Instability to the phase space structure of Dynamical Systems with emphasis to barred galaxy models”** (H. Skokos, University of Cape Town, S. Africa, P. Patsis, A. Bäcker, Technische Universität Dresden, Germany). 2019-2021. Program funded by the University of Cape Town, supporting the visits of H. Skokos at RCAAM. H. Skokos visited RCAAM in July 2019  
One paper in preparation.
11. **“N-body simulations of galactic disks – The relation between observed spiral disk morphologies a/d the dynamical properties of DM halos”** (P. Patsis, A. Burkert. University of Munich, T. Naab, Max Planck Institute für Astronomie, P. Grosbol, European Southern Observatory, Munich). Program funded by the interdisciplinary program of excellence “Excellence Cluster ” involving 4 German institutes. The Max-Planck Institute für Astrophysik supports the visits of P. Patsis in Garching. Computational time is provided in the Computational Center RZG, Garching, Germany, where numerical simulations with N-body models are conducted. A request is applied for observational time in the VLT telescope of ESO in Chile.  
One paper in preparation.
12. **“Marie Curie Innovative Training Network StarDust-Reloaded”** (C. Efthymiopoulos, M. Harsoula, E. Legnaro), funded by the European Union.  
Publications in journals with referees.: 10,12.  
Talks-presentations: CE-2, CE-6.
13. **“PHAROS COST Action CA16214”**: Program PHAROS COST Action CA16214 for the funding of a short-term scientific mission) at the observatory of Strasbourg, University of Strasbourg. Participation from RCAAM: I. Contopoulos.  
Publication in journals with referees: “16”.  
Talks-presentations: IC-3, IC-4, IC-6, IC-8.

14. **Models of VHE Emission in Pulsars: Evaluation of the Current State-of-the-Art and Future Prospects.** International working group of the International Space Science Institute-ISSI Bern. Participation from RCAAM: I. Contopoulos. Talks-presentations: IC-3.
15. **“The nature of dark energy”** Research Program for the study of the nature of dark energy. It is a collaboration between several Universities (S. Basilakos, M. Plionis, AUT, J. Sola (Un. of Barcelona), S. Capozziello (Un. Of Naples), A. Lima (Un. of Sao Paulo) and N. Mavromatos (King College, Un. of London). It is financially supported by the Universities of Barcelona, Naples and Sao Paulo. Publication in journals with referees: “21-29”.
16. **“Development of the ASPIICS Coronagraph for the PROBA-3 Mission”** Program of the European Space Agency (ESA). Principal Investigator : Dr. Andei Zhukov, Royal Observatory of Belgium, Belgium, Principal Investigator from Greece: K. Tsiganos, (UOA). Participator from RCAAM: M. Georgoulis. 2009-undefined.
17. **“Solar Orbiter Modeling and Data Analysis Working Group (MADAWG)** Sponsor: ESA Principal Investigator: Dr. Alexis Rouillard, Insitute of Research in Astrophysics and Planetology (IRAP), Toulouse, France, Participation from RCAAM: M. Georgoulis. 2017 – undefined. Publication in journals with referees: “35”.
18. **“ University of Nagoya Working Team on Solar Flare Prediction”.** Sponsor: University of Nagoya, Japan. Principal Researcher: Prof. Kanya Kusano, U. of Nagoya. Participation from RCAAM: M. Georgoulis. 2017 – 2019. Publication in journals with referees: “32-34”.
19. **“ESA/SSA SWE Solar Weather Expert Service Center (ESC)”** Sponsored by the European Space Agency Space Situational Awareness Programme (ESA/SSA). Principal Investigator: Dr. Jesse Andries, Royal Observatory of Belgium. Participator from RCAAM: M.Georgoulis (12/2017-6/2019). Program number: not defined yet. Total budget (for the Academy of Athens): 55000 Euros
20. **“ESA/SSA SWE Solar Weather Expert Service Center (ESC)-Extension”** Sponsored by the European Space Agency Space Situational Awareness Programme (ESA/SSA). Principal Investigator: Dr. Jesse Andries, Royal Observatory of Belgium. Participator from RCAAM: M.Georgoulis (12/2017-6/2019). Program number: 200/902. Total budget (for the Academy of Athens): 35000 Euros
21. **“Advanced Particle Events Casting System (ASPECS)”** Sponsored by ESA. Principal Investigator: Dr. Anastasios Anastasiadis, NOA. Participator from RCAAM: M. Georgoulis. (2017-2019). Total budget for the Academy of Athens:= 150.000 Euros.

22. **“GSU Contributions to the Development of Forecasting Capabilities for the NASA SRAG”**. NASA Solar Radiation Analysis Group (SRAG) Χορηγός: NASA Principal researcher: Dr. R. A. Angryk, GSU Computer Science Dept. Participation from RCAAM: M. Georgoulis. June 2019 – December 2019. Total budget:= 150.000 Euros.
23. **“Elements: Comprehensive Time Series Data Analysis for the Prediction of Solar Flares and Eruptions”**. Sponsor: National Science Foundation. Principal researcher: Dr. R. A. Angryk, GSU Computer Science Dept. Participation from RCAAM, M. Georgoulis. October 2019 – September 2022. Total budget: 600.000 Euros.
24. **“Construction of experimental station for the measurement of Schumman waves and preliminary measurements”**. Scientific Director of research program, V. Tritakis. Program funded by Mariolopoulio Foundations and the University of Ioannina. Participator from RCAAM: I. Contopoulos. Experimental measurements also work for the construction of a permanent station are underway.

## Publications in 2019

### Special Editions

RCAAM published a special volume (in Greek) with title “Advances in Astronomy 2018” (Eds., G. Contopoulos and P.A. Patsis), which includes a series of papers summarizing the recent research results of RCAAM.

Dr. Patsis was the editor for the 2nd issue (Volume 3) of the journal of Hellenic Astronomical Society “Hipparchos”, (June 2019).

Furthermore Dr. Georgoulis was editor of the special volume:

Space Weather Research Across the Full Data Lifecycle (Eds. R. M. McGranaghan, A. Anastasiadis, E. Camporeale and M. K. Georgoulis), J. Space Weather Space Climate, in press

### Publications in International Journals with Referees

(Published or accepted for publication in 2019)

1. Contopoulos G., “A review of the third integral”, Math. Engin., in press.
2. Tzemos A.C. and Contopoulos G., “Chaos and ergodicity in an entangled two-qubit Bohmian system”, Phys. Scr., in press.
3. Tzemos A.C., Contopoulos G. and Efthymiopoulos C., 2019, “Bohmian trajectories in an entangled two-qubit system”, Phys. Scr., 94, 5218.

4. Efthymiopoulos C., Harsoula M. and Contopoulos G., 2019, "Manifold spirals in barred galaxies with multiple pattern speeds", *Astron. and Astroph.*, in press.
5. Harsoula M., Karamanos C. and Contopoulos G., 2019, "Characteristic times in the standard map", 2019, *Phys. Rev. E*, 99, 032203.
6. Patsis P. A. and Athanassoula E., 2019, "The orbital content of bars: the origin of 'non-x1-tree', bar-supporting orbits", *Mon. Not. R. Astron. Soc.* 490, 2740.
7. Chaves-Velasquez L., Patsis P. A., Puerari I., Moreno E. and Pichardo B., 2019, "Dynamics of Thick, Open Spirals in PERLAS Potentials", *Astroph. J.* 871, 79.
8. Font J., Beckman J.E., James P. A. and Patsis P. A., 2019, "Spiral structure in barred galaxies. Observational constraints to spiral arm formation mechanisms", *Mon. Not. R. Astron. Soc.* 482, 5362.
9. Efthymiopoulos C., Kyziropoulos P. E., Páez R. I., Zouloumi K. and Gravvanis G., 2019, "Manifold spirals, disc-halo interactions, and the secular evolution in N-body models of barred galaxies", *Mon. Not. R. Astron. Soc.* 484, 1487.
10. Gkolias I., Efthymiopoulos C., Celletti A. and Pucacco G., 2019, "Accurate modelling of the low-order secondary resonances in the spin-orbit problem", *Comm. Nonlin. Sci. Num. Sim.* 77, 181.
11. Guzzo M., Efthymiopoulos C. and Paez R.I., 2019, "Semi-analytic computations of the speed of Arnold diffusion along single resonances in a priori stable Hamiltonian systems", *J. Nonlin. Sci.* 94G.
12. Gkolias I., Daquin J., Skoulidou D.K., Efthymiopoulos C. and Tsiganis K. 2019, "Chaotic transport of navigation satellites", *Chaos (Fast Track Communications)*, 29, 1106.
13. Contopoulos I., 2019, "Current closure in the pulsar magnetosphere", *Mon. Not. Lett.*, 482L, 50.
14. Contopoulos I., 2019, "Generation and transport of magnetic flux in accretion-ejection flows", *Galaxies*, 7, 12.
15. Contopoulos I. and Stefanou P., 2019, "A ring of fire in the pulsar magnetosphere", *Mon. Not. R. Astron. Soc.*, 487, 952.
16. Contopoulos I., Petri J. and Stefanou P., "Hybrid numerical simulations of Pulsar magnetospheres", *Mon. Not. R. Astron. Soc.*, in press.
17. Papadopoulos D. B. and Contopoulos I., 2019, "The magnetic Rayleigh-Taylor instability around astrophysical black holes", *Mon. Not. R. Astron. Soc.*, 483, 2325.

18. Florios K., Contopoulos I., Christofilakis V., Tatsis G., Chronopoulos S., Repapis C. and Tritakis V., 2019, "Pre-seismic electromagnetic perturbations in two earthquakes in northern Greece", *Pure and App. Geophys.*, in press (tmp.353F).
19. Karageorgopoulos V., Gourgouliatos K. N. and Contopoulos I., 2019, "Current closure through the neutron star crust", *Mon. Not. R. Astron. Soc.*, 487, 3333.
20. Christofilakis V., Tatsis G., Votis C., Contopoulos I., Repapis C. and Tritakis V., 2019, "Significant ELF perturbations in the Schumann Resonance band before and during a shallow mid-magnitude seismic activity in the Greek area (Kalpaki)", *J. Atm. Solar-Terr. Phys.*, 182, 138.
21. Basilakos S., Mavromatos N. and Sola J., 2019, "Scalar field theory description of the running vacuum model: the vacuumon", *JCAP*, 12, 025.
22. Basilakos S., Mavromatos N. and Sola J., 2019, "Do we come from a Quantum Anomaly?", *Int. J. Mod. Phys. D.*, 28, 1944002.
23. Basilakos S., Leon G., Papagiannopoulos G., Saridakis E. N. and Anagnostopoulos F. K., 2019, "Dynamical system analysis at background and perturbation levels: Quintessence in severe disadvantage comparing to  $\Lambda$  CDM", *Phys. Rev. D.*, 100, 043524.
24. Tsiapi P. and Basilakos S., 2019, "Testing dynamical vacuum models with CMB power spectrum from Planck", *Mon. Not. R. Astron. Soc.*, 485, 2505.
25. Anagnostopoulos F. K., Basilakos S. and Saridakis E. N., 2019, "Bayesian analysis of  $f(T)$  gravity using  $f\sigma_8$  data", *Phys. Rev. D.*, 100, 083517.
26. Anagnostopoulos F. K., Basilakos S., Kofinas, G. and Zarikas V., 2019, "Constraining the Asymptotically Safe cosmology: cosmic acceleration without dark energy", *JCAP*, 02, 053.
27. Anagnostopoulos F. K., Benisty D., Basilakos S. and Guendelman E.I., 2019, "Dark energy and dark matter unification from dynamical space time: observational constraints and cosmological implications", *JCAP*, 06, 003.
28. Paliathanasis A., Pagagiannopoulos G., Basilakos S. and Barrow J., 2019, "Dynamics of Einstein-Aether scalar field cosmology", *European Phys. J. C*, 79, 723.
29. González-Morán A. L., Chávez R., Terlevich R., Terlevich E., Bresolin F., Fernandez-Arenas D., Basilakos S. et al., 2019, "Independent cosmological constraints from high- $z$  H II galaxies", *Mon. Not. R. Astron. Soc.*, 487, 4669.
30. Kontogiannis I., Georgoulis, M. K., Guerra J. A., Park S.-H. and Bloomfield D. S., 2019, "Which Photospheric Characteristics are Most Relevant to Active Region Coronal Mass Ejections?", *Solar Phys.*, 294, 130.

31. Campi C., Benvenuto F., Massone A. M., Bloomfield D. S., Georgoulis M. K. and Piana M., 2019, "Feature Ranking of Active Region Source Properties in Solar Flare Forecasting and the Uncompromised Stochasticity of Flare Occurrence", *Astroph. J.*, 883, 150.
32. Leka K. D., Park H.-S., Kusano K., et al. (incl. Georgoulis, M. K.), 2019, "A Comparison of Flare Forecasting Methods. II. Benchmarks, Metrics and Performance Results for Operational Solar Flare Forecasting Systems", *Astroph. J. Suppl. Series*, 243, 36.
33. Leka K. D., Park H.-S., Kusano K., et al. (incl. Georgoulis M. K.), 2019, "A Comparison of Flare Forecasting Methods. III. Systematic Behaviors of Operational Solar Flare Forecasting Systems", *Astroph. J.*, 881, 101.
34. Park S.-H., Leka K. D., Kusano K., et al. (incl. Georgoulis M. K.), 2019, "A Comparison of Flare Forecasting Methods. IV. Evaluating Consecutive-Day Forecasting Patterns", *Astroph. J.*, in press.
35. Rouillard A. P., Pinto R. F., Vourlidas R. A. et al. (incl. Georgoulis M. K.), 2019, "Models and Data Analysis Tools for the Solar Orbiter Mission", *Astron. Astroph.*, in press.
36. Kontogiannis I., Tsiropoula G., Tziotziou K., Gontikakis C., Kuckein C., Verma M. and Denker C., "Emergence of small-scale magnetic flux in the quiet Sun", *Astron. Astroph.*, in press.
37. Tatsis G., Christofilakis V., Chronopoulos S.K., Kostarakis P., Nistazakis H.E., Repapis C. and Tritakis V., "Design and Implementation of a Test Fixture for ELF Schumann Resonance Magnetic Antenna Receiver and Magnetic Permeability Measurements", *Electronics*, in press.
38. Jin S., Daddi E., Magdis G. E., Liu D., Schinnerer E., Papadopoulos P. P., Gu Q., Gao Y. and Calabrò A., 2019, "Discovery of Four Apparently Cold Dusty Galaxies at  $z = 3.62 - 5.85$  in the COSMOS Field: Direct Evidence of Cosmic Microwave Background Impact on High-redshift Galaxy Observables", *Astroph. J.*, 887, 15.

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

1. Georgoulis M. K., Nindos A. and Zhang H., 2019, "The Source and Engine of Coronal Mass Ejections" (Invited Review, Special Volume Entitled 'Solar Eruptions and their Space Weather Impact'), *Phil. Trans. Royal Astron. Soc.*, 377, 20180094, doi:10.1098/rsta.2018.0094.
2. Cai X., Aydin B., Georgoulis M. K. and Angryk R., 2019, "An Application of Spatio-temporal Co-Occurrence Analyses for Integrating Solar Active Region Data from Multiple Reporting Modules", *Workshop on Solar and Stellar Astronomy Big Data (SABID)*, 2019 Proceedings.



3. Ahmadzadeh A., Hostetter M., Aydin B., Georgoulis M., Kempton D., Mahajan S. and Angryk R., "Challenges with Extreme Class Imbalance and Temporal Coheremce: A Study on Solar Flare Data", Workshop on Solar and Stellar Astronomy Big Data (SABID) 2019 Proceedings.
4. Ma R., Ahmadzadeh A., Filali Boubrahimi S., Georgoulis M. K. and Angryk R., 2019, "Solar Flare Classification with Time Series Profiling", Workshop on Solar and Stellar Astronomy Big Data (SABID), 2019 Proceedings.
5. Hostetter M., Ahmadzadeh A., Aydin B., Georgoulis M. K., Kempton D. J. and Angryk R., 2019, Understanding the Impact of Statistical Time Series Features for Flare Prediction Analysis, Workshop on Solar and Stellar Astronomy Big Data (SABID) 2019 Proceedings.
6. Gontikakis C., 2019, "The upper solar atmosphere. A brief history and recent results", Hipparchus 3, Issue 2, p.26.
7. D. Romano D., Zhang Z.-Y, Matteucci F., Ivison R. J. and Papadopoulos P.P., 2019, "The Evolution of CNO Isotope Ratios: A Litmus Test for Stellar IMF Variations in Galaxies Across Cosmic Time", In: Formicola A., Junker M., Gialanella L., Imbriani G. (eds) Nuclei in the Cosmos XV. Springer Proc. Phys., 219.

#### **Publications in conference proceedings without referees:**

1. Patsis P. A., 2019, "The face-on views of X-shaped "bulges" - boxy features in the central parts of bars", Πρακτικά του συνεδρίου "Galactic Dynamics in the Era of Large Surveys", IAU Symposium No. 353, M. Valluri, & J. A. Sellwood (eds.), International Astronomical Union Proceedings Series, in press.
2. Contopoulos I., 2019, "A Cosmic Battery in accretion flows around astrophysical black holes", Proceedings of Science, in "International Conference on Black Holes as Cosmic Batteries: UHECRs and Multi-messenger Astronomy -BHCB2018", September 12-15 2018, Foz de Iguazu, Brasil.
3. Kalapotharakos C., Kazanas D., Harding A., Contopoulos I. and Wadiasingh Z., 2019, "The Magnetospheres of Merging Neutron Stars", American Astronomical Society HEAD Meeting 17, 112.87.
4. Fukumura K., Kazanas D., Shrader C., Behar E., Tombesi F. and Contopoulos I., 2019, "Confronting UFO Models through Correlation Analysis in AGNs", Amer. Astron. Soc. HEAD Meeting 17, 106.15.

#### **Publications in Greek**

1. G. Contopoulos: "Mans position in the Universe", Aktines, 2019.
2. G. Contopoulos: "Science and Religion", Aktines, 2019.
3. G. Contopoulos: "100 years of the International Astronomical Union", Physics News, H.P.S., 2019.

The contents of the special edition "Advances in Astronomy 2018" are:

1. G. Contopoulos and R. Paez: Order in Chaos
2. P. Patsis: Dynamics of 3-d galactic spirals
3. C. Efthymiopoulos : Tides in our solar system
4. I. Contopoulos: Physical processes around a black hole
5. S. Vasilakos and M. Pleionis: Cosmology: The science of the birth and the evolution of Universe
6. C. Gontikakis: Solar Physics: Study of the upper solar atmosphere
7. M. Georgoulis: Space weather forecasting in era of artificial intelligence: FLARE-CAST program and its main results
8. M. Harsoula, C. Efthymiopoulos and G. Contopoulos: Galactic model of our Galaxy with two pattern speeds
9. V. Tritakis and K. Florios: Empirical-statistical method for the prediction of earthquakes of short space-time window in the Greek territory based on electromagnetic perturbations of low frequency (ELF)
10. C. Karamanos: Characteristic recurrence times (according to Poincaré) for 1-d and 2-d maps

## Distinctions

Dr. C.Efthymiopoulos was elected Vice President of the A4 Committee "Celestial Mechanics and Dynamical Astronomy" of the International Astronomical Union.

Dr. S. Vasilakos received an honorary distinction for the work "22" in the international gravity competition that is done every year in the USA by the Gravity Research Foundation (USA), May 2019.

Dr. M. Georgoulis was jointly invited by ESA and NASA to attend as Official launch of ESA's Solar Orbiter mission from Cape Canaveral in Florida, USA on February 5, 2020. Also in July 2019 he was the only member of the Evaluation Committee of the entire National Solar Observatory of the United States (NSO), which is not a U.S. citizen.

## Participation in Conferences and Talks

### G. Contopoulos

- GC-1. Highlights in Chaos Research, invited talk at the 26th Summer School-Conference: "Chaos in Quantum Mechanics", NTUA, July 14-20.

## **P. Patsis**

- PP-1. European Week of Astronomy & Space Science", special meeting with title "Dynamics of disk galaxies in the era of large surveys", Lyon, France, June 24-28. Talk with title: "Inner boxiness in face-on bars and its relation with peanut-shaped bulges" (25 Ιουτίου).
- PP-2. "Galactic Dynamics in the Era of Large Surveys" (IAU Symposium 353), Shanghai, China, June 30-July 5. Talk with title "The face-on view of X-shaped bulges" (3 Ιουλτίου).
- PP-3. "14th Hellenic Astronomical Conference", conference of hellenic astronomical society, Volos, July 8-11. Talk with title: "The thickness of the spiral arms and how it affects their extent" (July 9). One more talk for the public, in the same conference, with title "Spirals in galaxies" (July 11).
- PP-4. Participation in the 26th Summer School-Conference: "Dynamical Systems and Complexity", NTUA, July 14-20. Invited talk: "Structures supported by chaotic motion in galactic bars"

## **C. Efthymiopoulos**

- CE-1. "Manifold Dynamics: from molecules to Astrodynamics" Invited talk, Department of Physics of the University of Rome (Tor Vergata),
- CE-2. "Semi-Analytical Approaches to Arnold Diffusion". Invited talk in the international conference with title "Dynamical Systems: from Geometry to Mechanics", Department of Mathematics of the University of Rome (Tor Vergata), February 5-8).
- CE-3. "Manifold Dynamics and Orbit Design for Space Missions", Invited talk, Institute for Astrophysics, Planetology and Space Science (IAPS-INAF), Rome (February 12).
- CE-4. "14th Hellenic Astronomical Conference", Volos, July 8-11. Talk with title "Galactic Tidal Streams".
- CE-5. 26o Summer School-Conference: "Dynamical Systems and Complexity", NTUA, Athens, July 14-20. Invited talk with title "Chaos in Hamiltonian Dynamical Systems" (July 17).
- CE-6. "Chaotic Diffusion and its Application for Satellite Orbits". Invited talk, Opening Training School StarDust-Reloaded, Glasgow (December 2-7).

## **I. Contopoulos**

- IC-1. 2nd meeting for Astronomy and Astrophysics in honor of Prof. Vasileios Gerogianni, Department of Physics, University of Patras. Invited talk: "Magnetic winds around black holes" (December 16).
- IC-2. Student meeting of the Hellenic Physical Society, University of West Attica, Piraeus, December 13-15. Invited talk: "The research of pulsars in contemporary Astrophysics" (December 15).
- IC-3. 1st meeting of the international working group of ISSI, Bern, with title: "Models of VHE Emission in Pulsars: Evaluation of the Current State-of-the-Art and Future Prospects", International Space Science Institute, Bern, December 9-12. Talk: "Hybrid Modeling of Pulsar Magnetospheres: a personal view" (December 11).
- IC-4. Invited talk at the Department of Physics of AUTH with title: "Hybrid Modeling of Pulsar Magnetospheres" (November 22).
- IC-5. "14th Hellenic Astronomical Conference", conference of the Hellenic Astronomical Society, Volos, July 8-11. Talk with title: "Dynamics of Accretion-Ejection Flows", (July 10).
- IC-6. International conference with title "Magnetospheres of Neutron Stars and Black Holes", NASA- /Goddard Space Flight Center, Greenbelt, MD, USA, June 10-14. Invited talk with title: "A 'ring of fire' in the pulsar magnetosphere" (June 11).

## **M. Georgoulis**

- MG-1. Working Meeting: Applying ML/AI Technology to Forecasting of Solar Proton Events, NASA Goddard Space Flight Center, Greenbelt, MD, USA, June 27-28. Invited talk with title: "Connecting SEPs to their Parent Solar Eruptions: Self-Consistent Forecasts of the Flare - CME - SEP Trio".
- MG-2. Toward Future Research on Space Weather Drivers, San Juan, Argentina July 2-7. Invited talk with title: "A Comparative Evaluation of Solar Flare Prediction Models: Lessons Learned".
- MG-3. Solar, Heliospheric and Interplanetary Environment (SHINE) 2019, Meeting, Boulder, CO, HPA, August 5-9. Two talks: Invited talk with title "Machine Learning in Solar Eruption Forecasting: A Scene-Setting Attempt" • Talk with title "Coronal Mass Ejection Initiation: A Likely Irreversible Evolutionary Process".
- MG-4. Georgia State University Data Mining Lab Workshop, Atlanta, GA, USA, October 1-2 Invited talk with title: "Data Mining in Heliophysics: a Solar Physicist's Perspective".

- MG-5. Joint GSU – NASA/SRAG Workshop, Atlanta, GA, USA, October 11. Presentation with title “Hierarchical, Two-Tier SEP Forecasting: Data Needs and Construction of Positive
- MG-6. 2019 Fall Meeting of the American Geophysical Union, San Francisco, CA, USA, December 9-13. • Invited talk with title “Which ML or DL Methods are Most Appropriate for Solar Flare Prediction? Possibly, a Misleading Question”. • Talk with title: “Magnetic Impact of Propagating ICMEs in the Solar and Stellar Habitability Zones”.
- MG-7. 2019 COSPAR Bureau Meeting, March 18 - 21, Paris. National representative in COSPAR and head of the local organizing committee of COSPAR, Athens 2022.
- MG-8. Athens COSPAR Site Visit, December 2-3. Head of the local organizing committee of COSPAR, Athens 2022.

### **C. Gontikakis**

- CG-1. 14th conference of the Hellenic Astronomical Society. Talk with title: ‘Analysis of resonant scattering and opacity effects in solar EUV spectra emitted by transition region plasma’, Volos, July 8-11.

### **M. Harsoula**

- MH-1. 14th conference of the Hellenic Astronomical Society. Talk with title: “A Milky Way model with two pattern speeds”.

### **V. Tritakis**

- VT-1. Participation in the conference COST- Electronet, Sopron Hungary, September 2019. Talk with title: “Schumann Measurements in the Greek Area.”

### **A. Tzemos**

- AT-1. 26th Summer School-Conference: “Dynamical Systems and Complexity”, NTUA, July 14-20 Talk with title: “Quantum entanglement and Bohmian Mechanics”.

## **Organisation of Conferences and Meetings**

1. PP-1. Dr. Patsis was member of the scientific organizing committee of
  - the 14th conference of the Hellenic Astronomical Society, Volos, July 8-11.

- the 26th Summer school-Conference: Dynamical systems and Complexity, NTUA, Athens, July 14-20
2. PP-2. Dr. Patsis was the coordinator of the series of 9 talks for the public during the celebrations of the 100 years of the International Astronomical Union.
  3. CE-1. Dr. C. Efthymiopoulos is member of the scientific committee for the international symposium of IAU: "Multi-scale (time and mass) dynamics of space objects", which is going to take place at the Univeristy Al. I. Cuza, Roumania, July 6-10 2020.
  4. CE-2. Dr. C. Efthymiopoulos is member of the scientific committee for the 14th conference of the Hellenic Astronomical Society, Volos.
  5. IC-1. Dr. I. Contopoulos was member of the scientific committee of the "PHAROS Conference 2020: The multi-messenger physics and astrophysics of neutron stars", University of Patras, March 30 April-3 2020 (<https://indico.cern.ch/event/838511/>).
  6. IC-2. Dr. I. Contopoulos was coordinator of the international working group of the International Space Science Institute-ISSI Bern with title "Models of VHE Emission in Pulsars: Evaluation of the Current State-of-the-Art and Future Prospects" (<http://www.issibern.ch/teams/vheemission/index.php/team/>).
  7. IC-3. Dr. I. Contopoulos was member of the scientific committee of the international conference "High Energy Phenomena in Relativistic Outflows VII (HEPRO VII)", Barcelona, July 9-12 Ιουλίου (<https://indico.icc.uib.edu/event/9/>).
  8. SV-1. Dr. S. Vasilakos was coordinator of the international conference "NEB18: New developments in Gravity", 20-22/09/2018, Rhodes.
  9. MG-1. Dr. Georgoulis was co-organized of the meeting "Prediction of Solar Flares and Eruptions, 2019 EGU General Assembly", Vienna, Austria, April 7 – 12. Moreover he was member of the organizing committee for the 2nd China Europe Solar Physics Meeting, Hvar, Croatia, May 6 – 10. Finally of the Joint GSU – NASA/SRAG Workshop, Atlanta, GA, USA, October 11.

## Seminars

RCAAM, aiming at the continuous effort to inform both researchers and postgraduate students in modern research, organizes weekly seminars, funded mainly by the Academy of Athens, by decision of its Council, while some researchers of foreign institutions were funded by their institutions to come and speak in the seminars. In 2019 46 seminars took place at RCAAM, most of them about Astronomy, Astrophysics and Mechanics.

The invited speakers were, beside the researchers and students of RCAAM, Academicians, professors and distinguished scientists from various universities and research centers in Greece and abroad. Here is the complete list of the seminars.

### Invited Talks 2019

<b>Antonios Nathanail</b> Institute of theoretical Physics, Frankfurt	Neutron Star Collisions: Gravitational Waves and the Era of Multi-Messenger Astronomy	15/1/2019
<b>PanosPatsis</b> RCAAM of the Academy of Athens	Thick spirals revisited	29/1/2019
<b>AthanasiosTzemos</b> RCAAM of the Academy of Athens	Bohmian Trajectories of 3-qubit Entangled Systems	5/2/2019
<b>Konstantina Zouloumi</b> RCAAM of the Academy of Athens	Invariant Manifolds and Chaos in Milky Way and N-body models of barred galaxies	12/2/2019
<b>Christos Efthymiopoulos</b> RCAAM of the Academy of Athens	Semi-analytical approaches to Arnold diffusion	19/2/2019
<b>Constantinos Gontikakis</b> RCAAM of the Academy of Athens	Forecasting solar flares with the use of extreme ultraviolet radiation	26/2/2019
<b>NektariaGkizani</b> Hellenic Open University	The importance of Radio astronomy. The Hellenic radio telescope	4/3/2019
<b>Lia Athanassoula</b> University of Marseille	Formation, Evolution and Dynamics of Thick Discs	12/3/2019
<b>Constantinos Alissandrakis</b> University of Ioannina	mm- $\lambda$ observations of the quiet Sun with the Atacama Large millimeter and sub-millimeter Array (ALMA)	19/3/2019
<b>Stelios Kazantzidis</b> UOA	Investigating modern problems of Theoretical Astrophysics via N-body simulations	26/3/2019
<b>Stamatios Krimizis</b> Academy of Athens	Voyagers 1 and 2 in the Near Interstellar Medium: Observations and Predictions	2/4/2019
<b>Nicolaos Kylafis</b> UOC	Mass accretion and jet ejection in black-hole X-ray binaries	9/4/2019
<b>Pantelis Papadopoulos</b> UTH	High up in transparent skies, and other Seas	16/4/2019
<b>Ioannis Kontogiannis</b> Leibniz Institut for Astrophysics	Observing the Sun with the GREGOR telescope	23/4/2019



<b>Kanaris Tsiganos</b> UOA	Astrophysical Jets	7/5/2019
<b>Nicolaos Sergis</b> Office of Space Research and Technology of the Academy of Athens	Plasma dynamics in the magnetosphere of Saturn	14/5/2019
<b>Antonis Georgakakis</b> NOA	Forward Modeling the Energetic Universe: semi-empirical methods for interpreting the properties of Active Galactic Nuclei	21/5/2019
<b>Constantinos Bouratzis</b> UOA	Fine Structure of Metric Type IV Radio Bursts Observed with the ARTEMIS-JLS Radio-Spectrograph	28/5/2019
<b>Costas Tziotziou</b> NOA	The Sun: from worship, to philosophy and scientific observation and interpretation	4/6/2019
<b>Christos Efthymiopoulos</b> RCAAM of the Academy of Athens	Chaos at the crossroad: the dynamics of navigation satellites	11/6/2019
<b>Constantinos Dialynas</b> Office of Space Research and Technology of the Academy of Athens	Recent advances in the study of the global Heliosphere using Energetic Neutral Atoms from Cassini combined with Voyager 1 and 2 energetic ions	18/6/2019
<b>Spiros Antiochos</b> NASA/GSFC	The Magnetic Connection Between the Sun and Interplanetary Space	16/7/2019
<b>Eleni Christodoulidi</b> RCAAM of the Academy of Athens	The Fermi-Pasta-Ulam problem: Ergodic or not?	23/7/2019
<b>Perseas Christodoulidis</b> University of Groningen	Scaling attractors in multi-field inflation	10/9/2019
<b>George Contopoulos</b> Academy of Athens	A historical overview of George Contopoulos' scientific work (I)	17/9/2019
<b>George Contopoulos</b> Academy of Athens	A historical overview of George Contopoulos' scientific work (II)	24/9/2019
<b>Amr El-Zant</b> British University Aigyppt	'Heating' Dark Matter: Gas Fluctuations and Quantum Effects on Galactic Scales	1/10/2019

<b>Ioannis Contopoulos</b> RCAAM of the Academy of Athens	Hybrid Numerical Simulations of Pulsar Magnetospheres	8/10/2019
<b>Christos Efthymiopoulos</b> RCAAM of the Academy of Athen	Universal Quantum Equilibrium and the interpretation of quantum probabilities	15/10/2019
<b>George Papadopoulos</b> UTH	Preserving Kerr symmetries in deformed space-times	22/10/2019
<b>Ioannis Myserlis</b> Max Planck Institut	High-accuracy, linear and circular radio polarimetry as a probe of physical conditions in jets and outflows	29/10/2019
<b>Athanasios Tzemos</b> RCAAM of the Academy of Athen	Bohmian trajectories of entangled qubits	5/11/2019
<b>Lia Athanassoula</b> University of Marseille	What determines the formation and evolution of a bar in disc galaxies?	12/11/2019
<b>Stella Voula</b> UOA	Modeling the non-thermal emission from blazars	19/11/2019
<b>George Lukes-Gerakopoulos</b> Czech Academy of Sciences	Dynamical astronomy in extreme mass ratio inspirals	26/11/2019
<b>Lukas Vlachos</b> ΑΠΘ	Transport and acceleration of particles in turbulent astrophysical plasmas	4/12/2019
<b>Despoina Skoulidou</b> UTH	Dynamics of artificial satellites and space debris in near Earth region	10/12/2019
<b>Nicolaos Pappas</b> University of Thessaly	The large D limit of Gravity: applications and implications	10/12/2019
<b>Sophia Lianou</b> UOA	Interstellar medium and star formation properties in local Universe galaxies	16/12/2019
<b>Evangelos Sfakianakis</b> University of Leiden	Attractors, Bifurcations and Curvature in Multi-Field inflation	16/12/2019

<b>Constantinos Pallis</b> AUTH	B-L Higgs inflation Confronts PLANCK and LHC	17/12/2019
<b>Kyriaki Antoniadou</b> AUTH	Periodic orbits in the era of exoplanetary discoveries	17/12/2019
<b>Ioannis Dalianis</b> ΕΜΠ	Exploring the universe through the stochastic gravitational wave background	19/12/2019
<b>Mathaios Katsanikas</b> Univeristy of Bristol	The Phase Space Transport in a Caldera potential energy surface	23/12/2019
<b>Eleni Vardoulaki</b> Max Planc Institute	Radio AGN and their role in galaxy evolution	30/12/2019
<b>Grigorios Panotopoulos</b> University of Lisbon	Probing the unknown nature of Gravitation and Dark Matter in the Universe with compact objects	30/12/2019

## Teaching

Researchers of RCAAM taught postgraduate courses in university departments, seminars for students and researchers, and schools organized by scientific associations.

- **Dr. Patsis** taught, under assignment, the postgraduate lesson “Galactic and Extragalactic Astronomy” of the Astronomy, Astrophysics and Mechanics Division of UoA, (in collaboration with assistant professor Dr. S. Kazantzidis).
- **Dr. Efthymiopoulos** taught, under assignment, the postgraduate lesson “Dynamical Astronomy” in the postgraduate program Astronomy-Astrophysics of the Physics Department of UoA. He also taught, under assignment, the postgraduate lesson “Hamiltonian Perturbation theory and Applications in Celestial Mechanics”, in the Department of Mathematics of the University Rom II (Tor Vergata).
- **Dr. Basilakos** taught the lesson of Cosmology in the Mathematics and Physics Departments of UOA.
- **Dr. Georgoulis** taught, as a visiting professor in the Georgia State University, during the second semester of 2019 the introductory course “ASTR1010: Astronomy of the Solar System”.

- **Dr. Gontikakis** made two seminars for the lesson of Solar and Space Physics of UOA:
  - 1) "Heating of solar corona", April 10.
  - 2) "Solar spectroscopy in ultraviolet frequencies", April 11.

## Phds and Masters

RCAAM researchers participate in other PhD supervision committees inside and outside of RCAAM. Specifically, during 2019 RCAAM members supervised the PhD of:

- Dr. Patsis was co-supervisor of the PhD thesis of Leonardo Chavez Velasquez at Instituto Nacional de Astrofisica, Optica y Electronica (INAOE), Puebla, Mexico, with title "Numerical and Analytical Studies of Orbits in Models of Spiral Galaxies" (in the framework of programm "7"). The thesis was successfully presented in February 25 at the INAOE Institute of Mexico. Dr. Patsis is co-supervisor of the PhD thesis of Magdalini Aggelakopoulou with title "Numerical and theoretical study of 3-d Hamiltonian systems in Finance" (Department of Financial Studies, University of Thessaly).
  - Dr. Efthymiopoulos supervises the PhD thesis of Constantina Zouloumi at the University of Athens with title "Manifold theory of the spires and multiple pattern speeds in simulations of N-body discs". Moreover Dr. Efthymiopoulos was member of the scientific boards of the Ph.D. thesis of M. Volpi, Namur, Belgium, July 2019, M. Hatifi, Fresnel Institutue, Marseille, September 2019 and Skoulidou, Despoina, AUT, September 2019.
  - Dr. Contopoulos supervised the PhD thesis of E. Coutsantoniou with title "Study of radiation of the accretion discs around black holes". He is also member of the advisory committee of the PhD thesis of X. Sinnis (UOA) with title "Study of the stability of relativistic magnetised astrophysical jets". Finally he was member of the scientific board for the thesis of the postgraduate student P. Stefanou, UOA with title "Particle Acceleration in the Current Sheet of the Pulsar Magnetosphere".
  - Dr. Vasilakos supervises the PhD thesis of Ioannis Papagiannopoulos at the University of Athens with title "Study of symmetries in cosmological models of alternative gravity". Moreover he supervises the Phd thesis of Fotios Anagnostopoulos (UOA) with title "Study of the accelerating expansion rate of the Universe" and the PhD thesis of Pavlina Tsiapi (NTUA) with title "Study of the dark energy via cosmological microwave radiation from Planck"
- Finally, Dr. Vasilakos is member in the advisory board of the Phd thesis of A. Papageorgiou (AUTH) with title "Cosmological parameters and dark energy", A. Triantafyllopoulos (UOA) with title "Finsler geometries and cosmological

extensions” and G. Gakis (NTUA) with title “Generalized theories of gravity in the tangent bundle”.

- Dr. Georgoulis is member the advisory board of the Phd thesis of Loukas Xaplanteris at the Department of Physics in UOA with title “Coupling between primary and secondary cosmic radiation coming from galaxies and the sun”. Dr. Georgoulis is member of the board of the Phd thesis of Evangellia Samara, Department of Mathematics of the Katholieke Universiteit Leuven, Belgium, with title “Improved Model for Solar Wind Prediction Including Solar and Stellar Coronal Mass Ejection”.

Finally Dr. Georgoulis is scientific advisor in the Phd thesis of Varun Chaturmutha (supervisor: Prof. S. Jefferies, GSU Physics & Astronomy), Sumanth Rotti (supervisor: Prof. P. Martens, GSU Physics & Astronomy) and Azim Ahmadzadeh, Maxwell Hostetter & Ruizhe Ma (supervisor: Prof. R. Angryk, GSU Computer Science) and the MSc thesis of Xumin Cai (supervisor: Prof. R. Angryk, GSU Computer Science).

- Dr. Gontikais was member of the scientific board of the Phd thesis of Gabriel Pelouse with title: “Interprétation unifiée des écoulements associés à des cycles de condensation et d’évaporation dans les boucles coronales”, which was successfully presented in September 25 in Paris.

He also gave a talk at the department of Space Physics of UOA with title “Trying to predict solar bursts in the far UV”, March 6

Finally he is supervisor of the theses of the graduate students of the Physics Department of UOA S. Pastras with title “Study of the scattering of the uv radiation at a solar active region” and S. Athanasiou with title “Study of the geometry of the loops of the transition region and the corona of the solar atmosphere

- Dr. Harsoula is member of advisory board of the PhD thesis of Constantina Zouloumi with title “Manifold theory of the spires and multiple pattern speeds in simulations of N-body discs”.

## Missions – Visits to other Research Institutions

### 1. Panos Patsis

Invited visitor in the “Instituto Nacional de Astrofísica, Óptica y Electrónica” (INAOE) (October 1-15) by the Professor I. Puerari for collaboration with his group in the field of Galactic Dynamics, where he made 3 seminars (PP-2)

### 2. Christos Efthymiopoulos

Invited visiting professor in the Department of Mathematics of the University Tor Vergata of Rome (January-February 2019).

He also visited the Aix- Marseille University, September 2019.

### 3. **Ioannis Contopoulos**

International Space Science Institute, Bern, December 2019 (for the 1 meeting of the international group which he leads).

He visited the Physics Department of AUT, November 22 for collaboration with Professors D. Papadopoulos and N. Vlahos.

He also visited the Observatory of Strasburgm July 2019. Collaboration with Professor Jérôme Pétri.

He finally visited the NASA/Goddard Space Flight Center, Greenbelt, MD, USA, June 2019. Collaboration with D. Kazanas, C. Kalapotharakos and A. Harding.

### 4. **Spiros Basilakos**

He visited the Departments of Physics:

- of the Cambridge University where he gave an invited talk, March 2019.
- of the European University of Cyprus where he gave an invited talk, July 2019.
- of the University of Barcelona where he gave an invited talk, November 2019.
- of the University of Patras where he gave an invited talk, December 2019.
- of the AUT for the honorary doctorate of the Nobel price winner Kip Thorne, May 2019.

### 5. **M. Georgoulis**

He visited, after invitation, the John Hopkins University Applied Physics Laboratory, Laurel, MD, ΗΠΑ, June 2019, where he gave a talk with title "Coronal Mass Ejections: Why and How?"

### 6. **V. Tritakis**

In November 2019 he visited the University of Ioannina for collaboration with there technical team. A maintenance visit was made and observations were collected from the station located near the community of Doliana, outside the Kalpaki.

## **Incoming Visitors**

- Dr. P. Papadopoulos, associate professor in the University of Thessaloniki was hosted at RCAAM for collaboration with Dr. Patsis, Dr. Efthymiopoulso and Dr. Basilakos. (July and August 2019)

## **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 were invited to give lectures in educational institutions and events for the public. They also wrote articles for the public while their interventions helped to disseminate the research results of the Centre.

- P. Patsis: Presentation of the scientific activity of RCAAM in the national radio station of the Hellenic Church (8/1).

"Spirals in galaxies": Talk in the framework of the "14th Hellenic Astronomical Conference", of HELASET for the 100 years of the International Astronomical Union (IAU), July 11.

- C. Efthymiopoulos: Coordination of the Eratosthenis experiment, in collaboration with the High School of the Volos, May 2019.

Astronomical observation of objects in deep space in collaboration with the Junior High School of Anavryta, June 2019.

- I. Contopoulos: "Astronomy in the 21th century", camping of the Church of Nafpaktos, July 13. "Meeting with a researcher", High School of Callipolis, Peiraus, April 15. "Space trip", 7th Elementary School of Glyfada, February 18. "Space trip", 12th Elementary School of Glyfada, February 18.

- S. Vasilakos: An appearance in COSMOTE TV and 2 interviews in radio stations.

- M. Georgoulis:

"Space Weather: How it Plays Out in the Solar System and What Could it Mean for Other Stars and Exoplanets", Charlie Elliott Astronomy Club of Atlanta, Charlie Elliott Wildlife Center, GA, USA, February 2.

"Human appearance in the solar system and space weather, Museum of Chios, August 24.

Publication of the book with the title "Space Weather" by M. Georgoulis, Papadopoulos Press, (ISBN: 978-960-569-789-1), January 2019 Two coverages from electronic media •"Dr. Nour-Eddine Raouafi: The truth is out there, interview of the scientific coordinator of the Parker Solar Probe of NASA in the Huffington Post of Greece.

"Diving" in the core of a solar storm", a review of the Professor L. Vlahos of AUT for the book "Space Weather".

- An appearance in the radio station "Truth" of Chios, with Dr. Christina Gi-anopappa (ESA) August 23.

- Official presentation of the book *Space Weather* by M. Georgoulis in the bookstore Public.
- C. Gontikakis: "Solar eruptions", talk in the framework of the "14th Hellenic Astronomical Conference", of HELASE for the 100 years of the International Astronomical Union (IAU), July 11.  
"Apollo 11", talk in the Rotary Club of Glyfada, July 18.
- M. Harsoula: Talk at the 1st EPAL of Sivitanideios School with title "Exploring the near and far Universe", March 2019  
Talk at the 1st Elementary School of Papagou with title "Exploring the near and far Universe", November 2019.
- V. Tritakis: "The third industrial revolution", Rotary Club of Glyfada. "Astronomy and Astrology", Rotary Club of Glyfada.  
Finally, KEAEM organized a series of 9 talks for the general public in the Eastern hall of the Academy of Athens, on the occasion of the completion of 100 years since establishment of the International Astronomical Union (IAU).
  1. K. Tsiganos (UOA): "100 years of astronomical discoveries" (11/1).
  2. P. Patsis: "The spirals of the galaxies" (27/2).
  3. I. Contopoulos: "The research of pulsars in contemporary Astrophysics" (27/3).
  4. C. Gontikakis: "Solar eruptions" (17/4).
  5. M. Harsoula: "Tides in the Universe" (29/5).
  6. V. Tritakis: "The social and financial consequences of the space research: (26/6).
  7. S. Krimizis (Academician): "The Space Age of Humanity: 50 Years after the landing on the Moon and 62 years of the robotic exploration of the Solar System (17/7).
  8. C. Efthymiopoulos: "Modern achievements of the Celestial Mechanics: Solar system, black holes and galaxies (30/10).
  9. S. Vasilakos: "Modern Cosmology: From the big bang to the dark energy" (27/11).