ASTRONOMY, ASTROPHYSICS & SPACE PHYSICS IN GREECE

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ABSTRACT

In the present document I review the current organizational structure of Astronomy, Astrophysics and Space Physics in Greece. I briefly present the institutions where professional astronomers are pursuing research, along with some notes of their history, as well as the major astronomical facilities currently available within Greece. I touch upon topics related to graduate studies in Greece and present some statistics on the distribution of Greek astronomers. Even though every attempt is made to substantiate all issues mentioned, some of the views presented have inevitably a personal touch and thus should be treated as such.

Subject headings:

1. INTRODUCTION

The framework within which astronomers – a term that will be used rather loosely in the rest of the document to indicate individuals performing research in Astronomy, Astrophysics and Space Physics (AA&SP) – have been functioning in Greece is not too different from other European countries.

As in most other countries in Europe, the educational and research activity in Astronomy, Astrophysics and Space Physics in Greece has been fostered within public Universities and Research Institutes. Even though this may change in the near future currently no private academic or research institutions in AA&SP are operating in Greece. Thus the individuals who are employed full time to teach or do research in AA&SP are typically civil servants in permanent, tenure track, or fixed-term research associate positions. Currently the majority of them (see Sect. 3, Fig. 1) are in Universities and only a small fraction is associated with Research Institutes or Observatories.

Up until the early 1980s the structure of the University system in Greece followed the German style. It was based on “Chairs” of Professors in specific research fields (i.e. Astronomy, Classical Mechanics, etc.). The few astronomy Professors, typically as numerous as the corresponding number of university departments pursuing research in the various areas of AA&SP, held their position until the age of retirement. They made all major administrative decisions related to both teaching priorities and research directions in their institutions. Several junior staff members did support them in these activities but those members had only marginal control and rather limited independence to pursue their own research directions.

The University system presently in place was put forward in 1983, (with a few minor modifications over the past ~25 years) and has a structure similar to the current academic system of the United States. There are two ranks of tenure track positions: Lecturer and Assistant Professor, and two of tenured positions: Associate Professor and Full Professor. A minimum of three years is required on each rank before applying for promotion the next. Tenure is obtained upon successful evaluation after spending three years at the level of Assistant Professor. A university faculty can, in principle pursue his/her own research direction, teach courses, and supervise graduate students.

However, when this change in the academic system took place in the early 1980’s, there was no provision on the age distribution of the faculty to be hired. As a result a large number of individuals who were already affiliated with the universities at the time in junior level – the so-called “Assistant” appointments, automatically obtained tenure at the rank of Lecturer upon the completion of their PhD. Others, who already had a PhD, were considered for tenure at higher ranks. The evaluation for this process though was often not very strict and with criteria based mostly on social reasons or giving a disproportional emphasis to the teaching responsibilities of the faculty, rather than mostly based on their research background and potential or relevance of the field to the future direction of modern astrophysics. In addition, since most of the individuals who obtained these positions were past graduate students of the same universities, there was a disproportional hiring from “within”. This phenomenon, known as “academic inbreeding”, was more prevalent in the older institutions in Athens and Thessaloniki, which had the largest number of staff at the time. Even today there are institutions in Greece where well over 70% of their permanent staff members are past alumni who did their dissertation in the same institute and did not spend more than a couple of years away from their alma mater before obtaining permanent positions. It is beyond the scope of the present document to discuss this phenomenon and the serious negative consequences it has on both the quality of research performed and on the opening of new research horizons in academic institutions. We should note though that this phenomenon is not unique to Greece, as it also appears for example in the French academic system and in Korea, but it is practically absent in the United States. Greek universities in the periphery of the country did not suffer much
from this problem for two reasons. Either they had not produced their own PhDs due to their youth as institutions, or their faculty members made a conscious decision to have a broader perspective in their hiring process. For example, in the Department of Physics of the University of Crete, where the author is currently employed, only 1 out of the 33 faculty members obtained his PhD from this institution. All these political decisions had implications that continue to affect the evolution of Greek astronomy, and academic system in general, well into the 21st century.

Research Institutes in Greece have a similar structure to the Universities, with also four ranks, which are loosely indicated as Researcher-D, -C, -B and -A. Each researcher also has to remain in a given rank for a minimum of three years and tenure is obtained upon promotion from Researcher-C to Researcher-B. Research Institutes can not award academic degrees and as a result close collaboration with a University is needed in order for a researcher to be able to co-supervise students.

Public funding for development of infrastructures, direct support of research in astronomy, or fellowships towards graduate studies in the field, has been traditionally fairly limited. Such a low level support is not restricted to Greek astronomy but it is also the case in most disciplines. In 2004 Greece spent only 0.58% of its Gross Domestic Product (GDP) in R&D, which brings Greece as a nation in the last place among the 15 EU countries in this category, a position it holds for the past 5 years. At over the same period the European Union (EU) average was 1.95%, more than 3 times higher. As a result the possibilities for Greek astronomers to join large international collaborative projects, or just to obtain support to attend scientific meetings outside Greece have been scarce. Even though the situation has recently improved over the past decade, and the possibilities – mostly via the financial and organizational support of the European Union – are more numerous, the effects of this low level national funding can be seen in most indices quantifying the overall astronomy scientific output from Greece. It is worth noting that Greece, which joined the European Union as the 10th member in 1981, is still not a member state of the European Southern Observatory (ESO) and only joined the European Space Agency (ESA) in 2005.

2. GOVERNING BODIES

The policies that directly affect issues related to AA&SP in Greece are determined by the Ministry of Development, in particular the General Secretariat for Research and Technology, and the Ministry of Education. The first has administrative control over the research institutes and astronomy infrastructure and the latter controls the national university system.

Greek astronomers can express their opinion or shape policies on issues related AA&SP via the Greek National Committee for Astronomy (GNCA) or the Hellenic Astronomical Society (Hel.A.S.).

2.1. The Greek National Committee for Astronomy (GNCA)

The Greek National Committee for Astronomy (GNCA)\(^3\) was established, by Royal Decree, as the official advisory committee to the Greek Government for all matters relevant to Astronomical and Astrophysical research, in 1957. It is the official body, responsible for the promotion and coordination of Astronomy in Greece and for all matters related to international astronomical cooperation. The Minister of Development selects the members of GNCA and appoints them for a term of two years. Its official seat is the National Observatory of Athens. Since 1995, GNCA does not have its own budget, but obtains its funding from the budget of the General Secretariat of Research and Technology (GSRT) of the Ministry of Development. The GNCA has the following principal objectives:

- To co-ordinate and promote the various astronomical activities in Greece, including research and education.
- To act as the link between the Greek astronomical community and the International Astronomical Union (IAU), officially representing Greece in the General Assembly of the IAU.
- To facilitate the advancement of international collaboration between Greek and foreign astronomers and research groups.

Besides the IAU, GNCA has taken responsibility for Greece’s representation to the Board of Directors of the journal "Astronomy and Astrophysics" (and its financial contributions), to the European Joint Organization for Solar Observations (JOSO) and, recently, to the European Union FP6, I3, Network OPTICON (see Sect. 8).

The board of GNCA consists of five ordinary and five substitute members. The current (2005-2007) ordinary members are Prof. P. Laskarides (Chair - Univ. of Athens), Prof. T. Krimigis (Vice Chair - Academy of Athens), Dr. I. Daglis (Nat. Obs. of Athens), Prof. N. Kylafis (Univ. of Crete), and Prof. J.H. Seiradakis (Univ. of Thessaloniki). The substitute members over the same period are: Prof. S. Avgoloupis (Univ. of Thessaloniki), Dr. E. Dara (Academy of Athens), Prof. M. Kafatos (George Mason Univ., USA), Prof. A. Nindos (Univ. of Ioannina), and Prof. J. Papamastorakis (Univ. of Crete).

2.2. The Hellenic Astronomical Society (Hel.A.S.)

The Hellenic Astronomical Society (Hel.A.S.)\(^4\) exists for nearly 15 years and it is the major association of professional astronomers in Greece. Its overall structure and operation is similar to other national societies such as the “American Astronomical Society” in the US, or the “Société Française d’Astronomie et d’Astrophysique” in France.

Historically, the first serious attempt to establish a Hellenic Astronomical Society was undertaken in 1982 during the XVIII General Assembly of the International Astronomical Union, which took place in Patras, Greece. There, during several meetings, a dozen astronomers gathered in order to put the foundations of the long sought Society. The following years progress was slow even though material necessary for setting up the framework for the Society was being collected. It was much

\(^3\) Source EUROSTAT in [http://europa.eu.int/comm/eurostat/](http://europa.eu.int/comm/eurostat/)

\(^4\) The web page of GNCA is [http://www.astro.noa.gr/~gnca](http://www.astro.noa.gr/~gnca)

\(^5\) The web page of Hel.A.S. is [http://www.astro.auth.gr/elaset](http://www.astro.auth.gr/elaset)
later, in November 1991, when Prof. P. Laskarides (Univ. of Athens) issued the first announcement of the 1st Hellenic Astronomical Conference, that the idea of the establishment of an Astronomical Society was formally put forward again. With the help of several colleagues Prof. J.H. Seiradakis (Univ. of Thessaloniki) drafted the first Constitution for the Society. The final version was presented to the participants of the 1st Hellenic Astronomical Conference, which was held in Athens in September 1992.

During the Athens Conference, several astronomers became founding members of the Hellenic Astronomical Society. A few more founding members signed the Constitution during the next weeks bringing the total number of founding members to sixty six (66). Following the appropriate legal procedures, the Hellenic Astronomical Society (Hel.A.S.) was recognized by the Court of Justice in Athens on May 25 1993. The appointed Council of Hel.A.S. became aware of the verdict of the Court of Justice in June 1993. The President of the Council, Prof. B. Barbanis (Univ. of Thessaloniki), assisted by the members initiated the procedure for the first elections of Hel.A.S. In the elections, which took place on June 2nd 1994, participated 83% of the founding members.

According to its Constitution the Governing Council of Hel.A.S. consists of a President, six (6) members and three (3) auditors. The Council is elected for a two-year term and an individual cannot serve on it for more than two consecutive terms. The candidates for the Council must be members of Hel.A.S. who live and work permanently in Greece during the term of their candidacy and at least 42% of them should be affiliated with institutions outside the Athens metro area. The current Council, whose mandate ends in June 2006, consists of Prof. P. Laskarides (Univ. of Athens) as the president and Prof. D. Hatzidimitriou (Univ. of Crete), Prof. K. Tsinganos (Univ. of Athens), Prof. V. Geroyannis (Univ. of Patras), Prof. K. Kokkotas (Univ. of Thessaloniki) and Prof. X. Moussas (Univ. of Athens) as members. The auditors for the same period are Prof. E. Danezis (Univ. of Athens), Prof. E. Mavromichalaki (Univ. of Athens) and Dr. E. Xilouris (National Obs. of Athens)

The Hellenic Astronomical Society has been very active and currently has 272 members, 27% of which live and work outside Greece. It has been recognized as an Affiliated Member of the European Astronomical Society (EAS) and has established links with other international astronomical societies. It has been organizing a major science meeting every two years and in the summer of 1997 organized the Joint European and National Astronomical Meeting (JENAM-97).

3. ACADEMIC INSTITUTIONS

3.1. Human Resources in Astronomy, Astrophysics & Space Physics

As one would expect, since more than half of the population in Greece is concentrated in the Athens and Thessaloniki metro areas, most of the astronomers in Greece are also associated with institutes located in these two cities. This is depicted in Figure 1 where the fraction of tenured and tenure track astronomy faculty in the major AA&SP institutions in Greece is presented.

An additional issue, which affects the current state and has direct implications to the future of Greek astronomy, is related to the age distribution of Greek professional astronomers. In Figure 2, a histogram of 135 astronomers working in Greece is presented, using the database of the members of the Hellenic Astronomical Society, as well as ancillary information collected by the author. The study
Fig. 2.— A histogram of the age distribution of astronomers in Greece in 2006. The vertical line indicates the 67th year of age which is the current compulsory retirement age for civil servants.

was limited to individuals over the age of 30, since this is typically the age when one is competitive for tenure track or long term research associate positions. Some individuals over the retirement age of 67, who are on an emeritus-type position and/or still active, were included in the analysis. The error on a single 5-year bin is of the order of 5% but it is very likely that the values of bins at ages greater than 55 are somewhat underestimated. This is due to the fact that there are a number of individuals who formally have a tenured astronomy positions but as they are no longer active they were not included in the database of Hel.A.S, on which analysis was based.

Inspection of Figure 2 clearly reveals that almost 30% of Greek astronomers are near or over the age of 60. This was a direct consequence of the legislative changes that took place in Greece in the early 1980s mentioned in Sect. 1. Furthermore, statistics over the last 10 years indicate that on average there were less than 3 new tenure track astronomy position openings per year in the country, including both universities and research institutions. The fraction of astronomers near the age of retirement is even larger if we were to consider only the two older universities of Athens and Thessaloniki. This implies that within the next 5 to 10 years a large number of their current faculty members will retire and they will have to be replaced in a very short time scale. This will be an interesting challenge for Greek astronomy. Will it be possible for these institutions to find enough, well qualified, candidates from the available pool of post-docs and research associates for their needs? Will they be forced to lower their hiring standards in order to hire faculty for their teaching needs, or they will be able to hire with a lower pace, being selective and identifying the key scientific research areas they should be investing in? In 2016 we will know the answer to these questions!

Another topic worth touching upon is gender diversity in Greek astronomy. At the time of writing this report 13% of the permanent or tenure track astronomy positions in Greece were held by women. This percentage is less than in France, which leads the way with ~26%, or in Italy, Russia and Spain, all above 15%, but higher than the fraction of female astronomers in the United States which is ~10%. We should note though, that only recently one female astronomer in Greece reached for the first time the highest possible academic rank (Full Professor or Researcher A), a statistic that will hopefully improve very soon.

3.2. Research in Astronomy, Astrophysics & Space Physics

The latest organized effort to map the research activity in AA&SP in the various institutes in Greece took place in 1998. Dr. E. Kontizas, as the president of GNCA at the time, appointed an international six-member committee, chaired by Prof. Y. Terzian (Cornell Univ., USA), to report on the status of astronomy in Greece and propose recommendations for the future. The report was presented during the workshop “Astronomy 2000+: Greek Prospects for the 21st Century” which took place at the National Observatory of Athens on November 1998. The description presented in the following paragraphs draws from material included in this

6 The percentages for the other countries mentioned are based on the 2003 report by Dr. Florence Durret (Institute d’Astrophysique de Paris, France) available at: http://www2.iap.fr/sf2a/courrier.html

7 The complete “Terzian Report” is available at: http://www.astro.noa.gr/gnca/NEWS/ca-report2000.htm
report with some modifications mostly related to changes in the human resources of the institutes involved.

There are eight institutions in Greece with Departments or Sections devoted to teaching and research in Astronomy and Astrophysics. Three are located in Athens: the largest is the Section within the Department of Physics of the National Kapodistrian University, followed by the National Observatory of Athens, and an astronomy Section of the national Academy of Athens. In Thessaloniki there is a very small group within the Faculty of Engineering (Polytechnic School) and a considerably larger one within the Department of Physics of the Aristotle University. In Crete there is a Section of Astrophysics and Space Physics in the Department of Physics in Heraklion, while the Universities of Patras and Ioannina each have small Astronomy groups within either their Physics or Engineering Departments. Some research activity in very specific areas (i.e. cosmology or general relativity) also exists in a few Departments of Mathematics but the numbers of permanent staff are very small and there is no critical mass to be considered groups.

The principal institutions devoted to research and technical development in space sciences is the Department of Electrical and Computer Engineering at the “Democritus” University of Thrace (in particular the Laboratory of Space Electrodynamics in the Section of Telecommunications and Space Science) and the Institute for Space Applications and Remote Sensing of the National Observatory of Athens. Significant research in ground based ionospheric and atmospheric work is also a component of the overall Astrophysics and Space Science Section at the University of Crete. Activity relating to space science also exists in the Section of Astronomy, Astrophysics, and Mechanics of the University of Athens, and at the Research Center for Astronomy in the Academy of Athens.

In the following subsections we present a brief description of the various institutes in Greece hosting research groups with active research in AA&SP. More detailed annual activity reports from most institutions and groups are being collected by the Greek National Committee for Astronomy and they are made available from its web site mentioned in section 2.1.

3.2.1. University of Athens

The “National & Kapodistrian” University of Athens was founded in 1837, soon after the independence of Greece. It was the first University in Greece as well as in the Balkan Peninsula and the whole eastern Mediterranean region. The Department of Physics was created in 1904 and its current Section of Astronomy, Astrophysics, and Mechanics was formed in the mid 1980s by merging the previously independent Chairs indicated in its name. The Section is the largest in Greece and consists of 24 tenured or tenure track faculty. Most of them have research interests in the area of Astronomy and Astrophysics, while Mechanics is a rather small constituent. The Department of Physics started a graduate school in 1994, within which the Section has its own Masters and PhD programs with 12 graduate courses. Since January 2000 the Section also operates a 40cm Cassegrain telescope within a 5m rotating dome located on the top of the Physics building. The telescope was constructed by DFM engineering (USA) has an f/3 focal ratio and it is mainly used for educational activities.

In addition to the pursuit of astronomy, it should also be mentioned that the faculty of the Physics Department have been involved over many years in building a deep sea High Energy Neutrino telescope, known as NESTOR. Recently this effort has been put under the auspices of the National Observatory of Athens as an independent institute for Astroparticle Physics (see Sect. 3.2.2).

3.2.2. National Observatory of Athens

The National Observatory of Athens (NOA^8) was founded in 1842 and is the oldest research institute in Greece. It currently consists of five institutes three of which, the Institute of Astronomy and Astrophysics, the Institute for Space Applications and Remote Sensing and the Institute of Astroparticle Physics – Nestor, conduct research in AA&SP. The current director of NOA is Prof. C. Zerefos.

The Institute of Astronomy and Astrophysics has 11 permanent staff scientists as well as research associates and support personnel. Their research interests include a variety of topics in extragalactic astronomy, observational cosmology, interstellar matter, X-ray astronomy, and binary stars. The Institute supports the Astronomical Observatory in Kryoneri as well as the new Chelmos Observatory where the new 2.3m “Aristarchos” telescope, the largest in Greece, is located (see Sect. 4.1, 4.3). The institute is also very active in public outreach activities, among which are the operation of a Visitor Center and an annual summer school, which introduces basic concepts of modern astrophysics to high-school students since 1996. The current director of the Institute is Prof. C. Goudis.

The Institute for Space Applications and Remote Sensing has 11 tenure or tenure track research staff. The activities of the Institute encompass a wide area in Space Research and Applications. Its main objective is to carry out R&D projects in these fields, which include Remote Sensing, Telecommunications, Space and Ionospheric Physics. Additional activities include the systematic collection and processing of data derived from observations made either from the earth or space as well as the performance of autonomous studies in other specific subjects of space research and applications. The Institute is equipped with satellite and ionospheric ground stations, various RF and electronic test and measurement equipment, as well as an advanced computing center connected to international networks. The current director of the Institute is Dr. I. Daglis.

The Institute of Astroparticle Physics – NESTOR (Neutrino Extended Submarine Telescope with Oceanographic Research) became the fifth institute of the national Observatory of Athens in 2003. The institute is leading the development of a deep-sea high energy neutrino telescope approximately 14km off the shore from the town of Pylos in Peloponnese, at water depth of 4000m. NESTOR will detect the Cherenkov radiation produced by muons traversing the water when their particles, such as X-ray binaries, black holes, or Active Galactic Nuclei,

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8 More information on the National Observatory of Athens the can be found at: [http://www.noa.gr](http://www.noa.gr)
interact with water. The current director of the Institute is Prof. L. Resvanis.

3.2.3. Academy of Athens

The Academy of Athens was formally founded in 1926. It currently has among its members two Academicians (Prof. G. Contopoulos and Prof. T. Krimigis) with a background and research interests in astronomy. One of the centers of the Academy, the Research Center for Astronomy and Applied Mathematics, consists of 11 permanent research staff, and conducts research in solar and space physics, cosmology, particle physics and dynamical astronomy.

3.2.4. University of Thessaloniki

The “Aristotle” University of Thessaloniki was the second university in Greece and it was founded in 1925. There are two units in the University with activity in Astronomy. The smallest, in the Polytechnic School, consists of two faculty members and their research is concentrated mainly on flare stars. The largest is the Section of Astrophysics, Astronomy and Mechanics (AAM\(^9\)) of the Department of Physics, with 17 faculty members, several research associates, graduate students, and support personnel. The Section was formed in the mid-80s when the administrative structure of the Laboratories of Astronomy (founded in 1943) and Mechanics changed (see Sect. 1). The staff is active in many areas of theoretical and observational astrophysics, including an active theoretical group on gravitation and general relativity, as well as in education and public outreach. In addition to the Stephanion Observatory (see Sect. 4.4) the Section operates a 20cm refracting telescope (made by Secretan, Paris) in a rotating 6m-diameter dome, which is located within the University campus, and it is used for educational purposes.

3.2.5. University of Crete

The University of Crete was founded in 1973 but accepted its first students in 1978. Its Department of Physics was founded in 1978 and is the youngest of similar Departments in Greece. The Section of Astrophysics and Space Physics\(^10\) has 7 faculty members as well as several research staff and graduate students. Two (2) more tenured track astronomers, from the Foundation for Research and Technology-Hellas and the Technical Education Institute of Heraklion, are actively collaborating with the members of the Section. Research at the Univ. of Crete covers a broad range in theoretical and observational problems related to both galactic and extragalactic astrophysics. Significant efforts are being devoted to the operations of an Ionospheric Physics laboratory. Observations for several astronomical projects are also taken at the Skinakas Observatory (see Sect. 4.2) and others are performed using international ground and space born telescopes. The Department has a graduate program through which students can pursue their graduate studies in astrophysics.

3.2.6. University of Thrace

The Laboratory of Space Electrodynamics (LSE) at Department of Electrical and Computer Engineering of the “Democritus” University of Thrace is the largest space physics group in Greece with extensive experience in hardware development. It consists of 6 faculty, several research associates, support personnel, and many graduate and undergraduate students. The scientists are co-investigators or associated scientists on several international spacecraft missions (e.g. Ulysses, Geotail, Cluster II, and others), successfully funded through European programs and bilateral collaborations with other countries, including the U.S. The LSE has designed, developed and successfully flown particle experiments on a number of Russian spacecraft, as well as component systems to instruments involving data processing units and ASICs (Application Specific Integrated Circuits). Such high technology hardware capability in space instrumentation is rather unique within Greece. The LSE group has expanded their activities to antennae and propagation, satellite communications, and other related areas.

3.2.7. University of Patras

The University of Patras has a Laboratory of Astronomy and a Section of Astronomy in the Division of Theoretical and Mathematical Physics in the Department of Physics. A total of nine tenured and tenure track faculty teach courses and conduct research in a few astronomy areas and there is an active theoretical group on celestial mechanics.

3.2.8. University of Ioannina

This is the smallest group of Astronomy in a Department of Physics in Greece. It has three faculty members in the Section of Astrogaeophysics, within the Department of Physics. The staff performs research mostly in solar physics and in multi-wavelength observations of flare stars.

4. NATIONAL FACILITIES

The limited funding of the Greek government towards basic and applied research has had, as a result, the small investment in major infrastructures for astronomical facilities in Greece. This affected the oldest observatories in Greece, such as Penteli, Kryoneri and Stephanion Observatory, which have difficulties keeping up-to-date with the modern developments in telescope design, aperture size of the telescope primary mirrors, as well as the instrumentation available. More recent facilities, such as Skinakas Observatory, which currently hosts the largest operational telescope in Greece which is 1.29m in diameter, are more modern and do provide high quality instruments to the observers. However, they also suffer from the limited national financial support and they cannot function as facilities that can provide access to all Greek astronomers who may wish to use them. A major effort in improving the current situation has been the ongoing construction of the 2.3m “Aristarchos” telescope by the National Observatory of Athens. The telescope has its first light in the end of 2005 and when it becomes fully operational, before the end of 2007, will be the largest in Greece.

\(^9\) The online description of the AAM Section in Thessaloniki can be found at: [http://www.astro.auth.gr](http://www.astro.auth.gr)

\(^10\) The web page of the Astronomy Section in Crete can be found at: [http://www.physics.uoc.gr/en/](http://www.physics.uoc.gr/en/)
4.1. Chelmos Observatory

The site selected for the new 2.3m telescope is located in Northern Peloponese, on top of Chelmos mountain, near the small town of Kalavrita approximately 150km from Athens, with longitude: 22°13’, latitude: 37°58’ N and an elevation of 2340m. The total cost for the project is expected to be about 5 million Euros and it was financed mainly by the European Union, as well as by the General Secretariat for Research and Technology of the Ministry of Development. The telescope named “Aristarchos” is a Ritchey-Chrtien with a focal ratio f/8 and a 10 field of view as well an RC-corrected field of view of 1degree. The telescope and dome are constructed by Carl Zeiss (Germany).

The image scale on the focal plane is 1”=85µm and a 1024x1024 CCD camera was the first light instrument. A medium resolution (2.5Å-6Å) spectrometer covering the range between 4270Åand 7730Åas well as a 4096x4096 optical CCD will be the first generation instruments of the telescope. These will be followed by an echelle spectrometer covering the range between 3900Åand 7500Åwith a resolution of 6 km s⁻¹, as well as other instruments. The supervision of the telescope construction as well as its operation are managed by the Institute of Astronomy and Astrophysics of the National Observatory of Athens¹¹.

4.2. Skinakas Observatory

The Skinakas Observatory¹² 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.

The site of the Observatory (Longitude: 24°53’57”E, Latitude: 35°12’43”N), chosen on scientific and functional grounds, is the Skinakas summit of Mount Ida (also known as Psiloritis), at an altitude of 1750m and a distance of 60km from Heraklion. The Observatory has two telescopes: a Modified Ritchey-Chrtien telescope with a 1.29m aperture (focal ratio f/7.6), which became operational in 1995, and a 30cm telescope (focal ratio f/3.2). The building for the small telescope was constructed in 1986, and observations started in 1987. The site is one of the best in Greece with weather conditions often permitting photometric sub-arcsecond seeing. It includes a modern guest house powered with solar arrays and an Internet connection.

The optical system of the 1.29m telescope were manufactured by Carl Zeiss (Germany). The mechanical parts were built by DFM Engineering (USA). The instrumentation available includes a focal reducer, a number of op-

¹¹ More information on Skinakas Observatory can be obtained from: http://skinakas.physics.uoc.gr

¹² Details on the Chelmos Observatory is available at:
Fig. 4.— Left: A picture of the dome of the 2.3m Aristarchos telescope at Chelmos. Right: A photograph of the telescope inside the dome (Images courtesy of National Observatory of Athens).

Fig. 5.— An areal view of the Skinakas Observatory summit with the larger dome of the 1.29m telescope seen on the left, along with the smaller domes the guest house facilities. The 1.29m telescope inside its dome is seen in the right (Images courtesy of the Physics Dept., Univ. of Crete).
tical CCD cameras, and a low resolution long slit spectrograph. A 1024x1024 near-IR camera and an echelle spectrograph will soon be available on site, along with OP-TIMA, a fast photo-polarimeter with microsecond time resolution intended for observations of compact objects. Various research projects, both galactic and extragalactic, mostly led by members of the Department of Physics of the University of Crete or MPE astronomers have been ongoing since the facilities became operational. The close collaboration with the MPE group and the FORTH engineering support has helped the astrophysics group in Crete in keeping the telescope and the instruments in the forefront of technology, always taking into account the limitations in the budget.

4.3. Kryoneri Observatory

The Astronomical Station of Kryoneri\(^\text{13}\) was established in 1972. It is located in the Northern Peloponese, on top of mountain Kilini at an elevation of 930m, near the small village Kryoneri 110km from Athens (longitude: 22°37’E, latitude: 37°58’N). The 1.2m Cassegrain Coude telescope of the Astronomical Station Kryoneri, made by Grubb Parsons Co., Newcastle, was installed in 1975. Its optical system consists of a paraboloidal primary mirror of 1.23m in diameter and f/3 focal ratio, and a hyperboloidal secondary mirror (31 cm). Both mirrors are made of Zerodur. The telescope focal ratio is f/13, its field of view is about 40’ and the image scale is 12.5’/mm. As with Chelmos Observatory, Kryoneri is operated by the Institute of Astronomy and Astrophysics of the National Observatory of Athens.

4.4. Stephanion Observatory

The first observations at the Stephanion Observatory, in eastern Peloponese, were undertaken in March 1967 with a guest 38cm reflector and a UBV photometer that belonged to the Bergedorf Observatory of the University of Hamburg, Germany. Since then a large number of instruments have been hosted at the 800-m altitude observatory, which is located at longitude: 22°49’45” E, latitude: 37°45’9”N, including French telescopes, for monitoring satellites, and a 40cm reflector from the Utrecht Observatory, Netherlands. In June 1971, the 30-inch (76cm) Cassegrain reflector of the University of Thessaloniki was installed at the Observatory. Until 1975, when the 1.23m Cassegrain Coude reflector at Kryoneri became operational, this was the largest telescope in Greece.

The 30-inch reflector is mounted asymmetrically and its focal ratio is f/3 for the primary hyperbolic mirror and f/13.5 for the Cassegrain focus. It was constructed by Astro Mechanics, USA, a firm that has long ago discontinued making astronomical instruments. The majority of observations are carried out with a Johnson dual channel photopolarimeter with an offset guider unit mounted in the Cassegrain focus. It includes an RCA 1P21 and an RCA 7102 photo-multipliers, both of which are refrigerated by dry ice. Key photometric observations of variable stars (flare stars, Cepheid variables, RS CVNs, etc) have been undertaken in co-operation with large ground or space instruments. The international demand for co-operative and simultaneous observations at the Stephanion Observatory stems from the strict differential method used for obtaining absolute, above atmosphere, stellar magnitudes in the international UBV system. The error in the calibrated magnitudes obtained is usually better than 0.02 magnitudes.

4.5. Penteli Observatory

The Astronomical Station on Penteli Mountain, just 15km from downtown Athens, was established in 1937 when it became apparent that it was necessary to move the telescopes from the grounds of the old National Observatory in the center of Athens. In 1955 the National Observatory of Athens accepted the donation offered by the University of Cambridge, for a 62.5cm telescope designed by R. S. Newall, and constructed by the firm Thomas Cooke & Sons in 1868. Its big tube (about 9m in length), the German-type equatorial mount and its weight of about nine tons, required careful dismounting, transportation and installation in a new dome that was built in Penteli. This telescope, no longer used for research, is still available on site today.

4.6. Eudoxos Educational Observatory

The “Eudoxos” observatory is a web-accessible complex of optical and radio telescopes, founded in 1999, whose facilities are located 16km from Argostoli, in the Ionian island of Kefallinia at a plateau 600m below the peak of mount Ainos (1628m). It operates a 0.6m Cassegrain robotic telescope named after Dr. Andreas Michalitsianos, a Greek astrophysicist who was born in the island and had a successful career in NASA (USA) until his early passing away. The observatory was formed by a consortium of Greek institutes involving the National Research Center of Physical Sciences “Democritus”, the Hellenic Naval Academy, the Ministry of Education and the Prefecture of Kefallinia and Ithaki. It is being operated by the same consortium with the addition of the University of Athens and has already received substantial support from the Hellenic Air Force and the Ministry of Education. The 0.6m telescope consists of a fully autonomous computerized optical tube assembly, automated enclosure, GPS smart antenna for time synchronization, a full set of meteorological sensors, a large format imaging CCD camera and UBVRJi wheeled photometric filters, as well as a fleet of peripheral instruments currently under construction or testing. All equipment is completely controlled by two supervisory computers, which communicate via the Internet to the participating secondary schools and institutions.

5. High School and Undergraduate Studies in Astronomy

The Greek secondary education system does provide substantial training in physics and mathematics to the students who wish to follow university studies in sciences. Even though there is no compulsory astronomy course in high school (only an elective introductory astronomy course is available for high-school juniors) basic astronomy ideas related to the solar system, stars, galaxies, and the formation of the universe are presented in other courses. Since 1996 the “Society for Space and Astronomy” of Volos (see Sect. 7) has been organizing a very

\(^{13}\) Additional information on Kryoneri Observatory are at: http://www.astro.noa.gr/ASK_1.2m/ask_main.htm
successful national astronomy competition in which students from all over Greece attending the last three years of high school (“Lyceum” in greek) can participate. The top students are awarded various prizes while the first two are invited to attend an all-expenses-paid summer space-camp in the United States organized by NASA. This effort, mainly supported by private funds and volunteer work, has helped substantially in popularizing astronomy among high school students.

At the university level there is no Bachelors (BSc) degree in Astronomy or Space Science in Greece. Most individuals, who are now professionals in the field of AA&SP and did their undergraduate studies in Greece, obtained their BSc degree in Physics following a four-year program. Some, mostly theorists, have obtained their undergraduate degrees in Mathematics or Engineering. Even in the various Departments of Physics in Greece though, the curriculum of the astronomy courses varies depending on the number and research background of the astronomy faculty. Most Physics majors in Greece have to follow at least one compulsory junior course in Astrophysics while some complementary topics on dynamical astronomy are typically covered on compulsory sophomore and junior level courses in classical mechanics and modern physics. Most Departments of Physics offer the possibility of an astronomy specialization (or minor), even though this is not formally awarded as a degree. Within this framework, students, who are interested in astronomy, have the opportunity to attend typically five to ten junior and senior level courses in astrophysics, space physics and celestial mechanics, thus obtaining a fairly solid background if they wish to continue for graduate studies.

The level of this University astronomy training is usually very good in the theoretical and encyclopedic part and the top students are competitive with international standards. What the students lack sometimes is the hands-on practical knowledge, which can only be obtained with access to engineering facilities or observatories. The organization of summer schools, such as the one taking place at the University of Crete for the past 17 years, addressed to undergraduates at junior and senior level, can often fill this gap. There are also recent efforts at various institutions, such as the Univ. of Athens, to enhance the observational astrophysics courses with a more organized usage of small telescopes and new instruments.

6. GRADUATE STUDIES IN ASTRONOMY, ASTROPHYSICS & SPACE PHYSICS

Graduate studies in Astronomy Astrophysics & Space Physics leading to a Masters or a PhD degree can now be completed in most Greek Universities. The first well-organized physics graduate program in Greece with coursework, qualifying exams, and at least partial financial support for students was developed in the University of Crete in 1984. This was soon to be followed by the University of Athens and other institutions.

However, the system suffers from difficulties, which again stem from the limited national funding. Less than a handful of state fellowships for graduate studies in AA&SP are available each year. Providing financial support for graduate studies via European Union or national research proposals in astronomy is very challenging both due to limited funds available in this field as well as due to various bureaucratic and organizational difficulties. As a result graduate students in Greece have to either work, or rely on other means to support themselves during their studies. This sometimes affects their ability to invest the amount of time necessary for research in order to complete a very high quality PhD project.

These reasons have been pushing many of the Greek students to go abroad for their graduate studies. The most popular destinations are the United States, the United Kingdom, Germany, France and The Netherlands. The improved facilities and competitive research environment in those countries do provide high quality training to the students but often decrease the likelihood of their return to work in Greece. Recently though, the opportunities made available by the European Union, mostly via the Human Capital as well as Training and Mobility programs, have ameliorated the situation. These new possibilities have provided the means to establish close links between Greek and other European institutions, which improves substantially the training of local students thus bringing direct scientific return to the home institution.

7. AMATEUR ASTRONOMY IN GREECE

Amateur astronomy has been flourishing in Greece over the past decade. The availability of high quality and low cost small telescopes and the use of Internet to organize and advertise the activities of groups has greatly helped the development in the field. Many amateur organizations exist all over Greece. In particular one should mention the “Hellenic Astronomical Union” which is the society of amateur astronomers in Athens, the “Group of friends of Astronomy” in Thessaloniki, the “Corfu Astronomical Society”, and the very active “Society for Space and Astronomy” in the city of Volos. Since 1999 the Greek amateur astronomers have been organizing a national meeting every two years where they present their results and discuss issues of common interest.

8. GREECE AND INTERNATIONAL ASTRONOMY ORGANIZATIONS

Greece joined the International Astronomical Union as a funding member in 1920. It also contributes to the support of the international refereed journal of Astronomy & Astrophysics, which allows Greek astronomers to publish their scientific results without page charges. Since 2004 Greece also participates in OPTICON, a 19.2 million Euro 5-year European FP6 Infrastructure Network, which provides access to a number of medium size telescope facilities around the world.

In early 2005 Greece joined the European Space Agency (ESA) contributing to the annual budget of ESA with ~9 million Euros. This opens new opportunities for Astrophysics and Space Physics both in terms of technology development as well as in science. Over the past year significant organizational efforts have been taking place in order to stimulate the Greek AA&SP community so that it will be able to capitalize on this investment and join the rest of the western European countries in the forefront of space technology.

9. REMARKS

I believe that it is appropriate to end this article on the status of Greek astronomy with an optimistic note
on the many improvements we have all experienced over the past decade. As it can be seen from the material presented in the previous sections, the environment, both research and academic, for the current and next generation of Greek astronomers is considerably better than what our predecessors had experienced and worked through.

I must also touch upon, a subject, which was mentioned earlier but only briefly. Unfortunately Greece is still not a member of the European Southern Observatory, the major astronomical organization in Europe. As a result it has no access to the current European infrastructures of the Very Large Telescope (VLT), nor to the development of the Atacama Large Millimeter Array (ALMA) nor to the design of the future ESO projects, such as the 100m OverWhelmingly Large telescope (OWL). I should stress that the report\textsuperscript{14} of the international expert committee chaired by Prof. Terzian (Cornell Univ.) on the status of Greek Astronomy presented in 1998 during the workshop “Astronomy 2000+: Greek Prospects for the 21st Century” noted that joining ESO should be the first astronomy priority for the nation. Current rough estimates indicate that the cost for Greece to join ESO would be a one-time $\sim$10 million Euros entrance fee, similar to our annual contribution to ESA, and an annual membership fee of only $\sim$1 million Euros. Thus, if following the recommendation of the international expert committee, ESO were to be our lofty astronomy goal for the present century, one can only hope that the whole Greek community will embrace it and with a joined effort will convince the “powers that be” to turn the wheels and make it a reality before the end of the current decade.

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\textsuperscript{14} The complete “Terzian Report” is available at http://www.astro.noa.gr/gnca/NEWS/ca-report2000.htm