
SCIENTOMETRIC ANALYSIS OF PUBLICATIONS IN THE UKRAINIAN JOURNAL OF PHYSICS FOR THE PERIOD OF 1990—2004

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The results of our analysis of the papers published in the oldest physical journal of Ukraine — the Ukrainian Journal of Physics (UJP) — are presented. The information database about all publications in UJP within the period of 1990–2004 has been created. The articles have been classified, and the dynamics of the total number of publications, as well as the numbers of publications in different scientific domains, has been analyzed. The tendencies in the development of the collaboration of scientists from the institutions of the National Academy of Sciences of Ukraine (NASU) with the scientists of the Ukrainian higher educational institutes, the specialists from the former Soviet Union countries, and from abroad have been determined. The conclusions drawn took into account the results of studying the publications of Ukrainian physicists in leading foreign professional journals as well. Significant changes in the number of publications and in the thematic directions of researches within this historically short period have been revealed. The proportion of papers published in domestic journals to those published in foreign ones has changed substantially, which evidences for the breakthrough of the isolation of Ukrainian physics and its integration into the international science. This integration process has both positive and negative aspects with respect to the state of and the future prospects for the development of physics in Ukraine.

1. Introduction

In official and scientific circles, on pages of the domestic press, and even in the world literature, the state of science in Ukraine, the problems of its development, and the ways to reform the existing system of scientific researches have been discussed intensively for some last years [1–6]. The proper solution of those problems is impossible without taking into account the real state of researches and the tendencies of their development. It is of special importance for natural sciences, in particular, for physics, which forms the basis for scientific and technical progress. Physics plays a key role in understanding the world; physicists make an important contribution to the welfare and economic prosperity of our country. Knowledge, which the physics community accumulated, and the skill of physicists in resolving problems are essential for a good number of the branches of industry, as well as for the society

in the whole. It was not accidental that physics was enumerated the first by Alfred Nobel in his testament. The advanced countries pay a large attention and allot significant means just to the development of physics, including materials science. In order to unite the efforts of the physics community to tackle the general problems of the human society and to attract its attention to physics as the basis of progress, the United Nations Organization announced 2005 as the International Year of Physics.

The considerable attention is paid to physics at the NASU. Supporting by the State Foundation for Fundamental Researches, the comprehensive analysis of the development of physical researches is carried on nowadays at the scientific institutes of the NASU and at the institutions of higher education, the state of the professional training of the personnel with top-level qualification in physics is permanently monitored, and the scientometric analysis of articles published between 1990 and 2004 in leading physical journals released in the former Soviet republics and abroad is carried out.

The methods of the study of the state of science include the calculation of the number of publications, the analysis of scientific journals and individual researchers with respect to their citation index, plotting the “maps” of science branches and science in general, the bibliometric analysis of references in scientific publications, peer reviews, and so on [7–10]. The analysis of information flow intensities allows one to determine both the contribution of scientists of a certain country to the global information flow and those efforts which that country spends for developing science and its specific branches. Such quantitative parameters as the number of publications and their length (the number of pages, signs, etc.) are used to characterize information streams, because the number of publications is considered as reflecting the amount of elaborated scientific production [11–13].

The analysis of the state and the tendencies of the evolution of scientific researches in physics is important

for the prognosis of the development of the physical science and forming the demands for the results of fundamental science [14]. The scientometric studies carried out in Ukraine dealt mainly with separate, narrow-subject scientific directions, the activity of separate scientists or scientific schools [15].

In this work, we aimed at studying the scientific publications of Ukrainian physicists for more than a decade (1990–2004), in order to obtain objective characteristics of the state and the dynamics of the general development of physical researches in Ukraine, to determine the basic scientific directions of physical researches, and to study the processes of interdepartmental and international cooperation. For this purpose, we gathered, classified, and analyzed the scientific publications in the oldest Ukrainian physical journal, *Ukrainskyi Fizychnyi Zhurnal* (Ukrainian Journal of Physics). The scientometric data on publications of Ukrainian physicists in leading foreign periodicals, in particular, Russian and American ones, were taken into account as well.

The analysis of publications in UJP not only reflects the contemporary state of the physics development in Ukraine, but is of independent historical interest, because it characterizes the journal, the first issue of which was released 80 years ago, in December 1926. At that time, it had the title *Ukrainski Fizychni Zapysky* (Ukrainian Physical Proceedings), and its first editorial preface included the prophetic words that the journal “gives start to the formation of a periodic journal dealing with the scientific and research activity, the results of which will be published in Ukrainian”.

2. Dynamics of the Number of Publications in UJP

Within the period of 1990–2004, more than 3800 papers were published in UJP. The authors of the majority of them (3362 papers or 88.2%) were Ukrainian scientists, 281 papers (7.4%) were written by foreign authors, and 166 papers (4.4%) were the result of the cooperation between the Ukrainian and foreign authors (Table 1). It is evident that a drastic reduction of the total number of articles published in UJP is observed towards the end of this period. Their annual number diminished from 325 in 1990 to 190 in 2004, i.e. by more than 40%. The reduction in the number of articles written by domestic physicists was even more noticeable — 2.3 times smaller. In contrast to such a negative behavior, the number of publications of foreign authors and the number of common works of the Ukrainian and

foreign scientists within the period specified revealed a pronounced tendency to grow. Therefore, the reduction of the annual number of publications in UJP occurred mainly due to the reduction of the contribution of Ukrainian authors. At the beginning of the period studied, it made 98% of all publications, and, in 2004, only 73%. The share of common works amounted to about 10%, and that of publications of foreign authors only, i.e. without domestic co-authors, was 1.5–2 times higher, as a rule (Fig. 1).

The foreign researchers from more than 50 countries were the contributors to UJP during 1990–2004. Among the most presented countries, there are the former Soviet republics (Russia, Uzbekistan, Belarus), as well as Germany, USA, France, Austria, and Canada. One third of the works carried out with the participation of foreign authors were fulfilled by Russian scientists, and their prevailing number (70%) were done without Ukrainians. The same ratio between the publications of only domestic authors and in the co-authorship with foreign scientists is also characteristic of the works of Uzbek researchers, who contributed about 15.5% of the foreign authors' publications, as well as for articles of the US, Austrian, and Canadian physicists. At the same time, the majority of works of German, Polish, and French scientists were fulfilled together with Ukrainian physicists (Fig. 2).

The reasons of the tendencies revealed in the dynamics of articles published in UJP by domestic authors can be, on the one hand, the foundation of new scientific journals in Ukraine and the redistribution of articles between them and UJP and, on the other hand,

Table 1. Dynamics of the number of publications of domestic and foreign scientists in UJP

Year	Number of publications			
	total	by Ukrainian authors	by foreign authors	mutual
1990	325	318	0	7
1991	297	276	19	2
1992	301	274	21	6
1993	309	288	16	5
1994	265	244	11	10
1995	279	243	23	13
1996	214	194	20	0
1997	264	222	24	18
1998	254	225	19	10
1999	253	223	13	17
2000	258	220	21	17
2001	227	204	10	13
2002	187	168	12	7
2003	186	125	39	22
2004	190	138	337	19
Total	3809	3362	281	166

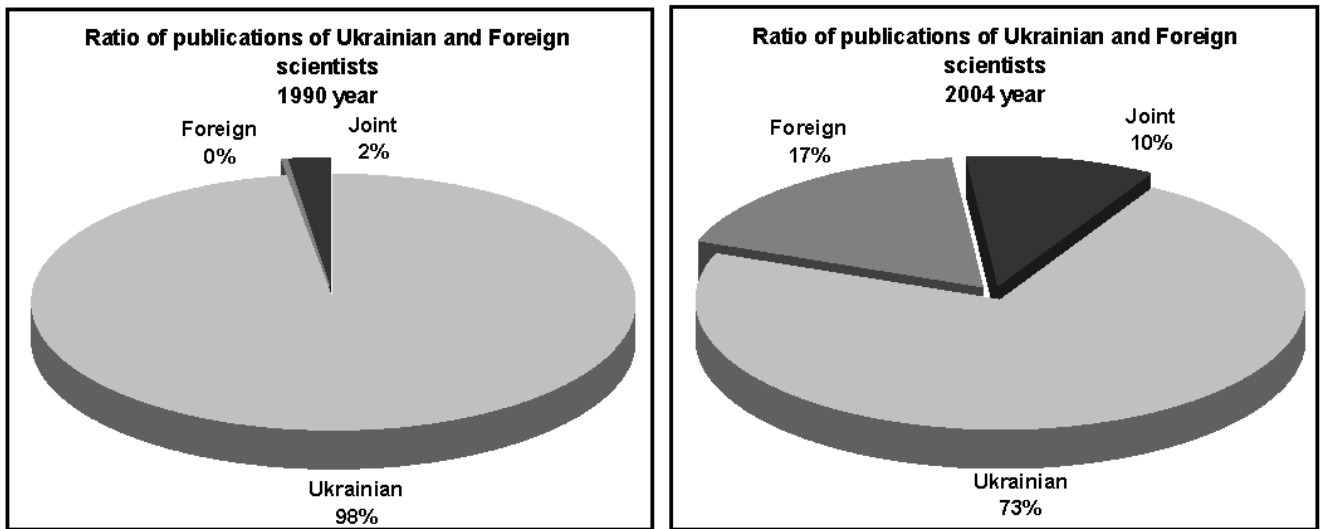


Fig. 1

the recession of the scientific activity of Ukrainian physicists. The growth of publications of foreign authors can be explained by the fact that Ukraine became more open after finding independence and because the access to UJP for foreign researchers became easier after the practice of publications in English had been introduced.

3. Subjects of Publications in UJP

Publications in UJP are classified according the following thematic sections: solid state physics; optics, quantum electronics, holography; fields, elementary particles, and nuclear physics; thermodynamics, statistical physics, and quantum mechanics; liquids and liquid crystals; plasma and gases; atoms and molecules; methods of physical experiments (Table 2).

The largest number of the articles of Ukrainian authors between 1990 and 2004 was devoted to solid state physics; these include 1532 papers, which comprises 43.4% of all publications. A considerable number of articles concerned researches in the “electromagnetic radiation and optics” (550 papers or 15.6%) and “field, elementary particles, and nuclear physics” domains (480 papers or 13.6%). Studies in thermodynamics, theoretical physics, statistical physics and quantum mechanics were presented by 337 articles (9.6%), in liquids and rare crystals by 251 articles (7.1%), in plasma and gases by 214 articles (6.1%). The share of publications on each other subject amounted to no more than 1–2.5%.

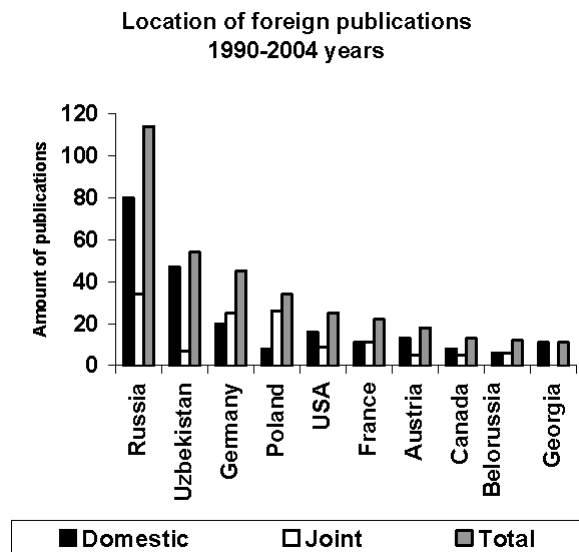


Fig. 2

During the period of 1990–2004, substantial variations took place in the distribution of publications of domestic scientists over various directions of physical researches. In particular, in 1990, articles belonging to solid state physics prevailed, and UJP was in fact a journal that specialized in this area. Variations within the indicated period gave rise to a noticeable leveling among subject-matters: in 2004, UJP became a journal, where the publications from various divisions of physics were presented practically identically (Fig. 3).

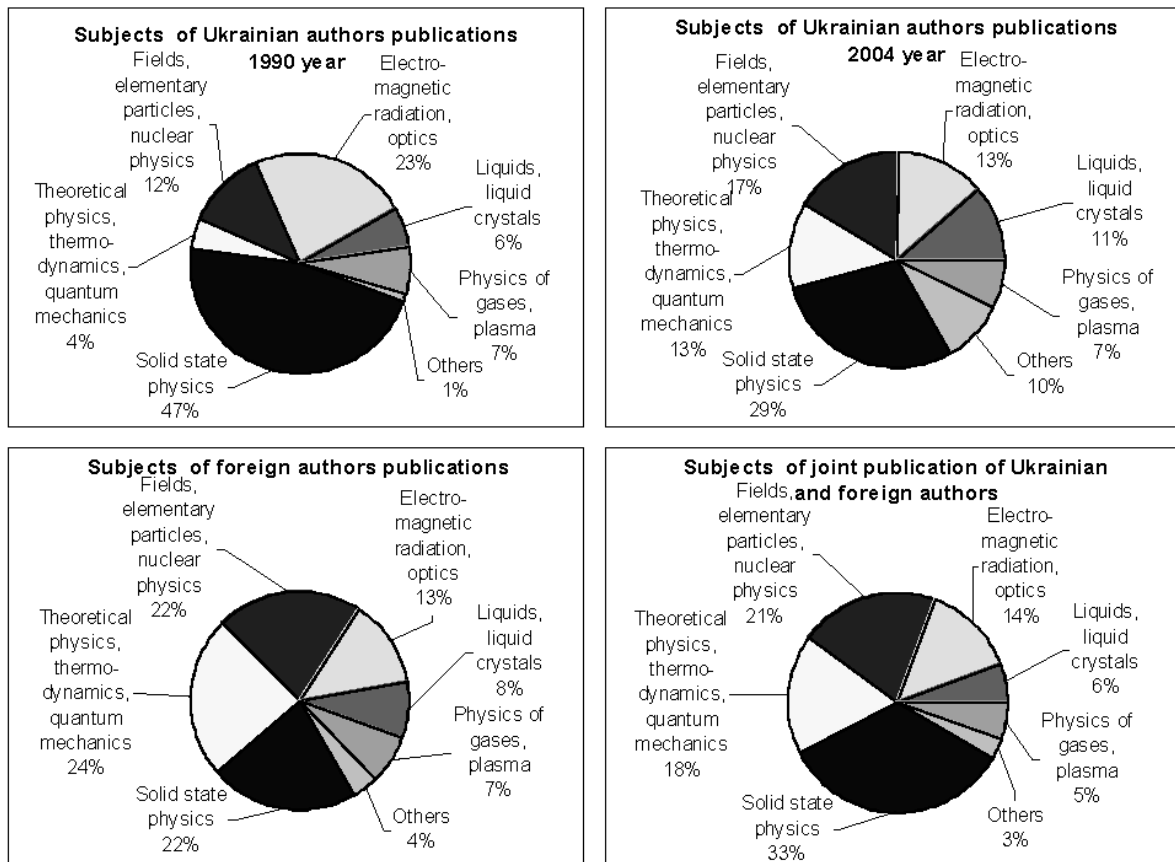


Fig. 3

Among the common publications of Ukrainian and foreign authors, those in solid state physics also prevailed: 34.1% of all publications. A considerable number of mutual publications was devoted to the

Table 2. Subjects of the UJP publications in 1990–2004

Year	Solids	Optics, quantum electronics, holography	Fields, elementary particles, and nuclear physics	Thermodynamics, statistical physics, and quantum mechanics	Liquids and liquid crystals	Plasma, and gases	Atoms and molecules	Methods of physical experiments
1990	152	76	38	14	19	22	4	0
1991	125	68	25	16	23	12	9	0
1992	126	55	24	16	22	13	22	0
1993	139	70	38	20	13	7	6	0
1994	106	69	36	5	15	13	9	0
1995	134	38	37	13	12	21	1	0
1996	78	19	34	25	23	8	3	4
1997	116	22	24	25	16	16	9	12
1998	87	17	39	40	18	27	1	6
1999	113	32	28	27	17	19	1	3
2000	105	15	40	29	16	16	7	5
2001	100	20	38	21	9	14	7	8
2002	61	18	25	32	18	8	4	7
2003	44	10	28	34	12	7	0	9
2004	46	21	26	20	18	11	5	4
Total	1532	550	480	337	251	214	88	58
in %	43.4	15.6	13.6	9.6	7.1	6.1	2.5	1.6

studies of the field theory, the theory of elementary particles, and nuclear physics issues (20.6%), as well as to the researches in thermodynamics, theoretical physics, statistical physics, and quantum mechanics (17.6%). Concerning other research subjects, mutual publications are distributed similarly to the publications of Ukrainian authors.

No single subject dominated in the publications of foreign authors. The largest share (24%) included the works on thermodynamics, theoretical physics, statistical physics, and quantum mechanics. The shares of papers on solid state physics (21.9%) and on the problems of the field theory, the theory of elementary particles, and nuclear physics (21.5%) were practically the same. Studies on electromagnetic radiation and optics, liquids and liquid crystals, plasma and gases, and in other sections comprised 13.3, 8.2, 7.2, and 3.9% of the publications, respectively. It should be noted that the distribution of domestic authors' publications over the subjects of researches at the end of the period investigated (in 2004) approached the corresponding distribution of foreign authors' papers (Fig. 3).

Despite the fact that the articles in the field of solid state physics prevail among publications in UJP, a persistent tendency of the reduction of their number is observed: from 152 papers in 1990 to 46 ones in 2004, i.e. it became more than three times smaller (Table 2). The same negative tendency is traced for optical researches as well: the number of publications decreased from 76 in 1990 to 21 in 2004. At the same time, the number of publications on thermodynamics, theoretical physics, statistical physics, and quantum mechanics permanently increased, becoming in 2004 twice as large as in 1990. The numbers of publications in other classification sections of UJP remain practically constant during this period (Fig. 4).

Thus, the overall recession in the number of publications in UJP during 1990–2004 was caused by a considerable reduction in the number of experimental works in the domains of solid state physics and optics. At the same time, the number of works of methodological and calculational character evidently grew. These tendencies were partially related to a substantial growth of both the quantity and quality of computers, which provided an opportunity for the calculational works to be performed quickly and effectively, and the created proper conditions for the theoretical models of physical phenomena to be developed and verified. But the main reason is the ageing of experimental facilities and the absence of the technological basis necessary for carrying out modern experimental

Dynamic of Ukrainian publications in different subjects

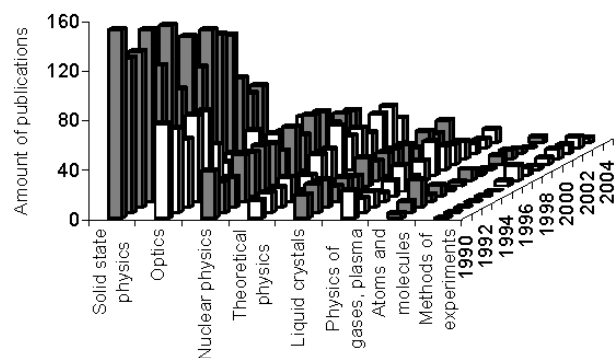


Fig. 4

researches, at scientific and educational institutions, which is undoubtedly a negative factor.

4. Interdepartmental Cooperation of Ukrainian Physicists

The works of Ukrainian authors published in UJP between 1990 and 2004 were mainly executed at the institutes of the NASU (1828 publications) and at the Ukrainian institutions of higher education (1509 publications). The share of works done by the scientists of those two departments in cooperation did not exceed 10%.

The tendencies in variations of the numbers of publications by the researchers of those departments differ substantially. In 1991–1992, the number of publications by the physicists of the NASU was approximately twice as large as the number of publications by the researchers of higher educational institutions. Nevertheless, every year, the number of publications submitted by the scientists from academic institutes decreased and, in 2004, became 2.5 times smaller: 71 publications against 176 ones. Within the same period, the dynamics of publications of the researchers from the higher educational institutions of Ukraine had an oscillatory character, with the annual number of papers remaining at approximately the same level — on the average, 100 publications per year. The different behaviors in the dynamics of publications made by researchers from the NASU and the higher educational institutions of Ukraine brought about the

Dynamic of different organizations publications

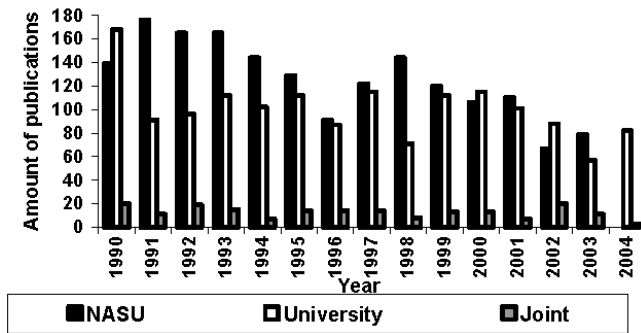


Fig. 5

situation, where the numbers of articles prepared at either of those departments and published in UJP became comparable to each other during last years (Fig. 5).

From the analysis of the UJP publications, one can see that the researches in solid state physics, optics, and liquid crystals were carried on to the same extent both at the academic and higher educational institutions of Ukraine. At the same time, such physical directions as plasma and gases, thermodynamics, theoretical physics, statistical physics, quantum mechanics, field theory, the theory of elementary particles, and nuclear physics developed mainly at academic institutions (Fig. 6).

5. Discussion and Conclusions

The permanent reduction in the number of publications of Ukrainian authors in UJP within the period of 1990–2004, which has been demonstrated above, can be a consequence, first of all, of the insufficient finance support and the related deficit of a skilled personnel, ageing the equipment, and the absence of materials for experimental works. This assumption is confirmed by the fact that the overall recession in the number of publications in UJP between 1990 and 2004 was caused mainly by the reduction of experimental works in solid state physics and optics, which require large material and financial spendings. It is also testified by the growth in the number of works of calculational character.

In addition, some scientific and research institutes and universities have founded several new scientific journals. These periodicals were recognized by the Higher Certifying Commission of Ukraine as professional and now publish the results of a considerable part of

Subjects of the different organizations researches

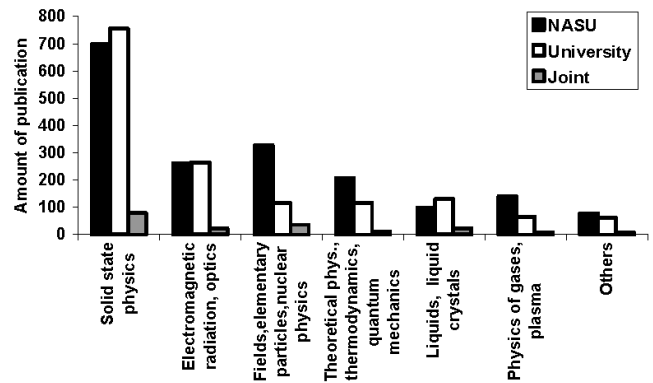


Fig. 6

scientific researches of Ukrainian physicists, “by dislodging” the main Ukrainian physical journal in such a way.

In order to obtain the additional information concerning the origins of the processes revealed, we analyzed the dynamics of the number of the Ukrainian physicists’ publications in leading physical periodicals of the Russian Academy of Sciences *Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki* (Journal of Experimental and Theoretical Physics, JETP) and *Pis'ma v Zhurnal Eksperimentalnoi i Teoreticheskoi Fiziki* (JETP Lett.) and the American Physical Society *Physical Review* (Phys. Rev.) and *Physical Review Letters* (Phys. Rev. Lett.).

Within the period of 1990–2004, Ukrainian authors published 377 articles in JETP and 345 ones in JETP Lett. The annual number of publications of Ukrainian physicists in those journals permanently decreases from year to year; in particular, in JETP from 42 papers in 1990 to 18 ones in 2004 and in JETP Lett. from 35 to 17, respectively. The same tendency is also observed for the dynamics of publications of Ukrainian physicists in other Russian physical journals, in particular, in the journals published by the Ioffe Physico-Technical Institute in St. Petersburg — *Fizika Tverdogo Tela* (English version — Physics of the Solid State), *Fizika i Tekhnika Poluprovodnikov* (English version — Semiconductors), *Zhurnal Tekhnicheskoi Fiziki* (English version — Technical Physics), and *Pis'ma v Zhurnal Tekhnicheskoi Fiziki* (English version — Technical Physics Letters). Within the period of 1996–2003, the annual number of publications submitted from Ukraine to those journals decreased from 160 to 120, i.e. by 25%. Thus, the number of articles of Ukrainian

physicists published in the leading Russian physical journals per year, similarly to the situation in UJP, decreased permanently in 1990–2004.

An absolutely different trend was observed in the case of Western physical periodicals. In particular, in *Phys. Rev. Lett.*, the annual number of publications of Ukrainian physicists grew by a factor of 10 within the same period (from 3 papers in 1990 to 30 ones in 2004). Such a behavior of the number of publications of Ukrainian physicists in this journal correlates well with the growth of the same parameter for *Phys. Rev.*: from 1 papers in 1990 to 127 ones in 2004. In 2002–2004, the annual numbers of publications of Ukrainian physicists in UJP and *Phys. Rev.* practically matched. It is even more puzzling, because only 12 articles were published by Ukrainian physicists in *Phys. Rev.* within the whole previous decade (1980–1989) — at that time, Soviet scientists did not always have an opportunity to be published in such journals because of the administrative barriers.

Hence, with respect to the publications of Ukrainian physicists in scientific periodicals, two opposite tendencies are observed: an appreciable reduction of articles published in the domestic journal (UJP) and in the journals of the former Soviet republics, and, at the same time, a substantial growth of publications in the Western journals. This conclusion concerns mainly the publications of scientists from the academic institutes. The number of articles of the higher-school researchers and the scope of journals, where they had been published, remained practically unchanged.

The increase in the number of publications of Ukrainian physicists in leading Western scientific journals, which possess high impact-factors, testifies, first of all, that a considerable portion of physical researches in Ukraine is carried out at a world-class level. This fact was promoted by the openness of Ukraine, strengthening of creative relations between Ukrainian scientists and their foreign colleagues, the availability of numerous foreign foundations, which enable Ukrainian scientists to obtain the additional financial support under competitive conditions, and the enthusiasm of individual persons who devoted themselves to science.

Disturbing is the fact that a significant deal of experimental works were carried out by Ukrainian scientists abroad, making use of the equipment and/or the materials of foreign institutions. Of course, this resulted from the unsatisfactory conditions for experimental works in Ukraine — the wear of the scientific experimental equipment and the absence of its updating for last 10–15 years.

The works, which are carried out by domestic physicists abroad, can be classified into two groups by their direction and essence. Ukrainian scientists are the initiators and the leaders of the researches in the first group and perform investigations in the framework of their actual thematics, using the foreign-made scientific facilities. The number of such works reveals the tendency to a reduction. In the second group, the works are carried on by the request of Western scientific institutions or in the framework of the subject-matters of their laboratories. In this case, Ukrainian physicists are employed as a highly skilled auxiliary personnel, and their subjects of researches appreciably depends on the needs of foreign customers. Unfortunately, the number of publications in this group tends to grow.

The substantial growth in the number of publications of Ukrainian physics in leading Western scientific journals, which was revealed on the basis of scientometric analysis, provides reasons to talk about the integration of the Ukrainian physics into the global one. Nevertheless, this process is characteristic of only physical researches, being not inherent to the researches of Ukrainian scientists in other science branches. In work [16], for example, on the basis of questioning the scientists from the NASU, it was established that they published more papers in domestic journals in 1998–2002 than it was in the previous period. It is especially typical of social sciences. According to the authors of work [16], this phenomenon can be explained, on the one hand, by the growth of scientists' productivity and, on the other hand, by the increase in the number of scientific periodicals in our country, as well as by more indulgent requirements to the level of publications in some novel journals. Those authors did not reveal changes in the publication activity of scientists in the CIS and Western countries, and made a conclusion that "the world science community remains ignorant of the scientific results obtained by Ukrainian scientists, as it was before".

The results of our scientometric studies testify that such negative tendencies do not concern Ukrainian physicists. The validity of our conclusion about the integration of Ukrainian physics into the global one and the availability of a high scientific potential in Ukraine in the physics domain is confirmed by the Institute of Scientific Information in USA (see ISI Essential Science Indicators [17]), according to which Ukraine is the world leader by the ratio between the publications on physical subjects and the total number of registered publications (39.25%). It is more than three times higher than the

share of physics publications in the world scientific literature, which makes 12.27%.

However, the insufficient financial support of science in Ukraine and the absence of money allotted for purchasing a modern equipment and materials are one of the principal reasons of the negative tendencies observed in the development of physical researches within last years. Among other reasons, there are the problem of determining the priorities for various directions of the science development and, as a result, the scatter of funds among them, the insufficient governmental support of the efforts towards the practical implementations of scientific achievements, and so on.

The inconsistency of the governmental policy with respect to the development of science and high technologies in Ukraine, as well as the scornful attitude of some part of our society to science as to an unproductive field of human activity, which must be, in its opinion, at least cardinally reorganized or totally eliminated, makes the existing problems in science and, in particular, in physics more profound. Rather illustrative, in this connection, is the fact that the overwhelming majority of people in our country did not even hear of the announcement 2005 as the International Year of Physics.

Such a situation underlies a catastrophic damage made to the prestige of scientific activity, which leads to the insufficient involvement of the youth into science and ageing the scientific staff. The most active part of the youth, who dared to devote themselves to science and obtained an opportunity to work at foreign scientific centers, did not always come back to Ukraine, because here they have neither the possibilities to continue their research works on modern facilities nor the prospects to provide themselves with a worthy level of life.

It should be emphasized that the high level of physical researches in 1990–2004 was supported by the staff potential and the scientific schools in the fundamental physics domain, which had been created in Ukraine in earlier decades, as well as by the favorable conditions for international cooperation. The dynamics of the number of publications of Ukrainian physicists, obtained by analyzing the database of the American Institute of Physics (100 scientific journals were covered) [18] evidences for a gradual increase of the annual number of the Ukrainian authors' articles between 1990 and 1997 by almost 50%: from 678 to 1121 papers. However, in the following years, the growth in the number of publications stopped, and this quantity was preserved at a level of about 1000 papers per year. Since 2002, this parameter has been demonstrating the

tendency towards a reduction. This testifies that the capabilities to develop physics in Ukraine have been exhausted, so that there are no conditions for their revival.

Thus, the scientometric analysis of the publications of Ukrainian physicists in a number of domestic and foreign periodicals, which was carried out in this work, has demonstrated that the rather noticeable changes took place both in the number of publications dealing with the physical researches and their distribution over the subjects concerned during the historically short period of 1990–2004. The publications became substantially redistributed between the domestic and foreign journals. This fact testifies for the transition from the isolation of the Ukrainian physics to its integration into the global one, the process being accompanied by both positive and negative effects on the state and the development prospects of physics in Ukraine.

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НАУКОМЕТРИЧНИЙ АНАЛІЗ ПУБЛІКАЦІЙ УКРАЇНСЬКОГО ФІЗИЧНОГО ЖУРНАЛУ У 1990—2004 РОКАХ

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Р е з ю м е

Аналіз стану і тенденцій розвитку наукових досліджень з фізики необхідний як для прогнозування розвитку фізичної науки та практичного використання нових знань, так і для розробки концепції наукової політики та шляхів реформування науки. Щоб одержати кількісні показники про стан та динаміку розвитку фізики в Україні в роки незалежності, ми здійснили аналіз публікацій українських фізиків в ряді наукових журналів України, Росії та країн далекого зарубіжжя.

У даній роботі наведено дослідження публікацій у найстарішому загальнофізичному журналі України — Українському фізичному журналі (УФЖ). Створена база даних про всі публікації УФЖ в 1990—2004 роках. Проведена систематизація статей, проаналізована динаміка зміни загальної кількості публікацій та публікацій за різними науковими напрямками, визначені тенденції в розвитку співпраці науковців установ НАН України з працівниками вищих наукових закладів (ВНЗ) України та з фахівцями країн близького та далекого зарубіжжя. У формулюванні висновків враховано результати дослідження публікацій фізиків України в провідних зарубіжних журналах. Виявлено, що за цей історично короткий період у фізичних дослідженнях відбулися досить відчутні зміни в кількості публікацій та тематичних напрямках досліджень. Суттєво змінився розподіл статей між вітчизняними та зарубіжними журналами, який свідчить про перехід від ізоляції української фізики до її інтеграції в світову науку. Цей процес інтеграції має як позитивний, так і негативний вплив на стан та перспективи розвитку фізики в Україні.