



# RESEARCH AND ENGINEERING INNOVATION PROJECTS OF THE NATIONAL ACADEMY OF SCIENCES OF UKRAINE

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## INTERNATIONALIZATION OF RESEARCH AT THE NATIONAL ACADEMY OF SCIENCES OF UKRAINE AS A KEY DEVELOPMENT PATHWAY IN THE CURRENT CONTEXT (A CASE STUDY OF FOUR INSTITUTES)

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**Introduction.** *International scientific cooperation has remained a key strategic priority in the development of modern science. For Ukraine, the internationalization of research is particularly significant amid complex geopolitical conditions.*

**Problem Statement.** *While internationalization is widely recognized as a critical vector for scientific advancement, the impact of military aggression on the international research activities of the National Academy of Sciences (NAS) of Ukraine has not been sufficiently studied.*

**Purpose.** *This study aims to assess the scope and structure of international collaboration by examining the publication activity of four leading institutes of the NAS of Ukraine: the Institute of Mathematics (IM), the Institute of Physics (IP), the Kukhar Institute of Bioorganic Chemistry and Petrochemistry (IBOPC), and the Institute of Molecular Biology and Genetics (IMBG). The analysis focuses on publications indexed in the Scopus database.*

**Materials and Methods.** *The research has employed comparative, statistical, and scientometric analysis. The Scopus database served as the primary data source, with journal rankings assessed by quartiles (Q1 indicating the highest impact, Q4 the lowest).*

**Results.** *The analysis has shown that over 70% of the publications from the selected institutes in 2022 appeared in international journals. Joint publications have constituted more than 80% of all articles in Q1 journals. The share of co-authored Q1 and Q2 articles relative to the total number of Q1 + Q2 publications was highest for*

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IMBG (78.6%), followed by IP (67.1%), IBOPC (57.5%), and IM (51.4%). Among all joint publications, those in Q1 + Q2 journals have comprised the majority: 86.4% (IP), 85.2% (IBOPC), 84.6% (IMBG), and 72% (IM). Notably, foreign co-authors have accounted for 50–80% of author teams in Q1 publications, while their presence was considerably lower in Q2 journals and marginal in Q3 and Q4.

**Conclusions.** The internationalization of Ukrainian science — which manifests itself in high-impact co-authored publications — has remained a defining feature of research activities at institutes of the NAS of Ukraine. Publishing in top-tier journals has primarily been facilitated through international collaborations. The research methodology developed herein offers a replicable framework for evaluating international partnerships and may support further strategic planning across a broader range of research institutions.

*Keywords:* scholarly research journals, Scopus database, internationalization, institutes of the National Academy of Sciences of Ukraine, scientific communications.

Scientific activity is inherently international, global, and multidimensional in nature. The scientific systems of individual countries collectively constitute the global scientific community, which is essentially indivisible. However, the development of scientific activity has occurred unevenly across the world. Researchers in leading countries — operating under favorable conditions of financial support and regulatory frameworks that nurture talent — have conducted breakthrough research that has defined the dominant trajectories of modern science (Mainstream Science) and generated the majority of new knowledge. This output has exerted a significant influence on the advancement of science in most other nations [1–3].

The *UNESCO Science Report: The Race Against Time for Smarter Development (Executive Summary)*, published in 2021, has emphasized that science, technology, and innovation have become synonymous with economic competitiveness and modernity. Even developing countries have increasingly sought to diversify their economies and render them more knowledge-intensive<sup>1</sup>. The report provides examples of 32 countries that have made the most significant contributions to the increase in global research expenditures during the period 2014–2018. Over this time, global research spending (in constant 2005 prices) has grown by 19.2%, outpacing the growth of the global economy

(14.8%) and resulting in an increase in research intensity from 1.73% to 1.79% of global GDP.

In today's world, globalization and integration processes have profoundly influenced the scientific landscape, contributing to the formation of a research environment characterized by open access to information, a growing share of interdisciplinary research, and expanding international cooperation. As demonstrated by the experience of developed countries, adequate research and development (R&D) funding plays a crucial role in scientific advancement. However, Ukraine's scientific system has remained under persistent economic strain for the past 30 years, and the situation has further deteriorated since the onset of Russian military aggression. The R&D intensity of Ukraine's GDP has steadily declined — from 0.70% in 2013 to 0.33% in 2022 [4]. The Russian–Ukrainian war has deepened the crisis in the Ukrainian science system, affecting human capital, material and technical resources, and financial support.

The internationalization of scientific activity through strategic partnerships has enabled Ukrainian researchers — particularly those within the National Academy of Sciences (NAS) of Ukraine — to build the capacity required to address complex contemporary scientific challenges. As a consequence of the war, international cooperation has expanded significantly and has taken on a new institutional structure. Many partnerships have shifted from inter-institutional collaborations to include both targeted support for indi-

<sup>1</sup> UNESCO Science Report: the Race against Time for Smarter Development; Executive Summary, 2021. URL: <https://unesdoc.unesco.org/ark:/48223/pf0000377250> (Last accessed: 11.05.2023).

vidual researchers and broader national-level initiatives. In 2022 alone, more than 100 academic institutions in Ukraine have engaged in international scientific cooperation, jointly implementing over 600 projects with foreign partners [5].

The experience of developed countries demonstrates that the internationalization of research is one of the key directions in the advancement of contemporary science. In 2020, 9 out of the 15 leading producers of R&D output – namely the United States, China, the United Kingdom, Germany, France, Australia, Canada, Italy, and Spain – have achieved the majority of their scientific results through international collaboration<sup>2</sup>.

Studies by prominent scholars have demonstrated that international collaboration offers significant advantages for both individual researchers and R&D institutions. It enhances research quality [6–8], increases publication activity, and boosts citation rates [9, 10]. The leading role of a group of top-performing countries in international collaboration – measured by the volume of co-authored publications – has been firmly established. Despite the rapid growth in global publication output and the increasing density of scientific communication networks, these leading countries continue to dominate international scientific cooperation [7]. This is further confirmed by Clarivate Analytics<sup>3</sup> data, which show that in 2024, 85.4% of the 6,886 Highly Cited Researchers from 59 countries were affiliated with institutions in just 10 countries – of which 74.4% were concentrated in the top five: the United States, China, the United Kingdom, Germany, and Australia.

Several studies have examined the publication activity of Ukrainian researchers within the global scientific landscape, including analyses of Uk-

rainian journals represented in the Scopus database [11–13], approaches to evaluating the quality of Ukrainian researchers' publications [14, 15], and the requirements for publishing in international journals indexed in Scopus [16–19].

However, the international publication activity of individual R&D institutions in Ukraine – and their collaboration with foreign partners, as reflected in publications indexed in Scopus – has remained largely unexplored. One notable exception is the study by S. Nazarovets, which analyzes co-authorship between researchers at Ukrainian institutions and Nobel laureates in selected fields [20].

It is also important to consider the global trend toward using bibliometric indicators “in pure form” (i.e., citation counts) for evaluation purposes, as well as the challenges posed by open access, which significantly reshape the foundations of scientific communication [21]. These circumstances have prompted the authors of this study to assess the degree of internationalization and the scientific significance of research at the NAS of Ukraine in the fields of mathematics and natural sciences, based on the publication output of four academic institutes in the global research arena.

The aim of this study is to characterize, using an original methodology, the international collaboration of four institutes of the NAS of Ukraine in mathematics and natural sciences by analyzing publications in journals indexed in the Scopus database, and to determine their level of representation within this database. The empirical data source is the Scopus database as of 2022 (with the most recent data accessed on May 21, 2023), focusing on the scholarly output of researchers from four leading institutes of the NAS of Ukraine: the Institute of Mathematics (IM), the Institute of Physics (IP), the Institute of Molecular Biology and Genetics (IMBG), and the Kukhar Institute of Bioorganic Chemistry and Petrochemistry (IBOCP). Notably, most of the articles analyzed had been submitted for publication in late 2021 or early 2022.

The IM and IP have been recognized as flagship institutions of NAS of Ukraine, covering core areas

<sup>2</sup> The State of U.S. Science and Engineering 2022. URL: <https://nces.nsf.gov/pubs/nsb20221/u-s-and-global-science-and-technology-capabilities> (Last accessed: 21.10.2023).

<sup>3</sup> URL: [https://clarivate.com/highly-cited-researchers/analysis/?utm\\_campaign=EM1\\_Highly\\_Cited\\_Researchers\\_Retention\\_AG\\_RA\\_Global\\_2024\\_Announcement&utm\\_medium=Owned\\_Email&utm\\_source=Eloqua](https://clarivate.com/highly-cited-researchers/analysis/?utm_campaign=EM1_Highly_Cited_Researchers_Retention_AG_RA_Global_2024_Announcement&utm_medium=Owned_Email&utm_source=Eloqua) (Last accessed: 01.12.2024).

of contemporary research in their respective disciplines. The IM is associated with the work of many distinguished mathematicians whose contributions have entered the international scientific lexicon (e.g., the Kravchuk matrix, the Krylov – Bogolyubov – Mitropolsky method, Skorokhod space, Sharkovsky's theorem, among others). In 2010, Maryna Viazovska defended her Ph.D. dissertation at the IM; in 2022, she was awarded the Fields Medal – one of the most prestigious honors in mathematics – becoming only the second woman in history to receive this distinction<sup>4</sup>.

The Institute of Physics is one of the most renowned and oldest academic institutions in Ukraine. With the involvement of IP researchers and the development of its scientific departments, several new academic institutes have subsequently been established in key areas of physical science: the Institute of Metal Physics (1955), the Institute of Semiconductor Physics (1960), the Bogolyubov Institute for Theoretical Physics (1960), the Institute for Nuclear Research (1970), and the Institute of Applied Optics (1995). The IP has been home to many distinguished researchers who have made pivotal contributions to the advancement of various branches of modern physics. Notably, six scientific discoveries made at the Institute have been officially recognized at the national level<sup>5</sup>.

The Institute of Molecular Biology and Genetics was established in alignment with global scientific trends to advance molecular biological research focused on the mechanisms of heredity and the practical applications of research findings across various sectors of the economy. Today, the Institute employs the students and followers of the eminent researcher, Academician of the NAS of Ukraine S.M. Gershenzon, who was among the first in the world (in 1947) to recognize the role of

DNA in genome function<sup>6</sup>. Over the past 30 years, several dozen IMBG researchers have pursued successful careers abroad. Among them is Marina Rodnina, who in 2008 became the director of one of the institutes of the Max Planck Society and, in 2022, was elected a Foreign Member of the U.S. National Academy of Sciences. Rodnina remains the only woman researcher who has ever worked in Ukraine to receive this prestigious honor<sup>7</sup>.

The V.P. Kukhar Institute of Bioorganic Chemistry and Petrochemistry was founded by the prominent researcher and science administrator V.P. Kukhar to conduct cutting-edge research in the field of bioorganic chemistry, while simultaneously addressing issues related to the practical application of chemical science<sup>8</sup>.

A distinguishing feature of IBOPC, compared to other chemistry-focused institutes, is its close collaboration with business entities, particularly the company *Enamine Ltd.* This collaboration has enabled IBOPC researchers to maintain a high standard of R&D activity through access to advanced reagents, state-of-the-art equipment, and extensive networks with international partners. Enamine Ltd. is a key provider of R&D services across the Euro-Asian region.

For the purposes of this study, a query was constructed in the Scopus database for each institute under review (e.g., for the Institute of Mathematics: AFFILCOUNTRY (Ukraine) AND LIMIT-TO (AF-ID, National Academy of Sciences in Ukraine, Institute of Mathematics 60025237) AND (LIMIT-TO (PUBYEAR, 2022))). Based on the retrieved data, a dataset was compiled manually for each institute, including the following parameters: article title, journal name and quartile

<sup>4</sup> Official website of the Institute of Mathematics of the NAS of Ukraine. URL: <https://www.imath.kiev.ua/> (Last accessed: 21.10.2023).

<sup>5</sup> Official website of the Institute of Physics of the NAS of Ukraine. URL: <http://www.iop.kiev.ua/ua/history/> (Last accessed: 21.10.2023).

<sup>6</sup> Official website of the Institute of Molecular Biology and Genetics of the NAS of Ukraine. URL: <http://imbg.org.ua/uk/about/gershenzon> (Last accessed: 21.10.2023).

<sup>7</sup> USNAS. Member Directory. URL: <http://www.nasonline.org/member-directory/members/20054148.html> (Last accessed: 11.10.2023).

<sup>8</sup> Official website of V.P. Kukhar Institute of Bioorganic Chemistry and Petrochemistry of the NAS of Ukraine URL: <http://bpci.kiev.ua/ua/ibopc/history/> (Last accessed: 21.10.2023).

Table 1. Publication Activity of the Four Institutes of the NAS of Ukraine in the Scopus-Indexed Journals in 2022

Institute	Number of journals where researchers of the NAS of Ukraine publish their research works, by quartile						Number of published research works of researchers of the NAS of Ukraine, by quartile					
	Total	Including in the NAS of Ukraine	Q1	Q2	Q3	Q4	Total	Including in the NAS of Ukraine	Q1	Q2	Q3	Q4
Institute of Mathematics	41	5	13	15(1)*	10(3)*	3(1)*	91	34	15	20(2)**	53(31)**	3(1)**
Institute of Physics	76	13	29	26	12(6)*	9(7)*	124	27	40	36	21(15)**	27(12)**
V.P. Kukhar Institute of Bioorganic Chemistry and Petrochemistry	54	11	18	13	13(6)*	10(5)*	72	12	20	20	15 (7)**	17 (5)**
Institute of Molecular Biology and Genetics	54	8	25	11	9 (2)*	9 (6)*	73	19	27	15	11 (2)**	20(17)**

\* – the number of Ukrainian journals is indicated in brackets; \*\* – the number of articles in Ukrainian journals is indicated in brackets.

Source: Scopus DB.

ranking, publisher, full names of the authors, the number of authors, and their affiliations (i.e., home institute, other Ukrainian institutions, or foreign organizations).

The study focused exclusively on scholarly research publications in peer-reviewed journals. It excluded monograph chapters, editorials, letters to the editor, and reports from scientific forums.

The significance of journals indexed in the Scopus database was assessed using quartile rankings (Q1–Q4) provided by the publicly accessible SCImago Journal & Country Rank portal, where Q1 represents the highest level of journal impact and Q4 the lowest<sup>9</sup>.

All four institutes have been represented by publications in journals indexed in the Scopus database in 2022, the majority of which are international. The share of articles published in foreign journals accounted for 87.8% for IM, 85.2% for IMBG, 82.9% for IP, and 79.6% for IBOPC; the remaining articles appeared in domestic peer-reviewed journals.

Among the publishers of these international journals, leading global publishing houses prevailed – such as Elsevier, Taylor & Francis, Multidisciplinary Digital Publishing Institute (MDPI), Springer Nature, and Wiley – as well as highly reputable national publishers such as the American Institute of Physics, American Chemical Society, and Oxford University Press. These publishers accounted for 88.9% of foreign journal publications for IP, 87.8% for IBOPC, 78.3% for IMBG, and 77.8% for IM.

The presence of publications by researchers from these four institutes in leading international journals reflects the ongoing internationalization of research at the NAS of Ukraine and points to active collaboration with foreign colleagues.

Overall, in the natural sciences institutes, journals in the top two quartiles (Q1 and Q2) predominated over those in the lower quartiles (Q3 and Q4), both in terms of the number of journals and the number of articles published therein (Table 1).

Journals in the Q1 and Q2 quartiles at the Institute of Physics encompassed 55 titles, representing 72.4% of all journals publishing IP researchers' articles, with 76 articles published in these

<sup>9</sup> SCImago. URL: <https://www.scimagojr.com/aboutus.php> (Last accessed: 11.09.2023).

journals, accounting for 61.3% of the institute's total publications. At IBOPC, Q1 + Q2 journals comprised 57.4% of the journals and 55.6% of the articles published, while for IMBG, these figures were 66.7% and 57.5%, respectively.

It is worth noting that at IM, Q1 + Q2 journals accounted for 68.3% of all journals; however, only 38.5% of the institute's annual article output was published in these journals.

Among Ukrainian journals, only one – *Carpathian Mathematical Publications*, in which IM researchers published two articles – was classified as Q2.

IM researchers published the largest share of their articles (58.2%) in Q3 journals, whereas this proportion did not exceed 21% in the natural science institutes. The high activity of IM researchers in Q3 journals can be partly explained by the reclassification of the *Ukrainian Mathematical Journal* – which published 28 articles (30.7% of IM's total) – from Q2 in 2021 to Q3 in 2022.

Internationally co-authored publications, i.e., articles written collaboratively by NAS Ukraine researchers and foreign partners, accounted for 53.4% of IMBG's output, 47.6% for IP, 37.5% for IBOPC, and 27.3% for IM (Table 2).

In journals classified in the highest quartile (Q1), internationally co-authored articles accounted for 92.6% of all Q1 publications at IMBG, 90%

at IBOPC, 82.5% at IP, and 80% at IM. In Q2 journals, the share of international articles ranged from 25% (IBOPC) to 53.3% (IMBG) of the total Q2 publications. Overall, international publications in Q1 + Q2 journals accounted for 78.6% of IMBG's, 67.1% of IP's, 57.5% of IBOPC's, and 51.4% of IM's total articles in these quartiles.

It is important to highlight that the largest proportion of joint publications was published in Q1 + Q2 journals: 86.4% at IP, 85.2% at IBOPC, 84.6% at IMBG, and 72% at IM.

Fig. 1 illustrates that the number of foreign researchers as co-authors in the analyzed institutes was highest in Q1 journals, with their share being 79.9% at IMBG, 58.2% at IBOPC, 54.2% at IM, and 53.3% at IP. In Q2 journals, the participation of foreign researchers in author teams was lower than that of Ukrainian researchers across all institutes, ranging from 38.0% at IMBG to 15.4% at IBOPC. In lower quartile publications, foreign co-authors were rare, with only one instance reaching a 13.3% share at IBOPC in Q3 journals.

Thus, the majority of international articles are published in high-impact journals, a trend characteristic of all four institutes of the NAS of Ukraine.

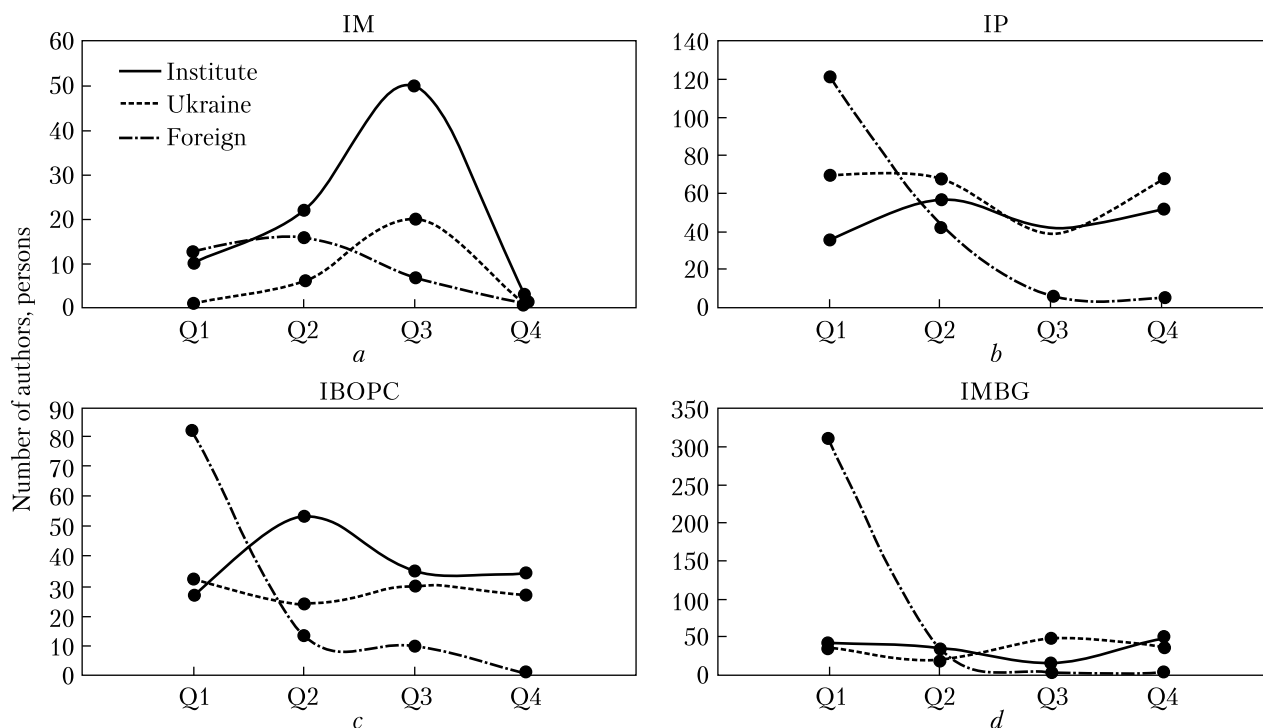
Further analysis of the internationalization of NAS R&D activity focuses on the participation of foreign researchers as co-authors in joint publications at each institute.

**Table 2. International Research Works of the Four Institutes of the NAS of Ukraine in Scopus-Indexed Scholarly Research Journals in 2022**

Institute	Number of international research works of researchers of the NAS of Ukraine, by quartile					
	Total	Including in the NAS of Ukraine	Q1	Q2	Q3	Q4
Institute of Mathematics	91	25	12(15)*	6(20)*	6(53)*	1(3)*
Institute of Physics	124	59	33(40)*	18(36)*	3(21)*	5(27)*
V.P. Kukhar Institute of Bioorganic Chemistry and Petrochemistry	72	27	18(20)*	5(20)*	3(15)*	1(17)*
Institute of Molecular Biology and Genetics	73	39	25(27)*	8(15)*	3(11)*	3(20)*

*Note.* \* the total number of research works published in journal during the quartile is indicated in brackets.

*Source:* prepared by the authors.



**Fig. 1.** Contribution by researchers of the institutes of the NAS of Ukraine: *a* – Institute of Mathematics, IM; *b* – Institute of Physics, IP; *c* – V.P. Kukhar Institute of Bioorganic Chemistry and Petrochemistry, IBOPC; *d* – Institute of Molecular Biology and Genetics, IMBG, institutes of Ukraine and foreign institutes in 2022 published in Scopus-indexed journals, by quartile Q1–Q4

Source: prepared by the authors.

The international output of the Institute of Mathematics includes 25 articles co-authored with researchers from 16 countries worldwide (Table 3). German researchers have demonstrated the highest level of collaboration, co-authoring 12 publications. These collaborations involved researchers from the University of Bamberg (3 articles), University of Cooperative Education Gera-Eisenach (2 articles), Friedrich Schiller University Jena, as well as the Universities of Paderborn, Chemnitz, Stuttgart, and Saarland, research centers of the Helmholtz Association in Jülich and Munich, and the Technical Universities of Dresden and Munich.

In addition to German collaborators, two publications included co-authors from other countries: one with researchers affiliated with Chalmers University of Technology and the University of

Gothenburg (Sweden), and another with a researcher affiliated with the Free University of Amsterdam (Netherlands) and the University of Exeter (United Kingdom).

Furthermore, researchers from Italy contributed to four publications, representing the University of Urbino Carlo Bo, University of Pisa, University of Padua, and University of Venice. In three of these papers, one of the co-authors was affiliated with the Catholic University of the Sacred Heart, Milan (Italy), and the Technical University of Ostrava (Czech Republic). Two publications co-authored by IM researchers and their Italian colleagues from the Federico II University of Naples and Carlo Bo University of Urbino also involved researchers from the Vienna University of Economics and Business (Austria) and the Technical University of Cartagena (Spain).

Two publications were produced by Ukrainian researchers collaborating on joint projects with researchers from Norway, specifically from the University of Oslo and the Norwegian University of Science and Technology in Trondheim, while two others involved collaborations with researchers from Canada’s Memorial University of Newfoundland.

**Table 3. Contribution of Foreign Researchers in Joint Publications with Researchers of the Institute of Mathematics of the NAS of Ukraine**

Country	Number of foreign researchers	Number of joint publications
Germany	13	12
Italy	4	6
Austria	2	3
Canada	2	2
Norway	4	2
Poland	3	2
Czech Republic	2	2
Other 9 countries	9	8

Source: prepared by the authors.

**Table 4. Contribution of Foreign Researchers in Joint Publications with Researchers of the Institute of Physics of the NAS of Ukraine**

Country	Number of foreign researchers	Number of joint publications
USA	29	17
Germany	23	12
Poland	10	10
China	22	6
France	14	5
Australia	6	2
Italy	6	2
Japan	7	2
Korea	21	2
Other 18 countries	40	20

Source: prepared by the authors.

These data indicate that IM researchers actively engage in scientific communication networks, with a significant portion of their international publications (10 out of 25 articles) involving collaborators from Germany, Italy, and Ukraine. Such research groups have authored papers in some of the highest-ranked journals, including *Chaos, Solitons and Fractals*, *Chaos*, *SIAM Journal on Applied Dynamical Systems*, among others – these journals represent the most prestigious mathematical publications considered in this study.

Given that most articles feature no more than two authors [14], this may reflect a current trend toward internationalization even in specialized scientific fields such as mathematics.

International publications by researchers from the Institute of Physics comprise 59 articles (Table 4), of which 42 are produced in collaboration with researchers from a single foreign country, 15 with researchers from two countries, and 2 with co-authors from three or more countries.

The number of co-authors in the analyzed publications ranged from 2 to 28 researchers; however, 88.1% of these articles included between 3 and 9 co-authors. The publication with the largest number of authors, as well as the highest participation of foreign collaborators, appeared in the journal *Science*. This paper featured five co-authors from the United States, affiliated with Oak Ridge National Laboratory and the US Department of Energy; 21 specialists from the Republic of Korea, including three researchers from the Samsung Advanced Institute of Technology, two experts from the Korea Basic Science Institute, and others from five leading Korean universities. This article, dedicated to the study of new materials, included two co-authors from the National Academy of Sciences of Ukraine – researchers from the Institute of Physics and the I. M. Frantsevich Institute for Problems of Materials Science.

In 2022, IP researchers co-authored publications with researchers from 27 countries worldwide. The institute’s international collaboration network is predominantly represented by 43 articles involving researchers from the USA, Germany, Po-

land, and China, accounting for 72.9% of all international works. Specifically, US researchers co-authored 17 articles (28.8% of the total international publications), 14 of which were published in Q1 journals, 2 in Q2 journals, and 1 in a Q4 journal. Among these, 11 publications involved researchers from Oak Ridge National Laboratory, university and government institutions in Tennessee, University of Maryland, Pennsylvania State University, and Wright-Patterson Air Force Base in Ohio. These works also included collaborations with researchers from South Korea, Germany, and France. Additionally, six articles featured American and Ukrainian researchers working alongside large international teams from institutions in Australia, the Netherlands, New Zealand, and Denmark.

With the participation of 23 researchers from Germany, 12 joint publications were produced together with 19 researchers from the Institute of Physics. Nine of these articles were published in Q1 journals, and three appeared in Q2 journals. One publication also included a co-author from Poland. Another article featured co-authors from Germany, Italy, and Kazakhstan, while a further publication included four researchers from the Interuniversity Microelectronics Center (Leuven, Belgium) and two from Germany. The co-authors affiliated with German institutions represented universities such as the Technical University of Kaiserslautern, Humboldt University of Berlin, Research Center Dresden-Rossendorf, Helmholtz Association, Leibniz Institute for Crystal Growth, Chemnitz University of Technology, Technical University of Ilmenau, Fraunhofer Institute for Applied Polymer Research, and University of Heidelberg.

Researchers affiliated with six Polish R&D institutions contributed to ten publications, including two articles in Q1 journals, four in Q2 journals, and four in Q3 journals.

Six joint articles by IP researchers and researchers from China (three articles each in Q1 and Q2 journals) were published. Chinese collaborators were affiliated with Shenzhen University, Southern University of Science and Technology, Guangdong University of Technology, and Jilin

University. In two of these papers, there was also participation by one researcher each from the Czech Republic (University of Chemistry and Technology, Prague) and Germany (Technical University of Kaiserslautern).

In total, 168 researchers from 90 R&D institutions across 28 countries have co-authored publications with IP researchers.

Researchers from the IBOPC have co-authored 27 articles together with 92 colleagues from 20 countries, as well as 47 Ukrainian researchers from academic, educational institutions, and business organizations (see Table 5). These articles were published in 24 journals, of which 17 journals are classified as Q1, containing 18 articles; 5 articles appeared in 4 Q2 journals; 3 articles were published in 2 Q3 journals; and 1 article was published in a Q4 journal.

The greatest international collaboration of IBOPC has been observed with researchers from the PRC, accounting for 9 articles. These works involved 4 Ukrainian researchers and 33 Chinese researchers affiliated with University of Hainan, Jiangxi University of Science and Technology (Ganzhou), Nanjing Forestry University, and the Chinese University of Hong Kong. Among these 9 articles, three also included co-authors from the United States, published in high-impact journals such as *Science*, *Journal of Fluorine Chemistry*, and *Cell Reports Physical Science*. In the latter pub-

**Table 5. Contribution of Foreign Researchers in Joint Publications with Researchers of the IBOPC of the NAS of Ukraine**

Country	Number of foreign researchers	Number of joint publications
China	33	9
France	7	6
Germany	10	5
USA	21	5
Spain	5	4
Other 15 countries	16	6

Source: prepared by the authors.

lication, the author team included Ukrainian and Chinese researchers as well as researchers from the University of Palermo (Italy), Technical University of Denmark, and Ruhr University Bochum (Germany). Four Spanish researchers from the University of Basque Country and related institutions were co-authors of three other articles alongside Ukrainian and Chinese colleagues, with two of these also including co-authors from the USA. Seven of the nine articles were published in Q1 journals, with one article each in Q2 and Q3 journals.

In five international IBOPC articles, co-authors included 23 researchers from R&D institutions in the United States. The largest representation of U.S. researchers was in the aforementioned weekly journal *Science*, where out of 24 co-authors, 11 were affiliated with the University of California, San Francisco; two researchers were from Stanford University; and one from the University of North Carolina at Chapel Hill. This publication also included four researchers from the PRC (Chinese University of Hong Kong), two from Canada (University of Montreal), five researchers from Germany (Friedrich-Alexander University Erlangen-Nuremberg), and two Ukrainian researchers, one of whom is additionally affiliated with an institution in Latvia.

Among the co-authors of a collaborative article published in the *Journal of Physical Chemistry B*, alongside six researchers from the University of Central Florida and two from the University of Heights, Newark, were one researcher from IBOPC and one from IP. The authorship of two other articles primarily consisted of IBOPC researchers, with the addition of one researcher from the University of California, San Francisco, and two researchers from Clemson University and Louisiana Tech University. International publications involving U.S. researchers were predominantly published in Q1 journals (three articles), with one article each in Q2 and Q3 journals.

French researchers, who co-authored six articles, were affiliated with institutions including the INSA Rouen Normandie Applied Research Institute, University of Angers (two researchers), CNRS Enzyme & Cell Engineering Laboratory, Univer-

sity of Lille, University of Le Mans, and Sorbonne University. These works involved 31 Ukrainian researchers, including 17 researchers from IBOPC. In two of these six articles, collaborators from Poland and the Czech Republic also participated. Five of the six publications appeared in Q1 journals, while one was published in a Q2 journal.

German researchers, in addition to their involvement in the previously mentioned *Science* and *Cell Reports Physical Science* articles, contributed to three other publications. They were affiliated with the University of Münster and the Helmholtz Research Center in Munich. Two of these articles were published in Q1 journals, and one in a Q2 journal.

These data indicate that in 2022, IBOPC researchers predominantly collaborated with colleagues from China, France, the United States, Germany, and Spain, which together accounted for 77.8% of the Institute's international publications. An additional six articles were co-authored with researchers from 15 other countries.

A distinctive feature of the international publications by IMBG, setting them apart from the other institutes analyzed, is the notably high number of foreign co-authors. Specifically, 33.3% of all IMBG's international articles included researchers from three or more countries, including five articles with authors from more than nine countries. By comparison, IP had only two such publications, representing 3.4% of its international articles, while IBOPC's share was 18.5%.

Another distinctive feature of the international publications from IMBG, characterized by significant representation of researchers from multiple countries, is the presence of studies conducted by authors affiliated with several research institutions within a single country. An example is the article titled *Biosignature Stability in Space Enables Their Use for Life Detection on Mars*<sup>10</sup> pub-

<sup>10</sup> Baqué, M., Backhaus, T., Meeßen, J., Hanke, F., Böttger, U., Ramkissoo, N., ..., de Vera, J. P. (2022). Biosignature stability in space enables their use for life detection on Mars. *Sci. Adv.*, 8(36), eabn7412. <https://doi.org/10.1126/sciadv.abn7412>

lished in the journal *Science Advances* in the field of astrobiology, which lists 37 authors from nine countries. Among these, 10 researchers are affiliated with two institutions, and one researcher is affiliated with three institutions.

The largest contingent of authors (18) represents Germany, affiliated with universities in Berlin, Potsdam, and Cologne, as well as with the Helmholtz Centre for Polar and Marine Research, the German Research Centre for Geosciences, the Institute of Aerospace Medicine, and the German Aerospace Center. Seven researchers from Italy are affiliated with the Italian Space Agency, the Italian Antarctic National Museum, and the University of Rome. Three researchers from the Netherlands are affiliated with the Universities of Amsterdam and Leiden and the European Space Research and Technology Centre. Three British researchers are affiliated with The Open University (Milton Keynes) and the University of Bradford, while two U.S. researchers represent NASA Ames Research Center, Washington University, and Brown University. One researcher each from Ukraine, Switzerland, and Sweden also contributed, along with two from France affiliated with the CNRS Molecular Biophysics Center.

In 2022, researchers at IMBG published 39 international articles involving 307 foreign researchers from 52 countries worldwide. Of these publications, 25 articles (64.1%) appeared in Q1 journals, 8 in Q2 journals, 3 in Q3 journals, and 3 in Q4 journals.

The highest number of joint publications by IMBG researchers were with collaborators from Germany (13 articles), the United Kingdom (11 articles), the United States (9 articles), and France (6 articles) (Table 6).

The publications of 24 IMBG researchers in collaboration with 39 German researchers have been included in numerous international authorship teams. For instance, the article published in *iScience* included 34 researchers from 18 countries; the article in *Environmental Research* involved 33 researchers from 17 countries; and the publication in *Global Biogeochemical Cycles* featured 93 authors

representing 28 countries. In each article, IMBG was represented by a single researcher.

German co-authors in the *iScience* article included three researchers from the University of Tübingen. In the other two publications, German contributors were affiliated with the University of Potsdam, the Robert Koch Institute, and the Leibniz Institute of Freshwater Ecology and Inland Fisheries. Co-authors of these publications also included substantial research teams from the United States (University of Colorado, University of Maryland, and University of Louisville), as well as researchers from the United Kingdom, Brazil, China, Poland, France, and other countries.

Three publications, appearing in *Science Advances*, *Astrobiology*, and *Frontiers in Microbiology*, were authored by researchers from the German Aerospace Center (DLR). German collaborators in these studies were also affiliated with Heinrich Heine University, the University of Potsdam, the University of Göttingen, the University of Bremen, the Free University of Berlin, and the Robert Koch Institute. These collaborations also involved researchers from the U.S., Italy, and the U.K. One of these articles included contributions from four researchers affiliated with the National Research Council of Italy and eight researchers from the University of California, Santa Cruz, and the Federal University of Minas Gerais, Brazil. Another article featured twelve co-authors from the

**Table 6. Contribution of Foreign Researchers in Joint Publications with Researchers of the Institute of Molecular Biology and Genetics of the NAS of Ukraine**

Country	Number of foreign researchers	Number of joint publications
Germany	39	13
Great Britain	23	11
USA	43	9
France	11	6
Other 48 countries	183	28

Source: prepared by the authors.

same Brazilian universities and several researchers from India.

One article published in *Tree Physiology* involved two researchers from the Helmholtz Center for Environmental Research, one researcher from Austria, six from the University of Oulu (Finland), and additional collaborators from Brazil, the United States, and the United Kingdom. Other international collaborations in six additional articles included researchers from Austria, Brazil, Italy, China, South Korea, South Africa, Portugal, Finland, and Switzerland.

The level of collaboration between IMBG and German researchers has been notably high, with 11 of the joint publications appearing in Q1 journals, two in Q2 (*Journal of Microbiology and Biotechnology* and *Journal of Antibiotics*), and one in a Q4 journal (*Biopolymers and Cell*).

A distinctive feature of IMBG's international collaboration with researchers from the United Kingdom is the relatively modest representation of British co-authors: six articles involved only one researcher from the U.K., four articles had 3–4 British co-authors, and one article included 10. These researchers primarily participated as members of large international research teams.

The majority of joint publications by British researchers in collaboration with IMBG colleagues appeared in Q1 journals – 9 articles in total – with one publication each in *Microbes and Environments* (Q2) and *Biopolymers and Cell* (Q4).

In nine joint publications authored by IMBG and U.S.-based researchers, 43 U.S. researchers were involved. Four of these publications included numerous co-authors from Germany, while three involved researchers from the United Kingdom, France, and other countries. For instance, an article in *Global Biogeochemical Cycles* featured 21 researchers from 27 countries: 9 researchers from U.S. universities and Oak Ridge National Laboratory, 7 from Canada, 4 from Australia, and 3 each from Spain, Germany, Finland, Norway, Switzerland, the Netherlands, and Japan. The remaining 17 countries were represented by 1–2 authors each. Four of the collaborative publications involved bet-

ween 3 and 9 authors, with one or two international co-authors affiliated with U.S. institutions.

The collaborative research with U.S. researchers was of a notably high level: seven of these publications appeared in Q1 journals, one in a Q2 journal, and one in a Q3 journal.

International collaborations between IMBG and French researchers were represented by five articles co-authored with researchers from the U.K., Germany, and the U.S., all published in Q1 journals. Another publication in *Biopolymers and Cell* featured eight researchers from IMBG alongside a collaborator affiliated with the CNRS Institute of Analytical Sciences and two Lyon-based universities.

In total, researchers from four countries – the United Kingdom, Germany, the United States, and France – co-authored 28 of the 39 international publications produced by IMBG in 2022, accounting for 71.8% of the institute's international output. The remaining 11 articles were published in collaboration with partners from 48 other countries. These data demonstrate that IMBG plays an integral role in the global scientific communication network, through co-authored publications with researchers from leading institutions, predominantly in highly developed countries.

A distinguishing feature of IMBG's international publications is the high number of articles with large authorship teams, where foreign collaborators accounted for more than 80% of the total co-authors. Articles with more than 10 authors (ranging from 11 to 93 co-authors in the case of IMBG), among which only 1–2 were Ukrainian, accounted for 5.1% of all international articles at IP, 11.1% at IBOPC, and 33.3% at IMBG.

Thus, summarizing the results of the analysis of the publication activity of researchers from four institutes of the NAS of Ukraine, it is important to note that the publication achievements of NAS institutes with a focus on natural sciences demonstrate common patterns. In each institution under review, researchers contributed at least one article to the American weekly *Science* and authored several significant papers published in leading specialized journals. Notably, the publica-

tion by IMBG researchers in *Science*<sup>11</sup>, featuring 18 co-authors, including 4 from Ukraine and 14 from 8 other countries, stands as a high-profile appeal to the global scientific community, highlighting the challenges and calls for support faced by Ukrainian researchers.

Overall, all four NAS institutes analyzed, including the Institute of Mathematics, demonstrated in 2022 a solid presence of high-quality publications, most of which appeared in top-ranking journals indexed in the Q1 and Q2 quartiles of the Scopus database. Approximately 20% of these publications were authored exclusively by Ukrainian researchers without foreign co-authors – 20.8% for IBONH, 20.2% for the Institute of Physics, 18.7% for the Institute of Mathematics, and 12.3% for IMBG – indicating the high level of independent scientific research conducted within these institutions.

The findings of this study highlight the active participation of Ukrainian researchers in large-scale international scientific collaborations addressing key challenges in contemporary science. Informal research networks involving scholars from the Institute of Physics extended across Canada, Australia, China, and numerous European countries, forming extensive consortia composed of several dozen researchers from all continents. This evidences the involvement of NAS Ukraine researchers in major global scientific developments and confirms their essential role within diverse international research teams.

Key hubs for international collaboration with Ukrainian academics included prominent institutions in global scientific leaders such as the United States (e.g., Stanford University, University of California San Francisco, Oak Ridge National Laboratory), China (e.g., Jiangxi University of Science and Technology, Nanjing Forestry University, University of Hong Kong), as well as notable

European centers such as CNRS (France) and the Helmholtz Association (Germany). Altogether, the list of partner institutions whose researchers co-authored international publications with Ukrainian researchers comprises nearly 350 organizations. This list encompasses world-renowned universities and research institutions in Australia, Canada, South Korea, Germany, Italy, France, and academic bodies from Poland, the Czech Republic, and other countries, thereby affirming the global integration and recognition of NAS research institutes within the international scientific community.

The validated methodology enables the analysis of international collaboration involving Ukrainian researchers, identification of sustained partnerships, and monitoring the evolution of international scientific networks. Future research aims to extend the scope to a broader range of institutes and to conduct a multi-year comparative analysis.

A positive trend observed in the activity of academic institutions is a shift in research focus towards the life sciences, which is particularly significant in the context of Ukraine's integration into the global scientific community. According to Scopus data<sup>12</sup> from 2020, among the eight major scientific domains (health sciences, biological and biomedical research, engineering, physics, chemistry, materials science, computer science, and social sciences), the combined share of publications in health sciences, biological and biomedical research, and life sciences accounted for 37.7% of global scientific output. This share was 50.9% in the United States, 40.6% in the EU-27, and only 18% in Ukraine.

At the turn of the millennium, the Institute of Physics established a Department of Physics of Biological Systems, and by 2022, researchers from the Institute had published 19 biology-related

<sup>11</sup> Chhugani, K., Frolova, A., Salyha, Yu., Fiscutean, A., Chhugani, K., ..., Mangul, S. (2022). Remote opportunities for scholars in Ukraine. *Science*, 378(6626), 1285–1286. <https://doi.org/10.1126/science.adg0797> (Last accessed: 11.11.2023).

<sup>12</sup> National Science Foundation. National Science Board. Science and Engineering Indicators. 2020, Publications Output: U.S. Trends and International Comparisons. Figure PBS 2. URL: <https://nces.nsf.gov/pubs/nsb20214/publication-output-by-country-region-or-economy-and-scientific-field> (Last accessed: 11.11.2023).

papers, representing 15% of their total annual output. The IBOPC currently operates five research departments with a biological focus. In 2022, its researchers contributed to 19 publications (25% of the institute's annual output) in 11 journals within the life sciences domain.

These data, reflecting the presence of biological research within institutions traditionally focused on physics and chemistry, align with global trends emphasizing the life sciences and the broader objective of addressing human needs<sup>13</sup>. The involvement of physics and chemistry institutions in life sciences research is characteristic of the world's leading scientific organizations, such as the Max Planck Society (Germany), where 8 of 27 astrophysics and astronomy<sup>14</sup> institutes and 11 of 25 materials science and technology institutes engage in biomedical research<sup>15</sup>. A similar focus is evident in other multidisciplinary research organizations such as RIKEN (Japan)<sup>16</sup>.

The process of internationalizing scientific research in Ukraine, and specifically within the NAS of Ukraine, involves multiple dimensions. These include leveraging international experience and capacity to develop new scientific directions and addressing structural, financial, and human resource challenges. Participation in EU framework programs and calls from international funding agencies holds promise but yields limited results in the short term due to the insufficient research output caused by prior stagnation, the absence of a coherent national science policy, and, most recently, the impact of ongoing military conflict.

One viable approach to addressing human resource gaps and rapidly advancing cutting-edge research directions is to draw on the experience of countries that actively engage researchers working abroad. This is particularly relevant for Ukraine, as approximately 1,300 NAS researchers – roughly 10% of its pre-2023 workforce – are currently working outside the country, raising questions about their possible return and reintegration.

Relevant examples include academic programs in the Czech Republic<sup>17</sup> and Hungary<sup>18</sup> aimed at attracting outstanding early-career researchers from abroad, including expatriates, to promote innovation and facilitate the dynamic renewal of research agendas in academic institutions. Likewise, the Chinese Academy of Sciences has successfully implemented programs involving returning researchers (repatriates), who bring advanced expertise and act as liaisons with the Chinese scientific diaspora and former colleagues abroad<sup>19</sup>.

These precedents suggest the need for Ukraine to develop dedicated national programs – jointly supported by the state budget, partner countries, international and national R&D institutions, and philanthropic organizations – to facilitate the return and reintegration of researchers and science-based entrepreneurs with international experience, as well as foreign experts willing to work in Ukraine and meeting relevant qualification criteria. Even the arrival of a relatively small but highly qualified cohort of professionals could catalyze the rapid modernization of Ukraine's science and technology infrastructure and accelerate its transition to a modern innovation-driven research system.

<sup>13</sup> UNESCO Science Report: the Race against time for Smarter Development; executive summary, 2021, UNESCO. URL: <https://unesdoc.unesco.org/ark:/48223/pf0000377250> (Last accessed: 17.09.2023).

<sup>14</sup> The Max Planck Institutes. Astronomy and Astrophysics. URL: <https://www.mpg.de/institutes?category=astronomy-and-astrophysics&tab=institutes> (Last accessed: 11.11.2023).

<sup>15</sup> The Max Planck Institutes. Material and Technology. URL: <https://www.mpg.de/institutes?category=material-and-technology&tab=institutes> (Last accessed: 11.11.2023).

<sup>16</sup> RIKEN, Japan. URL: <https://www.riken.jp/en/about/> (Last accessed: 11.11.2023).

<sup>17</sup> J. E. PURKYNĚ FELLOWSHIP. URL: [https://www.avcr.cz/export/sites/avcr.cz/.content/galerie-souboru/vyrocnizpravy/Vyrocnizprava\\_AVCR\\_2021ENG.pdf](https://www.avcr.cz/export/sites/avcr.cz/.content/galerie-souboru/vyrocnizpravy/Vyrocnizprava_AVCR_2021ENG.pdf) (Last accessed: 11.2023).

<sup>18</sup> Impulse Program of the Academy of Sciences of Hungary. URL: <https://mta.hu/lendulet/lendulet-program-105403> (Last accessed: 11.11.2023).

<sup>19</sup> Cao, C., Baas, J., Wagner, C., Jonkers, K. (2019). Returning Researchers and the Emergence of China's Science System. *Science and Public Policy*, 47(2), 172–183. <https://doi.org/10.1093/scipol/scz056>

REFERENCES

1. Arunachalam, S. (1995). Science on the periphery: Can it contribute to mainstream science? *Know. Techn. Pol.*, 8, 68–87. <https://doi.org/10.1007/BF02825969>
2. Wagner, C., Leydesdorff, L. (2003). Mapping global science using international co-authorships: a comparison of 1990 and 2000. *Proceedings of the 9th International Conference on Scientometrics and Informetrics* (Dalian, China, 2003), 330–340. (Dalian, China. URL: [https://www.issi-society.org/proceedings/issi\\_2003/34\\_wagner.pdf](https://www.issi-society.org/proceedings/issi_2003/34_wagner.pdf) (Last accessed: 15.10.23).
3. Braun, T., Glänzel, W., Schubert, A. (1988). The newest version of the facts and figures on publication output and relative citation impact of 100 countries 1981–1985. *Scientometrics*, 13, 181–188. <https://doi.org/10.1007/BF02019957>
4. Pysarenko, T. V., Kuranda, T. K. (Eds.) (2023). R&D activity in Ukraine in 2022: scientific-analytical report. UkrINTEI. 94 p. URL: <https://mon.gov.ua/storage/app/media/nauka/2023/07/25/Nauk-analit.dopov.Naukova.ta.nauk-tekh.n.diyaln.v.Ukr.2022-25.07.2023.pdf> (Last accessed: 16.01.2024).
5. *Report on the activities of the National Academy of Sciences of Ukraine in 2022.* (2023). NAS of Ukraine. Kyiv. URL: <https://files.nas.gov.ua/PublicMessages/Documents/0/2023/05/230509205447582-3171.pdf> (Last accessed: 15.10.2023).
6. Katz, J. S., Hicks, D. (1997). How much is a collaboration worth? A calibrated bibliometric model. *Scientometrics*, 40(3), 541–554. <https://doi.org/10.1007/BF02459299>
7. Leydesdorff, L., Wagner, C. S. (2008). International collaboration in science and the formation of a core group. *Journal of Informetrics*, 2(4), 317–325. <https://doi.org/10.1016/j.joi.2008.07.003>.
8. Van Raan, A. F. J. (1998). The influence of international collaboration on the impact of research results: Some simple mathematical considerations concerning the role of self-citations. *Scientometrics*, 42, 423–428. <https://doi.org/10.1007/BF02458380>
9. Glänzel, W. (2001). National characteristics in international scientific co-authorship relations. *Scientometrics*, 51, 69–115. <https://doi.org/10.1023/A:1010512628145>
10. Persson, O., Glänzel, W., Danell, R. (2004). Inflationary bibliometric values: The role of scientific collaboration and the need for relative indicators in evaluative studies. *Scientometrics*, 60, 421–432. <https://doi.org/10.1023/B:SCIE.0000034384.35498.7d>
11. Yazvynska, M. V., Radchenko, A. I. (2019). NAS of Ukraine periodicals in some scientometric databases and the list of scientific professional publications of Ukraine. *Science of Ukraine in the global information space*, 16, 46–56. <https://doi.org/10.15407/akademperiodyka.391.046> [in Ukrainian].
12. Kavunenko, L. F., Kostritsa, E. P., Chernogaeva, O. G. (2015). Publication activity of Ukrainian researchers in the Scopus database. *Science of Ukraine in the light information space*, 11, 89–99. URL: [https://www.nas.gov.ua/publications/books/series/9789660247048/Documents/2015\\_11/13\\_kavunenko.pdf](https://www.nas.gov.ua/publications/books/series/9789660247048/Documents/2015_11/13_kavunenko.pdf) (Last accessed: 15.10.23).
13. Kavunenko, L. P., Khorevin, V. I., Kostrytsia, O. P. (2024). Publishing activity of researchers of the National Academy of Sciences of Ukraine: successful examples. *Science and science*, 1(123), 43–75. <https://doi.org/10.15407/sofs2024.01.043> [in Ukrainian].
14. Nazarovets, S. (2020). Controversial practice of rewarding for publications in national journals. *Scientometrics*, 124(1), 813–818 <https://doi.org/10.1007/s11192-020-03485-7>
15. Hladchenko, M. (2022). Implications of Publication Requirements for the Research Output of Ukrainian Academics in Scopus in 1999–2019. *Journal of Data and Information Science*, 7(3) 71–93. <https://doi.org/10.2478/jdis-2022-0016>
16. Didenko, Yu. V., Radchenko, A. I. (2017). Publishing activity as a way of scientific communication and the pursuit of ratings. *Bulletin of the National Academy of Sciences of Ukraine*, 9. 83–99. <https://doi.org/10.15407/visn2017.09.082> [in Ukrainian].
17. Tykhonkova, I. O. (2018). Strategy of development of a scientific publication. *Science of Ukraine in the Global Information Space*, 15, 16–27. <https://doi.org/10.15407/akademperiodyka.372.016>
18. Hladchenko, M., Moed, H. F. (2021). National orientation of Ukrainian journals: means-ends decoupling in a semi-peripheral state. *Scientometrics*, 126(3), 2365–2389. <https://doi.org/10.1007/s11192-020-03844-4>
19. Hladchenko, M., Moed, H. F. (2021). The effect of publication traditions and requirements in research assessment and funding policies upon the use of national journals in 28 post-socialist countries. *Journal of Informetrics*, 15(4), 101190. <https://doi.org/10.1016/j.joi.2021.101190>
20. Nazarovets, S. A. (2020). Quantitative analysis of joint publications of Ukrainian researchers with Nobel laureates 1994–2018 in certain fields of science. *Nauka innov.*, 16(5), 110–117. <https://doi.org/10.15407/scin16.05.110> [in Ukrainian].

21. Radchenko, A. I., Didenko, Y. V. (2022). New sincerity: polymodality of scientific communication. *Bulletin of the National Academy of Sciences of Ukraine*, 2, 85–103. <https://doi.org/10.15407/vsn2022.02.085> [in Ukrainian].
22. Bohdanov, V. L. (2023). Searching for an Optimal Strategy for the Development of the National Academy of Sciences of Ukraine in the Context of Current Challenges and Threats (based on the report). *Science and science*, 1(119), 8–9. <https://doi.org/10.15407/sofs2023.01.009> [in Ukrainian].

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## ІНТЕРНАЦІОНАЛІЗАЦІЯ НАУКОВИХ ДОСЛІДЖЕНЬ НАН УКРАЇНИ ЯК ОДИН З ОСНОВНИХ ШЛЯХІВ ЇЇ РОЗВИТКУ В УМОВАХ СЬОГОДЕННЯ (НА ПРИКЛАДІ ЧОТИРЬОХ ІНСТИТУТІВ)

**Вступ.** Міжнародна співпраця в науці є одним з пріоритетних напрямів її розвитку.

**Проблематика.** Інтернаціоналізація наукової діяльності є стратегічною рисою розвитку сучасної науки. Однак вплив військової агресії на міжнародну співпрацю НАН України недостатньо досліджено.

**Мета.** Охарактеризувати рівень міжнародного співробітництва на прикладі провідних інститутів НАН України: Інститут математики (ІМ), Інститут фізики (ІФ), Інститут біоорганічної хімії та нафтохімії ім. В.П. Кухаря (ІБОНХ), Інститут молекулярної біології та генетики (ІМБГ) на основі аналізу публікацій у журналах з бази даних *Scopus*.

**Матеріали й методи.** Використано методи порівняльного, статистичного і наукометричного аналізу. Джерелом даних є *Scopus*, значущість видань якого визначено за квантилями:  $Q_1$  – найвищий,  $Q_4$  – найнижчий.

**Результати.** Аналіз статей науковців інститутів НАН України у *Scopus* показав, що публікації українських учених представлені роботами переважно у закордонних журналах, частка яких складала у 2022 р. понад 70 % від усіх статей аналізованих інститутів. У виданнях, віднесених до  $Q_1$ , спільні роботи налічували в чотирьох установах понад 80 % від усіх публікацій  $Q_1$ , а в журналах  $Q_1 + Q_2$  такі публікації склали серед усіх статей цих квантилів у ІМБГ – 78,6 %, ІФ – 67,1 %, ІБОНХ – 57,5 %, ІМ – 51,4 %. Журнали, які включені до  $Q_1 + Q_2$ , мали найбільшу кількість спільних статей: ІФ – 86,4 % від загалу, ІБОНХ – 85,2 %, ІМБГ – 84,6 %, ІМ – 72 %. Закордонні учені були найбільш представлені у роботах з видань  $Q_1$ , де їхня частка становила 50–80 % від усіх авторів, у статтях з видань  $Q_2$  участь закордонних учених була меншою, ніж учених з України, а в роботах з видань  $Q_3$  та  $Q_4$  вони були поодинокими.

**Висновки.** Оприлюднення результатів досліджень українських вчених у журналах перших двох квантилів реалізується, насамперед, завдяки міжнародній співпраці. Розроблена методика дослідження дозволяє аналізувати міжнародні контакти та моніторити подальшу співпрацю широкого спектра установ.

**Ключові слова:** наукові журнали, база даних *Scopus*, інтернаціоналізація, інститути НАН України, наукові комунікації.