UNIVERSITY OF CRETE
Physics Department
Section of Astrophysics and Space Physics

Faculty members (in 1998):

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D. Hatzidimitriou, Assistant Professor (Observational Astrophysics)

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I. Vardavas, Associate Professor (Theoretical Environmental Physics)

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J. Contopoulos (Theoretical Astrophysics)

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GENERAL DESCRIPTION OF RESEARCH

Research in Astrophysics and Space Physics - both theoretical and observational - covers a broad range of subjects, ranging from studies of the Earth's atmosphere/ionosphere, to the study of distant galaxies. Within our Solar System, research is concentrated on the dynamics of solar plasmas and the solar wind, as well as the evolution of planetary atmospheres. In our Galaxy, young stellar objects, white dwarfs, neutron stars, black holes, planetary nebulae, supernova remnants, globular clusters, and RR-Lyrae variable stars. Beyond our Galaxy, on the star formation history and evolution of galaxies in the Local Group, on dust distribution in spiral galaxies, astronomical MASERS, jets and other exotic phenomena in active galactic nuclei and quasars.

The data used are obtained from a variety of optical telescopes (Skinakas, AAT, CTIO), radio telescopes (VLBI, AT), the Hubble Space Telescope, several satellites and radars.

The scientific impact of the Section is quantified with about 10 - 15 publications in refereed journals per year and about 5 - 10 invited talks in international conference proceedings per year.

The main research activities of the Section, as well as a description of the activities of the Skinakas Observatory, are given below.

SPECIFIC RESEARCH WORK

Research on the evolution of planetary atmospheres and that of the Earth's atmosphere is being conducted with the use of computer simulation models of atmospheric composition, radiation field and thermal structure. These models generate the vertical structure of the atmosphere's temperature and the concentrations of the molecular constituents. The research fields include the evolution of the earth's climate in relation to solar and geological evolution, and the atmospheres of Titan and Mars. Research is also carried out on atmospheric ozone in the upper atmosphere, and on other environmental issues such as the energy balance of the Earth's surface/atmosphere, and sustainable water resource exploitation.

Research in ionospheric physics, such as investigation of coherent radio wave backscatter phenomena from, magnetic aspect-sensitive, electrostatic plasma waves in the lower ionosphere. Operation of HF (Valensole system in South France) and VHF (SESCAT system in Crete) Doppler radars at midlatitude for ionospheric backscatter Doppler measurements. Experimental and theoretical study of plasma instability mechanisms and electrodynamics in the midlatitude E region ionosphere, in the presence of sporadic E_s layers and atmospheric gravity waves. Ionospheric Auroral zone plasma studies of coherent and incoherent scatter phenomena using the European Incoherent Scatter radar. Wind potential and turbulence studies and applied research on wind energy problems using wind measurements and mass-consistent models.

Modern observations, including recent ones with the Hubble Space Telescope, have shown that our Universe is replete with dynamic plasmas and enigmatic outflows. One area of research is the study of solar plasmas, i.e., magnetofluids in the interior of the Sun and its dynamic atmosphere and solar wind. Another broad direction of active research concerns astrophysical plasmas, such as stellar winds, collimated outflows from young stellar objects and accretion disks, jets associated with enigmatic binaries and symbiotic stars, relativistic outflows from galactic objects or active galactic nuclei and quasars probably fueled by supermassive black holes.

Research in Theoretical High Energy Astrophysics including, in particular, the physics of high magnetic fields, pulsars, neutron stars, radiative processes, radiative transport and spectral formation in these objects, accretion onto neutron stars and black holes in binaries, and gamma-ray burst sources.

Research in Theoretical Astrophysics is also in subjects related to modelling of astronomical objects and transfer of radiation of all wavelengths in various astronomical environments. Specific objects of research are: a) X-ray sources (white dwarfs, neutron stars, black holes), b) astronomical MASERs and c) spiral galaxies.

Using the 1.3m Telescope at Skinakas Observatory, research is done in observational astrophysics including the study of the morphology and chemical composition of Supernova Remnants and Planetary Nebulae (using observations through narrow band interference filters and spectrophotometry), with the aim of better understanding the emission processes and the last stages of stellar evolution (e.g., detection of extended halos in planetary nebulae resulting from stellar winds). Also, study of galactic globular clusters with the purpose of better determining their ages and distances (using RR-Lyrae variables), as well as of investigating in detail various stages in stellar evolution. Also, using large telescope facilities (both spectroscopic and direct imaging, in the optical and radio, in Australia with the AAT and AT and Chile at CTIO), study of star formation history, chemical evolution, and dynamics of Local Group Galaxies, including the Magellenic Clouds, and the dwarf spheroidals (Carina, Sculptor, Fornax).

SKINAKAS OBSERVATORY

The favourable climatological conditions prevailing in Crete (large number of clear-sky nights per year) combined with the high mountains, place the island of Crete among the best locations in Europe for high quality astronomical observations. These facts were influential in the establishment of the Skinakas Observatory.

The Skinakas Observatory has been built and 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 of Germany (in charge of the Greek side is Professor J. Papamastorakis and of the German side Professor G. Haerendel). The site of the Observatory, chosen on scientific and functional grounds, is the Skinakas summit of Mount Ida (Psiloritis), at an altitude of 1760 m and 60 km from Heraklion.

In 1985 a road 2.5 km long was built to the Skinakas summit and the first observatory building was constructed, housing since 1986 a telescope with a 30 cm reflector of focal ratio f/3.2. A 200 m^2 residential building was completed in 1988.

Since a 30 cm telescope is too small for research purposes, it was decided in 1990 and in the framework of the collaboration between the three Institutions (University of Crete, FORTH, Max-Planck Institut) to significantly extend the Skinakas installations by building a larger observatory containing a telescope with a 1.3 m reflector, which is the biggest telescope installed in Greece to date. The inauguration of the new telescope took place in October 1995.

The new Observatory, built entirely of metal, has a dome of 8 m diameter. The telescope is of Ritchey-Cretien type with focal ratio f/7.6 and a maximum field of view of 45 arcmin. The optical components were manufactured by the Karl-Zeiss Company in Germany. The mount and computer-driven control system of the telescope (which also controls the rotation of the dome) were constructed by DFM Engineering (USA); it is of similar design to that of the Harvard Smithsonian Observatory.

The instrumentation of the 1.3 m telescope includes:

- A Focal Reducer which reduces by 1.9 the focal length of the telescope. In addition, it allows for low resolution spectroscopic measurements.
- An Autoguider.
- Three CCD cameras: one with 1024 x 1024 pixels and two with 800 x 2000 pixels. A fourth CCD camera (1024 x 1024 pixels) has been ordered.
- A tip-tilt system for the reduction of the atmospheric seeing (typical seeing on Skinakas is about 1 arcsec or less) is under construction and will be completed in 1998.
- A high resolution (R=35000) Echelle Spectrograph is under construction and will be commissioned in 1998.
- An infrared camera (for the spectral region 1μ - 2.4μ) is at the design stage.

The main ongoing astronomical projects at the Observatory of Skinakas include:

- studies of planetary nebulae (imaging faint halos, 2-D mapping of abundances),
- supernova remnants (imaging of known SNRs, optical detection of X-ray emitting SNRs),
- globular clusters (horizontal branch, CMD, age, RR Lyrae),
- distribution of dust in spiral galaxies,
- low-resolution spectroscopy of X-ray active stars.

PUBLICATIONS

1993

I. Journal Publications (alphabetical by first author)

1. "Preferential Phase Velocities for Type 4 Irregularities in the Auroral E-region Plasma", C. Haldoupis, J. A. Koehler, G. J. Sofko, D. W. Danskin, M. J. McKibben and D. Andre, 1993, *J. Geophys. Res.*, **98**, 6173 – 6179.

2. "Some Observations of Radio Auroral Backscatter at 140 MHz During E-region Electron Gas Heating", 1993, C. Haldoupis, K. Schlegel and E. Nielsen, *Ann. Geophys.*, **11**, 283 – 295.

3. "A 50 MHz Radio Doppler Experiment for Mid-latitude E-region Coherent Backscatter Studies. System Description and First Results", C. Haldoupis and K. Schlegel, 1993, *Radio Science*, **28**, 959 – 978.

4. "Kinematics in the Outer Regions of the SMC", D. Hatzidimitriou, R. D. Cannon and M. R. S. Hawkins, 1993, *M.N.R.A.S.*, **261**, 873.

5. "Low-mass X-ray Binary Models for the Supersoft X-ray Sources CAL 83, CAL 87 and RX J 0527.8-6954 in the Large Magellanic Cloud", N. Kylafis and E. Xilouris, 1993, *A&A*, **278**, L43.

6. "Hercules X-1 During the ROSAT All-Sky Survey", F. Mavromatakis, 1993, *A&A*, **273**, 147.

7. "Two Outbursts from A 0538-66 in the ROSAT All-Sky Survey", F. Mavromatakis and F. Haberl, 1993, *A&A*, **274**, 304.

8. "The X Per System in the ROSAT All-Sky Survey", F. Mavromatakis, 1993, *A&A*, **276**, 353.

9. "Morphological Study of the Extended Halo Around the Dumbbell Nebula (NGC 6853)", J. Papamastorakis, K. M. Xilouris and E. V. Paleologou, 1993, *A&A*, **279**, 536.

10. "Analytical Studies of Collimated Astrophysical Winds. III. Nonrotating Meridional MHD Outflows", E. Trussoni and K. Tsinganos, 1993, *A&A*, **269**, 589 – 600.

11. "MHD Equilibrium with Flows in Uniform Gravity. II. A Class of 2-D Exact Solutions for Coronal Loops", K. Tsinganos, G. Sourlantzis, and E. Priest, 1993, *A&A*, **275**, 613 – 629.

12. "Helically Symmetric MHD Equilibrium Solutions", M. Villata and K. Tsinganos, 1993, *Phys. Fluids B*, **5** (7), 2153 – 2164.

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15. "Detection of Optical Emission in the Area of G127.1+0.5", K. M. Xilouris, J. Papamastorakis, E. V. Paleologou, Y. Andredakis and G. Haerendel, 1993, *A&A*, **270**, 393.

II. Publications in Conference Proceedings (alphabetical by first author)

1. "The Oosterhoff Dichotomy in the Globular Cluster ω Cen", R. J. Dickens, D. Hatzidimitriou and R. T. Rood, 1993, in *The Globular Cluster–Galaxy Connection*, Proc. of the Santa Cruz Workshop, G. H. Smith and J. P. Brodie (eds.), p. 194, Publ. Astronomical Society of the Pacific.

2. "A New Radio Doppler Experiment for Mid-latitude E-region Coherent Backscatter Studies", C. Haldoupis and K. Schlegel, 1993, in *Proceedings of the First Panhellenic Astronomical Meeting*, P. Laskarides (ed.), (Athens: National Astronomical Committee), p. 345-352.

3. "New Results on the Magellanic Clouds", D. Hatzidimitriou, 1993, invited review at the *IAU Symposium 161*, Potsdam, Germany, p. 489.

4. "Kinematics in the Small Magellanic Cloud", Hatzidimitriou, D. and Cannon, R. D., 1993, in *Lecture Notes in Physics no. 416*, 'New aspects of Magellanic Cloud Research', Baschek et al. (eds.), Springer-Verlag, p. 17.

5. "Structural parameters for the eight galactic dwarf spheroidals", Irwin M. and Hatzidimitriou D., 1993, in *The Globular Cluster–Galaxy Connection*, Proc. of the Santa Cruz 1992 Workshop, G. H. Smith and J. P. Brodie (eds.), Publ. Astronomical Society of the Pacific, p. 322.

6. "Search for Mass Segregation in NGC2098 in the Large Magellanic Cloud", M. Kontizas, D. Hatzidimitriou, Y. Bellas-Velidis, R. D. Cannon, E. Kontizas and A. Dapergolas, 1993, in *Lecture Notes in Physics no. 416*, 'New aspects of Magellanic Cloud Research', Baschek et al. (eds.), Springer-Verlag, p. 368.

7. "Low-mass X-ray Binary Models for the Supersoft X-ray Sources CAL 83, CAL 87 and RX J0527.8-6954 in the Large Magellanic Cloud", N. D. Kylafis and E. Xilouris, 1993, in *Proceedings of the First Panhellenic Astronomical Meeting*, P. Laskarides (ed.), (Athens: National Astronomical Committee), p. 373.

8. "Carbon Stars in the Small Magellanic Cloud", D. H. Morgan and D. Hatzidimitriou, 1993, in *proc. IAU Symposium 161*, Potsdam, Germany, p. 513.

9. "Observations of Extended Astronomical Sources with the CCD Camera of the Skinakas Observatory" (in Greek), J. Papamastorakis, K. M. Xilouris, E. V. Paleologou and G. Haerendel, 1993, in *Proceedings of the First Panhellenic Astronomical Meeting*, P. Laskarides (ed.), (Athens: National Astronomical Committee), p. 279.

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12. "Outflow Focusing in Rotating Stellar Magnetospheres", K. Tsinganos, E. Trussoni and C. Sauty, 1993, in *Advances in Stellar and Solar Coronal Physics*, J. Linsky and S. Serio (eds.), (Dordrecht: Kluwer), pp. 615 – 622.

13. "Steady MHD Flows in Uniform Gravity: A Class of Exact 2-D Solutions for Coronal Loops", K. Tsinganos, G. Sourlantzis and E. Priest, 1993, in *Advances in Stellar and Solar Coronal Physics*, J. Linsky and S. Serio (eds.), (Dordrecht: Kluwer), pp. 623 –

627.

14. "Focusing of Astrophysical Winds to Jets", K. Tsinganos and C. Sauty, 1993, in *Proceedings of the First Panhellenic Astronomical Meeting*, P. Laskarides (ed.), (Athens: National Astronomical Committee), pp. 391 – 398.

1994

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2. "Precambrian Glaciations and the Evolution of the Atmosphere", J. H. Carver and I. M. Vardavas, *Ann. Geophys.*, **12**, 674 – 682.

3. "Possible Evidence for Partial Demagnetization of the Electrons in the Auroral E-region Plasma During Electron Gas Heating", C. Haldoupis, 1994, *Ann. Geophys.*, **12**, 40 – 43.

4. "Auroral Radar Frequency Broadening Measurements at Large Aspect Angles and Comparison to Theory", C. Haldoupis, J. A. Koehler, G. J. Sofko, J. Mu, D. Andre, A. V. Kustov and D. W. Danskin, 1994, *J. Geophys. Res.*, **99**, 8925 – 8935.

5. "Soft X-ray Observations of EXO 2030+375", F. Mavromatakis, 1994, *A&A*, **285**, 209.

6. "Soft and Hard X-ray Observations of 4U 1626-67", F. Mavromatakis, 1994, *A&A*, **285**, 503.

7. "Model Atmospheres and Radiation of Magnetic Neutron Stars", G. G. Pavlov, Yu. A., Shibanov, J. Ventura and V. E. Zavlin, 1994, *A&A*, **289**, 837.

8. "Nonradial and Nonpolytropic Astrophysical Outflows. III. The Transition from Jets to Winds", C. Sauty and K. Tsinganos, 1994, *A&A*, **287**, pp. 893 – 926.

9. "Observation of the Modified Two-stream Plasma Instability in the Mid-latitude E-region Ionosphere", K. Schlegel and C. Haldoupis, 1994, *J. Geophys. Res.*, **99**, 6219 – 6226.

10. "Discovery of the New Emission Nebula G4.4+6.4", K. M. Xilouris, J. Papamastorakis, N. Sokolov, E. V. Paleologou and W. Reirh, 1994, *A&A*, **290**, 639.

11. "On the Nature of Pulsar Emission", K. M. Xilouris, M. Kramer, A. Jessner and R. Wielebinski, 1994 *A& A*, **288**, L17.

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1. "CCD Imaging with a 1^o Field", R.-J. Dettmar, B. A. Skilf and K. M. Xilouris, 1994, in *Astronomy from Wide Field Imaging*, T. Mac Gillivray (ed.), p. 79.

2. "Coherent Scattering of Radio Waves from Plasma Irregularities in the E-region of the Earth's Ionosphere" (in greek), C. Haldoupis, 1994, in *2nd Panhellenic Conference on Solar and Space Physics*, Xanthi, p. 218 – 240.

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5. "MHD Jets and Winds", K. Tsinganos and C. Sauty, 1994, in *Cosmical Magnetism*, D. Lynden-Bell (ed.), (Dordrecht: Kluwer), pp. 45 – 54.

6. "Ο Ηλιακός Ανεμος στο ταξείδι του ΟΔΥΣΣΕΑ (The Solar Wind in the Voyage of Ulysses)", Κ. Τσίγκανος, 1994, στο *Ηλιακή και Διαστημική Ερευνα στην Ελλάδα – Βασική Ερευνα, Τεχνολογία και Εφαρμογές*, (in *Solar and Space Physics in Greece: Basic Research, Technology and Applications*), pp 74 – 93.

7. "Η Θέρμανση του Ηλιακού Στέμματος (The Heating of the Solar Corona)", Κ. Τσίγκανος, 1994, στο *Ηλιακή και Διαστημική Ερευνα στην Ελλάδα – Βασική Ερευνα, Τεχνολογία και Εφαρμογές* (in *Solar and Space Physics in Greece: Basic Research, Technology and Applications*), pp 53 – 73.

8. "Atomic Motion and Ionization in Pulsar Atmospheres", J. Ventura, H. Herold and N. Kopidakis, 1994, in *Lives of Neutron Stars*, M. A. Alpar, U. Kiziloglou, J. van Paradijs (eds.), (Dordrecht: Kluwer), p. 97.

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2. "Atmospheric Carbon Dioxide and The Long Term Control of the Earth's Climate", J. M. Carver and I. M. Vardavas, 1995, *Ann. Geophys.*, **13**, 782 – 790.

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4. "An Overview of Type 3 Radar Auroral Research. Basic Observational Properties and New Interpretation Propositions", C. Haldoupis, G. J. Sofko, G. C. Hussey and J. Mu, 1995, *Ann. Geophys.*, **13**, 10 – 24.

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7. "Modeling the Centimetre–Millimetre–Infrared Flaring Behaviour of the Quasar 1253−055 (3C279)", S. J. Litchfield, J. A. Stevens, E. I. Robson and W. K. Gear, 1995, *M.N.R.A.S.*, **274**, 221 – 234.

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13. "The Acceleration of the Nonspherically Symmetric Solar Wind and the Solar Probe", K. Tsinganos, 1995, *Adv. Sp. Res.*, **17**, No. 3, pp. 65 – 74.

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15. "Thermal Radiation from Rotating Neutron Star: Effect of the Magnetic Field and Effective Temperature Distribution", V. E. Zavlin, G. G. Pavlov, Yu. A. Shibanov and J. Ventura, 1995, *A&A*, **297**, 441.

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4. "Spectral and Temporal Variability in Low-mass X-ray Binaries", N. D. Kylafis, 1995, (invited review) in *Currents in High Energy Astrophysics*, NATO/ASI, M. Shapiro, R. Silberberg and J. Wefel (eds.), (Dordrecht: Kluwer), p. 45.

5. "Opacity Diagnostics in Spiral Galaxies", N. D. Kylafis, 1995 (invited review) in *The Opacity of Spiral Disks*, NATO/ARW, J. Davies (ed.), (Dordrecht: Kluwer), p. 55.

6. "Model Atmospheres of Neutron Stars", Yu.A. Shibanov, V.E. Zavlin, G.G. Pavlov and J. Ventura, 1995, in *Lives of Neutron Stars*, NATO/ASI, A. Alpar, U. Kiziloglu and J. van Paradijs (eds.), (Dordrecht: Kluwer), pp. 91 – 95.

7. "Atomic Motion and Ionization in Pulsar Atmospheres", J. Ventura, H. Herold and N.Kopidakis, 1995, in *Lives of Neutron Stars*, NATO/ASI, A. Alpar, U. Kiziloglu and J. van Paradijs (eds.), (Dordrecht: Kluwer), pp. 97 – 100.

1996

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1. "An Explanation for Type 1 Radar Echoes from the Midlatitude E Region Ionosphere", C. Haldoupis, 1996, *Geophys. Res. Lett.*, **23**, 97.

2. "Midlatitude E Region Coherent Backscatter Observed Simultaneously at Two Frequencies", C. Haldoupis, A. Bourdillon, M. Six and J. Delloue, 1996, *J. Geophys. Res.*, **101**, 7961.

3. "Characteristics of Midlatitude Coherent Backscatter from the Ionospheric E Region Obtained with Sporadic E Scatter Experiment", C. Haldoupis and K. Schlegel, 1996, *J. Geophys. Res.*, **101**, 13387.

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6. "Two-dimensional MHD Models for Stellar Winds", J. Lima, K. Tsinganos and E. Priest, 1996, *Astrophysical Letters & Communications*, **34**, 281.

7. "Modelling X-ray Colour-Colour hanges in Z Sources", S. Litchfield and N. Kylafis, 1996, *A&A*, **314**, L25.

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9. "OH Masers as Diagnostics of Physical Conditions in Star-forming Regions. I. Thermal Effects", K. Pavlakis and N. Kylafis, 1996, *ApJ*, **467**, 300.

10. "OH Masers as Diagnostics of Physical Conditions in Star-forming Regions. II. Effects of Large Velocity Gradients and Infrared Radiation", K. Pavlakis and N. Kylafis, 1996, *ApJ*, **467**, 309.

11. "Separatrix Characteristics in Steady MHD Flows", G. Sourlantzis, K. Tsinganos and E. Priest, 1996, *Astrophysical Letters & Communications*, **34**, 251.

12. "Spherical Accretion onto Neutron Stars and Black Holes", L. Titarchuk, A. Mastichiadis and N. Kylafis, 1996, *A&A Suppl.*, **120**, C171.

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1. "Decameter Midlatitude Sporadic E Irregularities in Relation with Gravity Waves", A. Bourdillon, E. Lefur, C. Haldoupis, Y. Le Roux, J. Menard and J. Delloue, 1997, *Ann. Geophys.*, **15**, 925.

2. "Type 1 Radar Echoes from the Midlatitude E Region", C. Haldoupis, D. T. Farley and K. Schlegel, 1997, *Ann. Geophys.*, **15**, 908.

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II. Publications in Conference Proceedings (alphabetical by first author)

1. "Kinematics of Carbon Stars in the Outer Regions of the Small Magellanic Cloud", D. Hatzidimitriou, 1997, invited review in *AIP Conference Proceedings 393*, American Institute of Physics, Woodbury, New York, p. 561.

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