

## Research Performance of Turkish Astronomers in the Period of 1980–2010

Selçuk Bilir · Ersin Gögüş · Özgecan  
Önal · Nazlı Derya Öztürkmen · Talar  
Yontan

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**Abstract** We investigated the development of astronomy and astrophysics research productivity in Turkey in terms of publication output and their impacts as reflected in the Science Citation Index (SCI) for the period 1980-2010. Our study involves 838 refereed publications, including 801 articles, 16 letters, 15 reviews, and six research notes. The number of papers were prominently increased after 2000 and the average number of papers per researcher is calculated as 0.89. Total number of received citations for 838 papers is 6938, while number of citations per papers is approximately 8.3 in 30 years. Publication performance of Turkish astronomers and astrophysicists was compared

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S. Bilir

Istanbul University, Faculty of Science, Department of Astronomy and Space Sciences, 34119,  
University, Istanbul, Turkey  
Tel.: +90-212-440 00 00 - 10534  
Fax: +90-212-440 03 70  
E-mail: sbilir@istanbul.edu.tr

E. Gögüş

Sabancı University, Faculty of Engineering and Natural Sciences, 34956, Orhanlı-Tuzla, Is-  
tambul, Turkey

Ö. Önal

Istanbul University, Faculty of Science, Department of Astronomy and Space Sciences, 34119,  
University, Istanbul, Turkey

N. D. Öztürkmen

Istanbul University, Faculty of Science, Department of Astronomy and Space Sciences, 34119,  
University, Istanbul, Turkey

T. Yontan

Istanbul University, Faculty of Science, Department of Astronomy and Space Sciences, 34119,  
University, Istanbul, Turkey

with those of seven countries that have similar gross domestic expenditures on research and development, and members of Organization for Economic Cooperation and Development (OECD). Our study reveals that the output of astronomy and astrophysics research in Turkey has gradually increased over the years.

**Keywords** Astronomy & Astrophysics · Science citation index · Web of science

## 1 Introduction

The 1933 university reform marks an important cornerstone for the development of contemporary teaching and scientific research in Turkey. Even though the roots of astronomy within the present geographical territories of Turkey dates back to antiquity (e.g., Hipparchos of Nicaea), modern astronomy research in Turkey, along with many other fields in science, gained its founding principles with the 1933 university reform. A rather rapid progress was made in the subsequent years mainly with the help of visiting German scientists who escaped the suppression and persecution of the regime in Nazi Germany (İshakoğlu Kadioğlu 1998). By 1960, there were already 48 papers published in refereed international journals at three well established astronomy institutes (Özkan 2004; İnönü 2009).

1970s and onward has witnessed rapid changes in astronomy research infrastructure. With the 1973 Universities Act, astronomical institutes were transformed into departments. Following the regulation change by the Higher Education Council in 1982, the departments were named Astronomy and Space Sciences to carry on both undergraduate and graduate teaching, as well as performing astronomical research (Eker et al. 2012). In the meantime, the necessity for larger telescopes arose, which sparked the idea of a national observatory in 1960s. After very intensive astronomical testing of numerous sites by Turkish astronomers, Antalya-Bakırlitepe was decided to establish the national observatory (Aslan et al. 1989). The national observatory became operational in 1997 and has constantly been improving in instrumental capabilities since then. Over the recent years, few research groups embraced into astrophysical investigations with multi-wavelength approach rather than being limited to the ground based optical window. This scheme provides important opportunities for Turkish astronomers and astrophysicists to engage into international collaborations.

Publication performance of researchers based in Turkey and impact of those publications have been studied for time periods of about 10 years: Demircan (1988) used the Science Index and Citation Index to determine the performance statistics of Turkish researchers in the time span from 1975 to 1984. Derman (1992) expanded this study by searching additional five years (until 1989). A similar investigation was performed by Uzun & Özel (1996) covering the period of 1985-1994. Özkan (2004) explored institutional developments

and growth in the variety of study fields in Turkish astronomy from the foundation of the Turkish Republic in 1923 until 2003. Demircan (2008) provided the performance profiles of all researchers in Turkey for the years of 2006 and 2007. İnönü (2009) presents one of the most extensive panorama of astronomy and astrophysics studies in Turkey, including historical developments of main astronomy departments. Finally, present day astronomy and its development in Turkey were studied by Eker et al. (2012).

Assessing collective performance of scientific research has been a complicated issue. Martin & Irvine (1983) investigated indicators of scientific progress via numerous channels, including citation based indicators of the impact of research articles in radio astronomy. Some variants of citation related indicators include simply the number of citations, citations per publication and peak year citations per publication (Hsieh et al. 2004). More recently, the h-index (Hirsch 2005) has been instrumental in assessing the research output of an individual, as well as research groups.

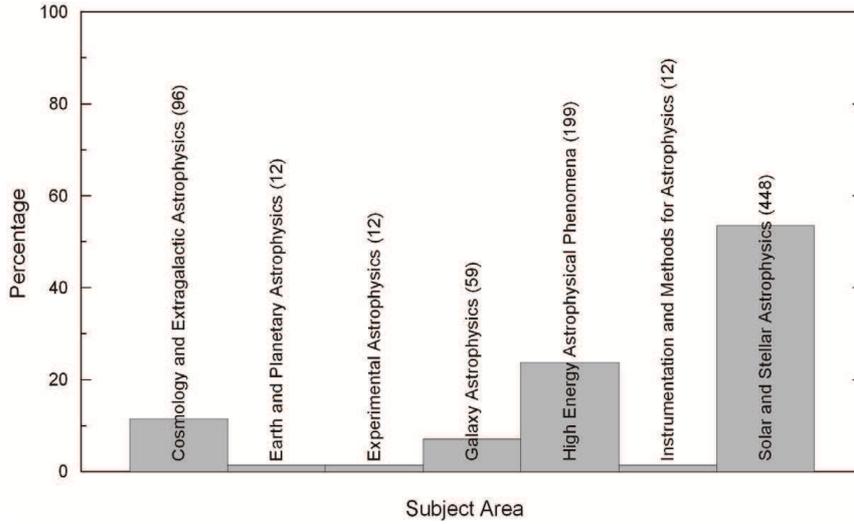
In this paper, a thorough investigation of all publications in the fields of astronomy and astrophysics between 1980 and 2010, which are in the Science Citation Index (SCI) and includes researchers based in Turkey, has been performed. Some indicative results have been compared with those of OECD countries which have similar gross domestic expenditure. The method employed to determine the research performance in the investigated 30 years is presented in Section 2. Results of these investigations and discussion of the main results are presented in Sections 3 and 4, respectively.

## 2 Method

Thomson Reuters Web of Knowledge<sup>1</sup>, which includes twelve different databases, is used while searching papers in astronomy and astrophysics. The database provides a list of SCI expanded journals and citation records of papers since 1980 to present day. All 55 refereed journals with SCI subject category of “Astronomy & Astrophysics” were identified for the thirty year period. Note that such a subject field delineation scheme would exclude articles published in multidisciplinary journals (Rinia et al. 1993). However, the number of papers published in such journals originating from Turkey between 1980 and 2010 is very few and our applied scheme would still be a reliable indicator.

The search for papers by authors or co-authors based in Turkey between 1980-2010 resulted in 1394 papers. These papers were found in astronomy and astrophysics related fields but also included sub-branches of molecular physics, meteorology and atmospheric sciences, geochemistry, geophysics, space engineering, multi disciplinary math applications, multi disciplinary physics, and astrobiology. It was, therefore, needed to make a refinement by investigating the keywords and abstracts of each individual article to include only papers in astronomy and astrophysics. As a result, 886 papers were reached. Publication type is another criteria which was considered next. It has been seen

<sup>1</sup> <http://apps.webofknowledge.com>



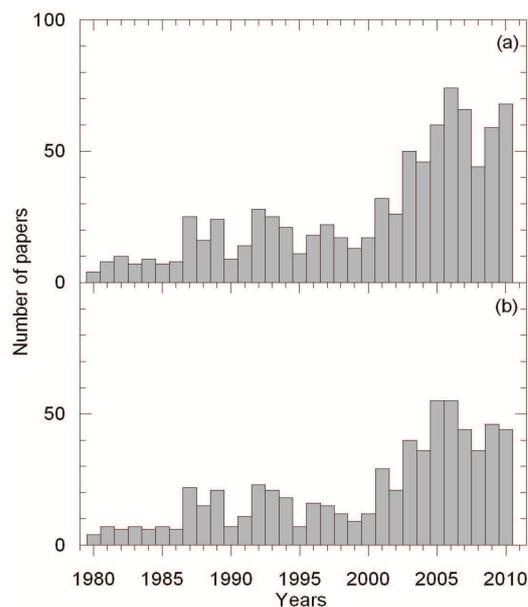
**Fig. 1** The distribution of 838 papers over subject areas. The numbers in parenthesis show that the number of papers belong to relevant subject area.

that these 886 papers had been divided into six groups based on their types: articles (801), proceedings (37), letters (16), reviews (15), errata (10), and research notes (7). It was also found that some of these studies were presented at meetings before they have been published, some of them were corrected then re-published and one research note was the summary of a dissertation. Because of these reasons only the articles, letters, reviews, and scientifically motivated research notes were considered in this study. These conditions resulted in 838 publications.

The subject classification scheme of the arXiv database<sup>2</sup> of the Cornell University Library, is used while categorizing these 838 publications according to their subjects in astronomy and astrophysics<sup>3</sup>. These categories are cosmology and extragalactic astrophysics, Earth and planetary astrophysics, galaxy astrophysics, high energy astrophysical phenomena, instrumentation and methods for astrophysics, solar and stellar astrophysics. These 838 papers were divided into above categories by considering their keywords and abstracts. Distribution of papers based on their subjects areas were presented in Fig. 1. It is clear that the most of the papers were published in solar and stellar astrophysics (53.5%). This is followed by high energy astrophysical phenomena (23.8%), cosmology and extragalactic astrophysics (11.5%) and galaxy astrophysics (7.0%). These four subject categories constitute about 96% of the subjects of publications studied in Turkey.

<sup>2</sup> <http://www.arxiv.org>

<sup>3</sup> The subject classification of the arXiv database was adopted since it is an open access resource and used heavily by researchers. This classification scheme was used commonly in the literature (e.g. Cho 2008)



**Fig. 2** Distribution of papers that published in SCI journals between 1980-2010 in years: (a) all the papers, (b) the corresponding authors from Turkey.

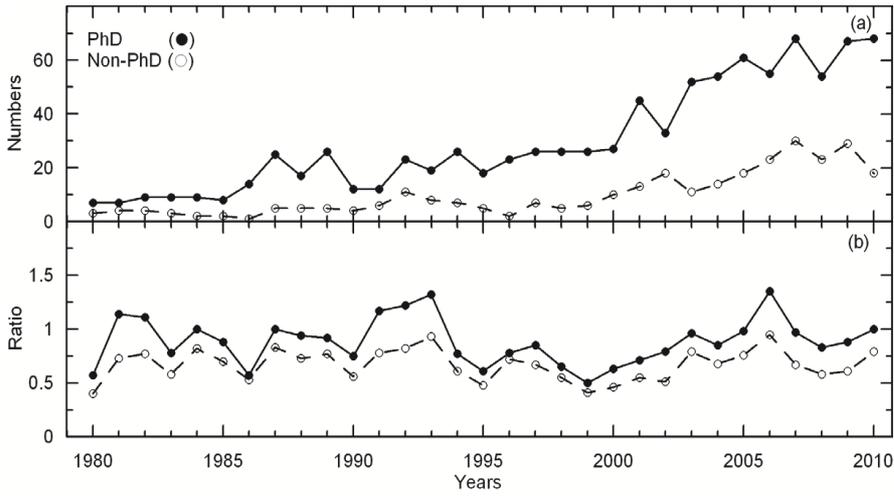
### 3 Results

We have obtained 838 astronomy and astrophysics papers that have been published in SCI journals between 1980 and 2010 based on the abovementioned criteria. We have analyzed these papers according to their release years, number of citations, and collaboration countries. Furthermore, we proceeded our analysis with considering the academic levels of the authors, the subject areas and annual impact factors of the journals. Finally, we compared these results with some OECD countries having similar gross domestic expenditures on research and development.

#### 3.1 The Distribution of Annual Number of Papers and their Citations

The distribution of the papers published by researchers from Turkey in SCI journals is shown in Fig. 2. There are two cases shown in this figure; one is for all papers (Fig. 2a) and the other one is for papers with the corresponding authors from Turkey (Fig. 2b).

It is clear from Fig. 2a that there exists three prominent periods; 1980-1987, 1988-2000, and 2001-2010. The average number of papers annually in these periods are 9.8, 18.1, and 52.5, respectively. If we take into account the papers with corresponding authors from Turkey, no obvious overall difference in all three time periods were seen and the average annual number of papers



**Fig. 3** (a) The distribution of PhD and non-PhD holder researchers that contributed to the papers published in SCI journals between 1980-2010 over the years. (b) The ratio of papers to PhD and all of the researchers.

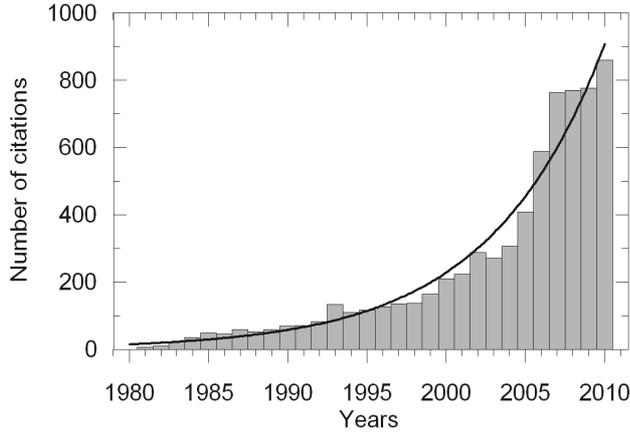
were found as 8.1, 14.4, and 40.6, respectively. The papers with corresponding author from Turkey constitute about 79% of all papers.

In 838 papers, the total number of contributed researchers from Turkey were found as 290 professional astronomers and 183 of them hold PhD degrees. The distributions of PhD holders and co-researchers in the published papers were shown in Fig. 3. While the number of papers per year per individual PhD, range between 0.50-1.35, the number of papers per all researchers change between 0.40-0.95 per year. Average number of papers per PhD and all researches are 0.89 and 0.67 per year, respectively.

One of the quality indicator of a scientific publication is the fact that if it can form a basis or have a supporting nature for prospective studies. This can be provided by receiving citations from other authors. In the last thirty years the number of citations to the identified 838 papers found to be 6938 as of January 1, 2011. The average number of citations per paper is about 8.3. If the number of self-citations subtracted from all of the citations, then the number of citations become 4559 and the average number of citations per paper become 5.4. In Fig. 4, the distribution of citations for total number of papers of each year were shown. It is easy to see from the figure that while the number of citations ascending linearly until the 2000s, there is a sudden jump afterwards. This jump can expressed in terms of exponential form:

$$\ln N = 0.1382 \times t - 270.9260 \quad (1)$$

Here  $N$  and  $t$  are number of citations and years, respectively. The correlation coefficient  $R^2=0.94$  indicates that the relation is well fit to the data. It is expected that the annual number of citations will exceed 1000 by the end of 2011. The analysis for 2011 showed that the number of citations for these



**Fig. 4** Distribution of citations of 838 papers that published in SCI journals between 1980-2010.

papers is 995. From equation [1], the calculated number for 2011 was found 1042. This shows equation [1] is sensitive.

In three different periods between 1980 and 2010, the increase of the average number is found proportional to the number of researchers that contributed to these papers (Figs. 2 and 3). The parallel increase among the number of papers and researchers indicate that the number of papers per researcher do not increase significantly during the period 1980 - 2010. However, it was shown by Abt (2007) that the publication rate depends on the number of scientists working in natural sciences.

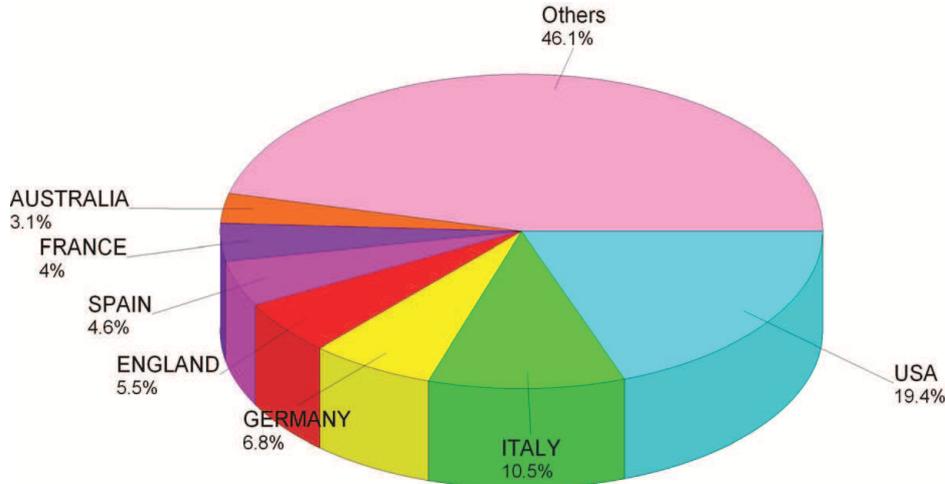
### 3.2 The Distribution of Papers over Turkish Institutions

To unveil the combined research performance of individual Turkish institutions, we selected papers with the lead author based in Turkey. We find that out of all 838 identified papers, 658 papers fall in this category (i.e., 79% of all publications). In Table 1, the total number of papers originating from nine leading institutions, their citations and combined h-indices are listed. Note that COMU (Çanakkale Onsekiz Mart University), Sabancı University and Akdeniz University were established much later than others. Therefore, the year of the first publication of each institution in astronomy and astrophysics is also tabulated during the period 1980-2010. We find that the largest proportion of papers in the time frame from 1980 to 2010 originated from Ege University and METU (Middle East Technical University). There were 65 papers originated from 24 institutions other than the nine listed here. Those institutes were combined in the last row of the table as the Others. As far as the impacts of the papers are concerned, the number of citations per paper exceed 10 for three institutions: Boğaziçi, Sabancı and TÜBİTAK. The insti-

**Table 1** Number of papers, their citations and h-index values of leading Turkish institutions.

ID	University/ Institute	Year of First Publication	Number of Paper	% of 658	Citations	Citations/paper	h-index
1	Ege	1980	116	17.63	646	5.57	11
2	METU	1980	112	17.02	902	8.05	15
3	COMU	1996	75	11.40	327	4.36	9
4	Boğaziçi	1981	71	10.79	789	11.11	14
5	İstanbul	1981	70	10.64	413	5.90	12
6	Ankara	1980	64	9.73	315	4.92	9
7	TÜBİTAK	1986	37	5.62	446	12.05	12
8	Sabancı	2001	29	4.41	348	12.00	11
9	Akdeniz	1993	19	2.89	47	2.47	4
10	Others	1980	65	9.87	326	5.02	11

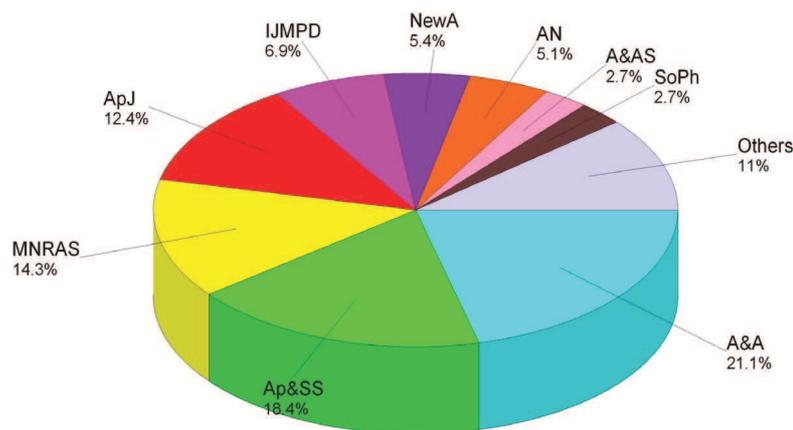
METU: Middle East Technical University, COMU: Çanakkale Onsekiz Mart University

**Fig. 5** Distribution of collaborated countries from 1980 to 2010.

tutional h-indices are quite similar to each other: majority ranging between 9 and 15, with an average value for the first eight in the list of 11.6.

### 3.3 The Distribution of Papers over Collaborated Countries

The distribution of the identified 838 papers according to the countries of the collaborated groups is shown in Fig. 5. Most of the studies that been done in collaboration are with researchers from the United States of America (19.4%). This is followed by Italy (10.5%), Germany (6.8%), England (5.5%), Spain (4.6%), France (4.0%), Australia (3.1%) and others (46.1%), respectively (Fig. 5). It is prominently common that the first seven of the mostly collaborated countries are very advanced in astronomy and astrophysics.

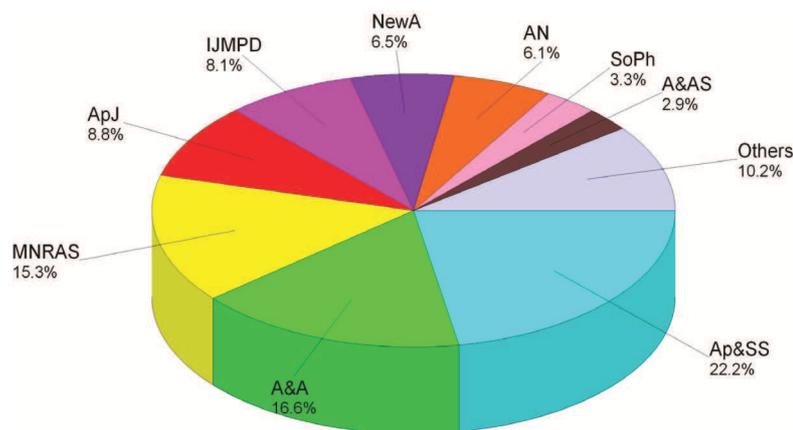


**Fig. 6** Distribution of published papers in SCI journals researchers from Turkey from 1980 to 2010.

### 3.4 The Journal Distribution of the Published Papers

We also examined the 838 papers according to journal distribution in which they were published in Fig. 6. It was found that researchers from Turkey sent their studies mostly to the *Astronomy and Astrophysics* (21.1%). This is followed by *Astrophysics and Space Science* (18.4%), *Monthly Notices of the Royal Astronomical Society* (14.3%), *Astrophysical Journal* (12.4%), *International Journal of Modern Physics D* (6.9%), *New Astronomy* (5.4%), *Astronomische Nachrichten* (5.1%), *Astronomy and Astrophysics Supplement* (2.7%), *Solar Physics* (2.7%), and others (11%). If one considers the papers with the corresponding authors from Turkey (that is, 658 out of 838 papers), they were sent to *Astrophysics and Space Science* (22.2%), *Astronomy and Astrophysics* (16.6%), *Monthly Notices of the Royal Astronomical Society* (15.3%), *Astrophysical Journal* (8.8%), *International Journal of Modern Physics D* (8.1%), *New Astronomy* (6.5%), *Astronomische Nachrichten* (6.1%), *Solar Physics* (3.3%), *Astronomy and Astrophysics Supplement* (2.9%), and others (10.2%). The distribution is shown in Fig. 7.

By further investigating the SCI journals that preferred by the researchers from Turkey between 1980 and 2010, we find that seven journals constitute 84% of all journal articles. The annual distribution of papers published in these seven journals are presented in Fig. 8. In the figure, filled and empty regions represent the rank of the authors depending on whether they are the corresponding author from Turkey, or not, respectively. When *Astronomy and Astrophysics* and *Astrophysical Journal* were taken into account, it is found that number of papers with corresponding authors from Turkey dropped significantly. The cause of such drop is clearly the page charges asked from Turkish authors by these two journals (Fig. 8). However, this situation is not the case for other journals, such as, *Astrophysics and Space Science*, *Monthly Notices of the Royal Astronomical Society*, *International Journal of Modern Physics*



**Fig. 7** Distribution of published papers in SCI journals where as the corresponding author from 1980 to 2010.

D, New Astronomy, *Astronomische Nachrichten*. Most of the papers published in these journals were made by the corresponding authors from Turkey.

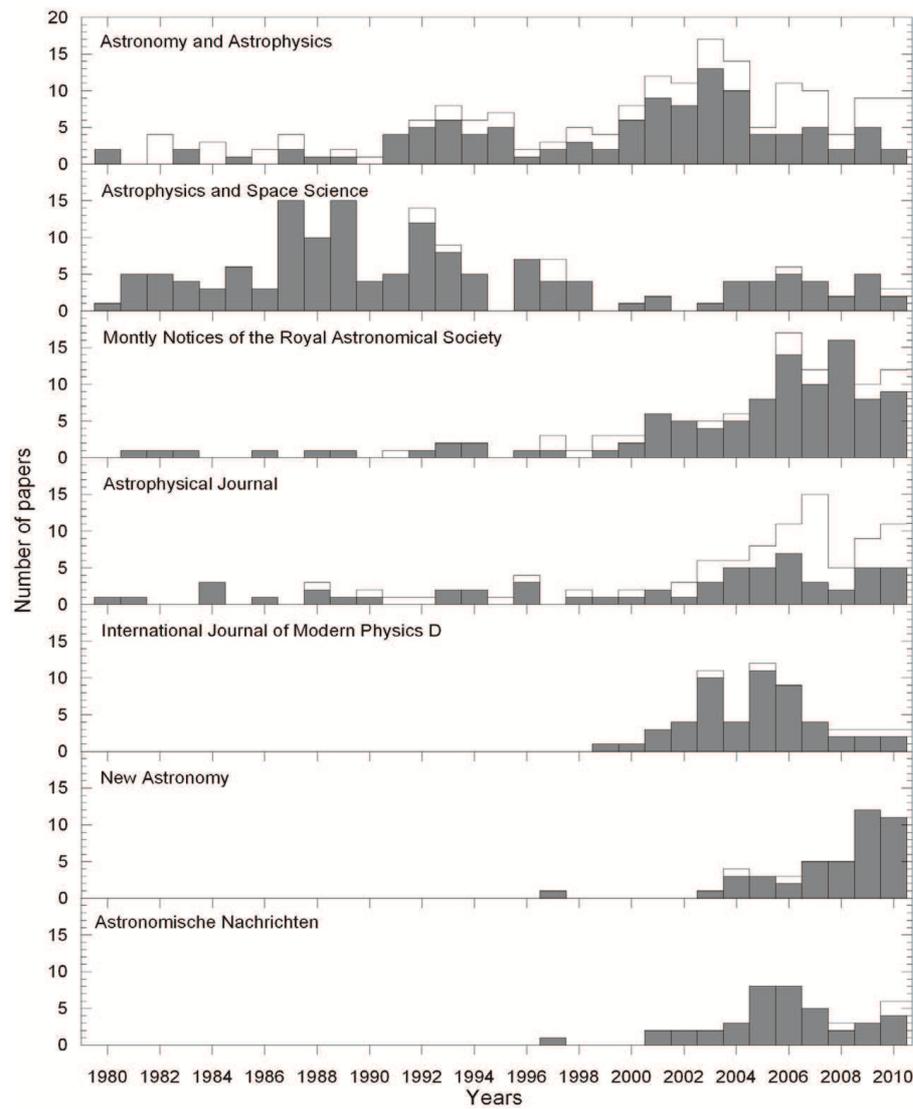
### 3.5 Impact of the Papers from 2006 to 2010

Since impact factors of all journals included here are available only between 2006 and 2010, we limited our investigation of their impacts only in this range. There are 225 papers produced by researchers from Turkey in 2006 - 2010. This comprises of 27% of all the published papers in the thirty year period. The distribution of papers based on their impact factor from 2006 to 2010 is shown in the Fig. 9. In this period the papers that were sent and published in the SCI journals which have impact factors less than six. It is very clear from the Fig. 9 that the distribution has two peaks with median impact factor of three. The detailed analysis of the distribution shows that the average number of impact factors for less and more than three are 1.65 and 4.97, respectively. It is clear that the astronomers from Turkish institutes publish equally in high and mid level journals.

### 3.6 Comparison of Research Performance with some OECD Countries

The Organization for Economic Cooperation and Development<sup>4</sup> (OECD) is a body comprised of 30 developed and developing countries, aiming for developments through exchange of ideas. Here, we compared research performance of astronomers and astrophysicists in Turkey with those nations having similar Gross Domestic Expenditure (GDE) on Research and Development (R&D). For this purpose, Chile, Mexico, Slovak Republic, Greece, Poland, Hungary

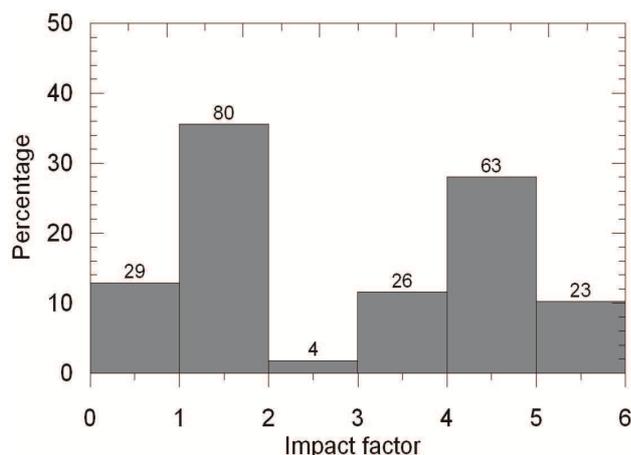
<sup>4</sup> <http://www.oecd.org>



**Fig. 8** Distribution of papers in years over the seven SCI journals between 1980-2010 according to all authors (empty bars) and corresponding authors from Turkey (filled bars).

and Italy are selected and the same search criteria explained earlier were applied. In Table 2, the number of publications in astronomy and astrophysics, total citations to these publications, their h-indices are listed for these seven selected OECD countries, as well as for Turkey.

As seen in the Table 2, among these eight nations Italy has produced the highest number of publications and collected the highest number of citations in the period of 1980-2010. In both categories, Italy was followed by Chile,



**Fig. 9** Distribution of 225 papers based on their impact factor of SCI journals in 2006-2010.

**Table 2** Numbers of astronomy and astrophysics papers and their citations of comparison OECD countries from 1980 to 2010. This analysis were made as of November 2012.

Country	Chile	Mexico	Slovak Republic	Greece	Poland	Turkey	Hungary	Italy
Number of papers	5577	3494	367	1832	3734	838	1092	17882
Sum of the times cited	206184	84364	3816	30173	100450	7525	42804	567359
Sum of times cited without self-citations	185388	72832	3416	26585	88000	6938	40471	503828
Citing articles	84191	42057	2815	18712	51584	5755	24804	223839
Average citations per item	36.97	24.15	10.40	16.47	26.90	8.28	39.20	31.73
h-index	146	102	26	70	115	37	83	219
GDE on R&D (*)	0.36	0.39	0.51	0.59	0.61	0.69	1.02	1.17
Number of IAU members	106	124	42	109	160	46	56	587

(\*) These indicate average percentage values of GDP between 2004-2010.

[http://www.oecd-ilibrary.org/science-and-technology/gross-domestic-expenditure-on-r-d\\_2075843x-table1](http://www.oecd-ilibrary.org/science-and-technology/gross-domestic-expenditure-on-r-d_2075843x-table1)

Poland, Mexico, Greece, Hungary, Turkey and Slovak Republic. In the category of number of citations per publication, Hungary is on top of these eight nations with 39.2 citations/paper, followed by Chile ( $\sim 37$  citations/paper), Italy, Poland, Mexico, Greece, Slovak Republic and Turkey. In case of country h-index ranking, Italy again appears on top Chile, Poland, Mexico, Hungary, Greece, Turkey and Slovak Republic follow.

#### 4 Discussion and Conclusions

We have investigated the research performance of scientists based in Turkey working in various fields of astronomy and astrophysics in the period of 1980-2010. As far as the annual number of papers are concerned, there are clear corner stones, around which publication productivity was increased remarkably. These two are around 1988 and 2000. The former one is probably a

combined results of developments in computing and file sharing technologies, developments in space based observations and the launch of X-ray satellites (in particular EXOSAT), relatively easier access to journals via electronic submission, and the return of prominent scientists after the completion of their post graduate studies abroad. The other jump in productivity around 2000 is likely due to (i) initiation of the optical observations with the 1.5m Russian-Turkish telescope at the TÜBİTAK national observatory <sup>5</sup>, (ii) graduation of a group of active researchers, who were attracted to astronomy and astrophysics in the second half of 1990s, (iii) participation in international collaborations, as well as (iv) return of scientists back to Turkey after receiving their PhD degrees and other factors mentioned above. There are other important factors that may have played role in the increase, such as, faster and efficient communication with international partners, obligation of producing SCI based scientific papers for academic promotions, and shortened evaluation periods via electronic handling and reviewing of the journal articles.

The scientific impact of these publications (i.e., the number of citations) have been increasing rapidly. Note here that several shortcomings in our database searches might have affected our sample (see a detailed discussion on bibliographic shortcomings in Marx et al. (2001) and van Leeuwen (2007)). The most probable shortcomings in evaluating the performance could originate from erroneous or inadequate citations, and insufficient time for an article to get citations after it is published. For the latter, we find that the average cited life time of journals investigated here is about six years. As our searches were performed on 2011 January 1, citation counts of the latest publications may not reflect their actual values.

The distribution of impact parameters of the refereed journal, to which Turkish astronomer and astrophysicists prefer to send their manuscripts, shows a bi-modality; the distribution has peaks around 1.7 and 5.0. Note that journals with impact factor larger than four usually require publishing charges while those with impact factor less than three are usually free of charge. As there is usually no available budget for page charge fees, many Turkish researchers prefer to send their papers to journals with no charge. Unavoidably, some of the higher quality studies may end up being published in journals with lower impact factor.

Among all astronomical and astrophysical study topics, papers on stellar astrophysics and high energy astrophysics constitute almost 80% of all publications of Turkish scientists between 1980 and 2010. On the other hand, the fields of solar system astrophysics and astronomical instrumentation are severely under-studied. There has been a growing interest in the observational aspects of extra-solar planets but this extremely popular field has not been matured yet to yield scientific publications.

Comparison of the scientific productivity of Turkish astronomers and astrophysicists with those in a set of OECD countries with similar R&D spending from their gross domestic products shows that Turkey is lagging behind both

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<sup>5</sup> <http://www.tug.tubitak.gov.tr/>

in number of publications and the number of citations per paper. It is not surprising that Italy leads in many respects among these eight countries as it is the birth place of modern astronomy (science). Chile's produces significantly large number of papers (which are highly cited), even though its gross national expenditure on R&D is the lowest within the OECD countries. This is because Chile hosts some of the largest optical telescopes on its soil and attracts a lot of high profiles scientists as short or long term visitors. Another important factor that affects the productivity is the number of active researchers. According to the International Astronomical Union (IAU) records, Turkey has the second least number of IAU members (after Slovak Republic) among all OECD countries. There had been other socioeconomic and cultural reasons behind the lag in productivity. Nevertheless, rapid growth in Turkish astronomy and astrophysics research over the recent years indicates that the gap is narrowing.

Developments in instrumental capabilities through domestic resources or international collaborations have been one of the main driving factor for astronomy and astrophysics in Turkey. The 1.5m Russian-Turkish Telescope and one of four Robotic Optical Transient Search Experiment (ROTSE), both installed at the Bakırlıtepe observing site, have impacted scientific productivity positively. These developments can be sustained by improving observing tools, building unique telescopes and joining large international bodies. Recently, Development Ministry of Turkey approved the foundation of a 4m class infrared telescope in the eastern part of Turkey <sup>6</sup>. In the future, with the increasing number of active researchers in Turkey, joining the European Southern Observatory (ESO) and European Space Agency (ESA) will likely be a necessity rather than a dream.

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<sup>6</sup> <http://dag-tr.org/>

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