

ASTRONOMY IN MODERN TURKEY

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Abstract. Present-day astronomy and its development in the recent history of Turkey are described. Current astronomy education in modern-day Turkish Republic from primary to high schools, including modern-day university education is discussed. Astronomical and space research together with the existing observatories and present-day Turkish astronomy in the global state is presented.

1. Introduction

Early contacts with the Copernican heliocentric system and modern astronomy in the modern Turkey were made through translations of astronomical tables, *e.g.* Noël Duret (d. 1650) translated by Tezkireci Köse İbrahim in 1660-64, and through many translated maps and atlases, *e.g.* Atlas Major by Wilhelm Blaeu (d. 1638) (Unat 2008). However, full acceptance of the new astronomy was not achieved until the middle of 19th century. The two military schools, the Marine Engineering School and the Army Engineering School were founded in 1773 and 1795 respectively, and astronomy courses began to be taught in these schools¹. Among the three systems of the world (geocentric, heliocentric and Tycho Brahe's hybrid system), the heliocentric system was favoured.

A fundamental modernising reform in the Ottoman education system was implemented in 1839. In the aftermath of this reform, astronomy courses were introduced as a separate subject to be taught in schools, both at the secondary and university level. This arrangement continued until 1937, thereafter, the study of astronomy was integrated into the mathematics curriculum. Nevertheless it was redesigned as a separate elective course and began to be taught as an independent subject in high schools in 1974 (Tunca 1974). Until then instruction was given in a purely descriptive manner since it was regarded as a suitable form for developing the mental discipline of high-school students. Note that this era corresponds to the aftermath of the launch of Sputnik in 1957 and the Moon-landing of American astronauts in 1969. The significance of astronomy also came to be appreciated by Turkish governments, as did most of the countries of the world. In addition the relationship between different disciplines emerged as an important subject amongst science educators. This newly-found appreciation was reflected in the earlier words of E. Miller (1895) on the role of astronomy giving a mental discipline to a high-school student: "A course in Astronomy ... would certainly do as much for the average high-school boy or girl in strengthening the intellectual faculties, in broadening the character, in elevating and stimulating thought, desire, and purpose, and in creating a strong and pure imagination, as in any other subject, whether scientific or literary, embraced within any course for high schools."

Recently, a research was conducted by the Turkish Scientific and Technical Research Council among youngsters (aged from 15 to 24) for measuring scientific literacy. It showed that the most attractive subjects for Turkish youngsters were the "internet" and "astronomy". Such demands and the known developments in space sciences obliged education authorities to take

¹[http:// www.kktc.itu.edu.tr/](http://www.kktc.itu.edu.tr/)

necessary measures to fill the gap especially in teaching material, *i.e.* text books and necessary instrumentation in the subject of astronomy.

In 1992 a change was enforced in the curriculum and the name of the program was called “Astronomy and Space Science Course” for which an appropriate textbook was ordered from university scholars. Indeed a textbook was written by five scholars in 1996 to be used by secondary-school teachers in high schools.

In 2010 the Ministry of Education decided to lay aside the previous “Astronomy and Space Science Course” programme. In the context of the restructuring of secondary schools a new programme was developed by a committee whose members were from the Ministry of Education, an astronomy professor from a university and secondary-school teachers (in mathematics, physics, educators specialized in programme development and measurement and evaluation). The group of eleven specialists have prepared a new programme which was accepted by the Ministry of Education. It has been in force since the beginning of the 2010-2011 calendar years.

The program was designed to cover:

- i. Description of astronomy and its development.
- ii. Getting familiar with the universe
- iii. Coordinate systems and apparent motion
- iv. Apparent motion of the Moon and the Sun
- v. Time and calendar.
- vi. Space sciences and space activities

It should be remarked that astronomy teaching, as an elective course in schools, has not been very effective hitherto. First the elective course system was not a familiar tradition, neither to students nor to teachers so choosing a course as an elective was not something that was practised before. Another reason is that the subject of astronomy has not been included in the “University Entrance” exam which determines the students’ motivation, and for that reason students generally do not choose to study astronomy during their high-school education. An even more serious reason is that astronomy graduates are not employed by the Ministry of Education to teach astronomy in secondary schools.

Nevertheless some astronomy subjects have also been included in the physics programme of high schools, within the context of the latest curriculum developed for physics in 2007. Details of the subjects are: stellar structure, white dwarfs, supernovae, stellar luminosity, Doppler effect and expansion of the universe.

Astronomers have been trying hard to have astronomy courses properly included in the high-school curriculum for some time. It looks as though a good deal has been achieved but is not completely satisfactory yet. Another

thing is that astronomers have been pushing so that Ministry of Education must hire astronomy graduates as teachers in high schools, and this subject is still hot among astronomers and the Ministry of Education authorities.

Turkish astronomers took advantage of the International Year of Astronomy in 2009 and thus several meetings were held to discuss the subject of “Expanding Astronomy Education in Primary and High Schools in Turkey²”. One of these meetings was held on 24-25 October 2009, at Kuşadası, Aydın. Participants of this meeting were university professors and high-school teachers.

There is a growing interest and demand in space science activities and related educational devices in Turkey. To meet such demands, several national companies or entrepreneurs started to produce simple astronomical devices or kits for both schools and public³. Mostly, instrumentation and devices are produced to allow school children and ordinary people to visualize and comprehend the whole of space and the solar system.

2. Astronomy and Astrophysics Education in Universities

Astronomical and astrophysical studies are mainly organized in universities. Both educational and research activities are done simultaneously. Astronomy and space science departments require students to take basic astronomy and astrophysics and some fundamental physics and math courses. In addition students are all learning how to use computers and run basic computational programs.

In some universities where there is no formal astronomy department but there may be astrophysics minor program in which fundamental astronomy and astrophysics courses are offered.

The following are the five Turkish state universities which have independent Astronomy and Space Science Departments:

- i. İstanbul University (1936)
- ii. Ankara University (1954)
- iii. Ege University (İzmir, 1962)
- iv. Erciyes University (Kayseri, 2001)
- v. İnönü University (Malatya, 2012)

Each department enrolls about 60 undergraduate students yearly. Both MSc and PhD programmes were offered.

In addition there are new departments, which are named “Space Sciences and Technologies” founded in Çanakkale, 18 Mart University (COMU) and

²http://www.istanbul.edu.tr/fen/astronomy/sempozyum2009/?page_id=185

³<http://www.renkoltd.com.tr/>



Figure 1. Map of Turkey with independent astronomy and space science departments (squares), physics with astronomy subfield and newly established departments of space sciences and technologies (triangles), observatories (stars) and ancient historical cities (balloons) connected with history of astronomy.

Antalya, Akdeniz University. Both have not begun formal undergraduate education yet. Nevertheless, COMU began accepting MSc students.

There are a dozen additional universities with physics departments including astronomy and/or astrophysics as a minor activity.

Fig. 1 shows the location of modern Turkish universities and astronomical observatories. The total number of modern day Turkish astronomers with PhD degrees including the retired ones is about 153.

Astronomy Departments, by taking the advantage of the “International Year of Astronomy” in 2009 decided to review their undergraduate curricula for the sake of uniformity in parallel departments. The aim was to make their students benefit from a national exchange program called Farabi Exchange program which has been in effect since 2008. For that matter, the chairpersons of the Astronomy and Space Science Departments and representatives of astronomy groups within physics departments in other universities met several times and they agreed upon a new program. The Farabi Exchange program is similar to the European counterpart called “Erasmus” exchange program. Erasmus exchange program was founded within the Bologna process. It may be appropriate to give some information about the Bologna process and how Turkey is integrated to the system. The aim of the process is to cohere a uniform and better education within the European community that began with the Bologna Declaration signed by 29 countries on 9 June 1999. Turkey became involved in this organization in the year of 2001 and thereafter Turkish universities began to be integrated into the Bologna process. To increase the effectiveness of especially student exchange, universities did their homework in adapting themselves to the European Credit Transfer System (ECTS). After a uniform credit system is completed, it is expected a more extensive exchange of undergraduate and graduate students will take place. The name of the program under which university students of different nationalities go to another country and spent some time there during their education is called “Erasmus” after the famous philosopher from Netherlands. The idea of such an exchange is to recognize and learn about other cultures and societies while they do their undergraduate studies.

As for the astronomical observations, they are done in university observatories and in the National Observatory, TUG (TÜBİTAK National Observatory) in Antalya. Both educational and research activities are going on effectively with the available telescopes in university observatories. In addition, they are also open to the public on certain occasions during the year for popular astronomical activities.

Undergraduate education covers four years in Turkey. Students will obtain the title *astronomer* when they finish their courses after four years. Graduate programs are accepting applications twice a year. An MSc stu-

dent prepares a thesis after his/her course work corresponding 24 credit hours in total. Normally it takes one year for course work and one year for the thesis. According to new regulations, there is no upper limit. Similar rules apply to the PhD curriculum with two years of courses and two years of thesis work. PhD holders are expected to publish their thesis and a few articles in journals listed SCI as independent from the thesis in order to apply for Assistant Professor positions. Such positions are not permanent ones. Renewals are subject to academic performance including research, teaching and public activities. To be promoted to an associate professorship requires an evaluation of scientific and academic activities by a jury, followed by an oral examination. An Associate Professor may apply for professorship after five years. A candidate must get a positive evaluation report from the jury selected by the university council.

3. Research Opportunities for Scientific Studies

Astronomical researches in Turkey have a chance for a support by Scientific Research Projects (SRP) departments of the universities themselves, by the Scientific and Research Council of Turkey (TÜBİTAK), by the Ministry of Development (MD) and from international sources if available at the time. Incipient graduate students may receive limited support for their thesis studies by applying to their universities SRPs and having their supervisors as the project coordinator. University staff can also apply to SRP for various types of projects and can obtain additional levels of funding for their researches.

The projects with larger budgets are supported by the Ministry of Development. These projects are generally for establishing infrastructure and founding new research centres. Some of the research projects are primarily administered by the university observatories within their capacities. When university telescopes are insufficient in size or unsuitable for the proposed project then, TÜBİTAK National Observatory (TUG) and national telescopes can be used. Observational project applications to TUG are evaluated and approved by the TUG's academic council. Observers whose projects are accepted by TUG receive travel and accommodation support from TUG.

4. The Observatories in Turkey

4.1. THE ROYAL (KANDILLI) OBSERVATORY

A 1m-class telescope was bought for educational purposes for the Army (Harbiye) School, but it was fully destroyed in a big fire during the Kırım (Crimean) war (1853-1856). The first western style observatory was estab-

lished as a meteorological station in 1868, known as “Rasathane-i Amire” (The Imperial Observatory) at Pera in İstanbul. It could be considered the national observatory of the Ottoman Empire. According to a report by a French engineer Aristide Coumbary it received a warm and considerable support from the state and he was appointed as the first director of the Observatory. It is unfortunate that this observatory too was destroyed during an uprising in April 1909. In fact with the assistance of Salih Zeki who was one of the most important mathematicians of the late Ottoman period (Topdemir 2007), Fatin Gökmen was appointed as the director of this observatory (Kaçar 2007). Besides Fatin Gökmen was also given the responsibility of establishing a new observatory. He started working on the project in 1910 and this later became the Kandilli Observatory as we know it today. At the beginning it served only as a meteorological station and it published its first results in meteorology bulletins in 1911/1912. Fatin Gökmen’s work later became more astronomically oriented and continued to be so until today.

Other departments, such as solar physics, radio astronomy, time measurement, seismology and geo-magnetism were developed in the years after 1925. After the Turkish Republic was founded in 1923, Fatin Gökmen proposed to establish an astronomy and geophysical observatory. The proposal was accepted and a full-fledged astronomical observatory with equatorial refractor of 20cm diameter and 305cm focal length began to operate. The name “Rasathane-i Amire” (Royal Observatory) was abandoned, and “Kandilli Observatory” as a new name was accepted after 1928. Thus the Royal (Kandilli) Observatory can be considered as having been the National Observatory of the Ottoman Empire until 1923. It was astronomically specialized more on solar observations, but has served basically for seismology since 1982 in which year the Observatory became a part of Bosphorus University. Its name has become the “Kandilli Observatory and Earthquake Research Institute” and it is administered by the Bosphorus University. The main building and the 20cm equatorial refractor are displayed in Fig. 2.

4.2. ISTANBUL UNIVERSITY OBSERVATORY

Istanbul University Observatory⁴ which was established in 1936 is the first modern observatory of the Turkish Republic. It was established on the Beyazit Campus of Istanbul University by Erwin F. Freundlich as the laboratory of the Astronomy Institute which was formed just after the 1933 university reform in the young Turkish Republic. The 30cm Carl-Zeiss astrograph installed in 1936 in the observatory (Fig. 3) is still used for solar observations. Two small reflectors (30cm and 20cm) are still used for pop-

⁴<http://www.istanbul.edu.tr/fen/astronomy/>



Figure 2. Kandilli Observatory which was originally a Royal Ottoman Observatory (top). Equatorial refractor of 20cm diameter at Kandilli Observatory (bottom). (Courtesy Kandilli Observatory)

ular astronomical activities. The observatory site is now under heavy light pollution. To get away from the light pollution the observatory started operating a joint 60cm robotic telescope installed at the Çanakkale (Dardanelles) 18 Mart University Observatory in 2011.



Figure 3. The dome of Istanbul University Observatory (top) and the 30cm Carl Zeiss astrograph (bottom) installed in 1936 (right). (Courtesy Istanbul University Observatory)

4.3. ANKARA UNIVERSITY OBSERVATORY

The idea of building the Ankara University Observatory⁵ was initiated by Edberg A. Kreiken in 1958 at Ahlatlibel/Ankara and The Observatory was opened formally in 1963 with an international NATO Summer school at the Observatory. A 15cm Zeiss Coude refractor, a 15cm photographic refractor and a small radio antenna (Fig. 4) were installed in the Observatory in 1964. A 30cm Maksutov telescope started photometric research on different classes of variable stars in 1974. Later on three more telescopes with

⁵<http://rasathane.ankara.edu.tr/>

D=12.7cm, 35.6cm and 40cm were added to the assets of the observatory. Because of urbanization the Observatory site is polluted with light and thus astronomers in Ankara University submitted a project to the Ministry of Development for a modern observatory with a two meter size telescope to be established at a site 75km from Ankara.

4.4. EGE UNIVERSITY OBSERVATORY

The construction of the Ege University Observatory⁶ (EUO) was started at the end of 1963 and completed in 1965, just 10 years after the foundation of Ege University in 1955 in İzmir, the third largest city in Turkey. The Science Faculty was established in 1962. In early 1963 Abdullah Kizilirmak from Ankara University was appointed to the faculty to establish the Department of Astronomy and the Observatory.

The first instruments of the observatory were a 15cm Unitron telescope, a Foucault pendulum and an Iris photometer. The telescopes and instruments used in the Observatory are the following ones (construction years in parenthesis): 13cm spectrograph (1967), 48cm Cassegrain telescope (1968 – Fig. 5), 30cm Meade telescope (1999), 35cm Meade telescope (2004), 40cm Meade telescope (2004) respectively.

As of today there are 21 researchers with PhD and five research assistants in the department and the observatory. So far about 40 astronomers have completed their PhD thesis using the facilities of the observatory. The Department has 350 undergraduate and 27 graduate students who are continuing their education. The number of papers published in the most-cited journals and the citations given to these papers reached 18 and 64 per year, respectively.

Furthermore the observatory performs an intensive educational program both for schools and public, including short courses and one-week multi-faceted international public outreach programs. The observatory is open to the public and schools on Friday evenings. EUO conducts special programs for hundreds of elementary and secondary-school teachers and students. Such a popular night-time public program includes a presentation, observing through a 30cm telescope with assistance of a telescope operator, and a sack dinner. Visitors can enjoy fine views of the Moon, the planets and some of the best-loved features of the sky. One-week educational programs are designed to inspire and motivate students and are suitable for ages from 8 to 18 years. Programs are also available for groups who have special needs and access requirements. All educational programs are conducted by well-trained astronomers. Participants are divided into groups of 15 students and are accompanied by an astronomer at all times. Participants are

⁶<http://astronomy.ege.edu.tr/EUGUAM/TR/>



Figure 4. Ankara University Observatory. The 40cm Kreiken telescope dome and the radio antenna built in 1964 (top) with the 15cm Coudé telescope (bottom). (Courtesy Ankara University Observatory)

encouraged to ask questions throughout the courses. The courses includes units on exploring the heavens, astronomical concepts, star gazing skills and using a small telescope, variable stars, stellar evolution, universe and cosmology.



Figure 5. Ege University Observatory (top) and the 48cm Cassegrain telescope (bottom).
(Courtesy of Ege University Observatory)

Since the 1990s, the rapid urbanization of İzmir has resulted in a significant increase in the amount of sky glow. If such light pollution continues to increase, it will seriously reduce the effectiveness of the Ege University Observatory for a good science. The observatory has already applied to the Ministry of Development for a modern observatory with a 2m-class telescope at a light pollution free area, around İzmir.

4.5. ÇANAKKALE 18 MART UNIVERSITY OBSERVATORY (ÇOMU)

ÇOMU Observatory⁷ started operating with a 40cm reflector in 2002. To meet the needs of researchers to study on variable stars more intensely three more reflectors with D=20, 30 and 30cm were purchased within five years of its foundation. They are mostly used for post-graduate studies and research projects.

There are about 30 researchers, half of whom hold PhD degrees, working in the Observatory. To do spectroscopic observations, a new telescope with a relatively large aperture (D=122cm) was purchased and installed in the Observatory in 2009 (Fig. 6). In accordance with the joint project between ÇOMU and Istanbul University a 60cm robotic telescope owned by Istanbul University is installed at ÇOMU's site in 2011.

As in almost all other observatories ÇOMU Observatory also organizes popular astronomy activities. The observatory infrastructure with 30cm telescope, a Foucault pendulum and a detailed sundial are used for science and society activities.

4.6. TÜBİTAK NATIONAL OBSERVATORY (TUG)

Early ideas and intentions to have a national observatory goes as far back as 1968. Nüzhet Gökdoğan, the first Turkish astronomer of Istanbul University, Abdullah Kızıllırmak, the founder of Ege University Astronomy Department and the Observatory, and Dilhan Eryurt from the Middle East Technical University were among the pioneers of the idea of having a national observatory. They convinced the new generation of young astronomers about having such an observatory during the years from 1968 to 1978. The kick off meeting dedicated to the establishment of a national observatory was held in Ankara University on May 26, 1978. The same issue was discussed in more detail in a general meeting of Turkish astronomers in Istanbul (Silivri) on 11-16 September 1978. A real step forward came after the formation of the "Space Science Research Unit" (SSRU) within TBAG (Basic Science Research Group) at TÜBİTAK in 1979. Under the patronage and guidance of SSRU a site selection investigation started in 1983. Seven astronomers representing Ankara University, Istanbul University, Ege University, Boğaziçi (Bosphorus) University and Middle East Technical University formed a kind of council to guide the selection of candidate sites all over Turkey. Seventeen candidate locations were pre-examined. Among them with 1612m altitude Kurdu (Muğla), 2159m altitude Ödemiş (İzmir), 2206m altitude Nemrut (Adıyaman) and 2547m altitude Bakırlıtepe (Antalya) were chosen for simultaneous site testing observations. Almost all

⁷<http://physics.comu.edu.tr/caam/>



Figure 6. Çanakkale 18 March University Observatory with the 122cm alt-azimuth telescope building (top) and the telescope itself (bottom). (Courtesy Çanakkale 18 March University Observatory)

Turkish astronomers participated and contributed to site testing observations in these locations. These observations continued for four years from 1982 to 1986. Finally a concluding report was prepared and published by Aslan *et al.* (1989). Bakırhıtepe (Antalya) was chosen as the best place for



Figure 7. Panoramic view of TÜBİTAK National Observatory (TUG). From the top RTT150, T60, ROTSEIIIId telescopes, Central Guest House, Security Building respectively and T100 telescope at lower left. (Photo: Raşid Tuğral)

the location of the National Observatory.

The foundation work started in 1991 and with the leadership of principal investigator Zeki Aslan who later became the first director of the observatory, the project was realized. The road and electricity had reached the top of the hill (Bakırlitepe) where the observatory was to be built, in 1994. After bureaucratic procedures and regulations were completed in 1995, the work of construction began on the site and the main building and the first generation telescope domes were completed within two years (1996 and 1997). Finally, the TÜBİTAK National Observatory⁸ was officially opened on 5 September 1997 by the President of the Turkish Republic Süleyman Demirel. Fig. 7 offers a panoramic view of the observatory.

The first observatory telescope was a 40cm Utrecht-made equatorial reflector that saw its first light in January 1997. This telescope was replaced in 2006 by a robotic 40cm aperture Meade LX200GPS and, later on, this telescope itself was replaced by an American-made OMI (Optical Mechanics Inc.) robotic telescope with 60cm aperture. Currently named T60, it is serving scheduled CCD observations and is dedicated to long-period variables since August 2010.

⁸<http://www.tug.tubitak.gov.tr/>

The main telescope of the National Observatory is owned by Kazan State University, Kazan (Tataristan). In accordance with the triple protocol among TÜBİTAK, KSU (Kazan State University) and IKI (Russian Academy of Sciences) signed in 1995, the telescope operates on a time-sharing basis since its first light in September 2001. The name of the telescope RTT150 implies Russian-Turkish telescope with 150cm aperture. The telescope has three changeable foci capabilities. Two are used commonly by interchanging manually: one is a Coudé focus ($f/48$) that is used for high-resolution ($R=40000$) spectroscopy; and the other is a Cassegrain ($f/7.7$) focus that is used for low-resolution spectroscopy and imaging.

The Robotic Optical Transient Search Experiment (ROTSE) which is located at Bakırlıtepe is one of the four optical telescopes operating around the world for observing gamma-ray bursts. The four telescopes are scattered around the world such that any event that occurred in space could be observable by at least one of the telescopes. ROTSE IIIId telescopes are 45cm aperture and fully robotic. It is at Bakırlıtepe in the site of TÜBİTAK National Observatory in accordance with a collaboration signed between Michigan University and TÜBİTAK since 2003.

The most recent telescope installed on Bakırlıtepe is the T100 telescope with 100cm aperture reflector made by Optical Mechanics Inc. (USA). The T100 is a Richey-Chrétien type telescope with a wide field of view. It is equipped with a $4k \times 4k$ CCD camera giving an image of 21.5×21.5 arcmin². The T100 telescope has been serving Turkish astronomers since October 2010. It is dedicated primarily to solar system objects, wide field studies and any other kind of imaging.

Apart from Turkish National Observatory (TUG) the university observatories, there are few attempts to have larger size telescopes: three of them by Ege, Ankara and Anadolu Universities. Two more projects, one by TUG, and the other by Atatürk University (at Eastern Anatolia) ask two 3-4m-class telescopes. Atatürk University considers an infrared telescope to be installed in the high plateau of Eastern Anatolia (Palandöken Mountains).

5. National and International Organizations

The Turkish National Astronomy Meetings hold in every two years. Most of the astronomers participate to these meetings with an oral or a poster presentation. Some foreign astronomers are also invited to give a talk on a selected topic which are chosen to be a current research subject or a relevant topic to Turkish astronomers. National or international papers to be presented are selected by a scientific committee. Besides these national and regular meetings, astronomers have small group meetings which do not have to be regular, on certain and specific topics, such as “Data Reduc-

tion Techniques” in various observational branches of astronomy and astrophysics. Turkish astronomers collaborate also with the Turkish Physics Society whose general meetings always have a section that belongs to astronomy and astrophysics.

As for international activities, Turkey became a member of International Astronomical Union (IAU) in 1961. It is a member of this organization via Turk Astronomi Derneği⁹ (TAD) (Turkish Astronomical Society). There are certain criteria to become an IAU member. Every two years, TAD presents a list to the General Assembly of the IAU of the Turkish astronomers who satisfy the criteria to become IAU individual members and, if accepted by the General Assembly, they are admitted as such. Currently there are 53 Turkish astronomers registered as IAU members.

Most of the astronomers on the list are currently active in astronomy, but some who passed away still appear on the list.

Turkish astronomers are generally very active in demanding observing times at international observatories through international projects. Apart from such direct involvements in international projects, they also benefit from data made available by international space organizations and satellites.

6. Turkish Astronomy in Global Scale

To have an idea where Turkish astronomy stands in the world a statistical study that covers a period of 30 years was undertaken. The *ISI Web of Science Knowledge* was searched with articles published in journals listed by the *Science Citation Index (SCI)* selected for this study. The result of the investigation is presented in Fig. 8. It should be noted that only articles originating from Turkey have been considered. It has been found out that there are about 832 articles published by the Turkish astronomers in the past 30 years (1980-2010).

In Fig. 8, the number of articles published in astronomy and astrophysics can be grouped in three periods:

- between 1980 and 1986, with an average of 7 articles/year,
- between 1987 and 2000, with an average of 18 articles/year and
- between 2001 and 2010, with an average of 53 articles/year.

The main research areas that covered by the published articles are stellar astrophysics, galactic structure, galaxies and cosmology, high energy astrophysics, binary stars, stellar evolution and solar physics.

⁹<http://www.tad.org.tr/>

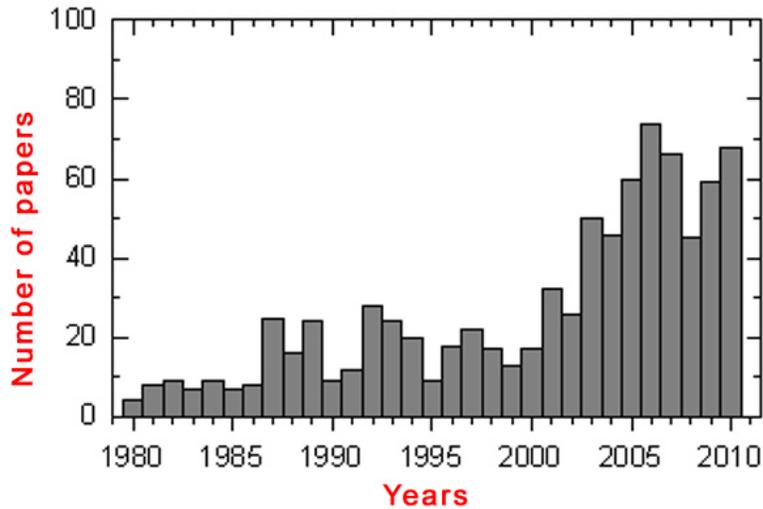


Figure 8. Number of astronomy and astrophysics papers with Turkish addresses within SCI, between 1980 and 2010.

7. Amateur Astronomy in Turkey

Amateur astronomy in Turkey began in 1980s with the initiatives of undergraduate students from the astronomy and space sciences and physics departments. These experienced amateur groups organize astronomical activities to share their knowledge and experiences with their friends and public. These activities were passed on to other amateurs with presentations, competitions, panels and unassisted-eye sky observations and thus were able to capture the attention of the public in general. Eventually popular astronomy topics became widespread with astronomical photographs and variable stars' observations conducted by amateurs.

With the fast development of computer technology in the early 1990s, high-resolution images taken from large telescopes and especially Hubble Space Telescope created great curiosity and enthusiasm among people. Those who had no amateur telescope nevertheless could have a chance to find popular software which taught them about the sky with the help of publicly available computer programs. Especially in the mid-1990s, the internet became widely reachable all over the country, and through electronic bulletins, e-mail lists, forums and portals, amateurs from distant regions had the chance to communicate with each other. This period of time overlaps with the foundation of observatories and planetariums by some private secondary schools which attracted the attention of both students and their parents. These initiatives led to astronomy awareness among stu-

dents and people who then chose astronomy and space science subjects for their university education.

Amateur astronomers with the help of professionals started to make their own telescopes by simply grinding their own mirrors in years after 2000. Meanwhile a big change in the focal plane instruments occurred after CCD cameras became widespread. For example, amateur sky photographs taken with CCD cameras and professional SLR started to publish their results in the famous web sites and magazines like APOD, TUG and *Sky & Telescope*.

Another turning point of amateur astronomy in Turkey was the International Year of Astronomy (IYA) activities in 2009. Hundred hours of astronomy, *Astronomy and World Heritage*, *Understanding the Universe*, *Female Astronomers*, *Universal Almanac*, *Galileo Nights*, *Galileoskope*, *Earth at Night and Cassini the Scientist*, were carried out by the Turkish Astronomy Association (TAD) and reached thousands of people. All activities done in universities, schools, private and state bodies were advertised in a private web site of TAD¹⁰. This web site was followed by approximately 100 000 people in between February 2009 and January 2010. TAD made a contribution to popularizing the astronomy with a magazine in which one can find astronomy news, popular articles and announcements related to activities. This magazine which has approximately 1200 fans is published monthly and subscribers are more numerous by the day.

The biggest amateur astronomy meeting in our country is organized every year by the lead of TÜBİTAK National Observatory (TUG) since 1997. This activity is already recognized as the National Sky Observation Festival with participation of approximately 500 amateur astronomers. Presentations of popular astronomy topics are done during daytime while observations of constellations, planets, satellites, galactic objects and other galaxies are conducted until the morning's first light.

One week Summer schools which contain astronomy education and observations have been organized for people with cooperation of astronomers and club members of Ege University and Çanakkale 18 Mart University. Courses about astronomical subjects such as sky and objects, telescopes, the Sun and Solar system, Milky Way, other galaxies and the universe are given in such Summer schools. On the other hand, the staff of Istanbul University shared their theoretical and observational knowledge with primary-school students in the context of the Kid's University in 2010.

Another education facility and activity center about space technology is the "Space Camp Turkey" located in the Free Zone of İzmir. The Space Camp Turkey which is a space and science centre concentrates on such sub-

¹⁰<http://www.astronomi2009.org/>

Table 2 – Amateur astronomy clubs, groups and forums in Turkey.

Clubs	Web Site
<i>Erciyes University Astronomy Club</i>	http://aster.erciyes.edu.tr/
<i>İstanbul University Sci. Fac. Amateur Astronomers Club</i>	http://astronomi.istanbul.edu.tr/aak/
<i>İstanbul Technical University Astronomy Club</i>	http://www.astronomi.itu.edu.tr/
<i>19 Mayıs University Astronomy Club</i>	http://astom.omu.edu.tr/
Groups	
<i>AKAT – Ali Kuşçu Astronomy Group</i>	http://www.akat.org/
<i>ASART – Ankara University Astronomy Research Group</i>	http://asart.science.ankara.edu.tr/
<i>Bilkent University Astronomy Group</i>	http://www.fen.bilkent.edu.tr/~astro/
<i>Çanakkale 18 Mart Univ. Physics and Astronomy Group</i>	http://physics.comu.edu.tr/ogrenciler/fizast
<i>ODTÜ Amateur Astronomy Group</i>	http://www.gokyuzu.org/
Portals	
<i>Gökbilim Forumu (Astronomy Forum)</i>	http://gokbilim.com/forum/
<i>Gökyüzü Forumu (Sky Forum)</i>	http://Forum.gokyuzu.org
Web Sites	
<i>Amateur Rocket</i>	http://www.oktanyumroket.com/
<i>Astronomi Diyarı (Astronomy Land)</i>	http://www.astronomidiyari.com/
<i>Bulutsu (Nebula)</i>	http://www.bulutsu.org/ggg/
<i>Gökbilgi Blog (Sky-Info Blog)</i>	http://gokbilgi.blogspot.com/
<i>Gökbilim (Astronomy)</i>	http://gokbilim.com/
<i>Türkçe Gökbilim (Astronomy in Turkish)</i>	http://gokbilimci.wikidot.com/
<i>Uzay ve Astronomi (Space and Astronomy)</i>	http://www.uzayveastronomi.com/
Planetariums	
<i>Cacabey Planetarium (Bursa)</i>	http://www.cacabey.com
<i>Derinmavi Planetarium (İstanbul)</i>	http://www.derinmavi.com.tr
<i>FMV Erenköy Işık Lisesi Planetarium (İstanbul)</i>	http://www.fmv.edu.tr
<i>İzmir Türk Koleji Gezegenevi (İzmir)</i>	http://www.gezegenevi.com
<i>Ondokuz Mayıs Üniversitesi (Samsun)</i>	http://planetarium.omu.edu.tr/
<i>Rahmi M. Koç Müzesi Discovery Sphere (İstanbul)</i>	http://www.kesifkuresi.com
<i>Tuzla Deniz Harp Okulu Uluğ Bey Planetarium (İstanbul)</i>	http://www.dho.edu.tr
<i>Space Camp Turkey Planetarium (İzmir)</i>	http://www.spacecampturkey.com

jects to motivate the youth to have a career and getting interested in math, science and technology. In this camp both children and adults can have education about space, communication, team work and leadership by using simulations in a very dynamical ambiance. The Space Camp Turkey is the fourth largest in the world, and the first and the only camp in the Middle East, southeastern Europe and western/middle Asia. Active amateur astronomy clubs, groups and forums in Turkey are listed in Table 2.

8. Concluding Remarks

In this review the state of astronomy in Turkey has been summarized. From what has been said it is clear that the number of astronomers compared to the total population is rather low. However, Turkish astronomers showed a great improvement in performance measured by publication of their research studies in respected journals. Besides it is really motivating that Turkish astronomy is getting reasonable support from both Governmental and private sources. All this support is given to project-based applications.

It is a common belief in Turkey that Turkish astronomy will make a good leap forward in coming years, both in education and in research.

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