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Contents

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Collaborators: (Other than those described in pages 8-10): Mygdakos Constantinos, software egineer in the framework of the program SSA/SWE Solar Weather Expert Service Center(in collaboration with M. Georgoulis), Demetrios Papadopoulos (AUTH), Demosthenes Kazanas (NASA/Goddard), Ioannis Mysleris (MPI Bonn) and Jerome Petri (Univ. of Strasburg) (in collaboration with I. Contopoulos).

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 2019-20 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 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 scientific stuff of RCAAM participated during 2020 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, K. Zouloumi).
   Publications in journals with referees No: ”6”
   Publications in conference proceedings No: ”1”

2. **“Dissemination of research results”** Program funded from the general bequests for education of the Academy of Athens (200/962) (G. Contopoulos, A.C Tzemos). 6 seminars at the RCAAM and a special volume of RCAAM (see catalog in the paragraph ”Seminars”).

3. **“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 “2-5”
   Talks: AT-1

4. **“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 parer in preparation.

5. **“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 supports visits of the researchers for collaborations.

6. **‘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.

7. **“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 fur 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.

8. **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.

9. **"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: "12", "14-21".

10. **"Skylight: European Space Agency"** (Program fo the development of broad-band network at the Helmos Observatory in the framework of the corresponding program of ESA. Participation from RCAAM: S. Vasilakos

11. **"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.

12. **"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: "25", "27".

13. **" 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: "22".

14. **"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 (12/2017-2/2021). Program number: not defined yet. Total budget (for the Academy of Athens): 120.000 Euros

15. **"Advanced Particle Events Casting System (ASPECS)"** Sponsored by ESA. Principal Investigator: Dr. Anastasios Anastasiadis, NOA. Participator from RCAAM: M. Georgoulis. (2017-2020). Total budget for the Academy of Athens:= 150.000 Euros.

16. **"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 2020. Total budget:= 500.000 Euros.
Publication in journals with referees: "3".
Publications in conference proceedings No: "3"

17. **"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.
Publication in journals with referees: "24".
Publications in conference proceedings No: "2, 4, 5".

18. **"Space Weather Training Network (SWATNET)"**. Sponsor: European Union, Horizon 2020 Programme National Scienc Foundation. Principal researcher: Dr. E. Kilpua, University of Helsinki, Finland. Participation from RCAAM, M. Georgoulis. March 2020– September 2025. Total budget: 3.128.225 Euros. .

19. **"Machine Learning for Solar Energetic Particle (SEP) Event Forecasting"**. Sponsor: NASA. Principal researcher: Dr. I. Kitiashvili, NASA Ames Space Flight Center. Participation from RCAAM, M. Georgoulis. March 2020–undefined .

20. **"Marie Curie Innovative Training Network StarDust-Reloaded: The asteroid and Space Debris Network v2.0"** (C. Efthymiopoulos, M. Harsoula, E. Legnaro), funded by the european union in the framework of Horizon 2020 action.
2 papers in preparation for journals with referees.
Talks-presentations: MH-1

21. **"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. Addition of a second permanent station of Schumann waves on the mountain Parnon. Collaboration with the Schumann Resonance grop of the Polish University of Krakow and installation of an individual Polish Schumann station on the on mountain Parnon.

Publications in 2020

Special Editions

RCAAM published a special volume (in Greek) with title "Advances in Astronomy 2019" (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 3nd issue (Volume 3) of the journal of Hellenic Astronomical Society ”Hipparchos”, (June 2020).

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.

Publications in International Journals with Referees

(Published or accepted for publication in 2020)

1. Contopoulos G., 2020: “A review of the “Third’’ Integral’’, Math. In Engineering, 2 (3), 472.
2. Contopoulos G. and Tzemos A.C., 2020: “Chaos in Bohmian Quantum Mechanics: A short review”, Regul. Chaotic Dyn., 25, 476.
3. Tzemos A.C. and Contopoulos G., 2020: “Ergodicity and Born’s rule in an entangled 2-qubit Bohmian system’’, Phys. Rev. E, 102, 042205.
4. Tzemos A.C. and Contopoulos G., 2020: “Chaos and ergodicity in an entangled two- qubit Bohmian system”, Phys. Scr., 95, 065225.
5. Tzemos A.C. and Contopoulos G., “Integrals of motion in time periodic Hamiltonian systems: The case of the Mathieu equation’’, Regul. Chaotic Dyn. (in press).
6. Efthymiopoulos C., Harsoula M. and Contopoulos G., 2020: “Manifold spirals in barred galaxies with multiple pattern speeds’’, Astron. Astroph., 636, A44.
7. Patsis P.A., Xilouris E.M., Alikakos J. and Athanassoula E.: “Edge-on boxes with X-features as parts of galactic bars. NGC 352: A direct piece of observational evidence” Astron. Astroph. (in press).
8. Contopoulos I., Petri J. and Stefanou P., 2020: “Hybrid numerical simulations of Pulsar magnetospheres”, Mon. Not. R. Astron. Soc., 491, 5579.
9. Myserlis I. and Contopoulos I., 2020: “An underlying universal pattern in galaxy halo magnetic fields”, Astron. Astroph. (in press).
10. Florios K., Contopoulos I., Christofilakis V., Tatsis G., Chronopoulos S., C. Repapis C. and Tritakis V., 2020: “Pre-seismic electromagnetic perturbations in two earthquakes in Northern Greece”, Pure Appl. Geophys. 177, 787.
11. Florios K., Contopoulos I., Tatsis G., Christofilakis V., Chronopoulos S., Repapis C. and Tritakis V., 2020: “Possible earthquake forecasting in a narrow space-time-magnitude window” Earth Sci. Inform., 1-16.

12. Basilakos S. and Anagnostopoulos F., 2020: “Growth index of matter perturbations in the light of Dark Energy Survey ”, Eur. Phys. J. C, 80, 212.

13. Basilakos S., Mavromatos N. and Sola J., 2020: “Gravitational and chiral anomalies in the running vacuum universe and matter-antimatter asymmetry”, Pys. Rev. D., 101, 045001.

14. Basilakos S., Mavromatos N. and Sola J., 2020: “Quantum anomalies in string-inspired running vacuum universe: Inflation and axion dark matter”, Phys. Lett. B., 803, 135342.

15. Mehrabi A. and Basilakos S., 2020: “Does Λ CDM really be in tension with the Hubble diagram data?”, European Phys. J. C, 80, 632.

16. Anagnostopoulos F., Basilakos S. and Saridakis E., 2020: “Observational constraints on Barrow holographic dark energy ”, European Phys. J. C, 80, 826.

17. Papagianopoulos G., Basilakos S. et al., 2020: “Dynamics in varying vacuum Finsler-Randers cosmology”, European Phys. J. C, 80, 816.

18. Mavromatos N., Sola J. and Basilakos S., 2020: “String-inspired running vacuum—The Vacuumon-And the Swampland criteria”, Universe, 6, 218.

19. Yang W., Di Valentino E., Pan S., Basilakos S. and Paliathanasis A., 2020: “Metastable dark energy models in light of Planck 2018 data: Alleviating the H0 tension”, Phys. Rev. D., 102, 3503.

20. Papagianopoulos G., Tsiapi P., Basilakos S. and Paliathanasis A., 2020: “Dynamics and cosmological evolution in Λ -varying cosmology”, European Phys. J. C, 80, 55.

21. Bresolin F., Rizzi L., Ho I.-T., Terlevich R., Terlevich E., Telles E., Chavez R., Basilakos S. and Plionis M., 2020: “Internal kinematics of giant H II regions in M101 with the Keck Cosmic Web Imager”, Mon. Not. R. Astron. Soc., 495, 4347.

22. Park S-H., Leka K. D., Kusano K., et al. (incl. Georgoulis M. K.), 2020: “A 4357/ab65f0 Comparison of Flare Forecasting Methods. IV. Evaluating Consecutive-day Forecasting Patterns”, Astrophys. J., 890, 12.

23. Korsós M., Georgoulis M. K., Gyenge N. T. et. al., 2020: “Solar flare prediction using magnetic field diagnostics above the photosphere”, Astrophys. J., 896, 119.

24. Angryk R., Martens P. C., Aydin B et al. (incl. Georgoulis M. K.), 2020: “Multivariate time series data set for space weather data Analytics”, Nature Scient. Data, 7, 227.

25. Ruillard A. P., Pinto R. F., Vourlidas A. et al. (incl. Georgoulis, M. K.), 2020: "Models and data analysis tools for the Solar Orbiter Mission", Astron. Astroph., 642, A2.

26. Patsourakos S., Vourlidas, A., Torok T. et al. (incl. Georgoulis, M. K.), 2020: "Decoding the pre-eruptive magnetic field configurations of coronal mass ejections, Space Sci. Rev., 216, 131.

27. Zouganelis I., De Groof A., Walsh A.P., Williams D.R., Muller D., St Cyr O.C. et al. (incl. Gontikakis C. and Georgoulis M.K.), 2020: "The Solar Orbiter Science Activity plan.
Translating solar and heliospheric physics questions into action", Astron. Astroph., 642, 19.

28. Kontogiannis I., Tsiropoula G., Tziotziou K., Gontikakis C. et al., 2020: "Emergence of small-scale magnetic flux in the quiet Sun", Astron. Astroph., 633, 13.

29. Tatsis G., Christofilakis V., Chronopoulos S.K., Kostarakis P., Nistazakis H.E., Repapis C. and Tritakis V., 2020: "Design and implementation of a test fixture for ELF Schumann resonance antenna receiver and magnetic permeability measurements", Electronics, 9 (1), 171.

30. Tatsis G., Christofilakis V., Chronopoulos S.K., Baldoumas G., Sakkas A. et al. (incl. Tritakis V.), 2020: "Study of the variations in the Schumann resonances parameters measured in a southern Mediterranean environment", Sci. Total Environ., 715, 136926.

1. Patsis P.A., 2020: "The face-on views of X-shaped "bulges" - boxy features in the central parts of bars, Galactic Dynamics in the Era of Large Surveys", held 30 June - 5 July, 2019 in Shanghai, China. Proc. of the Int. Astron. Union 353, 162.

2. Cai X., Aydin. B., Ji A., Georgoulis M. K. and Angryk R., 2020: "A Framework for Detecting Polarity Inversion Lines from LoS Magnetograms", 2020 IEEE International Conference on Big Data.

3. Ji A., Aydin B., Georgoulis M. K. and Angryk R., 2020: "All-Clear Flare Prediction Using Interval-based Time Series Classifiers", 2020 IEEE International Conference on Big Data.

4. Aydin B., Ahmadzadeh A., Georgoulis M. K. and Angryk R., 2020: "Deep Neural Network-based Active Region Magnetogram Patch Super Resolution", 2020 IEEE International Conference on Big Data.

5. Habeeb M. S., Aydin B., Ahmadzadeh A., Georgoulis M. K. and Angryk R., 2020: "Neural Network-based Magnetogram Super Resolution", 2020 IEEE International Conference on Big Data.

6. Harsoula M., 2020: “The building blocks of spiral arms in galaxies”, Hipparchos, 3, 13.

Publications in Greek

1. G. Contopoulos: “Science as a value”, Aktines, 2020.
2. G. Contopoulos: “Order, Chaos and Randomness”, Aktines, 2020.
3. S. Vasilakos: “New perspectives for the Xelmos Observatory in the program ScyLight: European Space Agency”.
4. V. Tritakis: “Fourth Insustrial or Digita Revolution”. Newspaper “ΠΑΛΜΟΣ” (4 issues).
5. V. Tritakis: “200 years from 1821”. Newspaper “ΠΑΛΜΟΣ” (2 issues).

The contents of the special volume of RCAAM “Advances in Astronomy 2019” are :

1. G.Contopoulos, A.C. Tzemos and K. Zouloumi: The emergence of chaos in Bohmian Quantum Mechanics.
2. P. Patsis: The analysis of astronomical images as a tool for the understanding of Galaactic Dynamics
3. I. Contopoulos: Some thoughts for the current sheet in the magnetosphere of a pulsar.
4. S. Vasilakos: The variable vacuum energe as a mechanism for the understanding of the cosmic history of the Universe.
5. C. Gontikakis, I. Kontogiannis, G. Tsiropoula and K. Tziotziou: Solar Physics: Morphological study of the quiet Sun.
6. M. Harsoula, C. Efthymiopoulos and G. Contopoulos: The structural elements of the galactic spirals.
7. K. Florios and V. Tritakis: Forecasting of geophysical phenomena with advanced statistical methods. The case of predicting future seismic activity.

Distinctions

Dr. M. Georgoulis:

1. Was invited to serve as scientific editor of the AAS Journals of the American Astronomical Society.
2. Was appointed as advisor of the Georgia State University after the end of his tenure as Visiting Professor of the program Next Generation.
3. Was invited from ESA and NASA to to watch as official the launch of the Solar Orbiter space mission from Cape Canaveral, USA.

Participation in Conferences and Talks

P. Patsis

PP-1. Virtual Conference: "Chaos Indicators, Phase Space and Chemical Reaction Dynamics", May 4-6 Μαΐου, University of Bristol. Invited talk: "The phase-space structure at the radial and vertical 2:1 resonance region of disc galaxy models" (May 6).

PP-2. Conference o "The Dynamic Universe", Ringberg Castle, Bavaria[1].

I. Contopoulos

IC-1. "The Data Science Conference", Chicago, 14-15 Μαΐου 2020, Virtual Conference.

IC-2. Pahellenic Conference of Πανελλήνιο συνέδριο of the HPS "Η Φυσική μαγεύει", Eretria, September 25-27. Invited talk: " The research of pulsars i contemporary Astrophysics", September 25.

IC-3. "Understanding the Most Energetic Cosmic Accelerators: Advances in Theory and Simulation", Princeton Center for Theoretical Science, October 28-30 , Virtual Conference.

S. Vasilakos

SV-1. European Space Agency 18/08/2020.

SV-2. French Aerospace Society THALES, September 2020.

SV-3. German Society HB November, 2020.

[1]The participation and the invited talk were postponed due to the COVID-19 pandemic

M. Georgoulis

MG-1. EarthCube RCN Workshop: Machine Learning in Heliophysics and Space Weather Forecasting, January 16-17, New Jersey Institute of Technology, Newark, NJ, ΗΠΑ. Invited Talk "Fusing Space Weather Forecasting and Machine Learning in EarthCube's Framework".

MG-2. 2020 EarthCube Annual (Virtual) Meeting (Virtual), June 18 Ιουνίου,Boulder, CO, ΗΠΑ.

MG-3. Machine Learning, Data Mining and Data Assimilation in Space, September 21-24, Johns Hopkins University Applied Physics Laboratory (JHU/APL), Laurel, MD, ΗΠΑ (Διαδικτυακό). Invited tal "Data Mining and
Machine Learning in Solar Weather Forecasting Applications".

MG-4. PROBA-3 Science Working Team Meeting, September 22 Σεπτεμβρίου, Royal Observatory of Belgium, Βέλγιο (Virtual).

MG-5. ESA SWE Service Network Workshop, October 12-14, ESA/ESOC, Darmstadt, Γερμανία (Virtual).

MG-6. Solar Orbiter Modeling and Data Analysis Working Group (MADAWG) Workshop, October 26-27, ESA/ESAC, Madrid, (Virtual.

MG-7. European Space Weather Symposium (ESWS) 2020, November 2-6, University of Glasgow, Scotlnd and GB (Virtual). Short presentation "Facilitating the Systematic Application of Machine-Learning
Algorithms to Solar Flare and Eruption Forecasting: the SWAN-SF Benchmark Dataset".

MG-8. AAS Science Editors Meeting, April 3, USA (Virtual).

MG-9. Advisory Board Meeting, Artificial Intelligence for Data Analysis (AIDA), June 26, KU Leuven, Belgium (Virtual).

V. Tritakis

VT-1. Conference: "COST Action ELECTRONET Schumann resonance - WG4 workshop", February 25-28, Santander, Spain, University of Cantabria. Two announcements:

- "Possible Use of Pre-seismic SR Signals as a Forecasting Tool." https://www.atmospheric-electricity-net.eu.
- "Types and Sources of noise in the recorded data".

A. Tzemos

AT-1.

AT-2. Participation in the international online conference on Quantum Mechanics and Quantum Technologies " Quantum 2020: International ", organized by the IOP Publishing, 19-22 / 10/2020. Presentation of the electronic poster "Chaos and entanglement in Bohmian Qubits ".

Organisation of Conferences and Meetings

1. IC-1 Dr. I. Contopoulos:
   - Conference "PHAROS Conference 2020: The multi-messenger physics and astrophysics of neutron stars", University of Patras, March 30 - April 2020. [2]
   - Coordinator and leader of the International Working Group of International Space Science Institute-ISSI Bern on "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/).
2. MG-1. Dr. M. Georgoulis:
   - Workshop co-organizer of EarthCube RCN Workshop: Machine Learning in Heliophysics and Space Weather Forecasting, New Jersey Institute of Technology, Newark, NJ, ΗΠΑ, January 16 – 17 2020.
   - Member of the Scientific Organizing Committee, Online Advanced Study Program on Helicities in Astrophysics and Beyond, 2020 - 2021. Program of webinars on the elixir and its species in Astrophysics and Natural Sciences in general. It was organized by the IZMIRAN research center of the Russian Federation.

[2] Member of the Scientific and Local Organizing Committee of the international conference. (https://indico.cern.ch/event/838511/). The conference was canceled at the last minute due to COVID-19.

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 2020 only 6 seminars took place at RCAAM, due to the COVID-19 pandemic, most of them about Astronomy, Astrophysics and Mechanics.

The invited speakers were, besides 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 2020

Panos Patsis RCAAM of the Academy of Athens	Some open issues in Galactic Dynamics and the contribution of Image Processing in resolving them	14/1/2020
George Dimopoulos NOA	Coronal properties of Sy I Active Galaxies	21/1/2020
Athanasios Tzemos RCAAM of the Academy of Athens	Chaos and ergodicity in the trajectories of two entangled Bohmian qubits	28/1/2020
Constantinos Gontikakis Γοντικάκης RCAAM of the Academy of Athens	Moss, the trace of hot loops in EUV, an ongoing research	11/2/2020
Elias Koulouridis NOA	Tracing the Universe: X-ray surveys and cosmology	18/2/2019
Vasileios Basios University of Brussels	Labyrinth Chaos: Conservative, non-Hamiltonian Chaos without Attractors	25/2/2020
Anastasios Anastasiadis NOA	Unveiling Current Challenges in Space Weather Forecasting: The SAWS-ASPECS tool	3/3/2020

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. Basilakos** taught the lesson of Cosmology in the Mathematics and Physics Departments of UOA.
- **Dr. Gontikakis** participated in the teaching of the course of Solar Physics in the 3rd year of the Physics Department of the University of Athens, in collaboration with Prof. G. Daglis, Dr. A. Cheilaris, Dr. Chr. Katsavrias during the winter semester (October -June-December) of the Academic year 2020-2021.

Phds and Masters

RCAAM researchers participate in other PhD supervision committees inside and outside of RCAAM. Specifically, during 2020 RCAAM members supervised the PhD of:

- Dr. Patsis 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. 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 of X. Sinnis (UOA) with title "Study of the stability of relativistic magnetised astrophysical jets" and of the PhD thesis of V. Bisketzis (UOA) with title "Plasma Dynamics in the environment of a rotating black hole". Finally he supervises the thesis of the postgraduate student V. Spyrakou (UOA) with title "Magnetized accretion disks which produce winds" and the thesis of A. Dogas (UOA) with title "New method of using current sheets in the ideal MHD"
- 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”.

Dr. Georgoulis is also a member of the Advisory Committee of the thesis of the PhD candidate Aparna Venkataramanasastry in the Department of Physics and Astronomy of Georgia State University, USA, with the indicative title “Space Weather and Solar Flare Prediction”. He is a member of the Advisory Committee of the doctoral dissertation of the doctoral candidate Azim Ahmadzadeh in the Department of Computer Science of Georgia State University, USA, with the indicative title “Machine Leraning of Scientific Events: Detection, Classification and Segmentation”.

He is also a member of the Advisory Committee for the candidate’s doctoral dissertation Dr. Sumanth Rotti, Department of Physics and Astronomy, Georgia State University, USA, with the indicative title ‘Solar Energetic Particle (SEP) Event Forecasting Using Machine Learning”.

Finally, he has an advisory role in the work of doctoral candidates Varun Chaturmutha (supervisor: Prof. S. Jefferies, GSU Physics & Astronomy), Varun Chaturmutha (Supervisors: Prof. S. Jefferies, GSU Physics & Astronomy), Maxwell Hostetter, Annie Ji (supervisor: Prof. R. Angryk, GSU Computer Science) and the postgraduate student Xumin Cai (supervisor: Prof. R. Angryk, GSU Computer Science).

- 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” (supervisor C. Efthymiopoulos) and of the PhD thesis of Edoardo Legnaro with title “Orbital dynamics and diffusion to the resonance in the close space environment (supervisor C. Efthymiopoulos).

- Dr. Gontikakis was the supervisor of the dissertations of: 1) Mr. S. Pastras, senior student of the physical department of EKPA, entitled “Study of its scattering UV at a Solar Action Center´´ (September-August 2020), 2) by Mr. E. Athanassiou, a graduate student of the physical department of EKPA, entitled: solar atmosphere ”(September-August 2020) and 3) by Ms. B. Maimouna, a third-year physics student at the University of Grenoble, France, entitled: “Study of a solar eruption with the IRIS spectrograph” (April-July 2020).

Missions – Visits to other Research Institutions

1. **M. Georgoulis**

   (a) Georgia State University: Visiting Professor until June 2020. Reporting seminar at the end of the term entitled: “Visiting GSU’s Physics and Astronomy Department for the Academic Years 2019, 2020: An Account of Activities”.

(b) Center for Astrophysics, Harvard University: March 2 2020. Seminar with title: “An investigation on Stellar Magnetic Forcing in Planets: Lessons for Earth, Mars, and Some known Exoplanets”.

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** “Our galaxy and the position of Man in the Universe”, Rotary Club of Glyfada, May 14.
- **I. Contopoulos** “Space Travel”, 12th Elementary School of Glyfada, Glyfada, February 17.
- **S. Vasilakos** 8 interviews during 2020 in press (CosmoOTETV, ERT, Kathimerini, 9.84, etc.).
- **M. GeorgoulisΜ. Γεωργούλης** “The mapping of the Sun’s poles by the Solar Orbiter”, (March 11), Newsparer “Ta Nea” https://www.tanea.gr/print/2020/03/11/greece/i- xartografisi-ton-polon-tou-iliou-apo-to-solar-orbiter/

  “The most detailed images of the Sun so far from American Ground Telescope Inoue ”, (January 29) article in Athenian-Macedonian News agency https://www.amna.gr/home/article/426420/Oi-pio-leptomereis-eos-tora- eikones-tou-ιliou-apo-to-neo-amerikaniko-epigeio-tileskopio-Inouye

  “M. Georgoulis author of the first book for space weather ”, (January 30), Alithia newspaper of Chios.

  https://www.alithia.gr/tehnologia/o-manolis-georgoylis-syggrafeas-toy- protoy-vivlioy-gia-ton-diastimiko-kairo

  “Global distinction for the Greek Solar Physicist Dr. Manolis Georgouli”, (March 26), newspaper “Information” of the Peloponnese. https://www.enpel.gr/2020/03/παγκόσμια-διάκριση-για-τον-έλληνα- ηλι/?fbclid=IwAR2x-SY-QIUU8LDFYFGJdcaLJaTJJJpGvCNvySQ4GZNms6hJtYKjnLQJSuM

"Space Weather by Manolis GeorgoulisΔιαστημικός", (October 10), Alithia newspaper of Chio.

https://www.alithia.gr/magazine/psyhagogia/vivlio/diastimikos-kairos -toy-manoli -georgoyli

"Looking up with Dr. Nikolaos Sergis, its CEO of Greek NASA ", (October 24) interview of colleague Mr. N. Sergis (collaboration with M. Georgoulis) in the Huffington Post Greece.
https://www.huffingtonpost.gr/entry/koitazontas-psela-me-ton-dr-nikolao-\serye-ton-ceo-tes-ellenikes-nasa_gr_5f93d80dc5b69b2ad5aaf07b?utm_hp_ref=gr-homepage

"Six Greeks, members of the space dream team ", (November 29), newspaper Enimerosi Peloponnese
https://www.enpel.gr/2020/11/έξι-έλληνες-μέλη-της-διαστημικής-ντρ/?fbclid=IwAR2caoqvHtrHjgFaWfwfGW459K8xWubEbmyIrDA- CnDADMYZqCcMzIyG-wms

- **V. Tritakis** Online speech at the Society of Friends of the People entitled: " Social Impacts of the Digital Age.