# MILUTIN MILANKOVIC`S OPUS AS A TOPIC OF SCIENTOMETRIC REASEARCH

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**Abstract**. Revue of Milutin Milankovic`s opus studied in scientometric literature show that his theory is considered as a fundamental scientific achievement. Bibliometric analysis of his opus was performed in citation databases Web of Science and Scopus, and in databases searched by search engines Google Scholar and Microsoft Academic. Numbers of retrieved citations in result lists from those databases are different, between 440 and 2444, depending on their coverage. Search for his citations and of works that have his name in descriptors and not in reference list showed that there was much more mentioning of his name than explicite citations of his work. In Web of Scence 1992-2019, 25% of records mention his name in title, key word or abstract and not in reference list, and in Scopus 1996-2019 there were 55% such records. This finding is in concordance with the fact that his name became an eponyme, present in printed and online encyclopedias, textbooks, dictionaries, websites, blogs. His name is incorporated in the scientific language, showing that his scientific contribution is widely recognized.

**Sažetak.** Pregled proučavanja dela Milutina Milankovića u naukometrijskoj literaturi pokazuje da se njegova teorija smatra fundamentalnim naučnim dostignućem. Bibliometrijska analiza njegovog opusa izvršena je u citatnim bazama podataka Web of Science i Scopus i u bazama podataka pretraživača Google Scholar i Microsoft Academic. Brojevi pronađenih citata u spiskovima rezultata iz tih baza podataka su različiti, između 440 i 2444, i zavise od njihovog opsega. Pretraga njegovih citata i pretraga radova koji imaju njegovo ime u deskriptorima a ne i u popisu referenci pokazala je da pominjanja njegovog imena ima znatno više nego što ima eksplicitnih citata njegovih dela. U Web of Scence 1992-2019 bilo je 25% zapisa koji pominju njegovo ime u naslovu, ključnoj reči ili sažetku a ne i u listi citata, a u Scopusu 1996-2019 bilo je 55% takvih zapisa. Ovaj nalaz je u skladu sa činjenicom da je njegovo ime postalo eponim, prisutno u štampanim i mrežnim enciklopedijama, udžbenicima, rečnicima, veb lokacijama, blogovima. Njegovo ime je ugrađeno u naučni jezik, što pokazuje da je njegov naučni doprinos široko priznat.

**Key words:** Scientometrics, Milutin Milanković, bibliometric indicators, Citedness, Eponym
**Ključne reči:** Naukometrija, Milutin Milanković, bibliometrijski indikatori, citiranost, eponim

## 1. INTRODUCTION

Milutin Milankovic is a great name in world science. His biography and explanation of terms that bear his name is present in encyclopedias, textbooks, histories of science. For example, Encyclopedia Britannica lists Milankovic's biography in the GEOSCIENTISTS group, which contains a total of 245 biographies of scientists from all countries and all times. From the freely available online encyclopedias "Wikipedia", which create volunteers from around the world in 66 languages, 52 Wikipedias contain extensive or less extensive articles on Milutin Milankovic and his cycles. Term Milanković's cycles exist on Wikipedia's list of the most important concepts in all areas that every Wikipedia in a unique language should include. The list is planned to contain 1100 scientists and inventors from all countries and all times, and Milutin Milanković is one of them.

The result of many years of dedicated work on a scientific problem that he himself chose was a theory that now bears his name. Since he has accepted the notion formulated by *Kant* that in every natural science the amount of real science is equal to amount of mathematics in it, he would probably be interested in scientometric studies, and happy to learn that his opus is a subject of some of them.

In twentieth century science became a subject of research with quantitative measurement, used to describe and explain the complex system of scientific knowledge, its structure and development. Since publications were the main output of science, the discipline that evolved first was bibliometrics. Alain Pritchard defined bibliometrics as the application of mathematical and statistical methods to books and other media transmitting scientific information [Pritchard, A., 1969]. Empirical data collected on authors and publications from different disciplines, countries and periods show the existence of laws of distribution of bibliometric indicators: Lotka's law of Scientific Productivity (authors publishing in a certain discipline); Bradford's law of scattering (of articles in journals); Zipf's Law of Word Occurrence (ranking of word frequency in texts) and Garfield`s law of concentration (of relevant information in a few core journals and long "tail" of less relevant ones). In the late 1980s, those bibliometric laws were proven to be mathematically equivalent. They belong to the type of statistical distribution characteristic for complex systems and social phenomena, where there are small numbers of the highly productive holders of some phenomena and large number of less productive ones [Chen, J.S., Leimkuhler, F., 1986].

Nalimov and Mulchenko were the first authors to define scientometrics as a method of quantitative research of development of science as an information process [Nalimov, V, Mulchenko, B., 1971]. Subjects of research for scientometrics are individual scientific documents, references (citations), authors, institutions, scientific journals, and analysis of the development of certain scientific disciplines in the whole or in certain regions of the world. Basic postulate of scientometrics is that the only credible indicators for the scientific contribution of a scientist by his colleagues are: large number of citations in scientific literature which certify the use of his results, citation context analysis, and the occurrence of eponym – professional terms containing the name of the scientist [Gläser, J., Laudel, G., 2001].

## 2. CITATIONS AS A SOURCE OF INFORMATION

Citations are the best available approximation of the impact produced by a scientific publication. They indicate the transfer of information from one scientific work to the other. According to sociologist of science Robert Merton, citations have dual function – cognitive and moral [Merton, R., 1979]. The cognitive function is manifested by linking new knowledge to the history of science by sending readers to the sources of information that they can use in their work, and the moral function is to return the intellectual debts in the only possible way. Derek de Sola Price, "father" of scientometrics, in his famous book "Little Science, Big Science" divided the development of science in two periods: period of "small" science, i.e. science which is dominated by works of individual scientists, lasting until the fifties of the twentieth century, and the period of "big" science, dominated by the works of entire teams of scientists [De Solla Price, D.J., 1965]. . In the period of "small" science, the number of active scientists and their works is much smaller [Marx, W. et al., 2010]. Therefore, it is much less likely for these works to be cited.

Eugene Garfield, founder of the Institute for scientific Information in 1960 and author of the bibliometric laww of concentration, was the first to promote citations as the best source of information about the links between scientific documents that show the flow of information through the corpus of science. His intention was to enable scientists to easily find documents relevant to their work by searching for the citations of an older document relevant for the problem they were interested in. In 1963 he started publishing Science Citation Index, which covered the core journals in natural sciences, chosen according to their impact factor calculated as the average number of citations the article published in them gained two years after its publication. Citation indexes were very soon recognised as a rich source of information about the structure of science by sociologists and historians of science, and scientometric studies heavily used them. It is interesting to mention that the idea of ranking results acording to number and importance of links they have by search engine Google is based on the same principle as Garfield`s idea of ranking journals according to citations they get [Baykoucheva, S., 2019].

For decades the only citation indexes were produced by Institute for Scientific Information, but now there are other databases that include citations, as Scopus lounched by Elsevier from 2004, and search engines like Google Scholar and Microsoft Academic. Their coverage, transparency of data gathering and processing and openness is different. Bibliographic databases Web of Science (the

successor of Science Citation Index) and Scopus are available only for subscribed users and are very expensive. Microsoft Academic and Google Scholar are freely available for registered users. Web of Science coverage is completely transparent from 1900 onwards. Scopus is less transparent because it is constantly adding older publications. Google Scholar's and Microsoft Academic's coverage are not precisely defined because they are not bibliographic databases produced by a publisher with defined selection policy for coverage, but academic search engines, collecting information available on Internet and from publishers with whom they have contracts. Bibliographic metadata provided by them are of very different quality, because they are collected from repositories, publishers, websites, academic social media, etc. It is often the case that there are duplicate data about the same publication, collected from different sources and in different formats, so the absolute numbers collected by them are less precise. Google Scholar with about 390.000.000 records has the largest database, followed by Microsoft Academic with about 237.000.000. Web of Science and Scopus have about 60.000.000 bibliographic records. [Gusenbauer, M., 2019].

## 3. MILUTIN MILANKOVIC IN SCIENTOMETRIC RESEARCH

The indicator commonly used in bibliometric analyse of scientific contributions is the productivity (number of publications) of scientists for a specific period of time. Productivity of Professor Milanković is calculated according to his bibliography by Milica Indjić [Inđić, M., 1994]. The following chart shows the annual scientific and professional activity of Milutin Milanković, from 1905, when he's 26 years old and published the first work, up to 1957, when he published the last one at 78 years of age. Works that were translated or reprinted after the authors' death were not taken into account. Literary and popular publications are not included. Three creative periods are clearly shown. The first one lasts from his ages of 26 to 37, with a total of 23 works published. The second, the most fertile period lasts from his 41 until 61 years of age. It starts at 1920, with a monograph that contained his results so far, and ends in 1941 with a monograph in German, with the synthesis of his whole life's work. In second period he published 34 work. The third period starts after the Second World War and lasts until the very end of his life. In that period he published mainly university textbooks and articles from the history of science, assuming that his great research on astronomical theory of climate change was rounded up and that he is to old to begin anything new.

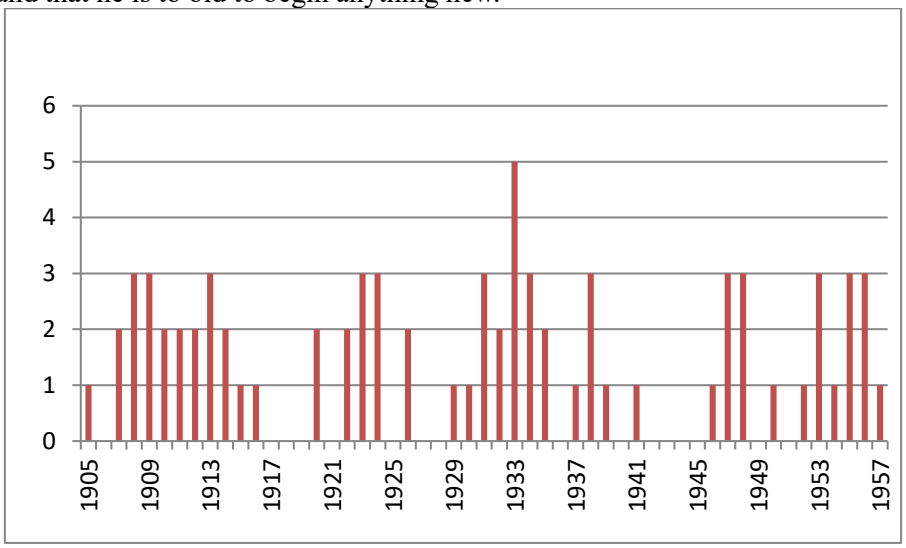



*Fig.1 Number of publications annualy*

*Table 1. Distribution of citations between publications in SCI/WoS 1928-2019*

| Number of citations | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 13 | 30 | 47 | 56 | 146 | 343 | 780 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of publications | 7 | 10 | 6 | 2 | 3 | 4 | 1 | 4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

The most cited work is ***Kanon der Erdbestrahlung und seine Anwendung auf das***

***Eiszeitenproblem*, Belgrad, Königlich Serbische Akademie, 1941**, with 780 citations, ***Mathematische Klimalehre und Astronomische Theorie der Klimaschwankungen, Handbuch der Klimatologie, Bd I*, T.A. Hrsg. von W. Köppen und R. Geiger, Berlin, Gebruder Borntraeger, 1930,** with 343 citations and ***Théorie mathématique des phénomènes thermiques produits par la radiation solaire,* Paris, Zagreb, 1920,** with 146 citations. It is interesting to notice that all three most cited publications were monographs published before the Second World War, but the number of citations that they receive is still high, showing their fundamental importance.

What Milanković is exceptional for, and especially from today's perspective of teamwork in science, is that he was the only author of all his publications. It is important to emphasize that he did work alone, but not in isolation. Milanković was aware that successful work in science is not possible without continuous monitoring of world scientific literature and without intensive communication with colleagues all over the world. To make his results discoverable and understandable to his international colleagues, he wrote his most important works in German and French, which were the main languages of communication in world science at that time. How closely he was connected to his colleagues from abroad is visible from his rich correspondence and his personal library, where he kept all the works of the authors who used and cited his works. All citations have been neatly recorded and on the list that was saved in his legacy at the Serbian Academy of Sciences and Arts. There are 110 works in which his scientific results were cited. In this regard also he was avant-garde, realizing that the citation networks are a much better system of connecting scientific literature by content than any existing classification scheme of scientific disciplines.

Different aspects of the problem of citations are increasingly being investigated, especially since the bibliometric criteria are used in the evaluation of scientific work. For our theme the most interesting is the article of Marx, Haunschild, Thor and Bornmann, dedicated to exploring the most cited publications in the literature on climate change. [Marx, W., et al., 2017]. Work deals with the general history of climate change research, with an emphasis on discovering the impact of greenhouse gases. The articles were collected from the database Web of Science from years 1980 to 2014, with a total of 222,060 articles, in which 10,932,050 publications were cited. Authors identified 35 publications that were most cited in the observed sample. Early works that are still much cited have been identified, for which it can be stated that they represent the intellectual roots of this discipline. It has been shown as expected that older publications are less represented in the cited literature, but that the distribution of the number of such publications by the years of publication gives a very high maximum of certain years. These maximums originate from individual early publications, which are of particular importance for the development of the discipline. The authors first extracted the cited publications published before 1971, whose number was 239,887. They then extracted those publications that were cited more than 100 times, whose number was 226. On the acquired table, the work of Milutin Milanković "Canon of insolation" was found in a thirteen place with 352 citations. Authors thoroughly analyzed the first 35 publications in the list, which, according to them, are the cornerstones of modern science about the climate.

The important fact that influenced on citations of Canon is also that it is written in German, and translated to English only in 1969, as a part of Israeli program for scientific translations of important scientific publications published in the Eastern Europe, financed by National Science Foundation of USA. John Levin analyzed the use of literature in geomorphology, and found that English use in scientific papers rose from 55% in 1970s to over 90% by the end of the century. There is much greater potential for the wider dissemination if the publication is in English, since it became “lingua franca” for scientists all over the world. In this article publications by Milankovic are used as an example of importance of translation to English language for enhancement of communication in geomorphology [Lewin, J., 2017].

In Serbia there are a few researches that analyzed Milutin Milankovic from a bibliometric perspective. The first data were published in an article by famous Serbian sociologist Vojin Milic (1922-1996), who analyzed science in Serbia as a subject of contemporary Serbian historiography. He collected data from the database Science Citation Index for years 1965-1989 for Serbian natural scientists. Milutin Milankovic was the most cited of them [Milić, V., 1993].

Serbian astronomer Milan Dimitrijevic analised citations of Milankovic 1946-1990. [Dimitrijević, M., 1997] and published in 2005 the book “Serbian astronomers in Science Citation Index in the XX Century”, analyzing the presence of citations for works by astronomers from years

1945 to 2000. The most cited author was Milankovic with 572 citations. [Dimitrijević, M., 2005].

Publishing house Zavod za udžbenike from Belgrade published two editions of Milutin Milanković's selected works. First edition of the book 8, published in 2008, contains article "Work of Milutin Milankovic from scientometric perspective" and lists all citations his works received, present in Science Citation Index 1945-2006. [Filipi Matutinović, S., 2008]. Extended version of that article was published in 2009, in the catalogue of the exhibition about Milutin Milankovic, prepared at the University Library "Svetozar Markovic" in Belgrade. [Petrović, A., Filipi Matutinović S., 2009].

Eugene Garfield, creator and editor of Science Citation Index, produced special software for bibliometric research of individual authors or subjects, named HistCite. Software was used for analysis of citations present in Science Citation Index database for the period 1900-2010. HistCite collections of papers consist of works by highly productive scholars and scientists. In Garfield`s digital library available in open access on Internet, there are data for citations of 178 authors from the period of "little science", and one of the chosen authors for presentation is Milutin Milankovic [Garfield, E, 2020]. Since Garfield introduced the method of citation as a qualitative measure of academic impact, the fact that he chose Milankovic as an example of important scientists whose citations matter for the history of science is very significant fact for estimation of his scientific reputation.

## 4. MILUTIN MILANKOVIC IN WEB OF SCIENCE, SCOPUS, GOOGLE SCHOLAR, MICROSOFT ACADEMIC AND ASTROPHYSICAL DATA SYSTEM

Bibliometric analyze of Milankovic's work was performed by analyzing the results of search for citations of his works and for topic (keywords and titles) in publications containing his surname in special databases or search engines that are available: two commercial databases – Web of Science and Scopus, and two search engines designed for academic use – Google Scholar and Microsoft Academic. The citation analysis was conducted using the "Cited reference search" feature in WoS. All citing documents and all citations to documents authored by "Milankovic M, Milankovitch M or Milankovich M" were retrieved. A complementary search was performed in WoS in order to retrieve all publications containing "Milankovic, Milankovitch or Milankovich" either in their titles, descriptors or abstracts. This should give an idea of how many citations have been omitted because his works have already been assimilated by the scientific community as common knowledge and therefore ceased to be cited directly any longer. The search was restricted to the field "Topic" (searches title, abstract, author keywords, and keywords plus), and repeated for the field "Title". The search for citations in Scopus was performed in the "References" field. All references containing the name "Milankovic M, Milankovitch M or Milankovich M" were retrieved. On the fig. 2 is shown that WoS retrieved more citations before 1988 and that Scopus started to collect more results than Web of Science after 1996. WoS included abstracts and enabled keyword search in 1992, so it is possible only in Scopus to search for keywords containing Milankovic or Milankovitch or Milankovich before 1992.

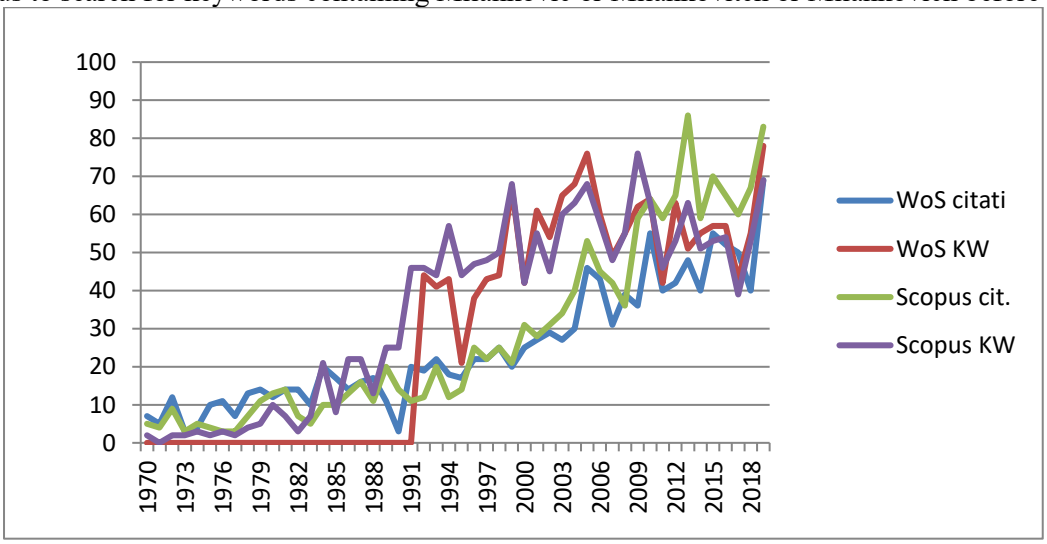



*Fig. 2: Number of citations and Keywords in WoS and Scopus*

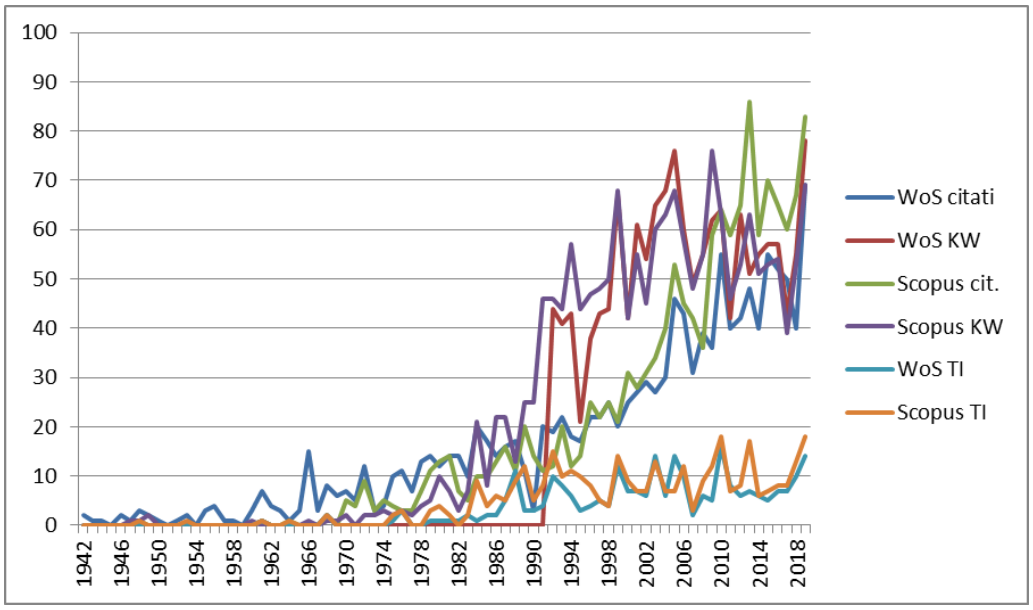



*Fig. 3: Citations, key words and title words in WoS and Scopus 1941-2019*

Figures 2. and 3. clearly show the trend of constantly growing usage of Milankovic's works, proving that his theory is a good example of a "sleeping beauty" in science that was widely recognized more than half a century after it was first published [Van Raan, A.F.J., 2004]. The number of citation is increasing. That is characteristic only for fundamental works; usual trend is decreasing after reaching maximum in the first decade after publication. Marxx founded that most of the works published at the beginning of the twentieth century were no longer cited at all after year 1960 – only works that had fundamental significance for the development of physics were cited [Marx, W. et al, 2010].

It is important to mention that citations of Milankovic's works appear in the journals with the highest impact in different research areas – geophysics, geology, climatology, astronomy, ecology and above all in multidisciplinary journals. The distribution of citing articles according to research areas in WoS and Scopus is very similar. Majority belongs to the earth and planetary sicences, important groups belong to environmental and multidisciplinary sciences, and there are also citations from physics and astronomy, engineering, mathematics, social sciences, arts and humanities, agricultural sciences, etc.

It is possible in WoS 1996-2019 to observe the distribution of the citing records between authors. There were 2730 authors citing Milankovic from 1996 to 2019. Authors that cited Milankovic ten or more times are: A. Berger, M.F. Loutre, V.A. Bol`shakov, M. Crucifix, G. Lohmann, W.F. Ruddiman, W.H. Berger and P. Huybers. In Scopus the authors citing Milankovic most in the whole database are: L.A. Hinnov, A. Berger, F.J. Hilgren, A. Strasser, S. Zhang, W.H. Berger, F.J. Rodriguez-Tovar, L.J. Lourens, T.R. Naish and P.E. Olsen. Authors are from 70 countries, and more than 50 citations are from USA, Germany, Great Britain, France, China, Russia, Italy, Belgium and Canada. The leading countries in climatology research according to a bibliometric study [Haunschild, R. et al., 2016] are USA, Britain, Germany, Canada, China, France and Australia, so our results are in accordance with it. Absolute majority of citing articles in Web of Science were published in English language (98%), 1% was published in French, and a few articles were published in Russian, German and Chinese.

Search for citations was repeated in search engines Microsoft Academic, which provides data from 1981 and Google Scholar, which provides data from 1945. Microsoft Academic retrieved 440 citations and Google Scholar retrieved 2444 citations. Data obtained from academic search engines Google Scholar and Microsoft Academic returned bigger absolute numbers because those search engines get data not just from journals but also from institutional digital repositories, dissertations, conferences, books, preprints, etc. and that they contain duplicate records because no control of metadata is provided. Data from Google Scholar and Microsoft Academic were retrieved with the help of open source "Publish or Perish" tool by Ann Vil Harzing. [Harzing, A-W, 2020]

Google Scholar gives an option for authors to register and create profile, enabling them to

analyze citedness of their works and search for profiles of other scientists that created profiles. We created a profile for Milutin Milankovic, and the result is the following graph.

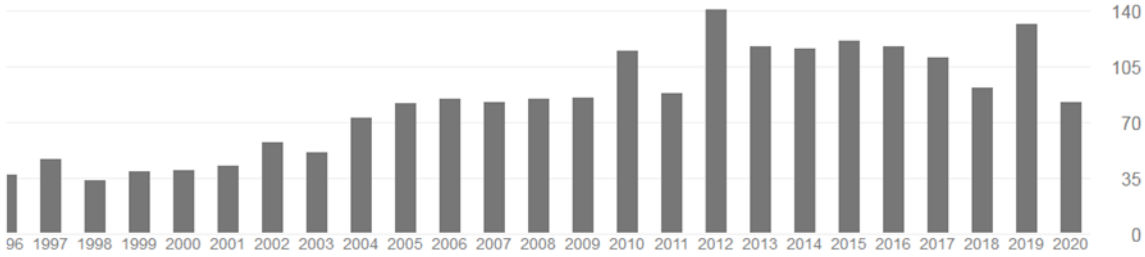



*Fig.3: Citations of works by Milutin Milankovic in Google Scholar*

The most cited works in Google Scholar are: "Kanon der Erdbestrahlung und seine Anwendung auf das Eiszeitenproblem" with 950 citations and its edition in English with 587 citations, "Mathematische klimalehre und astronomische theorie der klimaschwankungen" with 606 citations and "Théorie mathématique des phénomènes thermiques produits par la radiation solaire" with 387 citations. "Kanon" in the result list appeared as four different publications with the same publication year, each with separate number of citations because there is no metadata control.

SAO/NASA Astrophysics Data System (ADS) - a digital library portal for researchers in astronomy and physics, operated by the Smithsonian Astrophysical Observatory (SAO) under a NASA grant, contains about 13 million records. It also enables search for citations. On 16.06.2020 in that database Milankovic had 1992 citations.

The cumulative results obtained from Web of Science, Scopus, Google Scholar, Microsoft Academic and Astrophysical data system are compared in the table 2.

*Table 2: Total results from used databases*

| Database | No. citations | No. articles with keywords | articles with title words | Citations and keywords |
|---|---|---|---|---|
| Web of Science 1920-2019 | 1317 | 1458 | 255 | 242 |
| Scopus 1996-2019 | 1426 | 1756 | 352 | 308 |
| Google Scholar | 2444 | 29768 | 1021 | - |
| Microsoft Academic | 440 | 1996 | 398 | - |
| Astrophysical data system | 1992 | | | |

The first evident fact is that numbers provided by Google Scholar are much bigger. Number of citations is correct, but number of keywords is far too big and cannot be relevant for this analysis. Since it is possible to see only 1000 records for each search, it is impossible to analyze and perform cleaning of the inadequate records from the result list. It was noticed that Google Scholar collects keywords not just from abstracts, titles and full texts, but includes in the result list publications by all authors with the surname Milankovic (including Milutin Milankovic) and a lot of duplicate records collected from different sources – from publishers, repositories, etc. So we must conclude that WoS and Scopus are for the time being the only completely relevant sources for bibliometric analysis, because they provide the exact data of how and from which sources they include data in their databases, without duplications and with correct metadata.

Data in table 2 show that the number of citations is less than the number of keywords in all four databases. Most interesting fact is that there are only less than 10% of retrieved records in WoS and Scopus mentioning Milankovic that contain both citation to some work by Milankovic and keyword or title that contain his surname: Milankovitch cycles, Milankovitch forcing, Milankovich theory, etc. When analyzing the records lists retrieved as a result of three queries submitted to databases WoS and Scopus (articles citing Milankovic, articles with term Milankovic in title and articles with term Milankovic in keyword or abstract) it was observed that those lists are not overlapping. Those databases give the possibility to combine result lists of queries, so it was possible to determine the exact number of records present in all three lists. Number of mentioning Milankovic in those databases is nearly twice bigger than number of citing articles or number of articles with Milankovic in title or keywords. This results indicate that his name become an eponym.

## 5. EPONYMS IN SCIENCE AND MILANKOVIC

Eponyms are scientific terms formed after a person – inventor or scientist who was the first to discover or to communicate to other scientists some invention, discovery, theoretical explanation etc. Robert Merton, one of the pioneers of the sociology of science, defined eponymy as the practice of affixing the names of scientists to all or part of what they have contributed. He showed that eponymy is an important mechanism of recognizing scientific contribution. Creation of eponyms is a part of stimulation system for science development, since it gives great and long-lasting reward to scientists by their peers. [Ravlić, S., 2006]

Eponyms have an important role in communication in science, because they transfer a part of its meaning from abstract concepts to iconic scientists related to these concepts. This is very important for frequently used scientific concepts.[Koshlakov, D. et al., 2019] Eponyms are present in contemporary scientific terminology in many scientific disciplines. Webster unabridged dictionary lists about 9000 eponyms in all fields, The Eponyms dictionary index lists 13.000 eponymized persons, and there is a lot more dictionaries of eponyms for different fields.

The systematic use of eponyms can be regarded as one of the most effective reward systems in Western science. Astronomers practice to use eponyms to honor distinguished predecessors. In Milankovic honor, a crater on the dark side of the Moon was given his name at the Congress of the Astronomical Union in Brighton 1970, and in 1973 the same organization decided to give his name to a crater on Mars. A celestial body in the asteroid belt, discovered by Serbian astronomers also is named after him – 1605 Milankovic.

In scientific literature eponyms serve as implied citations. True eponymy is achieved when the following conditions are met contemporaneously:

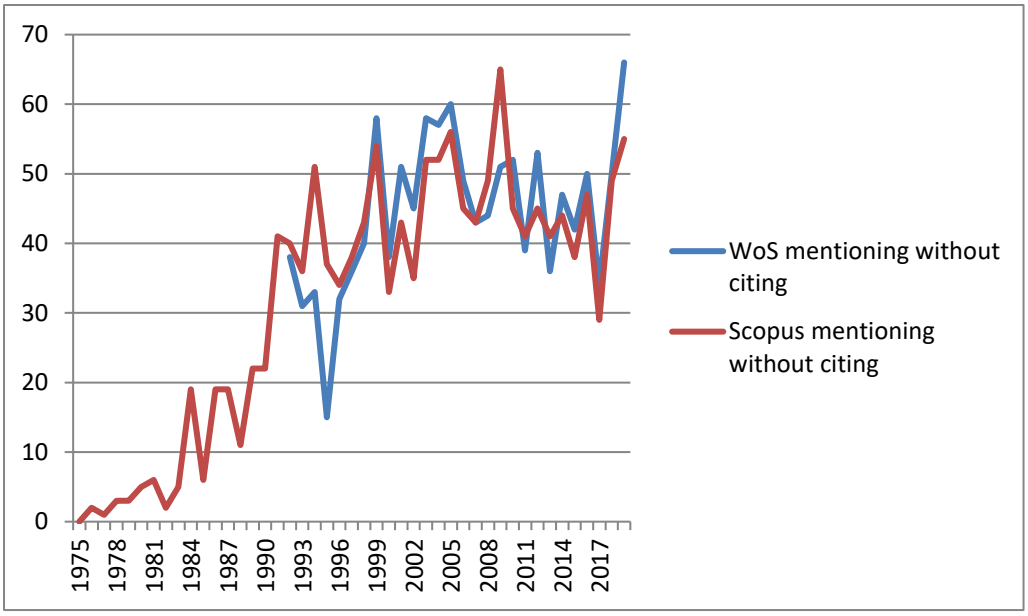
- The event in question (method, law, rule, etc.) is commonly called by its discoverer's name
- The eponym is recognized by its inclusion in the indexes of standard texts in its field
- The eponym is used as a heading in a paper or text
- The event is implicitly cited by the use of the eponym.[Thomas, K.S., 1992]

Existence of eponyms in a scientific discipline is influencing the possibility to correctly determine the number of citations for a specified scientist or a theory, as the eponymized author is not cited any more with a defined bibliographic reference. His name is incorporated in the scientific language of a discipline. This phenomenon is called obliteration by incorporation and was first described in detail in Merton's article about Matthew effect in science in 1968. [Merton, R., 1968]

Eugene Garfield wrote about the phenomenon of obliteration, claiming that most scientists will not cite a source if it has been absorbed into the scientific language, since the readers are already aware of it. [Garfield, E., 1974] In his essay about the importance of not being cited he states: " An implicit citation, made by incomplete, casual, or mere last-name reference in the text, indicates that the author assumes the reader will know that the theory, the method, or the technique referred to is part of their common working knowledge and need not be explained or verified"… That kind of uncitedness happens to "those whose work has become so well known (and presumably been previously so heavily cited) that one finds it at first tedious, then unnecessary, and finally actually gauche to cite such men at all".[Garfield, E., 1962]

In his essay about eponyms as a route to immortality, Garfield states: "Eponyms remind us that science and scholarship are the work of dedicated people. They allow us to immortalize sometimes obscure but deserving persons".[Garfield, E., 1983]

If we analyze the results of Milankovic's mentioning in databases WoS and Scopus, we can see that for the period 1992-2019 there are 25% of all retrieved records in Scopus and 55% of retrieved records in WoS where his name is mentioned without citation. That is clear evidence that his work has been obliterated by incorporation since his name became an eponym. The trend of using his name as an eponym, without explicitly citing his works is evident from graph 11. The run of both curves is similar in both databases. Both the number of citing articles and articles mentioning his name without citing has gradually increased within the last 50 years according to the growth in the scientific world output.




**Graph 14: Records mentioning Milankovic without citations**

The syntagm “Milankovitch cycles” is present in textbooks, encyclopedias and lexicons in many languages and is widely used in scientific literature. The best proof that his name is a widely used eponym is that the definition of the word "Milankovitch" is present in the Oxford English Dictionary [Oxford University Press Lexico Dictionary, 2019]. It is also present in cosmos, since craters on the Moon and Mars and one asteroid bear his name.

## 6. CONCLUSION

We can conclude that Milutin Milankovic achieved great international reputation. By becoming an eponym, his name will be part of the corpus of knowledge forever. This conclusion would not be so obvious if we analyze and compare just the plain numbers of citations for different authors. Citation analysis is definitely a useful tool to study the impact of the works of great scientists, but it is too restrictive, because it does not include the phenomenon of obliteration and creation and use of eponyms. We can state that Milankovic achieved his life goal and built his “eternal and inviolable scientific estate”. His theory is inseparable part of scientific legacy of humankind, surpassing the boundaries of his scientific environment and boundaries of the discipline he worked in. Results of this scientometric analyze confirm his exceptional place in world science.

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