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

ANNUAL REPORT FOR 2017

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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).
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 2017 calendar year. The staff of the Section consisted of 17 PhD research scientists, 12 PhD 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 2017 it resulted in 47 papers published in refereed journals, that is 2.8 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 2018, based on contributions from all members of the Section. The final editing was done by K. Tassis.

2. Personnel

2.1. PERSONNEL OF THE SECTION

The staff associated with the Section of Astrophysics and Space Physics consists of 17 PhD research scientists, 12 PhD students, and 4 technicians.

The 9 Physics faculty members of the Section during the period of the report were Vassilis Charmandaris (Prof.), Christos Haldoupis (Prof. - retired), Nikolaos D. Kylafis (Emeritus Prof.), John Papamastorakis (Emeritus Prof.), Iossif E. Papadakis (Prof.), Vasiliki Pavlidou (Assist. Prof.), Kostas Tassis (Assist. Prof.), Ilias M. Vardavas (Assoc. Prof. - retired), and Andreas Zezas (Assoc. Prof.). Pablo Reig (Principal Researcher at the Foundation for Research and Technology – Hellas) is also affiliated with the Section. Researchers in non-tenure track positions holding a PhD degree were Dr. Jeff Andrews, Dr. Dmitry Blinov, Dr. Fabio Del Sordo, Dr. Ioanna Leonidaki, Dr. Eva Ntormousi, Dr. Paul Sell, and Dr. Steven Williams. Support staff associated with the Skinakas Observatory were Mr. Anastasios Kougentakis, Dr. Eythymios V. Paleologou, Mr. George Paterakis, and Ms. Anna Stiakaki.

PhD students during this period were Konstantina Anastasopoulou (with A. Zezas), Tassos Epitropakis (with I. Papadakis), Konstantinos Kouroumpatzakis (with A. Zezas), Maria Kopsacheili (with A. Zezas), Konstantinos Kovlakas (with A. Zezas), Ioannis Kypriotakis (with K. Tassis), Ioannis Liodakis (with V. Pavlidou), Alexandros Maragkoudakis (with A. Zezas), Alexandros Psychogyios (with V. Charmandaris), Gina Panopoulou (with K. Tassis), Charalampos Politakis (with A. Zezas), and Aris Tritsis (with K. Tassis).

MSc students during this period were Mr. Stamatios Aliprantis (with A. Zezas), Mr. Konstantinos Kokolakis (with V. Pavlidou), Mr. George Maragkakis (with A. Zezas), Mr. Rafail Skalidis (with K. Tassis), Mrs. Sophia Tsiatsiou (with V. Charmandaris), Mrs. Maria-Christina Veli (with V. Pavlidou).

Undergraduate students working with the group were Mr. I Avgoustakis, Mr. D. Chatzakis, Mr. G. Chouliaras, Mr. K. Droudakis, Mrs. Vivi Georgakaki, Mrs. K. Fouka,

Mr. A. Karakonstantakis, Mr. G. Korkidis, Mr. I. Kyritsis, Mr. N. Mandarakas, Mrs. A. Pouliasi, Mrs. N. Spyropoulou, Mr. A Tsouros.

2.2. Personnel Changes and Notable Events

In June Dr. Eva Ntormousi joined the group coming from CEA/Saclay, France with a Marie Curie Fellowship. Also Dr. Fabio Del Sordo joined the group coming from Yale University, USA.

Dr. Pablo Reig was promoted to Research Director at FORTH in December.

In 2017 one doctoral student joined the group: Mr. Ioannis Kypriotakis (with K. Tassis); two students started working on their MSc degree under the supervision of members of the group: Mr. Stamatios Aliprantis (with A. Zezas), and Mr. George Maragkakis (with A. Zezas); seven undergraduate students joined the group: Mr. Ioannis Avgoustakis, and Mr. Angelos Karakostantakis (with I. Papadakis), Mr. K. Droudakis, and Mr. I. Kyritsis (with A. Zezas), Mrs. Niki Spyropoulou (with N. Kylafis), and Mr. Dimitris Chatzakis, Ms. Katia Fouka, Mr. George Korkidis and Ms. Alexandra Pouliasi (with V. Pavlidou).

In 2017 five doctoral students of the group were awarded their PhDs. In March Anastasios Epitropakis successfully defended his PhD thesis entitled "Variability studies of the iron line emission in AGN" under the supervision of Prof. Papadakis. The same month Georgia Virginia Panopoulou successfully defended her PhD thesis entitled "Structure and evolution of magnetic molecular clouds: Observational consequences and tests" under the supervision of Prof. Tassis. Also in March Alexandros Maragkoudakis successfully defended his PhD thesis entitled "A multi-wavelength study of the activity in a representative sample of nearby star-forming galaxies" under the supervision of Prof. Zezas. In April Ioannis Liodakis successfully defended his PhD thesis entitled "Revealing the physics of the most active of galaxies: connecting blazar theory and observations" under the supervision of Prof. Pavlidou. Finally, in July Aris Tritsis successfully defended his PhD thesis entitled "Multiscale Study of the Structure of Molecular Clouds: Connecting Theory and Observations" under the supervision of Prof. Tassis.

Dr. I. Liodakis and Dr. G. Panopoulou were jointly awarded the 2017 Young Researcher Award of the University of Crete.

Dr. I. Liodakis was awarded the 2016-2017 Best Thesis Award of the Hellenic Astronomical Society.

Dr. I. Liodakis was awarded the prestigious Institute Fellowship of the Kavli Institute for Particle Astrophysics and Cosmology and he moved to Stanford University (USA) as a postdoctoral fellow.

Dr. G. Panopoulou moved to California Institute of Technology (USA) as a Staff Scientist at the Astronomy Department.

Dr. A. Tritsis moved to the Research School for Astronomy and Astrophysics / Mount Stromlo Observatory of the Australian National University (Australia) as a postdoctoral fellow.

Dr. A. Maragkoudakis moved as a Postdoctoral Researcher to the Dept. of Physics & Astronomy, Western University (Canada).

Mr. K. Kokolakis obtained his MSc degree and moved to the Technical University of Crete to pursue a doctoral degree.

Mr. Aretaios Lalakos obtained his BSc degree and moved to Northwestern University (USA) to pursue a doctoral degree.

Mrs. Vivi Georgakaki obtained her BSc degree and moved to the University of Athens to pursue a Masters degree.

In the fall of 2017 Dr. Steven Williams moved to the US Naval Observatory (USA) as a research scientist.

3. FACILITIES

3.1. SKINAKAS OBSERVATORY

The Skinakas Observatory operates as part of a scientific research collaboration between the University of Crete and the Foundation for Research and Technology-Hellas (FORTH[1]). Faculty and staff of the Section, using the facilities of Skinakas, are also affiliated members of the Institute of Electronic Structure and Laser (IESL[2]) of FORTH. IESL provides additional hardware and logistics support towards the research of the members.

Only the 1.3 m telescope was operating full-time at Skinakas Observatory in 2017. This telescope 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 30 cm telescope (focal ratio f/3.2) was also operating, but for a limited time period. A number of modern instruments are permanently available on the 1.3 m telescope. 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 RoboPol[3] Collaboration, consisting of the Skinakas Observatory, the California Institute of Technology (USA), the Inter-University Center for Astronomy and Astrophysics (India), the Max-Planck Institute for Radio Astronomy (Germany), and the Nicolaus Copernicus University (Poland), continued the normal operations of RoboPol, a novel-design optical polarimeter mounted on the 1.3 m telescope of Skinakas Observatory. The main scientific aim of this collaboration is the study of optical polarization of AGN and other transients, as well as of the configuration of magnetic fields in the interstellar medium.

The development of the WALOP polarimeter at IUCAA, funded by the Stavros Niarchos Foundation, proceeds on schedule so far. A PhD student, I. Kypriotakis, has been recruited to participate in the instrument design, and is currently at IUCAA. Possible commissioning is scheduled for the end of 2018.

[1] For more information on FORTH visit: http://www.forth.gr
[2] For more information on IESL visit: http://www.iesl.forth.gr
[3] For more information on RoboPol visit: http://robopol.org/

The main projects during the 2017, April-to-November, observing period were:

- Polarimetric monitoring of stars to establish a set of polarimetric standards
- Photometry and Spectroscopy of Binaries with a compact star companion
- AGN monitoring observations
- Target of Opportunity optopolarimetric follow-up of gamma-ray bursts and other objects
- Polarimetry, Photometry, and Spectroscopy of Binaries with a compact star companion
- Narrow-band imaging of Galactic Supernova Remnants
- An Hα and near-infrared survey of nearby galaxies

The tradition of "open nights" continued and the Observatory was open to the public for 5 nights, from May until September 2017. They were very successful, with a "full-house" capacity at each night.

More details on Skinakas Observatory, the quality of the site, the telescopes, and the available instrumentation can be found in its recently updated web page at: http://skinakas.physics.uoc.gr

3.2. Ionospheric Physics Laboratory

The Ionospheric Physics Laboratory (IPL), in collaboration with Stanford University, continued the un-interrupted operation of a narrow-band very low frequency (VLF) receiver experiment throughout 2017, 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.

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 the calendar year 2017 these were:

- Spring Semester 2017
  - "Astrophysics II" (Galactic and extragalactic astrophysics)
  - "Production and Transfer of Radiation" (Graduate course)
  - "Astrophysics III" (Graduate course)
  - "Theory of Gravity" (Graduate course, taught by Prof. N. Tsamis)

- Fall Semester 2017
  - "Astrophysics I" (stellar structure and evolution)
  - "Atmospheric Environment"
  - "Astronomical Data Analysis"
  - "Gravity and Cosmology" (taught by Prof. T. Tomaras)
  - "Reduction and Analysis of Astronomical Observations"
  - "Astrophysics III" (Advanced radiative processes and radiative transfer)

A notable change from previous years is that in the fall semester the graduate course Astrophysics III that used to be taught by N. Kylafis was taught jointly by Prof. Pavlidou and Prof. Antony Readhead (Caltech), who was visiting the department in the fall, with a slightly different syllabus.

5. SCIENTIFIC RESEARCH

Here we present a brief description of the major research projects in which members of the Section were involved in 2017. 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 12.

5.1. THEORETICAL ASTROPHYSICS

- Relativistic effects in blazar jets: The intrinsic properties of blazar jets are obscured by relativistic distortions (boosting of apparent flux, compression of variability timescales, apparent speeds of jet components that can be significantly superluminal). The construction of theoretical models for the population of blazars and the optimization of these models using robust observables not affected or minimally affected by variability can help recover the intrinsic properties of the blazar population even when a source-by-source estimate of the strength of relativistic effects is unavailable. On the other hand, such models can help evaluate methods for the estimation of the relativistic distortions in individual sources, and uncover the local physics in jet emission regions. (Researchers involved: V. Pavlidou, I. Liodakis, A. Lalakos)

- Astrophysics of ultra-high-energy cosmic rays: With energies higher than 10^{18} eV, ultra-high-energy cosmic rays are the most energetic particles known. Their origin remains, to this day, unknown, but they are certain to encode important information about the most extreme processes in the Universe. Our group develops novel approaches to their study, including assessing the possibility of back-tracing of their paths through the Galactic magnetic field to uncover their true arrival directions and thus better constrain their origin; develop tests of a multiple-source-population origin; and use gamma rays resulting from intergalactic cascades to identify the location of their sources. (Researchers involved: V. Pavlidou, G. Magkos, K. Kokolakis, K. Fouka, D. Chatzakis)

- Black-hole X-ray binaries: Over the past several years, a rich phenomenology has been accumulated regarding black-hole X-ray binaries. When the sources are in the, so-called, hard X-ray state, a compact jet is always present. In the, so-called, soft X-ray state, no jet is ever detected. In the hard-to-soft transition, the jet disappears eruptively, while in the soft-to-hard transition the jet reappears in a smooth way. All this phenomenology has been explained with a physical model and only one free parameter, the mass-accretion rate. Work on the subject continues. (Researcher involved: N. Kylafis).

- Anomalous X-ray pulsars: Extremely interesting observations have been made recently on the hard X-ray spectra of Anomalous X-ray Pulsars (AXPs). The hard X-rays have luminosity comparable to that of the soft X-rays and they are pulsed, with the rotational period of the neutron stars involved. The pulsed fraction of the hard X-rays increases with the energy of the photons and it becomes ~100% at ~100 keV. In addition, the pulse shape changes with X-ray energy. A model to explain all of the above has been worked out and work on it continues. (Researchers involved: N. Kylafis, A. Zezas).

- Monte Carlo simulations of Compton upscattering in accreting neutron-star X-

ray binaries: A major issue in High-Energy Astrophysics is where the high-energy, power-law emission occurs in black-hole and neutron-star X-ray binaries. One possibility is the hot, inner, accretion flow and the other is the jet. In a series of papers, we have advocated for the jet and have explained a number of observational constraints using a simple jet model. In a recent paper, we have been able to explain the neutron-star X-ray spectra, using the same simple jet model. (Researchers involved: N. Kylafis, P. Reig).

- Simulations of Galactic star-forming regions: Non-equilibrium chemodynamical multi-fluid non-ideal MHD simulations of star-forming molecular cloud cores. Developed a novel recipe that uses observable molecular abundances to infer the actual 3D shape of molecular cloud cores. (Researchers involved: A.Tritsis, K. Tassis)

- Imprint of MHD waves in interstellar molecular clouds: Using a large suite of ideal MHD simulations the physical origin of the long parallel structures (striations) that appear in the outskirts of molecular clouds has been identified. Striations are the result of fast magnetosonic waves that are excited by Alfven waves in parts of the clouds that have sharp density boundaries. The current paradigm of streams of gas being the origin of the striations has been demonstrated to be false. (Researchers involved: A. Tritsis, K. Tassis)

- Sources of gamma-ray emission: Modeling of astrophysical populations that may be emitting gamma rays, such as blazars, and millisecond pulsars. Development of techniques to identify previously unknown members of this class (Researchers involved: D. Blinov, V. Pavlidou, N. Mandarakas, I. Liodakis, A. Pouliasi)

- Large-scale Structure Formation in the Universe: The formation of large-scale structure in the Universe is a cosmic battle between expansion inertia, gravity, and the accelerating influence of dark energy. Using analytic and semi-analytic calculations we follow the formation and growth of structure under different cosmologies. In universes with dark energy, the ultimate fate of structure formation is the halting of structure growth -- a state which can leave observable imprints in the mass-radius relations of local-universe structures such as groups and clusters of galaxies. (Researchers involved: V. Pavlidou, G. Korkidis, K. Tassis, E. Ntormousi)

- Astrostatistics: Application of statistical methods in astrophysical problems. Current projects include: assessing the significance of apparent correlations between average AGN fluxes at different wavelengths, analysis of data taking into account calibration uncertainties, derivation of spectral parameters from X-ray hardness ratios, classification of galaxies with respect to their energy source, analysis of noisy imaging data, analysis of LogN-LogS distributions, an MCMC approach for constraining the fomation and evolution of X-ray binary systems. We also held a regular Astrostatistics seminar aiming at the introduction of students and researchers to statistics techniques. (Researchers involved: A. Zezas, V. Pavlidou, J. Andrews).

- Modelling of X-ray binary populations: Standard methods of modeling the formation and evolution of high mass X-ray binaries rely on a brute force approach and are relatively inefficient. We add a statistical wrapper that uses a Markov Chain Monte Carlo technique to an already built and maintained binary

evolution code which focuses computational power on the region of parameter space of interest. This approach allows efficient fitting of observed binary populations, while taking into account their spatial distribution and the spatially resolved star-formation history of their parent stellar populations (Researchers involved: J. Andrews, K. Kovlakas, A. Zezas).

- Numerical studies of the Galactic Magnetic Field: Magnetic fields lie at the heart of all the outstanding problems in galactic evolution. We are developing the first simulations to include all the core processes of galactic evolution, such as a multi-phase interstellar medium, time-dependent star formation and stellar feedback, and the realistic non-ideal MHD terms necessary for modeling a realistic magnetic field evolution. The simulations are performed with the RAMSES code. (Researchers involved: E. Ntormousi, K. Tassis).

5.2. Observational Astrophysics

5.2.1. Observational Galactic Astrophysics

- X-ray variability of X-ray binaries (XRB): BHB consist of a 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. One of the main features of the environment in the vicinity of the black hole is the iron emission line at 6.4 keV. The goal here is to study the relationship between the line parameters with other observables (mass accretion rate, hardness of the spectrum). We employ advance timing techniques, such as, time lags, Fourier-resolve spectroscopy, and power spectrum analysis (Researchers involved: P. Reig, I. Papadakis).

- Characterization of the variability time scales in 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. A third observational property is that the light from a Be star is polarized. The origin of these three observational properties (emission lines, infrared excess, and polarization) lies in a gaseous, equatorially concentrated circumstellar disc around the OB star. This disc constitutes the main source of variability in BeX and the fuel that powers the X-ray emission through accretion. the main objective of this project is to characterize the optical/IR variability time scales of Be/X-ray binaries in correlation with their X- ray activity. (Researchers involved: P. Reig, A. Zezas)

- Study of the aperiodic variability of X-ray pulsars during giant outbursts. The main goal of this project is the definition and unified characterization of accretion-powered pulsar spectral states during giant outbursts. In the last twenty-five years, the discovery of different “states” in the X-ray emission of black-hole binaries (BHB) and neutron-star Low-Mass X-ray Binaries (LMXBs) constituted a large step forward in the understanding of the physics of accretion onto compact objects. While there are numerous studies on the timing and spectral variability of BHB and LMXBs, very little work has been done on High- Mass X-ray Binaries (HMXBs). We have found that Be/X-ray pulsars trace two different branches in the hardness-intensity diagram: the

horizontal branch corresponds to a low-intensity state of the source and it is characterized by fast color and spectral changes and high X-ray variability. The diagonal branch is a high-intensity state that emerges when the X-ray luminosity exceeds a critical limit. The two branches may reflect two different accretion modes, depending on whether the luminosity of the source is above or below a critical value. This critical luminosity is mainly determined by the magnetic field strength, hence it differs for different sources. The details of this work can be found in Reig & Nespoli (2013, A&A, 551, A1). (Researchers involved: P. Reig)

- Origin of the X-ray emission of accreting pulsars at quiescence. Several recent X-ray observations of accreting pulsars at periods when the mass transfer from the donor star is expected to be minimal, give very intriguing results, including the detection of pulsations. We continued a multi-wavelength observing program aiming at understaning the origin of this X-ray emission and the role of the propeller effect. (Researchers involved: P. Reig, A. Zezas)

- Spectral studies of accreting pulsars at high luminosities. We have embarked in a systematic study of the hard X-ray emission of outbursting accreting pulsars in the Small Magellanic Cloud. The goal of this project is to measure their magnetic field strength from the detection of Cyclotron lines, and the study of their phase resolved spectra at these high luminosities in order to constrain the dominant emission mechanisms and the geometry of the emitting region at different energies. (Researchers involved: A. Zezas, K. Droudakis)

- Wide stellar binaries: With orbital periods in excess of thousands of years, wide binaries have traditionally been identified by finding common proper motion stars within astrometric catalogs. Using the additional inclusion of parallax measurements, we are developing sophisticated Bayesian algorithms designed to mine the data from the Gaia astrometric satellite. Already, we have used this sample to place new constraints on stellar multiplicity, the strength of gravity in the weak acceleration regime, and the potential for chemical tagging to identify unique Galactic subpopulations. (Researchers involved: J. Andrews)

- The Origin of Ca-Rich Gap Transients: We have put strong constraints on the origin of calcium-rich gap transients, a recently discovered class of transient sources in the luminosity gap between novae and supernovae. By combining our recent Chandra observation of one of these transients with a simple model for fall-back accretion, we have ruled out the model of a white-dwarf being tidally disrupted by an intermediate-mass a black hole. While this observation was the deepest X-ray observation of one of these sources yet, it is consistent with a couple other triggered Chandra observations, strongly arguing against this model. (Researchers involved: P. Sell)

- Characterizing a Sample of Extreme Starburst Galaxies: We are studying a sample of (arguably the most) extreme starbursts using a large collection of observations across the electromagnetic spectrum, from radio to X-ray. The massive galaxies have recently undergone highly disruptive mergers, where a large fraction of the cold gas has been efficiently funneled to the central regions of the galaxy. This results in vigorous, very compact star formation: galaxies roughly the mass of the Milky Way forming stars within a projected area ~10000 times smaller. This then leads to high-velocity (the fastest yet seen at up to ~2000 km/s), starburst-driven, outflows heating up

and carrying away a large fraction of the gas mass, thereby rapidly truncating future star formation. Studying these galaxies helps us understand the origin of these outflows and more generally understand galaxy evolution during its most rapid and violent stages. (Researchers involved: P. Sell)

- Properties of the Linear Polarization in White Dwarfs. We performed the first linear polarimetric survey of white dwarfs (WDs). Our sample consists of DA and DC spectral types in the SDSS r magnitude range from 13 to 17. Almost all of the 74 objects of our sample are low polarized WDs with polarization degree (PD) smaller than 1%, while only 2 have PD higher than 1%. There is an evidence that on average the isolated WDs of DC type have higher PD (with median PD of 0.78%) than the isolated DA type WDs (with median PD of 0.36%). On the other hand, the median PD of isolated DA type WDs is almost the same, i.e. 0.36% as the median PD of DA type white dwarfs in binary systems with red dwarfs (dM type), i.e. 0.33%. This shows, as expected, that there is no contribution to the PD from the companion if the WD companion is the red dwarf, which is the most common situation for WDs binary systems. We do not find differences in the polarization degree between magnetic and non-magnetic WDs. Because 97% of WDs in our sample have PD lower than 1%, they can be used as faint zero-polarized standard star in the magnitude range from 13 up to 17 of SDSS r filter. They cover the Northern sky between 13 hour to 23 hour in right ascension and from -11 degrees to 78 degrees in declination. (Researchers involved: P. Reig)

- Polarization studies of the Interstellar Medium at low extinction regions: After suffering absorption by interstellar cloud dust, starlight may become polarised if the dust grains have a preferential alignment induced by the interstellar magnetic field. Studies of this polarisation with the RoboPol instrument can reveal the magnetic field structure in interstellar clouds. To assess the magnitude of the effect a mini survey of three regions of the northern sky with very low dust emission/extinction were performed. Probing the polarization at the low dust extinction regime is important in order to calibrate the expected efficiency of the PASIPHAE survey and set the required time and sensitivity thresholds. (Researchers involved: R. Skalidis, G. Panopoulou, K. Tassis, D. Blinov)

- Establishing polarimetric standards: A large fraction of the observing time with RoboPol this season was dedicated to the search for stable optopolarimetric standards distributed over the sky and over optical magnitudes. (Researchers involved: R. Skalidis, G. Panopoulou, K. Tassis, D. Blinov, I. Liodakis, V. Pavlidou)

- Understanding the origin of the "characteristic" width of Inrterstellar Molecular Cloud Filaments: Recent observational studies based on data obtained by the Herschel Space Observatory has highlighted the filamentary structure of interstellar molecular clouds. Furthermore, it has been argued that the filaments identified in the molecular clouds have a "characteristic" width of ~ 0.1 pc. The origin of this result remained elusive but a review of the algorithms and methods used to derive the width of filaments has revealed that the characteristic width may be an artefact of these techniques and not a real scale in molecular clouds (Researchers involved: G. Panopoulou, R. Skalidis, K. Tassis, E. Ntormousi)

- Narrow-band imaging of Galactic Supernova Remnants: Supernova Remnants (SNRs) are an important tool for understanding the physical processes that take place in the interaction between the shock wave from a supernova explosion and the stellar ejecta and/or the surrounding interstellar material. Narrow band images of SNRs in our Galaxy allow us to study their morphology and map their excitation, important parameters for understanding how the mechanical energy of the shock wave is transferred in the surrounding material. (Researchers involved: I. Leonidaki, A. Zezas, I. Kypriotakis)

5.2.2. Observational Extragalactic Astrophysics

- Study of X-ray sources in the Magellanic Clouds: The Magellanic Clouds provide a unique test-bed to study the X-ray binary populations in sub-solar metallicities. A systematic study of the X-ray source populations in the Small and Large Magellanic Clouds is underway, based on a Chandra X-ray Visionary Program focusing on the central region of the Small Magellanic Cloud (SMC), and archival observations of the Large Magellanic Cloud (LMC). Study of the optical counterparts and characterization of the star formation history in the specific areas of the X-ray sources has been conducted using optical imaging and spectroscopy with the 6m-Magellan Telescope, the 4m-Anglo-Australian Telescope (2df, AAOMEGA), and the 4.1m SOAR telescope. The goal of these studies is to understand the nature of the X-ray binaries in the SMC and LMC and their relation to star-formation history and metallicity. A key result from this work is the direct measurement of the formation efficiency of X-ray binaries at low metallicities. (Researchers involved: A. Zezas, J. Andrews, G. Maravelias, I. Kyritsis, S. Aliprantis).

- X-ray source populations in nearby galaxies: X-ray binaries are a key tool for understanding the evolution of binary stellar systems and the formation of their end-points such as sources of gravitational waves and short gamma-ray bursts. Studies of the discrete X-ray source populations (in particular accreting sources) in nearby galaxies allow us to: (a) probe areas of the parameter space that are not present in our neighbourhood (e.g. different metallicity or star-formation history), and (b) obtain large statistical samples and explore rare types of systems. We have embarked in a systematic study of the X-ray binary populations 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. Sell, K. Anastasopoulou, C. Politakis, J. Andrews).

- Constraining the distribution of supernova kick velocities. Supernova kicks are a critical parameter in the evolution of binary stellar systems with compact objects. They determine the survival of a system, its orbital parameters and its subsequent evolution. We are performing a multi-faceted study aiming at: (a) constraining the kick velocities of X-ray binaries based on modelling their evolution given their observed parameters, and (b) directly measuring their center-of-mass velocities based on their displacement from their birthplaces. (Researchers involved: A. Zezas, J. Andrews, C. Politakis).

- X-ray and radio observations of ultraluminous X-ray sources in nearby galaxies:

A subset of ultraluminous X-ray sources (those with luminosities higher than 10^{39} erg/s) are thought to be powered by the accretion of gas onto black holes with masses of ~5–20. The X-ray and radio emission are coupled in such Galactic sources, the radio emission originates in a relativistic jet thought to be launched from the innermost regions near the black hole, with the most powerful emission occurring when the rate of infalling matter approaches a theoretical maximum (the Eddington limit). Investigations of a new luminous ($>10^{39}$ erg/s) X-ray source in the nearby galaxy M 31, which showed extremely high radio luminosity and X-ray variability on a timescale of tens of minutes, indicate that the source is powered by accretion close to the Eddington limit for a stellar-mass black hole. (Researchers involved: P. Reig).

- Populations of Ultra-luminous X-ray sources in nearby galaxies. Ultra-luminous X-ray sources are an intriguing class of objects with luminosities above 10^{39} erg/s and often reaching extreme luminosities of 10^{40} or even 10^{41} erg/s, well above the Eddington limit for a stellar-mass black-hole. The nature and formation pathways of these sources is an open question, and their understanding is particularly important given their significant contribution in the X-ray output of galaxies. We have performed systematic studies of ULX populations in individual nearby galaxies, as well as, their demographics in large samples of galaxies. Our goal is to constrain the dependence of their populations on the age and metallicity of their parent stellar populations. (Researchers involved: A. Zezas, K. Anastasopoulou, K. Kovlakas).

- Hard X-ray observations of nearby galaxies: The NuSTAR observatory gives us an unprecedented view of the hard X-ray emission from nearby galaxies. We are leading the development of diagnostic tools for the characterization of the compact object and accretion state of X-ray binaries, and their application in X-ray observations of nearby galaxies with the NuSTAR and other X-ray telescopes. (Researchers involved: G. Maragkakis, K. Anastasopoulou, A. Zezas).

- A census of star-forming activity in the local Universe (the Star-formation Reference Survey): This is a systematic study of the star-formation and AGN activity in a representative sample of IR-selected galaxies in the local Universe. The main goal of this project is to investigate the connection between galactic activity (star formation and AGN) and galactic parameters such as stellar mass, dust content, and morphology. First results from this effort include: (a) the determination of the mass function of disks and bulges in the local Universe, (b), a census of AGN activity in local galaxies, and (c) a study of the relation between star-formation and stellar mass in sub-galactic scales (sub-galactic main sequence). On-going projects include Hα and NIR imaging which will be used for the comparison of Hα and other star-formation rate indicators in a variety of star-forming environments (Researchers involved: A. Zezas, A. Maragkoudakis, K. Kouroubatzakis)

- Scalling relations between star-formation, stellar mass and X-ray emission in galaxies. As part of our systematic effort to understand the formation of X-ray binaries we perform systematic studies of the relation between X-ray emission of galaxies and their star-forming activity and stellar mass. These studies are based on large, well-defined samples, such as the Star-Formation Reference Survey, and a complete sample of all known galaxies within 100Mpc (HECATE). These studies explore the galaxy-wide scaling relations, as well correlations in

sub-galactic scales. (Researchers involved: A. Zezas, K. Kouroubatzakis, P. Sell, K. Kovlakas, K. Anastasopoulou)

- 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 imaging data and spectroscopy from the Skinakas observatory, as well as other observatories (e.g. NOAO, CTIO). The goal of this project is to understand the populations of SNRs in different wavelengths in a variety of environments (Researchers involved: A. Zezas, M. Kopsacheili, I. Leonidaki).

- Massive stars in nearby galaxies: Massive stars are important tools for understanding stellar evolution. Observations of massive-star populations in nearby galaxies allow us to constrain their recent star-formation history, their dependence on parameters such as age and metallicity, and their connection with the compact object populations in these galaxies as witnessed in X-ray observations. (Researchers involved: S. Williams, A. Zezas).

- X-ray variability studies of AGN: Work continues, on the study of nearby luminous, and distant, faint AGN. (Researchers involved: I. Papadakis, A. Epitropakis).

- Optopolarimetric searches for low-energy counterparts of unidentified Fermi sources: Highly polarized point sources were looked for within the positional error circles of some of the most prominent high-Galactic-latitude gamma-ray sources that are yet to be associated with known systems at lower wavelengths. (Researchres involved: D. Blinov, I. Liodakis, N. Mandarakas, A. Pouliasi, V. Pavlidou)

- 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. Supporting simulations of galaxy interactions are used to model as a function of the merger stage the evolution of the star-forming and AGN activity, and the energy output of the interacting galaxies in different wavebands. The goal of this study is to address the connection between galaxy interactions and induced star-formation and AGN activity (Researchers involved: A. Zezas).

- Evolution of elliptical galaxies and their GC systems. Recent studies of the globular cluster systems in nearby elliptical galaxies revealed intriguing asymmetries and clumping in their two-dimensional distribution. This is a direct probe of the recent merging history of their host galaxies. We continued to explore this phenomenon in large samples of galaxies in the Fornax and Virgo clusters. In addition we extended this study to an investigation between the fine structure in elliptical galaxies and the stellar-mass deficit in their cores. (Researchers involved: A. Zezas, P. Bonfini)

- Mid-/Far-infrared and radio continuum properties of Luminous and Ultraluminous Infrared Galaxies (LIRGs/ULIRGs): This project was based on observations with the Spitzer Space Telescope in order to explore the mid-infrared properties of ULIRGs. The main goal is to improve our understanding of

the dominant mechanism of the energy source (accretion onto an active nucleus or a super-massive starburst) in these galaxies and ascertain their role in galaxy evolution, using multiwavelength observations. A major component is the characterization of the mid- and far-infrared emission for a complete flux-limited sample of local LIRGs/ULIRGs, the Great Observatories All-Sky Survey (GOALS) galaxy sample, using the Spitzer and Herschel Space telescopes. (Researchers involved: V. Charmandaris).

- Studying the multiwavelength morphology of galaxies in clusters: This project was based on optical and near-IR imagery of clusters obtained via the WIde-field Nearby Galaxy-cluster Survey (WINGS). Its main goal is to explore the evolution of galaxy morphology as a function of wavelength and environment. (Researchers involved: V. Charmandaris, A. Psychogyios).

- Star formation and stellar populations in Compact Groups: This project originated from the analysis of mid- and far-infrared observations of a sample of Hickson Compact Groups obtained with the Spitzer Space Telescope and Herschel Space Observatory. The analysis was extended to a larger sample of ~1700 compact galaxy groups identified in the Sloan Digital Sky Survey, with ancillary data from GALEX and WISE. The main goal is to study the effects of environment on the evolution of galaxies and their nuclear activity (Researchers involved: V. Charmandaris).

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, V. Georgakaki).

- 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)

- Ionospheric and Upper Atmospheric Physics: the research topics under study relate to the plasma physics and electrodynamics of irregular ionospheric phenomena occurring at mid-latitude, and problems associated with the interaction and coupling of the neutral mesosphere and lower thermosphere

with the earth's ionosphere. During 2016 our research focused on the following topics: 1) the effects on VLF (very low frequency) electromagnetic wave propagation and VLF response signatures associated with "transient luminous events", such as sprites, elves and gigantic jets, which are atmospheric electricity (thunderstorm and lightning) phenomena in the upper atmosphere and lower ionosphere, modelling the lifetimes of lightning-produced VLF perturbations, 2) studies of the annual and seasonal variations of mid-latitude sporadic E layers as well as the effect of lightning on sporadic E occurrence, and 3) effects of X-ray solar flare events on the lower ionosphere using Arecibo radar incoherent scatter measurements and modelling. (Researchers involved: C. Haldoupis)

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.

- ERC Consolidator Grant "A-Bingos", entitled " Accreting Binary populations in Nearby Galaxies: Observations and Simulations", (P.I.: A. Zezas, budget: €1,242,000, duration: 2014- 2019)
- H2020 RISE, entitled "ASTROSTAT: Development of novel statistical tools for the analysis of astronomical data", (P.I.: A. Zezas, budget: €526,500, duration: 2016- 2020)
- Stavros Niarchos Foundation Grant in support of the project "PASIPAHE" (P.I.: K. Tassis, budget: $1,457,000, duration: 2016-2019)
- Marie Curie Individual Fellowship "ORIGAMI", entitled: "The Origin of the Galactic Magnetic Field", (fellow: Ntormousi, budget: €153,000, duration: 2017-2019)
- ERC Consolidator Grant "PASIPHAE", entitled "Overcoming the Dominant Foreground of Inflationary B-modes: Tomography of Galactic Magnetic Dust via Measurements of Starlight Polarization", (P.I.: K. Tassis, budget: €1,887,500, duration: 2018- 2023) (awarded Dec. 2017)

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 Athens, Dept. of Physics, Athens
  - University of the Aegean, Dept. of Environment, Mytilene
  - University of Ioannina, Dept. of Physics, Ioannina

- International
  - Astronomical Institute of the Czech Academy of Sciences, Czech Republic
  - Aalto University, Finland
  - California Institute of Technology, Spitzer Science Center, Pasadena, CA, USA
  - CEA/Saclay, Service d'Astrophysique, Paris, France
  - Cornell University, Astronomy Department, Ithaca, NY, USA

- Eötvos-Lenard University, Budapest, Hungary
- ETH, Zurich, Switzerland
- Geophysical Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria
- Harvard-Smithsonian, Center for Astrophysics, Cambridge, MA, USA
- Hebrew University of Jerusalem, Jerusalem, Israel
- Institut d'Astrophysique de Paris, France
- Imperial College, London, U.K.
- Max-Planck-Institut für Extraterrestrische Physik, Garching, Germany
- Max-Planck-Institut für Kernphysik, Heidelberg, Germany
- Max-Planck-Institut für Radioastronomie, Bonn, Germany
- NASA Goddard Space Flight Center, Greenbelt, MD, USA
- NASA Jet Propulsion Laboratory, Pasadena, CA, USA
- NASA Langley Division of Atmospheric Sciences, Langley, VA, USA
- Nicolaus Copernicus Astronomical Center, Warsaw & Torun, Poland
- Northwestern University, Evanston, IL, USA
- Observatoire de Paris, Paris, France
- Oxford University, Oxford, UK
- Rome Observatory, Rome, Italy
- South African Astronomical Observatories, Sutherland, South Africa
- Shanghai Astronomical Observatory, Shanghai, China
- Stanford University, Palo Alto, CA, USA
- Université de Geneve, Geneva, Switzerland
- Université de Rennes, Rennes, France
- University of Alicante, Alicante, Spain
- University of Durham, Durham, UK
- University of Napoli Federico, Napoli, I
- University of Oslo, Norway
- University of Saskatchewan, Canada
- University of Southampton, Southampton, UK
- University of Texas at Austin, Austin, TX, USA
- University of Valencia, Valencia, Spain
- University of Wisconsin-Madisson
- University of Zielona Gora, Poland

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 Director of the Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing of the National Observatory of Athens since September 2013. He is member of the Haut Comité Scientifique of Paris Observatory (France), since 2015. He also serves as the representative of Greece to the Board of Directors and a member of the Executive Committee of the scientific journal "Astronomy & Astrophysics".

Prof. N. Kylafis is serving as the President of Greek National Committee for Astronomy, since 2011.

Prof. I. Papadakis continues to serve as the Chairman of the Department of Physics since October 2015.

Prof. V. Pavlidou and Dr. P. Reig are members of the Governing Council of the Hellenic Astronomical Society.

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

Dr. G. V. Panopoulou is serving as the Greek Representative to the International Tournament of Physicists.

Prof. K. Tassis is serving as the Management Panel Chair of the PASIPHAE Collaboration.

Prof. V. Pavlidou is serving as the Management Panel Chair of the RoboPol Collaboration and as a member of the Management Committee of the European COST action PHAROS on neutron star physics.

Prof. A. Zezas is serving as a member of the NuSTAR Users Committee.

9. Conference & Workshop Organization

The 13th conference of the Hellenic Astronomical Society took place in Heraklion from 2 to 6 July, 2017, and the Astronomy Group had the main responsibility for its organization. The Local Organizing Committee consisted of N. Kylafis (Chair), P. Reig, I. Papadakis, V. Pavlidou, I. Liodakis, K. Anastasopoulou, K. Kouroumpatzakis, while V. Pavlidou, P. Reig, and A. Zezas served also as members of the Scientific Organizing Committee.

The annual RoboPol 2017 meeting took place on March 29-30 in Heraklion at the Department of Physics and was organized by Prof. Pavlidou and her group.

The second PASIPHAE collaboration meeting took place on March 31 in Heraklion at the Department of Physics and was organized by Prof. Tassis and his group.

The first meeting of the RISE-ASTROSTAT consortium took place on June 26-28 in Heraklion at at the Department of Physics and was organized by Prof. A. Zezas, Prof. V. Pavlidou, and Dr. J. Andrews.

V. Pavlidou was a convener in the Extragalactic Sources session of the 2017 international TeV Particle Astrophysics Conference which took place at Columbus, OH between 7-11 August 2017.

10. Public Outreach

All members of the Section were involved in a number of public outreach activities throughout the year. These consist of giving public lectures, mostly in the island of Crete, along with dedicated tours to the facilities of Skinakas Observatory, as well as TV and radio interviews. The group also supports the activities organized by the local amateur astronomical societies in Crete.

The Skinakas observatory opened its doors to the public for five Sunday nights on May 14, June 11, July 9, August 6, and September 3. Hundreds of people visited the

observatory, where they were guided to the facilities by members of the Section and had the chance to look through the main 1.3 m telescope.

N. Kylafis opened the 13th conference of the Hellenic Astronomical Society with a public talk on Astrophysical Jets on July 2, 2017.

The Astronomy Group actively participated in the European Researchers' Night (September 29, 2017), which has become one of the most important events in science for the local community of Heraklion (Crete). As in the previous years the events of 2017 were very successful with large participation of the public. The Skinakas observatory participated with the presence of two senior astronomers (A. Zezas and P. Reig), one postdoc (I. Leonidaki), 4 PhD students (K. Kouroumpatzakis, M. Kopsacheili, K. Athanasopoulou and R. Skalidis) and one technician (A. Steiakaki). The show included a real-time tour of the observatory via video link, short video projections of the observatory and a selection of pictures of cosmic objects obtained with the cameras of the observatory.

The Astronomy Group participated in the 11th FORTH retreat from 13 to 15 October, 2017 (http://www.forth.gr/11th-forth-retreat/index.html) with N. Kylafis presenting the achievements of the Group and giving a public talk on astrophysical jets. Moreover, the Skinakas Observatory booth at the three day exhibit that took place at the Saint Marcus Basilica at the center of Heraklion was staffed by I. Leonidaki, K. Kovlakas, M. Kopsachili, K. Kouroubatzakis, K. Athanasopoulou, R. Skalidis and A. Steiakaki.

E. Ntormousi gave a public talk at the Talos Plaza on December 3 entitled: "The violent lives of stars: a trek through interstellar space".

11. VISITORS

A total of 17 scientists visited our Department during the 2017 calendar year in order to collaborate with staff members of the Section and/or give seminars. These individuals were: Dr. E. Angelakis (MPIfR, Germany), Dr. C. Casadio (MPIfR, Germany), Dr. G. Dewangan (IUCAA, Pune, India), Dr. T. Diaz-Santos (Univ. of Diego Portales, Chile), Dr. D. Elbaz (CEA/Saclay, France), Prof. H. K. Eriksen (Univ. of Oslo, Norway), Dr. M. Guainazzi (ESTEC, ESA, Noordwijk, Netherlands), Dr. A. Karakci (Univ. of Oslo, Norway), Mr. S. Maharana (IUCAA, Pune, India), Dr. I. Myserlis (MPIfR, Germany), Dr. M. Paolillo ("Federico II" University of Napoli, Italy), Prof. A. Ramaprakash (IUCAA, Pune, India), Prof. A. Readhead (Caltech, USA), , Dr. H. Spruit (MPA, Germany), Dr. J.-L. Starck (CEA/Saclay, France), Prof. I. K. Wehus (Univ. of Oslo, Norway), and Dr. T. Pearson (Caltech, USA).

12. PUBLICATIONS

The following **47** publications of the members of the Section appeared in print in international refereed journals (according to NASA/ADS) during the 2017 calendar year. This corresponds to 2.8 refereed publications per PhD researcher. For each publication, the names of the members of the Section are underlined.

1. Ahnen, M. L., Ansoldi, S., Antonelli, L. A., Antoranz, P., Babic, A., Banerjee, B., Bangale, P., Barres de Almeida, U., Barrio, J. A., Becerra González, J., Bednarek, W., Bernardini, E., Berti, A., Biasuzzi, B., Biland, A., Blanch, O., Bonnefoy, S., Bonnoli, G., Borracci, F., Bretz, T., Buson, S., Carosi, A., Chatterjee, A., Clavero, R., Colin, P., Colombo, E., Contreras, J. L., Cortina, J., Covino, S., Da Vela, P., Dazzi, F., De Angelis, A., De Lotto, B., de Oña Wilhelmi, E., Di Pierro, F., Doert, M., Domínguez, A., Dominis Prester, D., Dorner, D., Doro, M., Einecke, S., Eisenacher Glawion, D., Elsaesser, D., Engelkemeier, M., Fallah Ramazani, V., Fernández-Barral, A., Fidalgo, D., Fonseca, M. V., Font, L., Frantzen, K., Fruck, C., Galindo, D., García López, R. J., Garczarczyk, M., Garrido Terrats, D., Gaug, M., Giammaria, P., Godinović, N., González Muñoz, A., Gora, D., Guberman, D., Hadasch, D., Hahn, A., Hanabata, Y., Hayashida, M., Herrera, J., Hose, J., Hrupec, D., Hughes, G., Idec, W., Kodani, K., Konno, Y., Kubo, H., Kushida, J., La Barbera, A., Lelas, D., Lindfors, E., Lombardi, S., Longo, F., López, M., López-Coto, R., Majumdar, P., Makariev, M., Mallot, K., Maneva, G., Manganaro, M., Mannheim, K., Maraschi, L., Marcote, B., Mariotti, M., Martínez, M., Mazin, D., Menzel, U., Miranda, J. M., Mirzoyan, R., Moralejo, A., Moretti, E., Nakajima, D., Neustroev, V., Niedzwiecki, A., Nievas Rosillo, M., Nilsson, K., Nishijima, K., Noda, K., Nogués, L., Overkemping, A., Paiano, S., Palacio, J., Palatiello, M., Paneque, D., Paoletti, R., Paredes, J. M., Paredes-Fortuny, X., Pedaletti, G., Peresano, M., Perri, L., Persic, M., Poutanen, J., Prada Moroni, P. G., Prandini, E., Puljak, I., Reichardt, I., Rhode, W., Ribó, M., Rico, J., Rodriguez Garcia, J., Saito, T., Satalecka, K., Schröder, S., Schultz, C., Schweizer, T., Shore, S. N., Sillanpää, A., Sitarek, J., Snidaric, I., Sobczynska, D., Stamerra, A., Steinbring, T., Strzys, M., Surić, T., Takalo, L., Tavecchio, F., Temnikov, P., Terzić, T., Tescaro, D., Teshima, M., Thaele, J., Torres, D. F., Toyama, T., Treves, A., Vanzo, G., Verguilov, V., Vovk, I., Ward, J. E., Will, M., Wu, M. H., Zanin, R., Abeysekara, A. U., Archambault, S., Archer, A., Benbow, W., Bird, R., Buchovecky, M., Buckley, J. H., Bugaev, V., Connolly, M. P., Cui, W., Dickinson, H. J., Falcone, A., Feng, Q., Finley, J. P., Fleischhack, H., Flinders, A., Fortson, L., Gillanders, G. H., Griffin, S., Grube, J., Hütten, M., Hanna, D., Holder, J., Humensky, T. B., Kaaret, P., Kar, P., Kelley-Hoskins, N., Kertzman, M., Kieda, D., Krause, M., Krennrich, F., Lang, M. J., Maier, G., McCann, A., Moriarty, P., Mukherjee, R., Nieto, D., O'Brien, S., Ong, R. A., Otte, N., Park, N., Perkins, J., Pichel, A., Pohl, M., Popkow, A., Pueschel, E., Quinn, J., Ragan, K., Reynolds, P. T., Richards, G. T., Roache, E., Rovero, A. C., Rulten, C., Sadeh, I., Santander, M., Sembroski, G. H., Shahinyan, K., Telezhinsky, I., Tucci, J. V., Tyler, J., Wakely, S. P., Weinstein, A., Wilcox, P., Wilhelm, A., Williams, D. A., Zitzer, B., Razzaque, S., Villata, M., Raiteri, C. M., Aller, H. D., Aller, M. F., Larionov, V. M., Arkharov, A. A., Blinov, D. A., Efimova, N. V., Grishina, T. S., Hagen-Thorn, V. A., Kopatskaya, E. N., Larionova, L. V., Larionova, E. G., Morozova, D. A., Troitsky, I. S., Ligustri, R., Calcidese, P., Berdyugin, A., Kurtanidze, O. M., Nikolashvili, M. G., Kimeridze, G. N., Sigua, L. A., Kurtanidze, S. O., Chigladze, R. A., Chen, W. P., Koptelova, E., Sakamoto, T., Sadun, A. C., Moody, J. W., Pace, C., Pearson, R., Yatsu, Y., Mori, Y., Carraminyana, A., Carrasco, L., de la Fuente, E., Norris, J. P., Smith, P. S., Wehrle, A., Gurwell, M. A., Zook, A., Pagani, C., Perri, M., Capalbi, M., Cesarini, A., Krimm, H. A., Kovalev, Y. Y., Kovalev, Yu. A., Ros, E., Pushkarev, A. B., Lister, M. L., Sokolovsky, K. V., Kadler, M., Piner, G., Lähteenmäki, A., Tornikoski, M., Angelakis, E., Krichbaum, T. P., Nestoras, I., Fuhrmann, L., Zensus, J. A., Cassaro, P., Orlati, A., Maccaferri, G., Leto, P., Giroletti, M., Richards, J. L., Max-Moerbeck, W., Readhead, A. C. S., *Multiband variability studies and novel broadband SED modeling of Mrk 501 in 2009*, Astronomy & Astrophysics, 2017, **603**, 31, 30 pp.

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3. Andrews, J. J., Chanamé, Julio, Agüeros, Marcel A., *Wide binaries in Tycho-Gaia: search method and the distribution of orbital separations*, Monthly Notices of the Royal Astronomical Society, 2017, **472** (1), p.675-699

4. Barta, V., Haldoupis, Ch., Sátori, G., Buresova, D., Chum, J., Pozoga, M., Berényi, K. A., Bór, J., Popek, M., Kis, Á., Bencze, P., *Searching for effects caused by thunderstorms in midlatitude sporadic E layers*, Journal of Atmospheric and Solar-Terrestrial Physics, 2017, **161**, p. 150-159.

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