UNIVERSITY OF CRETE
DEPARTMENT OF PHYSICS
SECTION OF ASTROPHYSICS & SPACE PHYSICS

ANNUAL REPORT FOR 2008

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Image Credit of Cover Page
Top: View of the Skinakas summit with the telescope domes and the housing quarters (see Sect. 3.1).
Middle: The receiving antennae of the SESCAT experiment near Chania (see Sect. 3.2).
Bottom: The 1.3m telescope of Skinakas Observatory inside its dome (see Sect. 3.1).

1. INTRODUCTION

The present document summarizes the activities of the members of the Section of Astrophysics and Space Physics at the Department of Physics of the University of Crete, during the 2008 calendar year. The staff of the Section consisted of 16 PhD research scientists, 5 graduate students and 4 technicians. Members of the Section were involved in teaching undergraduate and graduate courses at the University of Crete, while doing research in the fields of theoretical and observational Astrophysics, as well as in Atmospheric and Ionospheric Physics. Their research has been funded by national and international research grants, and in 2008 it resulted in 40 papers published in refereed journals, that is 2.6 papers per PhD researcher. Significant efforts were also devoted in the operation and improvement of the infrastructure and hardware at Skinakas Observatory and the Ionospheric Physics Laboratory. This document was prepared in January 2009, based on contributions from all members of the Section. The final editing was done by V. Charmandaris.

2. PERSONNEL

2.1. PERSONNEL OF THE SECTION

The staff associated with the Section of Astrophysics and Space Physics consists of 16 PhD research scientists, 5 graduate students, and 4 technicians.

The 8 Physics faculty members of the Section during the whole period of the report were Vassilis Charmandaris (Assist. Prof.), Christos Haldoupis (Prof.), Despina Hatzidimitriou (Assoc. Prof.), Nikolaos D. Kylafis (Prof.), John Papamastorakis (Prof.), Iossif Papadakis (Assoc. Prof.), Ilias M. Vardavas (Assoc. Prof.) and Andreas Zezas (Assist. Prof.). Pablo Reig (Researcher B' at the Foundation for Research and Technology – Hellas) and Fotis Mavromatakis, (Assist. Prof. at the Technical Educational Institute of Heraklion) continued their affiliation with the Section. Researchers in non-tenure track positions holding a PhD degree were Dr. Elisabete da Cunha, Dr. Fabrizio Nicastro, Dr. Kostas Pavlakis, Dr. Natalia Primak, Dr. Agnieszka Slowikowska, and Dr. Malgosia Sobolewska. Support staff associated with the Skinakas Observatory were Anastasios Kougentakis, Dr. Eythymios V. Paleologou, George Paterakis, and Anna Stiakaki.

PhD students during this period were Vallia Antoniou (with D. Hatzidimitriou) and Marina Papadopoulou (with I. Vardavas). Masters students in Astrophysics were Emmanouil Chatzopoulos (commenced in Fall 2007) and Theodoros Bitsakis (commenced in Fall 2006). Paolo Bonfini an ERASMUS Masters student from the Univ. of Milano (Bicoca) spent 6 months working on his thesis research project with D. Hatzidimitriou, and Lusine Sargsyan a PhD student from the Yerevant State Univ. (Armenia) spent 0.5 months working on her thesis with V. Charmandaris.

2.2. PERSONNEL CHANGES

Drs. F. Nicastro and E. da Cunha joined the group in March and October 2008 respectively, as research associates under European Union grants. Dr. N. Primak joined the group as a research associate in May 2008. Dr. A. Zezas joined the group as an Assistant Professor of Observational Astrophysics in September 2008 and P. Bonfini commenced his PhD with him. In Spring 2008, N. Kylafis and J. Papamastorakis were on sabbatical / academic leave, while D. Hatzidimitriou and I.

Papadakis were on sabbatical in the Fall of 2008. During the calendar year C. Haldoupis was promoted to Professor, and I. Papadakis was promoted to Associate Professor. D. Hatzidimitriou was elected as Associate Professor at the Dept. of Physics of the University of Athens and she will be moving there in 2009.

2.3. GRADUATING STUDENTS

V. Antoniou obtained her PhD degree in April 2008 entitled "The X-ray Source Population of the Small Magellanic Cloud[1]" under the supervision of D. Hatzidimitriou. She moved to a postdoctoral researcher position at Harvard Smithsonian Center for Astrophysics (USA).

T. Bitsakis obtained his Masters degree in May 2008 and took a year off in order to complete his military service.

E. Chatzopoulos moved to the Astronomy Department of the Univ. of Texas at Austin (USA) in September 2008, to continue his graduate studies in Astrophysics towards a PhD.

3. FACILITIES

3.1. SKINAKAS OBSERVATORY

The Skinakas Observatory operates as part of a scientific research collaboration between the University of Crete, the Foundation for Research and Technology-Hellas (FORTH) and the Max-Planck-Institut für Extraterrestrische Physik in Germany. The Observatory has two fully operating telescopes. One is a Modified Ritchey-Chrétien telescope with a 1.3 m aperture (focal ratio of f/7.6), which was built by DFM Engineering and Zeiss and became operational in 1995. The second is a 0.6 m Cassegrain telescope (focal ratio of f/8) owned by the University of Tübingen (Germany) and co-operated with the Univ. of Crete, which is remotely controlled in a robotic mode via the web. A 30 cm telescope (focal ratio f/3.2) is also available but has not been used during the 2008 observing season.

A number of modern instruments are permanently available on the 1.3 m tepescope. These include several optical CCD cameras with complete filter sets, a long slit optical spectrograph, a high resolution (R=38,000) echelle spectrograph, as well as a near-IR wide field camera.

The main projects during the 2008 April-to-November observing period were:

- Photometry and Spectroscopy of Planetary Nebulae and SNe Remnants.
- R-band and Hα monitoring of the central region of M31 for the discovery and follow-up photometry of new Novae.
- Photometry and Spectroscopy of Binaries with a compact star companion.
- Photometry of BL Lac objects.
- Photometry of high-z quasars
- Near-infrared photometry of Hickson Compact Groups.
- Near-infrared photometry of Blue Compact Dwarf galaxies.
- Near-infrared observations of HMXB
- High speed photo-polarimetry of optical GRB afterglows

[1] The thesis of Dr. Antoniou is available at: http://www.physics.uoc.gr/thesis/Antoniou.pdf

- High photo-polarimetry of X-ray binaries (HMXR, microquasars)
- Non-radial pulsations in early-type stars

The High Time Resolution OPTIMA Instrument ("OPTIMA BURST"[2]) of the Max-Planck Institut für Extraterrestrische Physik was successfully installed at the 1.3 m telescope and was in operation for two months starting from the 1st of September 2008.

The tradition of "open nights" continued and the Observatory was open to the public for five nights during the 2008 observing season.

More details on the Observatory, the quality of the site, the telescopes, and the available instrumentation can be found at: http://skinakas.physics.uoc.gr

3.2. IONOSPHERIC PHYSICS LABORATORY

The Ionospheric Physics Laboratory (IPL), maintained operation of its main experimental facility, SESCAT (Sporadic E SCATter experiment), during the summer of 2008. SESCAT, which is the only ionospheric scatter radar that exists in Greece, operates at 50 MHz mostly as a Doppler radar but occasionally also as radio interferometer. It is observing magnetic aspect radio backscatter from electrostatic plasma waves in the E region of the ionosphere during times of strong dense layers of metallic ions, which form at altitudes of ~100 km and are subject to plasma instabilities. In addition, IPL in collaboration with Stanford University, continued (since 2003) the un-interrupted operation of a narrow-band very low frequency (VLF) receiver experiment throughout 2008, and maintained its VLF database. This experiment is used for studying VLF signatures and propagation effects in the lower ionosphere during times of intense atmospheric electrical activity and the occurrence of transient luminous events (sprites and elves) in the upper atmosphere. Also, since the summer of 2005, IPL operates, in collaboration with the Eötvos-Lenard Budapest University, a second automatic VLF receiver system on a routine basis side by side with the Stanford receiver in the rooftop of the Physics Building. In 2007, a new GPS (Global Positioning System) receiver station was set up in Crete (in collaboration with the Universite de Rennes, France) for continuous monitoring of the ionospheric variability by measuring total electron content and S4 index changes. E and F region EM coupling studies using joint SESCAT and GPS observations are planned for the near future.

4. COURSES

A number of elective undergraduate and graduate courses, directly related to the research areas covered by the Section, were offered as part of the teaching responsibilities of the faculty members. For 2008 these were:

- SPRING SEMESTER 2008
  - "Astrophysics II"
  - "Atmospheric Physics"
  - "Data Reduction and Analysis of Astronomical Observations"
  - "Gas Dynamics"
  - "High Energy Astrophysics"
  - "Production and Propagation of Radiation in Astrophysics"

[2] For more information on "Optima" visit: http://www.mpe.mpg.de/OPTIMA

- FALL SEMESTER 2008
  - "Astrophysics I"
  - "Astrophysics III"
  - "Atmospheric Environment"
  - "Planetary Atmospheres"

5. SCIENTIFIC RESEARCH

Here, we present a brief description of the major research projects in which members of the Section were involved in 2008. These are grouped by research area and the scientists associated with each project are indicated in parentheses.

The scientific publications that resulted from this work, over the same period, are presented at the end of the report in section 11.

5.1. THEORETICAL ASTROPHYSICS

- Black holes as X-ray sources: Modeling of the spectral states of black-hole X-ray binaries in order to explain their energy spectrum (from radio to X-rays) and the intricate time variability of their intensity. Compton up-scattering of soft photons in the jet seems to be the mechanism for producing the hard X-ray spectrum and the variability observed. (Researchers involved: N. Kylafis, P. Reig)

- Anomalous X-ray pulsars: Extremely interesting observations have been made recently on the hard X-ray spectrum of Anomalous X-ray Pulsars (AXPs). The hard X-rays have luminosity comparable to that of the soft X-rays and it is pulsed, with the rotational period of the neutron stars involved. In addition, the pulse fraction of the hard X-rays increases with the energy of the photons and it becomes ~100% at ~100 keV. A model to explain all of the above, plus the pulsed radio emission observed in some of them, has been worked out and it is in the final stages of preparation for submission for publication. (Researcher involved: N. Kylafis)

- Time-Evolving Photoionization: Updating and upgrading our in-house time-evolving photoionization code, to include: (a) portability (FITS-IO interface routines allowing general photo-ionizing light-curves, Spectral Energy Distributions, Ionization-Balance inputs, and output spectral fitting with the fitting package "Sherpa" of the Chandra Interactive Analysis of Observations - CIAO - software); (b) detailed time-evolving population level computation; (c) inclusion of fine-structures transitions for low-ionization metals, and (d) approximated radiative transfer computation. (Researchers involved: F. Nicastro)

- Astrostatistics: Application of statistical methods in astrophysical problems. Recent projects include: derivation of star-formation histories from colour-magnitude diagrams, analysis of data taking into account calibration uncertainties, derivation of spectral parameters from X-ray hardness ratios (Researchers involved: A. Zezas as member of the California/Harvard/ASC Astrostatistics Collaboration).

5.2. OBSERVATIONAL ASTROPHYSICS

5.2.1. OBSERVATIONAL GALACTIC ASTROPHYSICS

- Optical observations of supernova remnants: Deep narrow band observations of supernova remnants are performed with the 0.3m and 1.3m telescopes at Skinakas Observatory. The images are complemented by deep long slit spectra at selected positions of the target objects to study in more detail the energy distribution. Supernova remnants contribute to the recycling of heavy elements in the galaxy and impart great amounts of energy to the interstellar medium. The use of interference filters isolating major optical emission lines allow the study of the morphology of these faint objects and the factors that contribute to their shaping. Furthermore, imagery in low and medium ionization lines offers a unique opportunity to study the different zones of emission behind the shock front. The spectra provide useful information about the extinction that the optical emission suffers, the electron density at the given location and the speed of the shock traveling into the interstellar clouds. In addition, estimates of the initial explosion energy can be made if the distance to the remnant is known. (Researchers involved: F. Mavromatakis, J. Papamastorakis)

- X-ray variability of X-ray binaries (XRB): XRB consist of a compact star (neutron star or black hole) orbiting a regular star. When part of the material from the optical companion is accreted on the compact object the system brightens in X-rays. Hard X-ray observations provide a valuable probe of the emission region near the compact object. The goal here is to study their spectral and timing properties, using mainly data from RXTE and INTEGRAL. Regrading the timing studies, analysis techniques such as power spectra, Fourier-resolved spectra, phase-lag spectra are used. As for the characterization of their energy spectrum, we use sophisticated Comptonization codes to investigate the origin of the spectral variations that these objects exhibit (Researchers involved: P. Reig, I. Papadakis, M. Sobolewska)

- Optical/IR monitoring of Be/X-ray binaries (BeX): BeX consist of a neutron star orbiting a O9e-B2e main-sequence star. The letter "e" stands for emission, as instead of the normal photospheric absorption lines the optical spectra of Be stars display emission lines. Strong infrared emission is another defining characteristic of Be stars. The origin of these two observational properties (emission lines and infrared excess) resides in a gaseous, equatorially concentrated circumstellar disc around the OB star. This disc constitutes the main source of variability in BeX. The main objective of this project is to characterize the optical/IR variability time scales of Be/X-ray binaries. This objective is achieved by monitoring the evolution of the disc over many years. The main sources of data are the 1.3 m telescope of the Skinakas Observatory (optical) and the 1.5 m Carlos Sanchez Telescope in Tenerife (IR). (Researchers involved: P. Reig)

- Interaction of the neutron star with the Be star's envelope: Be stars may have an isolated life or take part in binaries (the BeX systems). The difference is the presence, or not, of a neutron star. Here the objective is to investigate the effects of the compact object on the structure and evolution of the circumstellar envelope. One of the most interesting effects is the truncation of this envelope by the neutron star. One of the main goals is to find observational evidence of such truncation. (Researchers involved: P. Reig, A. Slowikowska)

- Polarization from an exoplanetary atmospheres: Looking for polarized scattered light from an exoplanetary atmospheres. More than 330 extrasolar planets were discovered by indirect method of Doppler spectroscopy, photometric transits, microlensing, and pulsar timing. Polarization measurements allow detecting directly starlight that is scattered in the planetary atmosphere. The scattered light is linearly polarized perpendicular to the scattering plane. It possesses the information on the planetary atmosphere geometry, chemistry, and thermodynamics. During the OPTIMA-Burst campaign at Skinakas Observatory we performed the polarimetric observations of stars that host transiting planets. The goal is to obtain polarization characteristics of the target with very high time resolution as a function of orbital phase of the planet. (Researchers involved: A. Slowikowska)

- Search for optical periodic and quasi-periodic oscillations in High Mass X-ray Binaries by using high-speed photometer OPTIMA. Virtually all HMXB are X-ray pulsars. Pulsations come as a result of the misalignment of the rotation axis and the magnetic axis. Some HMXB also show QPO which are believed to be associated with the inner parts of the accretion disk. In this project we wish to investigate whether pulsations and QPO are also seen in the optical band and study the aperiodic optical variability. (Researchers Involved: P.Reig, A.Slowikowska).

5.2.2. OBSERVATIONAL EXTRAGALACTIC ASTROPHYSICS

- Study of X-ray sources and novae in M31: In collaboration with W. Pietsch and V. Burwitz (MPE/Germany) as well as the XMM-Newton -M31 consortium, we are performing an extensive study of the population of X-ray sources and novae in M31. Spectroscopy of optical counterparts has been obtained with the 1.3m Skinakas Telescope, and the 3.5m telescope at the Apache Point Observatory. Two new XMM-Newton projects have been recently awarded time to pursue this work in 2009 (D. Hatzidimitriou, P. Reig, P. Bonfini)

- Study of X-ray sources in the Small Magellanic Cloud: A study of the X-ray population in the Small Magellanic Cloud is underway, using Chandra observations of the central region of the Small Magellanic Cloud, dominated by a recent burst of star formation. Study of the optical counterparts and characterization of the star formation history in the specific areas of the Chandra sources, has been conducted using optical imaging and spectroscopy with the 6m-Magellan Telescope, and the 4m-Anglo-Australian Telescope (2df). Moreover, XMM-Newton time has been awarded (end of 2008) to an international team (PI: Frank Haberl – MPE), of which DH is a member, for the detailed study of the SMC X-ray binary population (Researchers involved: D. Hatzidimitriou, V. Antoniou, A. Zezas).

- X-ray source populations in nearby galaxies: Studies of the discrete X-ray source populations (in particular accreting sources) in nearby galaxies and their connection with their parent stellar populations (star-formation history, metallicity, etc) and star-cluster parameters. Studied objects cover the full spectrum of galaxies, ranging from dwarf-irregular star-forming galaxies to spiral and elliptical galaxies. (Researchers involved: A. Zezas, P. Bonfini).

- Extragalactic supernova remnant populations: Multiwavelength studies of the supernova remnant populations in nearby galaxies using data from the Chandra X-ray observatory and narrow-band data from the Skinakas observatory. The goal of this project is to understand the populations of SNRs in different wavelengths in a variety of environments (Researchers involved: A. Zezas; this is the PhD project of I. Leonidaki (NOA, University of Patras))

- X-ray variability study of AGN: The Fourier resolved analysis of archival XMM data is not yet complete. Results from the study of the AGN variability properties and their evolution with cosmic time, using the XMM-Newton archival data on Lockman hole, were published. A similar study using AEGIS-X data is underway (in collaboration with Imperial College). The study of the spectral variability of a large sample of nearby AGN, on time scales of months/years, using archival RXTE Data, has almost completed. A new study of the high energy cut-off in the energy spectra of nearby Seyferts has been initiated. Finally, the acquisition of the new XMM data on PKS 0548-508 (5 orbits in total) will surely keep the group quite busy in the following year (Researchers involved: I. Papadakis, M. Sobolewska, F. Nicastro).

- Optical variability study of AGN: We performed intensive optical monitoring observations (in the B and R bands) on 65 radio loud AGN. These observations are part of a project to study the variability of these objects across the electromagnetic spectrum (the project is organized by colleagues in MPI-Bonn) (Researchers involved: I. Papadakis, N. Primak)

- The Warm Hot Intergalactic Medium: a) Performed a review study of the Warm-Hot Intergalactic Medium, and perspectives for its detection with current and future UV and X-ray facilities b) Selection of an optimal UV and X-ray sample for WHIM studies with current - Chandra-LETG and XMM-Newton RGS - and future - HST-COS, IXO and dedicated X-ray WHIM missions like Xenia or Pharos. The selection is based on the brightness of the X-ray sources, F(0.1-2.5 keV) > $4x10^{-12}$ ergs/s/cm^2, the Galactic column of hydrogen, $N_H<3x10^{20}$cm^{-2}, the target redshift (z > 0.3) and the UV brightness (λF_λ(1400A)> $1x10^{-12}$ ergs/s/cm^2). c) Study of the diffuse emission from nearby poor-groups of galaxies in the X-rays, to put limit on the possible amount of OVII and OVIII X-ray absorption from these structures. The study was aimed to compare the strength of the possible OVII K-alpha absorption expected along a random line of sight from the point of view of an observed seated in a galaxy at the center of these groups, based on the measured diffuse X-ray emission, to compare with the OVII K-alpha absorption strength ubiquitously seen at z~0 from our observational point of view against all bright X-ray background extragalactic targets. The conclusion from this study is that the z~0 high-ionization absorption we see is compatible with being imprinted by hot gas in our own Local Group. d) Extensive spectral simulation with current and future X-ray facilities (particularly IXO) of the Warm-Hot Intergalactic Medium along randomly selected lines of sight from the latest hydro-dynamical simulation for the formation of structures in the Universe. Main aim of this work is to perform feasibility studies and establish the optimal technical parameters for upcoming WHIM-dedicated or general-observatory X-ray missions. (Researchers involved: F. Nicastro)

- AGN Warm Absorbers and Feedback: Analysis of XMM-Newton and Chandra LETG data of the Ionized outflows in the Seyfert 1 galaxies NGC985, NGC5548, and NGC4051), and study of their AGN-galaxy and AGN-IGM feedback contribution. (Researchers involved: F. Nicastro, Y. Krongold (CfA/Harvard, USA))

- Spectral states of quasars: In collaboration with M. Gierlinski (University of Durham/UK) and A. Siemiginowska (CfA/USA), optical (Hubble) and X-ray (Chandra) spectral characteristics of a sample of bright quasars spanning broad range in black hole mass, luminosity and redshift were used in order to determine their spectral states. We compared them with 6 well studied Galactic X-ray Black Holes Binaries (RXTE) and found that majority of studied quasars are in a spectral state corresponding to a very high/intermediate state of Galactic Black Holes, and minority resembles soft state GBHs. (Researchers involved: M.Sobolewska)

- Gamma Ray Bursts: a) Study of the multi-epoch high-resolution optical spectra of Gamma-Ray Burst (GRB) optical afterglows, aimed to measure the distance and the physical state (density, temperature, ionization degree, etc.) of the associated absorbing material along the line of sight, from the GRB. This study has made extensive use of our Time-Evolving Photoionization code and was mainly based on the observed opacity changes in the fine-structure lines of FeII. b) Study of the soft X-ray (0.1-2.5 keV) LogN-LogF (i.e. number of sources N with soft X-ray fluence >F: fluence = Flux * Time) of all Gamma-Ray Burst triggered by the high-energy wide-field Swift detector BAT and followed up in the soft X-rays with the Swift XRT detector. (Researchers involved: F. Nicastro, M.L. Conciatore (CfA/Harvard, USA))

- Multiwavelength studies of interacting galaxies: This is a comprehensive study of a large sample of interacting galaxies with the Spitzer Space Telescope and the Chandra X-ray Observatory. The goal of this study is to address the connection between galaxy interactions and induced star-forming and AGN activity (Researchers involved: A. Zezas).

- Mid-infrared properties of Ultraluminous Infrared Galaxies (ULIRGs): This project uses observations of the Infrared Spectrograph on the Spitzer Space Telescope in order to explore the mid-infrared properties of ULIRGs. The main goal is to improve the understanding of the dominant mechanism of the energy source (accretion onto an active nucleus or a super-massive starburst) in these galaxies by developing a robust diagnostic between a starburst and AGN in dust-enshrouded galactic nuclei. Preparatory work for the implications of this work in upcoming observations off deep surveys with the Herschel Space Telescope is being conducted. (Researchers involved: V. Charmandaris)

- Star formation and stellar populations in Hickson Compact Groups: This project is based on mid-infrared observations of a sample of Hickson Compact Groups obtained with the Infrared Space Observatory and the Spitzer Space Telescope. Additional near-infrared imaging data of the Palomar 5 m telescope, and Skinakas 1.3m telescope are being used in order to map in detail the star formation activity and old stellar population of these systems. (Researchers involved: V. Charmandaris, T. Bitsakis)

5.3. ATMOSPHERIC & IONOSPHERIC PHYSICS

- Earth Observation and climate Project: Research work on Earth Observation and the Earth's Radiation Budget is an ongoing project. Modelling work of the radiation forcing of aerosols on a planetary scale includes the effects of aerosols on the solar ultraviolet, visible and near-infrared radiation reaching the Earth's surface. Model input data include satellite data from the NASA EOS satellites, Aqua and Terra. Ground-based data include the AERONET (Aerosol Robotic Network) site operated in Crete and provided by NASA Goddard. Climate research includes the effects of the El Nino phenomenon on the surface radiation budget over the tropical Pacific ocean. Collaboration with NASA Langley and the Meteorological Institute of the University of Munich on the heat budgets of enclosed seas, such as the Mediterranean, Black and Red seas is ongoing.: (Researchers involved: I. Vardavas, N. Hatzianastassiou (Univ. of Ioannina), C. Matsoukas (Univ. of the Aegean), K. Pavlakis, A. Fotiadi, C. Papademas (Univ. of Ioannina)).

- Modelling the Evolution of Planetary Atmospheres Project: Research on modelling the evolution of planetary atmospheres has focussed on the development of a radiative/convective-photochemical-microphysical model for the global mean vertical atmospheric structure of the Precambrian Earth and of Titan. The Titan model has been validated against data from the recent Cassini/Huygens mission to Titan. A model for the formation of the haze layer that surrounds Titan has been developed. Work on the evolution of ultraviolet and XUV radiation of G-type solar like stars, which affects the atmospheric chemical composition of planets orbiting such stars, is ongoing with planned applications to exoplanets around G-type stars. (Researchers involved: I. Vardavas, P. Lavvas)

- Ionospheric and Upper Atmospheric Physics: The research topics under study relate to the plasma physics and electrodynamics of irregular ionospheric phenomena occurring at midlatitude, and problems associated with the interaction and coupling of the neutral mesosphere and lower thermosphere with the earth's ionosphere. During 2008 our research focused on the following topics : 1) the properties and mechanisms relating to the formation and destabilization of midlatitude sporadic E plasma layers (Es), and the role of wind shears and atmospheric tidal, gravity and planetary waves on sporadic E layer morphology and variability. 2) the electrodynamic coupling between the unstable Es plasma and midlatitude ionospheric "spread F" and the generation of large electric fields in patchy sporadic E plasma layers, 3) the role of plasma density gradients on the generation of short scale electrostatic plasma waves in the ionospheric E region, 4) the effects on VLF (very low frequency) electro-magnetic wave propagation and VLF response signatures associated with "transient luminous events", such as sprites and elves, which are atmospheric electricity (thunderstorm and lightning) phenomena in the upper atmosphere and lower ionosphere, 5) meteor trail plasma instabilities and unusually long-lasting meteor echoes observed with VHF (very high frequency) and HF radars, and 6) studies of ionospheric resonance phenomena observed in ultra low frequency (ULF) electromagnetic noise recordings with sensitive coil magnetometers, and 7) studies of the annual and seasonal variations of midlatitude sporadic E layers. (Researchers involved: C. Haldoupis, N. Christakis, N. Ambrosiadi, and A. Mika)

6. RESEARCH FUNDING

The following projects, funded by national and international agencies, enabled the research activities of the Section during the period of the report.

- EU funded Transfer of Knowledge grant for the "Development of an Astrophysics Center in Crete", (P.I.: N.D. Kylafis, budget: €741,000, duration: 2006-2010)
- EU funded FP7 Programme grant for the "Development of Space Astrophysics in Crete", (P.I.: N.D. Kylafis, budget: €1,120,000, duration: 2008-2011)
- EU funded FP7 Programme grant "COSMOS", (P.I.: I. Papamastorakis, budget: €110,000, duration: 2008-2009)
- Europlanet: Partners to a network funded by the European Union involving European institutes perfoming research on planets. Funding was provided for travel to conferences. (P.I. for Greece: I. Vardavas, duration: 2004-2008)
- PENED Doctoral Projet: Research funding for the doctoral thesis of C. Papademas entitled: "Aeorosol forcing climatic impacts on the Mediterranean Region", under the supervision of Prof. Vardavas and Prof. N. Hatzianastassiou (Univ. of Ioannina)), (budget: €60,000, duration: 2006-2008)
- Platon: French-Greek scientific exchange on the topic of Titan's atmosphere. (P.I. I. Vardavas, budget: €12,000, duration: 2006-2008)
- ESA funded project on the "Support to Development of a Standard Product Generation Pipeline and a Quality Control Framework for Data Products within the Advanced Data Processing System for Herschel", ESA/Herschel Mission. (P.I.: V. Charmandaris, budget: €271,000, duration: 2006-2009)
- John Latsis Foundation Grant: "Water Resources of Greece under Climatic Change", (P.I. I. Vardavas, budget: €40,000, duration: 2008-2010)
- Marie Curie International Reintegration Grant: (P.I.: A. Zezas, budget: €100,000, duration: 2008-2011)

7. COLLABORATIONS WITH OTHER INSTITUTES

Members of the group are actively collaborating with scientists affiliated with the following universities and research institutes:

- GREECE
  - Foundation for Research and Technology – Hellas (FORTH), Heraklion
  - National Observatory of Athens, Athens
  - Technical Education Institute of Crete, Dept. of Electrical Engineering, Heraklion
  - University of the Aegean, Dept. of Environment, Mytilene
  - University of Ioannina, Dept. of Physics, Ioannina

- INTERNATIONAL
  - Anglo-Australian Observatory, Australia
  - California Institute of Technology, Spitzer Science Center, Pasadena, CA, USA
  - CEA/Saclay, Service d'Astrophysique, France
  - Cornell University, Astronomy Department, Ithaca, NY, USA
  - Danish Space Research Institute (DSRI), Denmark
  - Eötvos-Lenard University, Budapest, Hungary
  - ETH, Zurich, Switzerland
  - Free University of Berlin, Germany

- Geophysical Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria
- Harvard University, Center for Astrophysics, Cambridge, MA, USA
- Imperial College, UK
- Institut d'Astrophysique de Paris, France
- Institute of Physics of the Earth, Russia
- Lawrence Livermore National Lab, CA, USA
- Leiden Observatory, Leiden, The Netherlands
- Max-Planck-Institut für Extraterrestrische Physik, Garching, Germany
- Max-Planck-Institut für Kernphysik, Heidelberg, Germany
- NASA Goddard Space Flight Center, Greenbelt, MD, USA
- NASA Langley Division of Atmospheric Sciences, Langley, VA, USA
- NASA Marshal Space Flight Center, Huntsville, AL, USA
- National Space Science and Technology Center, Huntsville, AL, USA
- Nicolaus Copernicus Astronomical Center, Warsaw & Torun, Poland
- Observatoire de Paris, France
- Royal Observatory Edinburgh, UK
- San Diego State University, CA, USA
- Stanford University, Palo Alto, CA, USA
- Tel Aviv University, Israel
- Université de Rennes, France
- University of Alicante, Spain
- University of Arizona, Tucson, AZ, USA
- University of Durham, Durham, UK
- University of Hawaii, Institute for Astronomy, Honolulu, HI, USA
- University of Oulu, Finland
- University of Saskatchewan, Canada
- University of Southampton, UK
- University of Texas at Austin, Austin, TX, USA
- University of Valencia, Spain

8. NATIONAL & INTERNATIONAL COMMITTEES

During the period covered by this report, members of the Section were in a number of national and international committees. More specifically:

Prof. V. Charmandaris is serving as the Secretary of the Hellenic Astronomical Society for a second term (2008-2010). He continued his duties as the Editor of the European Astronomical Society Newsletter (since 2005), and the Editor of the Newsletter of the Hellenic Astronomical Society (since 1997). He was also a member of the 2008 Time Alocation Committee Panel for the telescopes of the European Southern Observatory (ESO).

Prof. C. Haldoupis, is serving as an Associate Editor of the Journal of Geophysical Research (JGR), of the American Geophysical Union (2006-2009)

Prof. D. Hatzidimitriou is the President of the IAU Commission 37: "Star Clusters and Associations" for the 2006-2009 term, as well as the Vice-President of the IAU Division VII: "Galactic System" for the 2006-2009 term. She was also a member of the SOC of the IAU Symposium 256 "The Magellanic System: Stars, Gas and Galaxies", which took place in Keel (UK) between 28 July – 1 August 2008 (http://www.astro.keele.ac.uk/iaus256/)

Prof. N. Kylafis was an ordinary member of the Greek National Committee for Astronomy (GNCA) and a substitute to the representative of Greece to the Optical Infrared Coordination Network for Astronomy (OPTICON). He was also elected as Dean of the School of Sciences of the Univ. of Crete for the 2008-2012 term.

Prof. I. Papadakis was a member of the Governing Council of the Hellenic Astronomical Society for the 2006–2008 term.

Prof. J. Papamastorakis was a substitute member of the Greek National Committee for Astronomy.

Dr. M. Sobolewska was a member of the "AGN and Extragalactic Surveys" panel of the 2008 Chandra X-ray Center, Cycle 10, Time Alocation Committee.

Prof. I. Vardavas is on the Editorial Board of the Environmental Modelling and Software Journal

9. CONFERENCE & WORKSHOP ORGANIZATION

Prof. D. Hatzidimitriou was the chair of the organizing committee for the 2008 physics summer school organized for the 20th consecutive year by the Physics Department. The summer school provides introductory graduate level courses in various areas of modern physics to senior physics undergraduate students from all Universities of Greece. The theme for this year was "Detecting Black Holes across the Universe" and was attended by 15 students (see http://summer.physics.uoc.gr/).

Prof. J. Papamastorakis was the chair of the organizing committee of the "Onassis Foundation Science Lecture Series", which take place at the premises of FORTH every summer. The lectures are principally sponsored by the Onassis Benefit Foundation and selected students from across Europe are financially assisted to attend. A Nobel laureate as well as other leading scientists in the same field, present intensive lectures to students for a week. Typically two and occasionally three lecture series are organized every summer since 2001. The 2008 lectures addressed two topics, one in Computer Science: "Embedded Networked Systems: Theory and Applications" and one in Physics: "Cosmology: An Astrophysical Perspective" (see http://www.forth.gr/onassis).

Prof. I. Papadakis, Dr. Malgosia Sobolewska, and Prof. A. Zezas organized a week long Workshop on AGN, on 2-6 June 2008. The workshop took place in Agios Nikolaos, Crete, and was attended by 35 colleagues from all over the world. Participation was on an invitation basis only, and each presentation was 45 min long. A lot of emphasis was put on encouraging intensive discussions during and after each talk, a strategy that contributed significantly to the success of the workshop (see http://users.physics.uoc.gr/~malgosia/agnw/)

Prof. C. Haldoupis organized the "12th International Symposium on Equatorial Aeronomy" from May 18-24 2008. The conference took place near Heraklion, Crete and it was attended by ~200 scientists from all over the world. (see http://isea12.physics.uoc.gr/)

Prof. V. Charmandaris, in collaboration with Dr. J.-L. Starck (CEA/Saclay, France),

Prof. P. Tsakalidis (Univ. of Crete), and Prof. f. Murtagh (Univ. of London, UK) organized the 5th Astronomical Data Analysis Conference in May 2008. The conference took place near Heraklion, Crete, and was attended by ~75 scientists from all over the world (see http://www.ics.forth.gr/ada5)

Prof. V. Charmandaris, and Prof. N. Kylafis, organized a week long Workshop on "Challenges in Infrared Extragalactic Astrophysics", on 15-19 September 2008. The workshop took place in Heraklion, Crete, and was attended by ~35 scientists from all over the world. Participation was on an invitation basis only, and each presentation was ~40 min long. A lot of emphasis was put on encouraging intensive discussions during and after each talk, a strategy that contributed significantly to the success of the workshop (see http://www.physics.uoc.gr/~vassilis/irmtg08)

10. VISITORS

A total of 26 scientists visited our Department in order to collaborate with staff members of the Section and/or give seminars. During the 2008 calendar year these individuals were: Dr. L. Armus (Caltech/SSC, USA), Dr. E. Angellakis (MPI Radioastronomy Bonn, Germany), Dr. P. Appleton (Caltech/HSC, USA), Dr. J. Bernard-Salas (Cornell Univ., USA), Dr. D. Burrows (Penn State Univ., USA), Dr. D. Elbaz (CEA/Saclay, France), Dr. R. Chary (Caltech/SSC, USA), Dr. K. Dasyra (Caltech, USA), Dr. U. Ertan (Sabanci Univ., Turkey), Dr. J. Gutierrez-Soto (Obs. de Paris, France), Dr. G. Kanbach (MPE–Garching, Germany), Dr. D. Kazanas (NASA/GSFC, USA), Prof. K. Kokkotas (Univ. of Thessaloniki), Dr. C. Kouveliotou (NASA/MSFC, USA), Prof. P. Laguna (Penn State Univ., USA), Dr. S. Markoff (Univ. of Amsterdam, The Netherlands), Mrs E. Nespoli (Univ. Valencia, Spain) Dr. S. Ott (ESA/ESAC, Spain), Dr. D. Pancheva (BAS/Sofia, Bulgaria), Prof. M. Paolillo (Univ. of Napoli, Italy), Ms. H. Schlichting (Caltech, USA), Prof. J.H. Seiradakis (Univ. of Thessaloniki), Dr. J.-L. Starck (CEA/Saclay, France), Prof. J. Trumper (MPE, Germany), Dr. M. Wise (Univ. of Amsterdam, The Netherlands), Dr. M. Woche (MPE, Germany).

11. PUBLICATIONS

The following 39 publications of the members of the Section appeared in print in international refereed journals during the 2008 calendar year. This corresponds to ~2.6 refereed publications per PhD researcher. For each publication, the names of the members of the Section are underlined.

1. Arévalo, P., McHardy, I. M., Markowitz, A., Papadakis, I. E., Turner, T. J., Miller, L., Reeves, J., "Fourier-resolved energy spectra of the Narrow-Line Seyfert 1 Mkn 766", 2008, MNRAS, 387, 279
2. Barnard, R., Stiele, H., Hatzidimitriou, D., Kong, A. K. H., Williams, B. F., Pietsch, W., Kolb, U. C.; Haberl, F., Sala, G., "New XMM-Newton Analysis of Three Bright X-Ray Sources in M31 Globular Clusters, Including a New Black Hole Candidate", 2008, ApJ, 689, 1215
3. Beirão, P., Brandl, B.R., Forster-Schreiber, N., Smith, J.D., Appleton, P.N., Armus, L., Charmandaris, V., Houck, J.R. "Spatially resolved Spitzer/IRS Spectroscopy of the central region of M82", 2008, ApJ, 676, 304

4. Belczynski, K., Kalogera, V., Rasio, F. A., Taam, R. E., Zezas, A., Bulik, T., Maccarone, T. J., Ivanova, N., "Compact Object Modeling with the StarTrack Population Synthesis Code", 2008, ApJS, 174, 223
5. Bianchi, S., La Franca, F., Matt, G., Guainazzi, M., Jimenez Bailón, E., Longinotti, A. L., Nicastro, F. Pentericci, L., "A broad-line region origin for the iron Kα line in NGC 7213", 2008, MNRAS, 389, 52
6. Blay, P., Martínez-Núñez, S., Negueruela, I., Pottschmidt, K., Smith, D. M., Torrejón, J. M., Reig, P., Kretschmar, P., Kreykenbohm, I., "INTEGRAL long-term monitoring of the supergiant fast X-ray transient XTE J1739-302", 2008, A&A, 489, 669
7. Boumis, P., Alikakos, J., Christopoulou, P. E., Mavromatakis, F., Xilouris, E. M., Goudis, C. D., "First optical detection of the supernova remnant G 15.1-1.6", 2008, A&A, 481, 705
8. Brassington, N. J., Fabbiano, G., Kim, D.-W., Zezas, A., Zepf, S., Kundu, A., Angelini, L., Davies, R. L., Gallagher, J., Kalogera, V., Fragos, T., King, A. R., Pellegrini, S., Trinchieri, G., "Deep Chandra Monitoring Observations of NGC 3379: Catalog of Source Properties", 2008, ApJS, 179, 142
9. Charmandaris, V., Heydari-Malayeri, M., Chatzopoulos, E., "Spitzer Mid-infrared Study of compact HII regions in the Magellanic Clouds", 2008, A&A, 487, 567
10. Coustenis, A., …, Vardavas, I. M., …, "TandEM: Titan and Enceladus mission", 2008, Experimental Astronomy, DOI. 10.1007/s10686-008-9103-z
11. da Cunha, E., Charlot, S., Elbaz, D., "A simple model to interpret the ultraviolet, optical and infrared emission from galaxies", 2008, MNRAS, 388, 1595
12. Fragos, T., Kalogera, V., Belczynski, K., Fabbiano, G., Kim, D.-W., Brassington, N. J., Angelini, L., Davies, R. L., Gallagher, J. S., King, A. R., Pellegrini, S., Trinchieri, G., Zepf, S. E., Kundu, A., Zezas, A., "Models for Low-Mass X-Ray Binaries in the Elliptical Galaxies NGC 3379 and NGC 4278: Comparison with Observations", 2008, ApJ, 683, 346
13. Gliozzi, M., Papadakis, I. E., Sambruna, R. M., "Long-Term X-Ray Monitoring of NGC 6251: Evidence for a Jet-dominated Radio Galaxy", 2008, ApJ, 678, 78
14. Kylafis, N. D., Papadakis, I. E., Reig, P., Giannios, D., Pooley, G. G, "A jet model for Galactic black-hole X-ray sources: some constraining correlations", 2008, A&A, 489, 481
15. Lavvas, P. P., Coustenis, A., Vardavas, I. M., "Coupling photochemistry with haze formation in Titan's atmosphere, Part I: Model description", Planetary and Space Science, Volume 56, Issue 1, p. 27-66
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17. Lebouteiller, V., Bernard-Salas, J., Brandl, B.R., Whelan, D., Wu, Y., Charmandaris, V., Devost, D., " Chemical abundances and mixing in giant H ii regions as viewed from Spitzer/IRS ", 2008, ApJ, 680, 398
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19. Matsoukas, C., Banks, A. C., Pavlakis, K. G., Hatzianastassiou, N., Stackhouse, P. W., Vardavas, I., "Reply to comment by Kara and Barron on ``Seasonal heat budgets of the Red and Black seas''", 2008, Journal of Geophysical Research, Volume 113, Issue C12, CiteID C12009
20. Mika, A. Haldoupis, C., "VLF Studies During TLE Occurrences in Europe: A Summary of New Findings", 2008, Space Science Reviews, Vol. 137, 489-510

21. Neubert, T., Rycroft, M., Farges, T., Blanc, E., Chanrion, O., Arnone, E., Odzimek, A., Arnold, N., Enell, C.-F., Turunen, E., Bösinger, T., Mika, Á., Haldoupis, C., Steiner, R. J., van der Velde, O., Soula, S., Berg, P., Boberg, F., Thejll, P., Christiansen, B., Ignaccolo, M., Füllekrug, M., Verronen, P. T., Montanya, J., Crosby, N., "Recent Results from Studies of Electric Discharges in the Mesosphere", 2008, Surveys in Geophysics, Vol. 29, p71-137, 2008, DOI 10.1007/s10712-008-9043-1
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26. Papadimas, C. D., Hatzianastassiou, N., Mihalopoulos, N., Kanakidou, M., Katsoulis, B. D., Vardavas, I., "Assessment of the MODIS Collections C005 and C004 aerosol optical depth products over the Mediterranean basin", 2008, Atmospheric Chemistry and Physics Discussions, Volume 8, Issue 4, 2008, pp.16891
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38. Wu, Y., Bernard-Salas, J., Charmandaris, V., Lebouteiller, V., Hao, L., Brandl, B.R., Houck, J.R., "Elemental Abundances and of Blue Compact Dwarfs from mid-IR spectroscopy with Spitzer", 2008, ApJ, 683, 193
39. Wu, Y., Charmandaris, V., Houck, J.R., Bernard-Salas, J., Lebouteiller, V., Brandl, B.R., Farrah, D., "Blue Compact Dwarf Galaxies with Spitzer: The Infrared/Radio Properties", 2008, ApJ, 676, 970

12. CONTACT

The Department of Physics of the University of Crete is located on a campus 8 km west of Heraklion, the largest city in the island of Crete, Greece. At the end of 2008 it consisted of 36 faculty members, as well as a number of research associates and graduate students, working on various fields of theoretical and experimental physics. The postal address of the Section of Astrophysics and Space Physics is:

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