ISSN 2409-9066. Sci. innov. 2017, 13(6): 56–61
https://doi.org/10.15407/scine13.06.056

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TRENDS IN DOCTORAL DISSERTATIONS DEFENDED AT SPECIALIZED ACADEMIC COUNCIL OF THE MAIN ASTRONOMICAL OBSERVATORY OF THE NAS OF UKRAINE IN 1991–2016

The research is aimed at revealing trends and estimating quality of doctoral dissertations that have been defended at Specialized Academic Council of the Main Astronomical Observatory of the NAS of Ukraine within the period from 1991 to 2016. The analysis has shown a drop in the number of defended dissertations per year, which is consistent with the general downward trend in the number of employees in the R&D of Ukraine, as well as a rise in the average age of doctoral degree seekers. However, during this period, the share of women who have defended their doctoral dissertation increased significantly. The citation rate of doctoral researchers and their average h-index have remained constant. Overall, the quality of doctoral dissertations which have been defended at the Main Astronomical Observatory remains high throughout the period of Ukraine's independence.

Keywords: science, scientometrics, and Hirsch index.

In 2016, it turned 40 years since the beginning of operation of Specialized Academic Council at the Main Astronomical Observatory of the NAS of Ukraine (MAO). Having analyzed its activities during the 25 years of Ukraine's independence, one can see certain trends in preparation of DSc theses in the field of astronomy and estimate changes in the quality of defended dissertations.

The Specialized Academic Council at the MAO was established at the time of the USSR by order of the Chairman of the Higher Attestation Commission (HAC) No. 42-v dated 22.12.1975 on the approval of the Specialized Council for Awarding the CSc Degree at the MAO of the Academy of Sciences of the UkrSSR. The first meeting of the Council took place on June 11, 1976. By resolution of the Presidium of the Academy of Sciences of UkrSSR No. 75-ds dated August 20, 1984, the Specialized Academic Council for the Defense of Doctoral Dissertations in the specialties *01.03.01 Astrometry and Celestial Mechanics* and *01.03.02 Astrophysics* was founded at the MAO of the Academy of Sciences of the UkrSSR. Since that time, the Council members have changed and new specialties have been added [1], but the quality of theses defended still remains high. This can be confirmed by qualitative and quantitative analysis of the thesis works based on ADS Bibliographic Services data [1].

[1] Nowadays, there are four specialties to defend thesis: 01.03.01 Astrometry and Celestial Mechanics, 01.03.02 Astrophysics, Radio Astronomy, 01.03.03 Heliophysics and Physics of the Solar System, and 05.07.12 Remote Aerospace Research

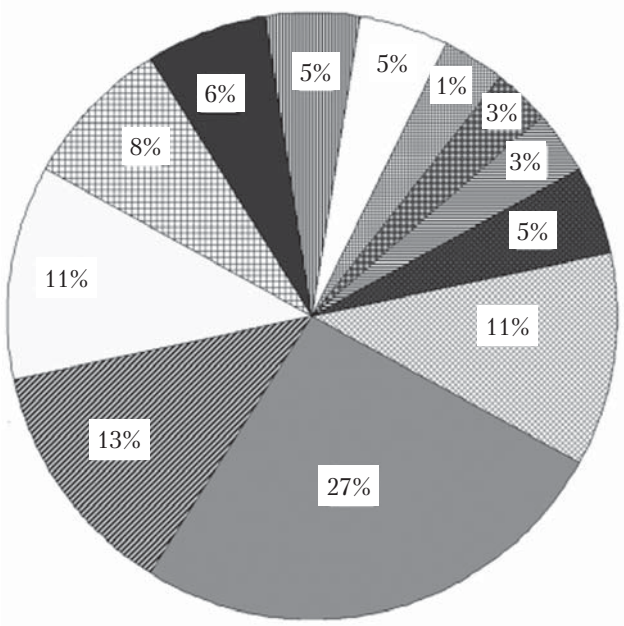


Fig. 1. Structure of doctoral research scholars by affiliation

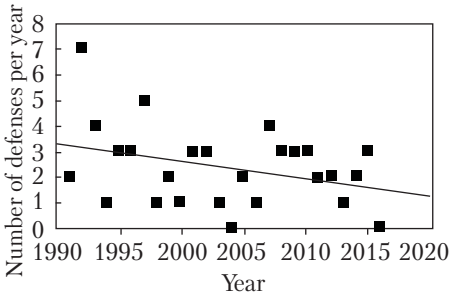


Fig. 2. Structure of the number of thesis defenses by year within the reported period

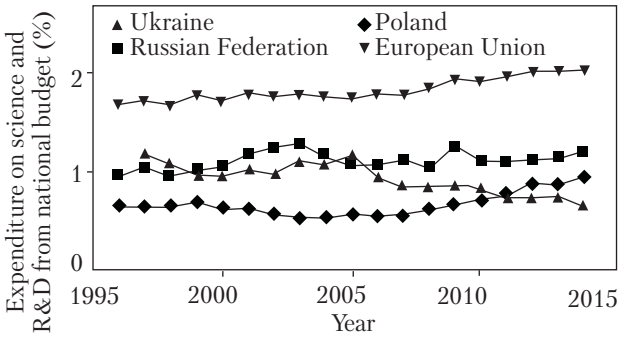


Fig. 3. Expenditure on science (percentage of the total national budget) according to the World Bank data

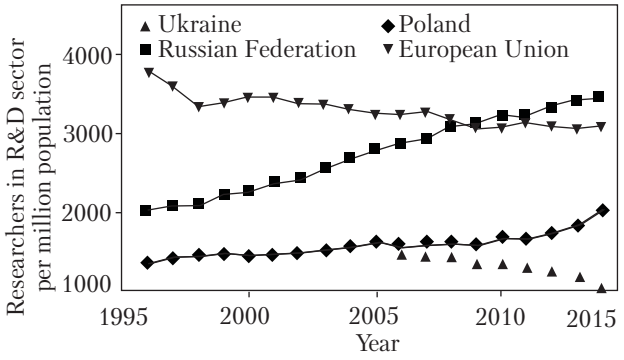


Fig. 4. Number of researchers in R&D sector (per 1 million of population) according to the World Bank data

QUANTITATIVE INDICATORS

Analysis of the quantitative indexes of defended DSc dissertations in Physics and Mathematics during the years of Ukraine's independence (25 years) has shown that during this time 62 dissertations were defended, including 11 in *Astrometry and Celestial Mechanics*, 28 in *Astrophysics, Ra-*

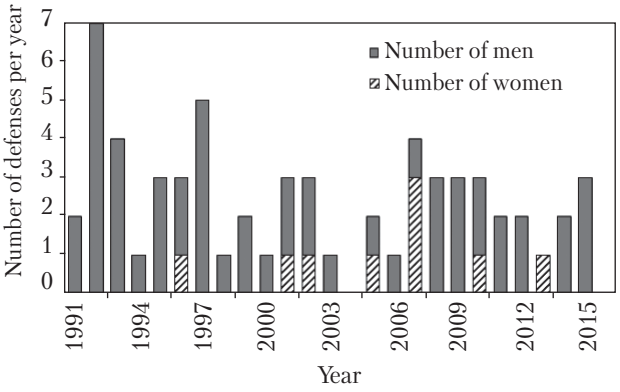


Fig. 5. Gender structure of defenders of doctoral dissertations

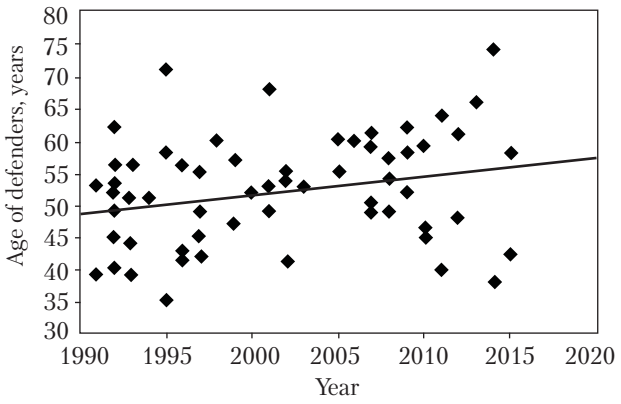


Fig. 6. Age range and average age of doctoral research scholars

dio Astronomy, 21 in *Heliophysics and Physics of the Solar System*, and 2 in *Remote Aerospace Research*. Thesis research were carried out at MAO, Taras Shevchenko Kyiv National University, other R&D institutions of Ukraine and foreign countries, including the USA, Poland, Czech Republic, Tajikistan, Kazakhstan, Azerbaijan, and Russian Federation. The structure of applicants by the place of research is shown in Fig. 1.

The maximum number of doctoral dissertations was defended in 1992 (7 theses). The average number of these defended per year is 2.5 (Fig. 2). Unfortunately, it shows steady downward dynamics and it can be predicted that in the future, only one thesis will be defended annually. This corresponds to the general trend in Ukraine as the number of employees in R&D decreases while that in the EU and even in Russia is kept stable or grows, which is consistent with the data on science financing (according to the World Bank [2]) (Figs. 3–4).

An important factor in modern society is gender equality. In 2015, the Global Gender Gap Index of the World Economic Forum ranked Ukraine 65th among 145 world countries. According to the report on R&D activities in 2015 [3], women account for 50% of the total number of researchers in Ukraine, but the total number of DSc women made up only 25%, as of 2015.

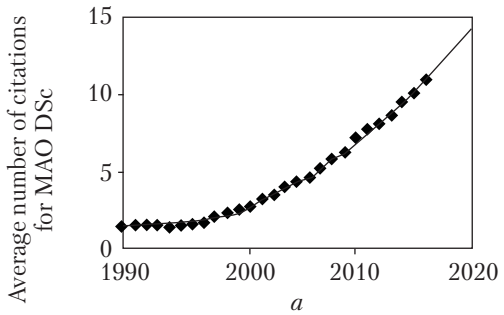
For the period from 1976 to 1991, only 2 doctoral theses were defended by women at the MAO Specialized Council [9]. Since then, the situation has improved as almost every fifth dissertation is defended by a woman. Given the fact that the total number of theses defended decreases, it can be predicted that by 2020, the number of women who defend their doctoral dissertation at the MAO Specialized Academic Council will exceed that of men (Fig. 5).

The age of DSc degree seekers ranges from 35 to 74 years (Fig. 6). By 2020, it will reach 57.5 years on average.

QUALITATIVE INDICATORS

As of today, many scientometric indices have been developed to assess the quality of researcher work. However, it is quite difficult to compare these indices for the works done the 1990s and in the present time. Globalization and access to modern means of communication have made the Ukrainian «Soviet» astronomical science a part of the world astronomy.

The quality of doctoral dissertations defended at the MAO Specialized Council from 1991 till nowadays has been analyzed by several criteria. This is the well-known Hirsch index, the total number of citations, and the total number of research publications. All these data can be obtained and analyzed using several databases, such as Google Scholar, Scopus, Web of Science, or ADS that was chosen as optimal one because of the number of publications and analytical tools [4, 5].



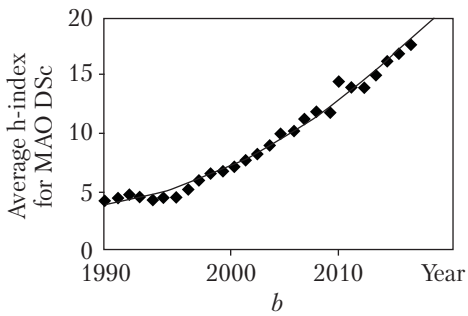
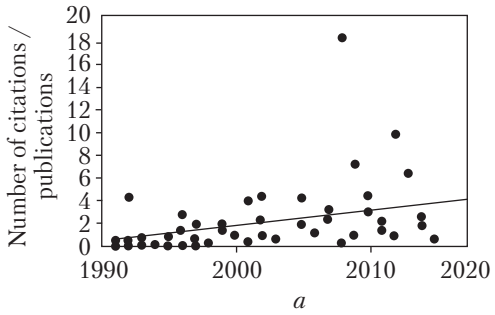


Fig. 7. Average number of citations per one publication for DSc employed with MAO of the NAS of Ukraine (*a*). Average h-index for DSc employed with MAO of the NAS of Ukraine (*b*)



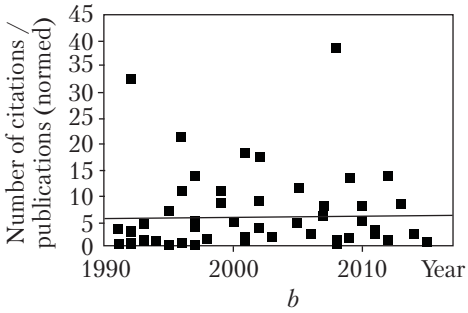
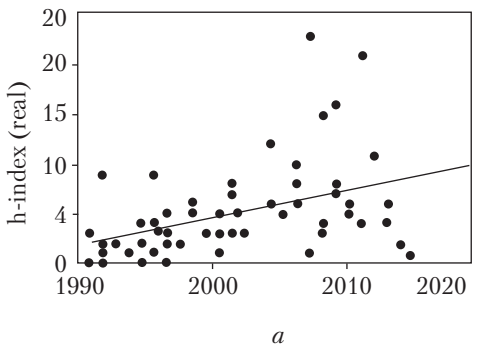


Fig. 8. Average number of citations per one publication for doctoral research scholars: real (*a*) and normed (*b*)



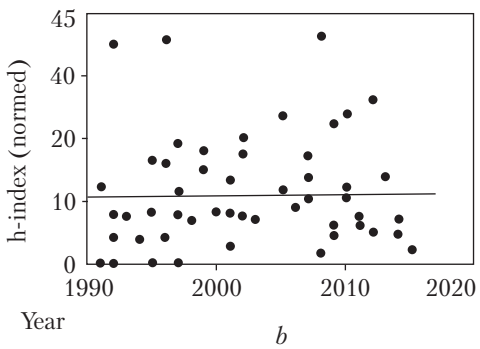


Fig. 9. *H*-index of doctoral research scholars: real (*a*) and normed (*b*)

In order to compare old and new indices, it is necessary to elaborate a criterion for converting citation indexes of the 1990s to those of the present day. To this end, the general index for the entire observatory for a given year was taken as a criterion. This service (search by affiliation) is provided by ADS database http://adsabs.harvard.edu/mighty_search.html. However, unfortunately, this cannot be done automatically. Even for large observatories, the name search gives approximately 80% of links [6, 7]. For MAO (Main Astronomic Observatory) sometimes it gives names such as «Maine Univ., Orono», «Mainz, Universität, Germany» or «Main Astrophysical Observatory, Pulkovo, Russia». Therefore, the average Hirsch index (*h*-index) and the average number of citations per work for DSc who worked at the Observatory in the respective year were used as normalizing factor for each year. For example, in 2015, the Observatory employed 17 DSc [8]. Their common h-index was 301, the average number of citations per work was 9.96.

The diagrams (Fig. 7) show an increase in the average number of citations per work and in the average Hirsch index of holders of DSc in Physics and Mathematics employed with MAO. These data were used as norm for assessing the quality of works defended at the Specialized Council of MAO of the NAS of Ukraine.

Fig. 8 shows the number of citations per one publication for each DSc who defended thesis at the Specialized Academic Council at the MAO of the NAS of Ukraine (for the year of defense). From the first diagram it may seem that in recent years the quality of DSc publications if judge by the number of citations has risen essentially. However, if this indicator is considered in terms of 2016, the growth will be less significant. Since 1991, the average number of citations has grown by about 6.9% and amounted to 6.19 citations per doctoral research scholar, in 2015. However, it should be mentioned that the average number of citations per one publication for DSc in Physics and Mathematics employed with MAO was 9.96.

From 1991 to 2015, the Hirsch index (in units of 2016) added about 5.7% and is expected to continue growing (Fig. 9). In 1991, the average *h*-index for doctoral research scholar was 10.37, while in 2015, it increased to 10.97 (for comparison: in 2015, the average *h*-index for MAO DSc was 16.72).

By specialties the average *h*-index is as follows: 3.85 for 01.03.01, 13.04 for 01.03.02, and 10.20 for 03.01.03. The real average *h*-index for the theses defended in 2015 on the specialty 01.03.02 is 2.0.

Consequently, the most probable next doctoral research scholar at the MAO for the period up to 2020 is a man or woman with equal probability born within the period from 1958 to 1962, a specialist in astrophysics and radio astronomy or heliophysics and physics of the solar system, who graduated from the university in 1983–1986 and has *h*-index of about 11.0 and average number of citations per publication of about 6.3.

CONCLUSIONS

Thus, quantitative and qualitative analysis of the work of the Specialized Academic Council at the MAO of the NAS of Ukraine in 1991–2016 has shown a decrease in the number of theses defended per year and an increase in the average age of doctoral research scholars. At the same time, during this period, the number of women who defended their doctoral theses significantly grew. The level of citation of doctoral publications and their average *h*-index is stable. The quality of doctoral theses defended at MAO remains high throughout the independence period.

The study was conducted using NASA ADS Bibliographic Services. The author appreciates contribution of LM. Kizyun who helped to obtain data from the MAO archive.

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Received 22.05.17

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ТЕНДЕНЦІЇ ДОКТОРСЬКИХ ДИСЕРТАЦІЙНИХ РОБІТ, ЯКІ БУЛО ЗАХИЩЕНО У СПЕЦІАЛІЗОВАНІЙ ВЧЕНІЙ РАДІ ПРИ ГОЛОВНІЙ АСТРОНОМІЧНІЙ ОБСЕРВАТОРІЇ НАН УКРАЇНИ У 1991-2016 РОКАХ

Метою статті є виявлення тенденцій та оцінка рівня докторських дисертацій, які було захищено в спеціалізованій вченій раді при Головній астрономічній обсерваторії НАН України з 1991 до 2016 року. Показано зниження кількості захистів протягом року, що відповідає загальній тенденції поступового зменшення кількості співробітників в галузі науково-дослідних та дослідно-конструкторських робіт в Україні, а також збільшення середнього віку дисертантів. Разом з тим, за цей час суттєво зросла кількість жінок, які захистили докторську дисертацію. Рівень цитування публікацій дисертантів та їх середній індекс Гірша є стабільними. Загалом рівень докторських дисертацій, захищених в Головній астрономічній обсерваторії, залишається високим протягом всього періоду незалежності України.

Ключові слова: наука, наукометрія, індекс Гірша.

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ТЕНДЕНЦИИ ДОКТОРСКИХ ДИССЕРТАЦИОННЫХ РАБОТ, ЗАЩИЩЕННЫХ В СПЕЦИАЛИЗИРОВАННОМ УЧЕНОМ СОВЕТЕ ПРИ ГЛАВНОЙ АСТРОНОМИЧЕСКОЙ ОБСЕРВАТОРИИ НАН УКРАИНЫ В 1991—2016 годах

Целью статьи является выявление тенденций и оценка качества докторских диссертаций, защищенных в специализированном ученом совете Главной астрономической обсерватории НАН Украины с 1991 по 2016 год. Показано снижение количества защищенных диссертаций в год, что согласуется с общей тенденцией постепенного сокращения числа сотрудников в области научно-исследовательских и опытно-конструкторских работ в Украине, а также увеличение среднего возраста диссертантов. Однако за этот период количество женщин, защитивших докторскую диссертацию, значительно возросло. Уровень цитирования публикаций диссертантов и их средний индекс Хирша остались неизменными. В целом, качество докторских диссертаций, которые были защищены в Главной астрономической обсерватории, остается высоким за время независимости Украины.

Ключевые слова: наука, наукометрия, индекс Хирша.