



Research Center for Astronomy
& Applied Mathematics
of the Academy of Athens



2013 Annual Report

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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 2009-13 include the study of the role of Chaos in supporting structures in N-body simulations, the Dynamics of the Milky Way and other galaxies, 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. During 2013 six (6) PhD and one (1) MSc thesis were supervised by RCAAM members. The work for these seven theses has been done in RCAAM under the supervision of RCAAM members on a daily basis. The researchers of our institute participate in five (5) more supervising committees of PhD theses. RCAAM participated in the teaching of the courses "Cosmology" and "Galactic and Extragalactic Astronomy" 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 it 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.).

During 2013 the research of Nonlinear Dynamics at RCAAM focused on the structure of phase-space in 2D and 3D Hamiltonian systems by means of numerical and analytical techniques. Using computer-algebraic algorithms developed in our center, it was possible to exploit the tools of canonical perturbation theory, namely the construction of high order resonant normal forms. It thus became possible to study the rate of chaotic diffusion in the resonance web of 3D systems. We also produced a visualization of the phenomenon of Arnold diffusion, and we gave particular applications of these methods in concrete problems of solar and extrasolar system dynamics. There is an ongoing collaboration with the La Plata University on the subject.

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.

Currently we study the stellar and gaseous flows in galactic disks, the photometry and the dynamics of young clusters in the spiral arms of galaxies, dynamical mechanisms acting on bar-spiral systems, the diffusion and escapes of orbits away from the equatorial plane of disk galaxies, the role of supermassive black holes in the centers of galaxies for their global dynamics, as well as various codes for N-body simulations.

In our research we collaborate with colleagues at the European Southern Observatory (ESO), Germany, the Max Planck Institute for Astrophysics, Germany, the University Observatory of Munich, the University Observatory of Strasbourg, France, and the Southwest Research Institute, Colorado, USA.

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 analyzing 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 organisations 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). Several of these colleagues are, at times, invited to visit RCAAM and deliver seminars and lectures. Moreover, RCAAM solar physicists are in continual pursuit of competitive research funding. As a result, RCAAM is a member institution of (1) NASA's Solar Dynamics Observatory Feature Finding Team (SDO/FFT) consortium that provides advanced tools of automatic, real-time solar data analysis, (2) ESA's PROBA-3 mission, as science Co-Investigators of the mission's ASPIICS coronagraph, and (3) the Hellenic National Network of Space-Weather Research, a THALES project funded by the Greek General Secretariat of Science and Technology. The RCAAM currently manages a Marie Curie grant on solar physics sponsored by the European Commission. Further, during 2013, RCAAM has been the Prime Contractor of an ESA Space Situational Awareness (SSA) Contract. A member of RCAAM is Greece's National Delegate to ESA's Science Programme Committee (SPC), Vice-President of the European Solar Physics Division (ESPD) of the European Physical Society (EPS), and a member of the Greek National Committee for Astronomy (GNCA).

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. We have active collaborations with NASA/Goddard (USA), the Aristotle University of Thessaloniki, University College Cork (Ireland), and the University of Crete. Our work is supported by the General Secretariat for Research and Technology with a grant "ARISTEIA" and the European Social Fund.

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.

During 2013 we have been collaborating with the following Institutes: University of Cambridge (UK), INAOE (Mexico), University of Barcelona (Spain), University of Sao Paulo (Brasil), University of Lethbridge (Canada), California State University (USA), IUCAA (India).

Publications in 2013

Publications in International Journals (with refereeing system) of the Scientific Citation Index

1. Contopoulos G., Harsoula M., 2013, 3-D chaotic diffusion in barred spiral galaxies, *Month. Not. Roy. Astron. Soc.* 436, 1201
2. Contopoulos G., Patsis P.A., Katsanikas M., 2013, Instabilities and Stickiness in a Rotating Galactic Potential, *Int. J. Bif. Chaos* 23, issue 02, 1330005
3. Lukes-Gerakopoulos G., Contopoulos G., 2013, Mind the Resonances: Final stages of accretion into bumpy black holes, *J. Phys. Conf. Ser.* 453, 012005
4. Tsigaridi L., Patsis P. A. 2013, The backbones of stellar structures in barred-spiral models - the concerted action of various dynamical mechanisms on galactic discs, *Mon. Not. R. Ast. Soc.* 434, 2922
5. Zachilas L., Katsanikas M., Patsis P. A, 2013, The Structure of Phase Space Close to Fixed Points in a 4D Symplectic Map, *Int. J. Bif. Chaos* 23, issue 07, 1330023
6. Faber N.T., Flitti F., Boily C.M., Collet C., Patsis P.A., Portegies Zwart S., 2013, Classifying two-dimensional orbits using pattern recognition, *New Astr.* 25, 74
7. Efthymiopoulos, C. and Harsoula, M: 2013, The speed of Arnold Diffusion, *Physica D* 251, 9
8. Gontikakis, C., Patsourakos, S., Efthymiopoulos, C., Anastasiadis, A., Georgoulis, M.K., 2013, Combining particle acceleration and coronal heating via data-constrained calculations of nanoflares in coronal loops, *Astrophys. J.* 771, 126
9. Efthymiopoulos, C., 2013, High order normal form stability estimates for co-orbital motion, *Cel. Mech. Dyn. Astron.* 117, 101
10. Christodoulidi, H., Efthymiopoulos, C., 2013, Low-dimensional q-tori in FPU lattices: dynamics and localization properties, *Physica D* 261, 92
11. Cincotta, P., Efthymiopoulos, C., Giordano, C.M., and Mestre, M., 2013, Chirikov and Nekhoroshev diffusion estimates: bridging the two sides of the river, *Physica D* 266, 49
12. Contopoulos I., Kazanas D., Papadopoulos D.B., 2013, The Force-Free Magnetosphere of a Rotating Black Hole, *Astrophys.J.* 765, 113
13. Contopoulos I., 2013, The Force-Free Electrodynamics Method for the Extrapolation of Coronal Magnetic Fields from Vector Magnetograms, *Solar Phys.* 282, 419
14. Contopoulos I., Nathanail A., Pugliese D., 2013, the orthogonal gamma-ray burst model, *Astrophys. J. Lett.*, 780, L5
15. Basilakos S., Stavrinou P., 2013, Cosmological equivalence between the Finsler-Randers space-time and the DGP gravity model, *Phys. Rev. D.* 113, 255
16. Lima A., Basilakos S., Sola J., 2013, Expansion history with decaying vacuum: a complete cosmological scenario, *Mon. Not. R. Ast. Soc.* 431, 923
17. Koulouridis E., Plionis M., Chavez. R., Terlevich. E., Terlevich R., Bresolin F., Basilakos S., 2013, The environment of HII galaxies revisited Order in de Broglie-Bohm quantum mechanics, *Astron. Astrophys.* 554, 13
18. Basilakos S., Nesseris S., Perivolaropoulos L., 2013, Observational constraints on viable $f(R)$ parametrizations with geometrical and dynamical probes, *Phys. Rev. D.* 87, 3529

19. Carvalho C.S., Tereno I., Basilakos S., 2013, CMB lensing reconstruction from the WMAP 7-year data, *Phys. Rev. D.* 88, 2002
20. Basilakos S., Lima A., Sola J., 2013, From inflation to dark energy through a dynamical Lambda: an attempt at alleviating fundamental cosmic puzzles, *Int. J. Mod. Phys. D.* 22 , 13420
21. Basilakos S., Kouretsis, A. P., Saridakis, E. N., Stavrinou P. 2013, Resembling dark energy and modified gravity with Finsler-Randers cosmology, *Phys. Rev. D.* 88, 123510
22. Perico E.L.D., Lima J. A. S., Basilakos S., Sola J., 2013, Complete cosmic history with a dynamical $\Lambda=\Lambda(H)$ term, *Phys. Rev. D.* 88, 3531
23. Tsamparlis M., Paliathanasis A., Basilakos S., Capozziello S., 2013, Conformally related metrics and Lagrangians and their physical interpretation in cosmology, *Gen. Rel. Grav.* 45, 2003
24. Nesseris S., Basilakos S., Saridakis E. N., Perivolaropoulos L., 2013, Viable $f(T)$ models are practically indistinguishable from LCDM, *Phys. Rev. D.* 88, 310
25. Basilakos S., Capozziello S., De Laurentis M., Paliathanasis A., Tsamparlis M., 2013, Noether symmetries and analytical solutions in $f(T)$ -cosmology: A complete study, *Phys. Rev. D.* 88, 3526
26. Pouri A., Basilakos S., 2013, Testing General Relativity using the growth rate of structure, *Int. J. Mod. Phys. Conf. Ser.* 453, 2012
27. Gontikakis, C., Winebarger, A.R., Patsourakos, S. 2013, Spectral diagnostic of a microflare. Evidences of resonant scattering in C IV 1548 Å, 1550 Å lines, *Astron. Astrophys.* 550, 16
28. Majhi B.P., Vagenas E.C., 2013, Modified Dispersion Relation, Photon's Velocity, and Unruh Effect, *Phys. Lett. B* 725, 477
29. Singleton D., Vagenas E.C., 2013, The covariant time-dependent Aharonov-Bohm Effect, *Phys. Lett. B* 723, 241
30. Dimitropoulou, M., Isliker, H., Vlahos, L., Georgoulis, M.K. 2013, A Dynamic, Data-Driven, Integrated Flare Model Relying on Self-Organized Criticality, *Astron. Astrophys.* 553, A65
31. Tziotziou, K., Georgoulis, M.K., Liu, Y. 2013, Interpreting Eruptive Behavior in NOAA AR 11158 via the Region's Magnetic Energy and Relative-Helicity Budgets, *Astrophys. J.* 772, 115
32. Georgoulis, M.K., 2013, Towards an Efficient Prediction of Solar Flares: Which Parameters and How?, *Entropy* 15, 5022

Publications in Press, already accepted for publication

33. Fukumura, K., Tombesi, F., Kazanas, D., Shrader, C., Behar, E., Contopoulos, I., 2013, Stratified Magnetically-Driven Accretion-Disk Winds and their Relations to Jets, *Astrophys. J.*, in press.
34. Contopoulos I., Kalapotharakos K., Kazanas D., 2013, A new standard pulsar magnetosphere, *Astrophys. J.*, in press
35. Basilakos S., Sola J., 2013, Effective equation of state for running vacuum: "mirage" quintessence and phantom dark energy, *Mon. Not. R. Ast. Soc.*, in press, tmp.2794B, doi: 10.1093/mnras/stt2135 (arXiv:1307.4748)

Publications in Conference Proceedings and Conference Presentations

1. Contopoulos G., Efthymiopoulos C., Katsanikas M., 2013, Analytical study of the structure of chaos near unstable points, Conference Proceedings of the 11th Hellenic Astronomical Conference
2. Harsoula M., Contopoulos G., 2013, Diffusion of 3D chaotic orbits in a barred spiral galaxy, Conference Proceedings of the 11th Hellenic Astronomical Conference
3. Patsis P.A., 2013, The dynamical backbones of observed structures in barred-spiral models, Conference Proceedings of the 11th Hellenic Astronomical Conference
4. Contopoulos, I., 2013, Astrophysical Jets from Black Holes, Hipparchos, 2, issue 9, 21
5. DeCesar M.E., Harding A.K., Miller M.C., Kalapotharakos C., Contopoulos I. and the Fermi Large Area Telescope Collaboration 2013, "Constraints on Emission and Field Geometry of Gamma-ray Pulsars from Phase Resolved Spectroscopy and Light Curve Modeling", American Astronomical Society, AAS Meeting 221, 412.06
6. Fukumura K., Kazanas D., Shrader C. R., Tombesi F., Contopoulos J., Behar E., 2013, "Modelling X-ray absorbers in AGNs with MHD-driven accretion-disk winds", HEAD meeting #13, 108.15
7. Contopoulos I. 2013, The force-free magnetosphere of a rotating black hole, πρακτικά του συνεδρίου "The innermost regions of relativistic jets and their magnetic fields - Jets 2013", EPJ Web of Conferences 61, 01007 (EDP Sciences)
8. A. Paschalis, N. Kranitis, G. Theodorou, A. Poulakidas, G. Haritakis, D. Habas, P. Levacher, W. Curdt, H. Michalik, B. Fiethe, K. Tsinganos, C. Gontikakis, J.-Y. Plesseria and the SPIICS team, SPIICS CCB, 2013, The Functional Control Electronics of an Externally Occulted Solar Coronagraph Instrument for the ESA PROBA-3 Mission, Proc. of the 5th International Conference on Spacecraft Formation Flying Missions and Technologies - <http://www.sffmt2013.org/PreliminaryProgram>
9. Tziotziou K., Georgoulis M.K., Raouafi N.-E., 2013, The Relation Between Magnetic Energy and Helicity and their Accumulation in Eruptive Solar Active Regions, 370 Years of Astronomy in Utrecht (eds. G. Pugliese, A. de Koter, and M. Wijburg), ASP Conf. Series, 470, 59

Projects, Proposals and Grants

Research in RCAAM is carried out in the frame of **25** research projects. Sixteen (**16**) of them are financed or financially supported by institutions in Greece or abroad. "Marie Curie", and "Aristeia" projects as well as projects in collaboration with NASA, ESO, ESA, Max-Planck institutes, the University of Stockholm, the Southwest Research Institute, the University of Vienna, the "Instituto Nacional de Astrofisica, Optica y Electronica" (IANOE), Cambridge University, the National Observatory of Athens, Montana State University, Johns Hopkins University. Finally there are projects financially supported by the International Space Science Institute and the European Science Council. During 2013 funding was approved by the "Excellence Cluster Universe" for the program "The relation between observed spiral disk morphologies and the dynamical properties of DM halos" (Patsis, Burkert, Naab, Grosbol).

Visits to other Institutes

Panos Patsis

Dr. Patsis was invited as a Scientific Visitor and went to the University of Stockholm, where he collaborated with Dr. K. Fathi within the framework of the “Feeding supermassive Black Holes” project.

Christos Efthymiopoulos

Dr. Efthymiopoulos visited the Astronomical Institute of the University of Vienna for 1 month.

Contopoulos Ioannis

Dr. I. Contopoulos visited the Universities of Cornell, Princeton and Purdue where he gave talks.

The following academics and researchers visited the RCAAM: C. Boily (University of Strasbourg), A. Jorba (University of Barcelona), D. Kazanas (NASA), S. Capozziello (University of Naples), J. Sola (University of Barcelona) and N. Mavromatos (Kings College London).

Organization of Conferences, Meetings and Other Events

RCAAM coorganized together with the Hellenic Astronomical Society the *11th Hellenic Astronomical Conference*. The Local Organizing Committee was chaired by Dr. Efthymiopoulos, who also participated in the Scientific Organizing Committee and convened the Extragalactic Astronomy section. Dr. Basilakos convened the Cosmology Section and Dr. Georgoulis the Solar Physics Section.

Dr. Contopoulos organized a two days workshop on *“The role and the origin of magnetic fields in astrophysics”*, within the framework of the “Aristeia” excellence project in Athens (11-12 March).

Dr. Vagenas participated in the organization of the *“Second Mediterranean Conference on Classical and Quantum Gravity”* at Veli Losinj, Croatia (9-15 June).

Dr. Vagenas participated in the organization of the *“International Conference on Mathematical Modeling in Physical Sciences”* in Prague, Czech Republic (1-5 September) and a two day meeting on *“Quantum Gravity Phenomenology”* also in Prague (4-5 September).

Dr. Georgoulis co-organized the *“Solar Flare Prediction: Progress and Challenges”* session (21 November) during the 10th European Space Weather Week (ESWW10), in Antwerp Belgium (18-22 November).

Dr. Georgoulis was member of the Scientific Organizing Committee for the *“Helicity Thinkshop on Solar Physics”* in Beijing, China (27-31 October).

Participation in Conferences and Talks

G. Contopoulos

1. "Review and Activities Report for the Research Centers and Offices of the Academy of Athens" during the presidential inauguration ceremony of the Academy of Athens (15 January).
2. "*Analytical study of the structure of chaos near unstable points*", invited talk at the 11th Hellenic Astronomical Conference, held in Athens (8-12 September).

P.A. Patsis

1. "*Order and Chaos in barred spiral galaxies*". Invited talk at the University of Stockholm, Sweden (19 February).
2. "*Galactic magnetic fields*" at "The role and origin of magnetic fields in astrophysics" workshop, Athens, Greece (11-12 March).
3. "*The backbones of spiral arms in models for barred-spiral galaxies*" talk during "The Role of Bars in Galaxy Evolution" conference, Granada, Spain (13-17 May).
4. "Amplitudes of spiral perturbations" (by P. Grosbol and P.A. Patsis). Invited talk at the "Structure and Dynamics of Disk Galaxies" conference, Petit Jean Mountain, Arkansas, USA, 12-16 August (given by P. Grosbol)"
5. "*The dynamical backbones of observed structures in barred-spiral models*". Invited talk at the 11th Hellenic Astronomical Conference, Athens, 8-12 September. At the same conference he co-authored the "Stellar and gas spiral arm dynamics in barred-spiral systems" poster presentation (S. Kitsionas, P.A. Patsis).
6. "*Building the peanut – The formation of X-shaped structures in the edge-on profiles of disk galaxies*". Invited talk at the special "In memoriam for J. Hadjidemetriou" meeting at the University of Thessaloniki (6 December).
7. "*Formation of massive clusters in grand-design spiral galaxies*" (by P. Grosbol and P.A. Patsis). Talk during the "Massive Young Star Clusters Near and Far: From the Milky Way to Re-ionization" conference, Puebla, Mexico, 2-6 December (given by P. Grosbol).
8. "*Barred galaxies observed edge-on. The explanation of their morphology*". Invited talk at the National Observatory of Athens (12 December).

C. Efthymiopoulos

1. "*Chaos in de Broglie - Bohm Quantum Mechanics and its Physical Consequences*" in the seminar of the Applied Analysis section of the Mathematics Department of the University of Patras (January).
2. "Experimental tests of quantum theory", round-table presentation during the "Quantum Theory without Observers III" international conference, organized within the framework of the COST Action MP1006: Foundations of Quantum Physics, in Bielefeld, Germany (April).
3. "Applications of Invariant Manifolds in Dynamical Astronomy", invited talk at the Astrodynamics Group, Institute of Astronomy, University of Vienna (May 2013).
4. "Hyperbolic normal form, analytic computation of invariant manifolds and applications in astrodynamics", invited talk at the "Planetary Motions, Satellite

Dynamics and Spaceship Orbits” conference organized by the Center of Mathematical Research of the University of Montreal, Canada (July 2013).

5. "Hyperbolic normal form and the analytic computation of invariant manifolds", talk during the "CELMEC IV 6th international conference" organized by the Italian Society for Celestial Mechanics, Viterbo, Italy (September 2013).
6. "Invariant Manifolds and chaotic spiral structure", talk at the 11th Hellenic Astronomical Conference, Athens, 8-12 September 2013. During the same conference a poster paper titled "*Particle acceleration and nanoflare heating in coronal loops*" was presented (with Gontikakis, Patsourakos, Efthymiopoulos, Anastasiadis, Georgoulis).
7. "*Resonant Co-orbital dynamics*". Invited talk at the special "In memoriam for J. Hadjidemetriou" meeting at the University of Thessaloniki (6 December).

I. Contopoulos

1. "*The Cosmic Battery in X-ray Binaries*", talk during "The role and the origin of magnetic fields in astrophysics" workshop, Athens, 11-12 March.
2. "*The Cosmic Battery in X-ray Binaries*", at the "Accretion 2013" ESA conference, Madrid, Spain 3 April.
3. "*The force-free magnetosphere of a rotating black hole*", talk during the "The innermost regions of relativistic jets and their magnetic fields - Jets 2013" conference, Granada, Spain, 11 June.
4. "*Magnetic Fields and Black Holes in Space*", inaugural talk for the 11th Hellenic Astronomical Conference, Athens, 8 September.
5. "*Black hole jets*", talk at the 11th Hellenic Astronomical Conference, Athens, 8-12 September 2013.
6. "*Black hole jets*" at the "From black holes to cosmic rays: when plasmas go wild" international conferences, Les Houches, France, 15 October.
7. "*The orthogonal model of gamma-ray bursts*", talk at Cornell University, USA, (4 December).
8. "*The orthogonal model of gamma-ray bursts*", talk at Princeton University, USA, (5 December).
9. "*The orthogonal model of gamma-ray bursts*", talk at Purdue University, USA, (6 December).
10. "*The orthogonal model of gamma-ray bursts*", talk at the XXVIIth Texas Symposium on Relativistic Astrophysics, Dallas, USA, 8-13 December.
11. "*Gamma Ray Bursts from Magnetic Black Holes*", invited talk at the University of Thessaloniki (19 December).

S. Basilakos

1. "*Geometrodynamics in Cosmology*", invited talk at the Department of Physics of the University of Thessaloniki (28 May).

C. Gontikakis

1. "*Study of the Transition Region using Spectral Lines*", talk during the Thales "Hellenic National Space Weather Research Network" project workshop, held in Portaria, Pilion, Greece (25-27 September).

2. *"The Role of Magnetic Reconnection, accelerating charged particles in nano-flares and in the solar corona heating"*, invited talk at the Department of Physics of the University of Athens (16 May).
3. *"Combining particle acceleration and coronal heating via data-constrained calculations of nanoflares in coronal loops"*, talk at the Sixth Coronal Loops Workshop, held in La Roche-en-Ardenne, Belgium (25-27 June).
4. *"On the possible importance of coherent resonant scattering in the solar transition region. A study of the C IV 154.8; 155.0 nm doublet"*, talk at the 11th Hellenic Astronomical Conference, Athens (8-12 September). At the same conference Dr. Gontikakis contributed a poster presentation titled *"Particle acceleration and nanoflare heating in coronal loops"* (along with Patsourakos, Efthymiopoulos, Anastasiadis, Georgoulis).

E. Vagenas

1. *"Are black holes really black?"*, invited talk at Kuwait University (14 April).

M. Georgoulis

1. *"Emergence and Evolution of Solar Active-Region Magnetic Fields"*, invited talk during the Thales "Hellenic National Space Weather Research Network" project School, held in Portaria, Pilion, Greece (25-28 February).
2. *"Heliophysics in the Heliosphere: Tales of Solar Magnetic Fields and their Defining Role in the Sun's Sphere of Influence"*, talk during "The role and the origin of magnetic fields in astrophysics" workshop, Athens, (11-12 March).
3. *"Solar Flare Forecasting via the Effective Connected Magnetic Field Strength"*, invited talk at the 2nd NWRA Flare-Forecasting Workshop, Boulder, CO, USA, 2 – 4 April.
4. *"Genesis of Free Magnetic Energy and Helicity in Solar Active Regions and their Role in Solar Eruptions"*, poster presentation at the 11th Hellenic Astronomical Conference, Athens (8-12 September).
5. *"Supporting Evidence for the Action of Self-Organized Criticality in Turbulent, Multiscale Active Regions"*, invited talk at the "International Space Science Institute (ISSI) on Self-Organized Criticality and Turbulence" conference, Bern, Switzerland, (16 – 20 September).
6. *"Self-Consistent Calculation of Magnetic Helicity in the Solar Magnetized Atmosphere: Outcome and Perspective"*, invited talk at the "Helicity Thinkshop on Solar Physics, Beijing, China, 27 – 31 October (with K. Tziotziou).
7. *"Which Data? Is Flare Prediction More Efficient Through Proxy Quantities, or Via Fundamental Physical Parameters?"* & *"Athens Effective Solar Flare Forecasting (A-EFFort)"*, poster presentations at the "10th European Space Weather Week (ESWW10)" conference held in Antwerp, Belgium (18 – 22 November).
8. *"Solar Eruptive Flares: from Physical Understanding to Probabilistic Forecasting"*, talk at the 2013 Fall AGU Meeting, San Francisco (9 – 13 December).

Dr. Georgoulis participated as National representative at ESA's Space Programme Committee (SPC) Meetings 141 (18-19 June) and 142 (28-29 November), in Paris, France.

He also filled in for the National Representative at ESA's PRODEX programme, at the 22nd PRODEX Participating States Meeting held in Paris (28 November).

Participation in European and Greek Committees

- Greek IGBP (International Geosphere-Biosphere Program) Committee: G. Contopoulos (member)
- Greek National Space Research Committee: G. Contopoulos (member)
- National Mathematics Committee of the Academy of Athens: G. Contopoulos (member)
- Energy Committee of the Academy of Athens: G. Contopoulos (member)
- Hellenic Astronomical Society (HELAS): C. Efthymiopoulos, member of the Governing Council and vice president.
- Hellenic Physical Society: C. Efthymiopoulos, member of the Governing Council.
- Management Committee of MPNS COST Action MP1006: Fundamental Problems in Quantum Physics (C. Efthymiopoulos, member of the administrative board)
- Hellenic Society on Relativity, Gravitation and Cosmology: E. Vagenas (Secretary)
- Scientific Program Committee (SPC) of the European Space Agency (ESA): M. Georgoulis
- European Solar Physics Division (ESPD) of the European Physical Society (EPS): M. Georgoulis (Vice President)
- Greek National Committee of Astronomy (2011-14): M. Georgoulis (member of the board)
- International Jury for the FP7 Odysseus Project: M. Georgoulis (Member)

All RCAAM researchers are referees in international scientific journals, while some are evaluators of international science project proposals and participate in the publishing council of scientific journals.

Dr. Efthymiopoulos is associate editor for the *Celestial Mechanics and Dynamical Astronomy* journal (Springer) and member of the editorial board for the *Serbian Astronomical Journal*.

Dr. Vagenas is editorial board member for (1) the *Central European Journal of Physics* (Springer), (2) *Advances in High Energy Physics*, (3) *Journal of Modern Physics and Applications* and (4) *Dataset Papers in Physics* and (5) *ISRN Mathematical Physics* and also member of the editorial board for *The Open Nuclear and Particle Physics Journal*.

Education

During 2013, RCAAM researchers gave series of lectures in postgraduate courses, research seminars and Schools, organized by scientific bodies.

Dr. P. A. Patsis, taught part of the course “Galactic and Extragalactic Astronomy” at the Department of Physics of the University of Athens for the academic year 2012-13.

Dr. S. Basilakos taught a Cosmology course (spring semester 2013) at the University of Athens (for the Physics and Mathematics departments).

Dr. I. Contopoulos gave a lecture on “Black Holes and Magnetic Fields in Space” during the “Students meet Physics and Physics Dazzles them” organized in Athens by the Hellenic Physical Society on 13 December.

Public Outreach

During 2013 RCAAM researchers were invited to give talks for the public and secondary education students:

P.A. Patsis, (1 talk and participation in round table discussion event), C. Efthymiopoulos (2 talks), I. Contopoulos (7 talks), S. Basilakos (1 talk), E. Vagenas (1 talk), M. Georgoulis (5 talks and an event on solar observations)

RCAAM activities were presented in a documentary titled “Research in the Attica Region” that was screened during the 7th Internationals Science Film Festival in Athens (24 Oct – 5 Nov 2013).

Researchers of the RCAAM have consulted and contributed in media coverage of astronomy related matters.

Awards and Distinctions

Dr. Basilakos received an Honorable Mention at the international Essay Competition of Gravity Research 2013.

PhD & MSc Theses

PhD theses in progress:

Liana Tsigaridi (Univ. of Athens)
Nonlinear Phenomena in Response Models of Galactic Disks
(supervisor: P.A. Patsis)

Nikos Delis (Univ. of Athens)
Stochasticity in Nonlinear Dynamical Systems
(supervisor: Ch. Efthymiopoulos)

Athena Pouri (Univ. of Athens)
Study of the Nature of Dark Energy by means of Extragalactic High Energy Sources
(supervisor: S. Basilakos)
Ms Pouri was awarded, following written examinations, the astronomy scholarship of the Academy of Athens

George Anastasiou (Univ. of Athens)
Aspects of Bigravity: Black Holes and Cosmology
(supervisor: E. Vagenas)

Petros Syntelis (Univ. of Athens)
Emergence of magnetic flux on the Sun, solar jets and coronal mass ejections
(supervisor: C. Gontikakis)

MSc thesis in progress:

E. Koutsantoniou (Univ. of Athens)

Numerical calculation of the Poynting-Robertson effect in General Relativity in the framework of the Cosmic Battery

Dr. Efthymiopoulos is member of the supervising committee for A. Paliathanasis' Thesis on "Symmetries of nonlinear differential equations and application in Dynamics", at the University of Athens. He was also member of the external committee for the PhD thesis by Z. Roupas, "*Thermogravitational instability in the presence of the cosmological constant*" at the National Polytechnic University of Athens.

Dr. I. Contopoulos is member of the supervising committee for N. Tryfonidis' Thesis on "Numerical study of non-linear magnetohydrodynamic phenomena with astrophysical applications", at the University of Thessaloniki.

Dr. Basilakos is member of the supervising committee for A. Paliathanasis' Thesis on "Symmetries of nonlinear differential equations and application in Dynamics", at the University of Athens.

Dr. Basilakos is member of the supervising committee for K. Parousis' Thesis on "Evolutionary algorithms and Physical applications", at the University of Peloponnese.

Dr. Georgoulis is member of the external committee for M. Dimitropoulou doctoral thesis, "Integrated Solar Flare Model Based on Self-Organized Criticality" at the University of Athens.

Table of Seminars organized by RCAAM during 2013

15/1	Piero Ranalli National Observatory of Athens, Greece & University of Bologna, Italy	X-ray Gaseous Emission in Star Forming Galaxies.
22/1	Ioannis Contopoulos Research Center for Astronomy and Applied Mathematics of the Academy of Athens	'Hairy' Black Holes and Astrophysical Jets.
29/1	Christos Efthymiopoulos Research Center for Astronomy and Applied Mathematics of the Academy of Athens	Towards a practical computation of the diffusion coefficient along resonances: bridging Chirikov with Nekhoroshev theory.
5/2	Emmanuel N. Saridakis National Technical University of Athens & CASPER, Physics Dept., Baylor University	f(T) Gravity and Cosmology
12/2	Amalia Corral IAASARS, National Observatory of Athens	AGN Iron lines from X-ray surveys
19/2	Loucas G. Christophorou Academy of Athens	Greek Energy Resources
26/2	George Contopoulos Academician, Research Center for Astronomy and Applied Mathematics of the Academy of Athens	The Foundations of Mathematics
5/3	Demosthenes Kazanas NASA/Goddard Space Flight Center, Corresp. Member of the Academy of Athens	GRB: Crisis, Some New Correlations, Back to an Old Motif and Some Light Eventually (perhaps?)!
13/3	Constantinos Kalapotharakos GSFC/University of Maryland	Numerical investigation of pulsar magnetospheres
19/3	Kostas Tziotziou Research Center for Astronomy and Applied Mathematics of the Academy of Athens	Interpreting Eruptive Behavior in NOAA AR 11158 via the Region's Magnetic Energy and Relative Helicity Budgets
26/3	Alexandros Kehagias National Technical University of Athens	Non-Gaussianity in the sky
2/4	Giorgos Anastasiou Research Center for Astronomy and Applied Mathematics of the Academy of Athens	Massive Gravity in (2+1)-dimensions and Lifshitz spacetimes
9/4	Christos Efthymiopoulos Research Center for Astronomy and Applied Mathematics of the Academy of Athens	The power-law dependence of the Lyapunov characteristic exponent of the chaotic orbits on the central mass in galaxies
16/4	Anastasios Anastasiadis Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing National Observatory of Athens	Magnetic Reconnection and the particle acceleration process in Solar flares
23/4	Ioannis Kontogiannis University of Athens, Physics Department, Section of Astronomy, Astrophysics and Mechanics	Magnetic shadows and power halos as a result of magnetohydrodynamic mode conversion in the solar chromosphere: The role of mottles and the magnetic field.
30/4	Elias Vagenas Research Center for Astronomy and Applied Mathematics of the Academy of Athens	Black Hole Thermodynamics: An update
8/5	Prof. Donald Lynden-Bell University of Cambridge	Thought experiments on the Gravity of Stresses and Currents.
14/5	Spyros Basilakos Research Center for Astronomy and Applied Mathematics of the Academy of Athens	Geometrodynamics in Cosmology.

21/5	Panos Patsis Research Center for Astronomy and Applied Mathematics of the Academy of Athens	Backbones of stellar barred-spiral morphologies.
28/5	Panagiotis Koumantos University of Athens, Dept. of Mathematics	Dynamical Systems and Thermodynamics-Magneto-hydrodynamics.
4/6	Mirella Harsoula Research Center for Astronomy and Applied Mathematics of the Academy of Athens	The diffusion of chaotic orbits in 3D barred spiral galaxies.
11/6	Sofia Carvalho Research Center for Astronomy and Applied Mathematics of the Academy of Athens	The Euclid space mission.
18/6	Angel Jorba Universitat de Barcelona	Invariant manifolds and Solar sails.
25/6	Christos Efthymiopoulos Research Center for Astronomy and Applied Mathematics Academy of Athens	Applications of Invariant Manifolds in Dynamical Astronomy.
3/7	Shohreh Abdolrahimi Oldenburg University	Distorted Five-dimensional Electrically Charged Black Holes.
3/9	Christian Boily Astronomical Observatory, University of Strasbourg	Orbital diffusion and anisotropies in dense stellar systems with black holes
16/9	Gang Zhao National Astronomical Observatories, Chinese Academy of Sciences	Introduction of LAMOST and its survey
24/9	Zacharias Roupas University of Athens	Gravothermal instabilities of fluid spheres in the presence of a cosmological constant
1/10	Maria Petropoulou University of Athens	Spontaneous gamma-ray absorption and astrophysical applications
8/10	Daniela Pugliese Research Center for Astronomy and Applied Mathematics of the Academy of Athens	Effective potential approach in thick toroidal disks
15/10	Christos Efthymiopoulos Research Center for Astronomy and Applied Mathematics of the Academy of Athens	Trojan captures and escapes
22/10	David Eden Liverpool John Moores University	The Role of Spiral Arms on the Star Formation Process
5/11	Michaila Dimitropoulou NSN Athens, Greece	Self-Organized Criticality: From the Sandpile to the Sun
12/11	Manolis Georgoulis Research Center for Astronomy and Applied Mathematics of the Academy of Athens	Self-Organized Criticality on Top of a Turbulent Substrate: the Possible Case of (Eruptive) Solar Active Regions
19/11	Kostas Karamanos Department of Physics, University of Athens	Are Fractals Optimal Geometries for Diffusion?
29/11	Joan Sola University of Barcelona	Higgs boson and vacuum energy in quantum field theory and cosmology
3/12	Nikolaos Nikoloudakis Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing National Observatory of Athens	Clustering analysis of high-redshift Luminous Red Galaxies in SDSS Stripe 82
10/12	Panos A. Patsis Research Center for Astronomy and Applied Mathematics of the Academy of Athens	"Sticky peanuts" - The building of boxy and X-shaped profiles in the edge-on views of disk galaxies
17/12	Prof. George Contopoulos Research Center for Astronomy and Applied Mathematics of the Academy of Athens	The latest book of Roger Penrose