

SCIENTIFIC ACTIVITIES OF PROFESSOR A. L. IVANOVSKII IN BIBLIOMETRIC INDICES

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The publication activity dynamics of Prof. A. L. Ivanovskii has been examined and the bibliometric indices of his scientific work have been analyzed.

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Alexander Leonidovich Ivanovskii (1953–2014), Professor, Doctor of Chemistry, was known in the scientific community as a leading specialist in the application of quantum-chemical computational methods for the modeling of physicochemical properties of novel compounds and materials. For almost forty years of his scientific career (1976–2014), he, personally and with co-authors, published more than 860 scientific works in domestic and foreign journals, 14 monographs and more than 20 reviews devoted to computational studies of materials science and inorganic systems. The research findings obtained by A. L. Ivanovskii are highly valued in the scientific community. His papers have high citation indices in international scientific and technical information resources.

The investigation of personal bibliographies of scientists is of theoretical and applied importance because it allows one to obtain individual and comparative quantitative characteristics of publication activity and efficiency of scientific work of a scientist. This also allows one to determine the place of the scientists' effort in the developed domains of science as well as to study the processes of formation and change in research trends in one or several scientific fields [1].

In this work, we analyze the dynamics of bibliometric indices of the scientific heritage of A.L. Ivanovskii from 1978 to 2013. In 2014, several articles by A.L. Ivanovskii have been already published and perhaps other works will appear later; that is why the quantitative indicators of the scientific heritage of A. L. Ivanovskii will change slightly in the future. The electronic database search was carried out in May 2014 with consideration of different spelling variants of the surname (Table 1). Figure 1 presents the general dynamics of publication activity of A.L. Ivanovskii in the considered period. The global scientific and technical information resources — Web of Science (WoS) [2], Scopus [3], Chemical Abstracts Plus (CAPlus) [4] and the Russian Science Citation Index (RSCI) [5] have been used. The experience in the bibliometric analysis of chemists' works earned after I.V. Zibareva et al. reveals that, the application of different electronic databases provides more complete volume of examined material since each database has its own peculiarities (different time periods, primary sources, functional capabilities, thematic scope) [6, 7, 8].

Analysis of the data in Fig. 1 allows one to distinguish three stages in the scientific work of A. L. Ivanovskii depending on his publication activity. In turn, each stage can be

TABLE 1. The main bibliometric indices of scientific activities of A. L. Ivanovskii

Index	RSCI	WoS	Scopus
Total number of publications	828	541	531
Total number of citations	5830	4022	3646
Average number of citations per 1 publication	5.6	7.4	6.8
Hirsch index	28	27	27

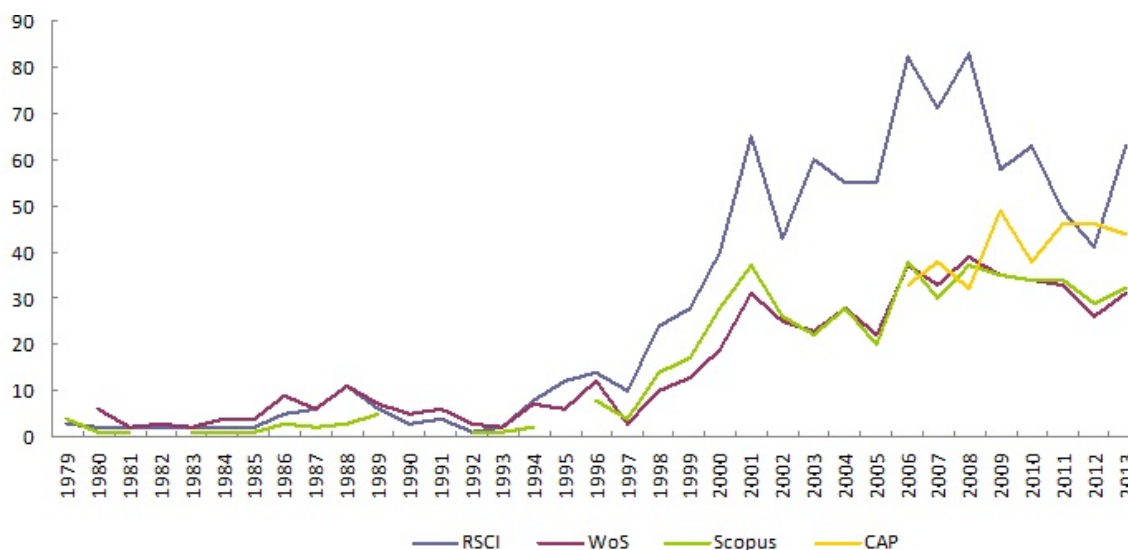


FIG. 1. The general dynamics of publication activity of A. L. Ivanovskii. The number of published items on the year is depicted concerning to different electronic databases

subdivided into separate phases. The first stage, from 1979 to 1987, reflects his formation as a scientist. The activity of young researcher is related to the investigations of the electronic structure, chemical bonding and interatomic interactions in transition metal compounds. This period can be characterized by low publication activity: about 30 papers are published in total. The activity peaks in 1986, when two monographs of A. L. Ivanovskii (in co-authorship with V. A. Gubanov, M. V. Ryzhkov, G. P. Shveikin) devoted to the evaluation of quantum chemical research methods have been published. As a result of this stage, the main approaches in the quantum chemical simulation of the properties of complex multi-component compounds and in the search of their optimal compositions have been formulated.

The second stage of the scientific activity begins in 1988, after the defense of his doctoral thesis. At that time, A. L. Ivanovskii is 36 years old, and everything promises the beginning of the most fruitful creative period. However, judging by the number of published articles, a decline begins, which continues from 1991 to 1993. This slowdown is typical for the majority of Russian scientists and is related to the general situation in the country. The Soviet system was disorganized, the support for research and development was drastically reduced, and science teetered on the brink of extinction.

In 1994, the third stage in the academic career of A. L. Ivanovskii begins, which can be characterized as a research and organization period. He got elected among other candidates to the position of the Head of Laboratory of Solid State Chemistry and Spectroscopy

at ISSC UB RAS. At that time, new forms of financing of the Russian science emerge: the support of scientists from the Russian Foundation of Basic Research was actively undertaken, the International Soros Science Education Program was created. Thanks to these and other foundations, Russian scientists were once again actively involved in R&D work. Besides, A. L. Ivanovskii directs the theoretical group and these reasons can explain the fact that more than fivefold increase in the publication activities of A. L. Ivanovskii takes place in the next 7 years. Under his leadership, investigations of chemical bonding, electronic structure and physicochemical properties of carbides, nitrides, silicides, hydrides, oxides, multi-component solid solutions and alloys were carried out in the laboratory. Together with his team, A. L. Ivanovskii elaborated original methods, performed research work and developed general theoretical models for the targeted control over the functional properties of inorganic compounds by modified structural defects. The organized teamwork provided a purposeful search for novel materials with pre-assigned characteristics (cermets, heat-resisting coatings, superconductors, nano-systems).

The phase of the highest creative productivity of the scientist falls on the first decade of the 21st century. The research team of A. L. Ivanovskii was reinvigorated by young scientists. About 80% of his publications are written in the last 13 years. On average, A. L. Ivanovskii published about 30 papers per year (or about 60 papers according to RSCI, which is probably due to the peculiarities of the Russian database, which takes into account both the original works in Russian and their English versions [8]). Obviously, such high productivity is due to the active participation in the rise of a new research area – computational materials science for inorganic nanostructures (nanotubes and fullerene-like clusters) and nanomaterials based thereon.

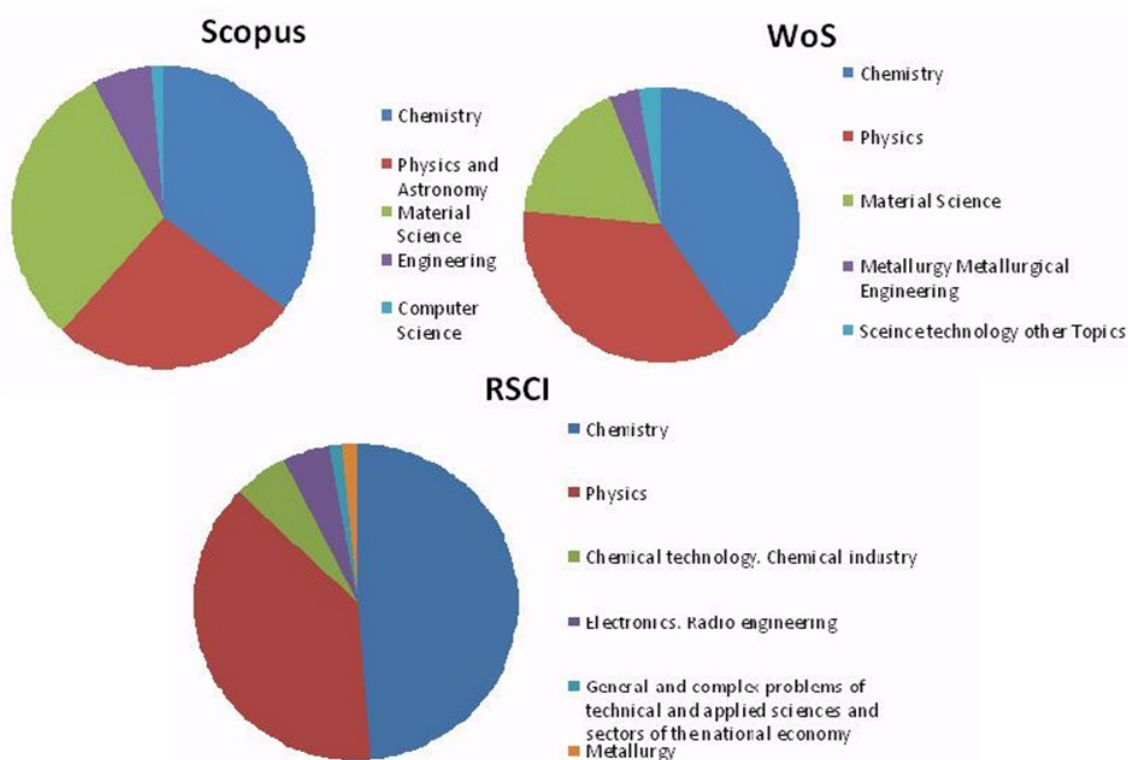


FIG. 2. The object domains of research in the publications of A. L. Ivanovskii

TABLE 2. Key words from the publications of A. L. Ivanovskii (Scopus)

Key word	Quantity
Electronic properties	89
Electronic structure / Band structure	67 / 19
Chemical structure	39
Calculations/ Ab initio calculations/ First-principles calculation/ First-principles	39 / 37 / 31 / 24
Chemical bond / Chemical bonds	28 / 24
Superconductivity / Superconducting materials	28 / 19
Structure / Structure analysis	26 / 19
Elastic properties / Elasticity / Elastic moduli	25 /19 /18
Density functional theory	24
Nanotubes / Fullerene	22 / 13
Magnetic properties	21
Carbon	19
Stoichiometry	18
Inter-atomic bonding / Molecular interaction	16 / 16
Unclassified drug	16

The works of A. L. Ivanovskii are at the intersection of three distinct domains, among which the major areas are Chemistry and Physics (Physics and Astronomy in Scopus) (see Fig. 2). Materials science is a separate research field in Scopus and WoS and also constitutes a significant part of his research. This is indicative of clearly defined scientific interest at the junction of three scientific disciplines. The use of keywords determined by Scopus show that the works of A. L. Ivanovskii deal mainly with electronic properties, electronic structure, chemical structure, first-principles calculations, chemical bond and stoichiometry (Table 2). These keywords allow one to single out from general articles the works where the properties of a substance (superconductivity, elasticity, magnetic properties) and the forms of a substance (nanotubes, fullerenes) play decisive roles.

The types of publication items are analyzed in Table 3. The main body of the creative heritage of A. L. Ivanovskii consists of the journal articles. In the foreign databases, review articles are classified in a separate category (review). According to CAPlus, data this type of publication possesses more than 10% of the total number of articles; in other databases, this index is smaller. It is worth noting that, among the 10 most frequently cited papers of A. L. Ivanovskii, three are reviews. Although A. L. Ivanovskii is known primarily as a theoretician, he is listed as an inventor on several patents (e.g. a device for ultrasound transmission, a method for producing ceramics etc.).

The list of journals, in which A. L. Ivanovskii publishes his works, includes more than one hundred titles, which confirms the multidisciplinary character of his research. At the same time, there are several journals, to which he contributes on a regular basis, in particular, *Zhurnal strukturnoy khimii*, *Zhurnal neorganicheskoy khimii* and *Fizika tvyordogo tela* among the Russian periodicals and *Physica Status Solidi B Basic Research* (Germany) occupying the leading place among foreign journals (Table 4).

TABLE 3. The distribution of the works of A. L. Ivanovskii by the types of publications

	APlus*	RSCI	WoS	Scopus
Article in journal / review	271/27	661	474/32	471/17
Article in conference proceedings	1	7	8	5
Patent	1	6		
Report		4		
Book or collection of articles		3		1

* In CAPlus, the authors considered the data for a period from 2006 to 2013.

TABLE 4. The distribution of the publications of A. L. Ivanovskii by the journals

Journal	RSCI	WoS	Scopus
Zhurnal strukturnoy khimii Journal of Structural Chemistry	51 20		54
Zhurnal neorganicheskoy khimii Russian Journal of Inorganic Chemistry	40 27	34	38
Fizika tvyordogo tela Physics of the Solid State	39 17	30	18
DOKLADY AKADEMII NAUK Doklady Chemistry Doklady Earth Sciences Doklady Physical Chemistry	36 3 2	3 21	22
Uspekhi khimii Russian Chemical Reviews	30	9 6	
Pisma v Zhurnal eksperimentalnoy i teoreticheskoy fiziki Journal of Experimental and Theoretical Physics Letters (JETP Letters)	28 17	24	19
Physica Status Solidi B Basic Research		13	21
Inorganic Materials		30	20
Mendeleev Communications	17	10	

The greatest number of works, reflected in the scientific and technical information resources, is published in English, the difference in the indices being small (see Fig. 3). The RSCI data are different: 82% of the articles are published in the Russian journals and 40% — in the Russian journals in translation.

The scientific activity of Prof. A. L. Ivanovskii is connected to a single institution — the Institute of Solid State Chemistry of the Ural Branch of the Russian Academy of Sciences (before 1991, the Institute of Chemistry UB USSR AS). The most of his articles is represented by this institute. In the foreign automatic search systems, the name of the Institute goes as the Institute of Solid State Chemistry, but more general names should be also taken into consideration during the search: Russian Academy of Sciences, Ural Branch Russian Academy of Sciences. For a long period of time, A. L. Ivanovskii cooperated with the Ural Federal University named after the First President of Russia B. N. Yeltsin (Ural

TABLE 5. The scientific cooperation of A. L. Ivanovskii

Co-author	Years of cooperation	RSCI	WoS	Scopus
Shein I.R.	2001 – 2013*	288	193	179
Enyashin A.N.	2003 – 2013	137	87	89
Medvedeva N.I.	1994 – 2013	121	66	68
Makurin Yu.N.	1999 – 2010	109	53	62
Ivanovskaya V.V.	2001 – 2011	80	38	42
Sofronov A.A.	1999 – 2006	69	33	46
Shveikin G.P.	1979 – 2006	62	34	28
Bannikov V.V.	2007 – 2013	49	40	39
Gubanov V.A.	1979 – 1992	38	41	22
Suetin D.V.	2008 – 2013	33	26	25
Okatov S.V.	1999 – 2005	32	18	21
Bamburov V.G.	1998 – 2012	30	13	15
Kiyko V.S.	2001 – 2011	30	20	21
Gorbunova V.M.	2006 – 2010	25	13	12
Kuznetsov M.V.	1995 – 2012	25	11	15
Anisimov V.I.	1979 – 2013	19	11	7
Novikov D.L.	1986 – 2002	19	13	7
Kozhevnikov V.L.	2005 – 2008	18	11	9
Moiseyev G.K.	2005 – 2008	18	8	8
Ryzhkov M.V.	1999 – 2013	18	12	-
Shein K.I.	2004 – 2007	17	13	-
Yuryeva E.I.	2000 – 2006	16	7	7
Medvedeva Yu.E.	1998 – 2005	13	5	4
Kurmayev E.Z.	1979 – 2004	12	16	12
Cherkashenko V.M.	1984 – 2001	12	5	5
Votyakov S.L.	2002 – 2013	11	6	5
Shchapova Yu.V.	2002 – 2013	11	6	5
Shalaeva E.V.	1995 – 2012	11	3	-
Gusev A.I.	2001 – 2008	10	3	5

* The first three papers co-authored by A.L. Ivanovskii and I.R. Shein were published as early as in 1990; however then there was a 10-year interval in this creative tandem.

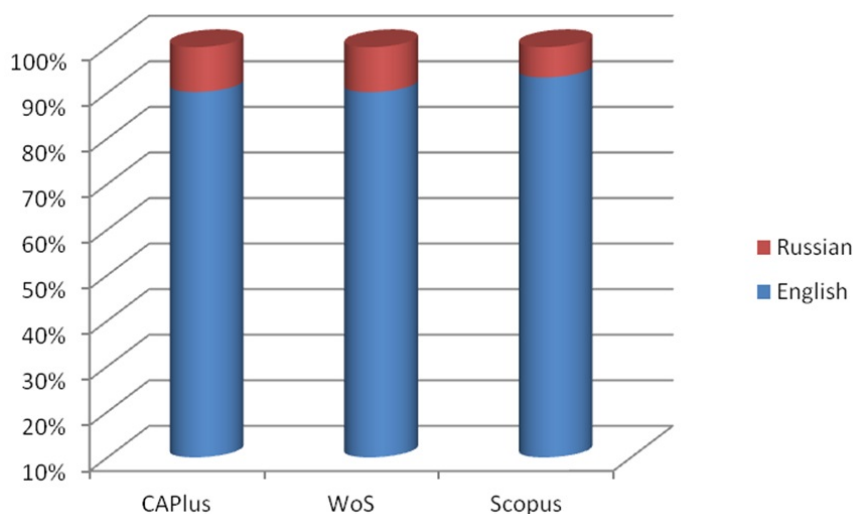


FIG. 3. The ratio of the articles of A. L. Ivanovskii published in Russian and English

Federal University), giving lectures on quantum and general chemistry at the Department of Chemistry and about 10% of his publications are affiliated with this University.

A characteristic feature of the research work of A. L. Ivanovskii is productive scientific co-authorship. The number of all co-authors of A. L. Ivanovskii exceeds one hundred. Table 5 lists the names of scientists who are the co-authors of more than 10 papers. According to this data several groups of co-authors can be distinguished. The first group can be tentatively called *tutors*. They are characterized by long-term and fruitful cooperation limited in time (G. P. Shveikin, V. A. Gubanov). The second group — *colleagues* — is represented by long-standing co-authorship of different intensity (N. I. Medvedeva, V. I. Anisimov). The third group — *pupils* — is characterized by temporary fruitful cooperation (V. V. Ivanovskaya, A. A. Sofronov, S. V. Okatov). It is noteworthy that some pupils later become the most productive co-authors (I. R. Shein, A. N. Enyashin).

In view of the aforementioned, the geography of cooperation of A. L. Ivanovskii covers primarily the Russian Federation. Among foreign countries, the most intensive cooperation took place with German scientific groups and to a lesser degree — with scientists from Switzerland, France and the US (Table 6).

TABLE 6. The geography of co-authors of A. L. Ivanovskii

Country	WoS	Scopus
Russian Federation	507	446
Germany	19	18
Switzerland	4	5
France	3	3
USA	6	3

Three of the ten most cited papers are reviews written by A. L. Ivanovskii as the sole author (Table 7). This is indicative of his tremendous working capacity and a wide scientific range of investigations. The current decade is marked by the most fruitful collaboration with the scientists of the Institute. A strong research team has been formed, which is regularly

TABLE 7. The most frequently cited articles (times cited)

Article	RSCI	WoS	Scopus
Ivanovskii A.L. Non-carbon nanotubes: synthesis and simulation. <i>Russ.Chem.Rev.</i> , 71, 3, P. 175–194 (2002)	121	60	41
Medvedeva N.I., Ivanovskii A.L., Medvedeva J.E., Freeman A.J. Electronic structure of superconducting MgB ₂ and related binary and ternary borides. <i>Phys. Rev. B</i> , 64, 2, P. 205021–205024 (2001)	119	92	119
Medvedeva N.I., Novikov D.L., Ivanovskii A.L., Kuznetsov M.V., Freeman A.J. Electronic properties of Ti ₃ SiC ₂ -based solid solutions. <i>Phys. Rev. B</i> , 58, 24, P. 16042–16050 (1998)	99	89	98
Ivanovskii A.L. New high-temperature superconductors based on rare-earth and transition metal oxyarsenides and related phases: synthesis, properties and simulations. <i>Phys.Uspekhi</i> , 51, 12, P. 1229–1260 (2008).	115	87	90
Shein I.R., Ivanovskii A.L. Elastic properties of mono- and polycrystalline hexagonal AlB ₂ -like diborides of s, p and d metals from first-principles calculations. <i>J. Phys. Condens. Matter</i> , 20, 41, 415218 (2008).	81	90	74
Enyashin A.N., Ivanovskii A.L. Graphene allotropes. <i>Phys. Status Solidi (B)</i> , 248, 8, P. 1879–1883 (2011).	39	53	55
Makurin Yu.N., Sofronov A.A., Gusev A.I., Ivanovskii A.L. Electronic structure and chemical stabilization of C ₂₈ fullerene. <i>Chem. Phys.</i> , 270, 2, P. 293–308 (2001).	53	–	51
Shein I.R., Medvedeva N.I., Ivanovskii A.L. Electronic and structural properties of cementite-type M ₃ X (M=Fe, Co, Ni; X=C or B) by first principles calculations. <i>Physica B: Cond.Matter</i> , 371, 1, P. 126–132 (2006).	48	49	50
Ivanovskii A.L. Band Structure and Properties of Superconducting MgB ₂ and Related Compounds (a Review). <i>PlaceNameplacePhys. Place-NameSolid PlaceTypeState</i> , 45, 10, P. 1829–1859 (2003).	63	51	47
Zakharova G.S., Volkov V.L., Ivanovskaya V.V., Ivanovskii A.L. Nanotubes and related nanostructures of d-metal oxides: Synthesis and computer design. <i>Uspekhi Khimii</i> , 74, 7, P. 651–685 (2005).	74	33	45

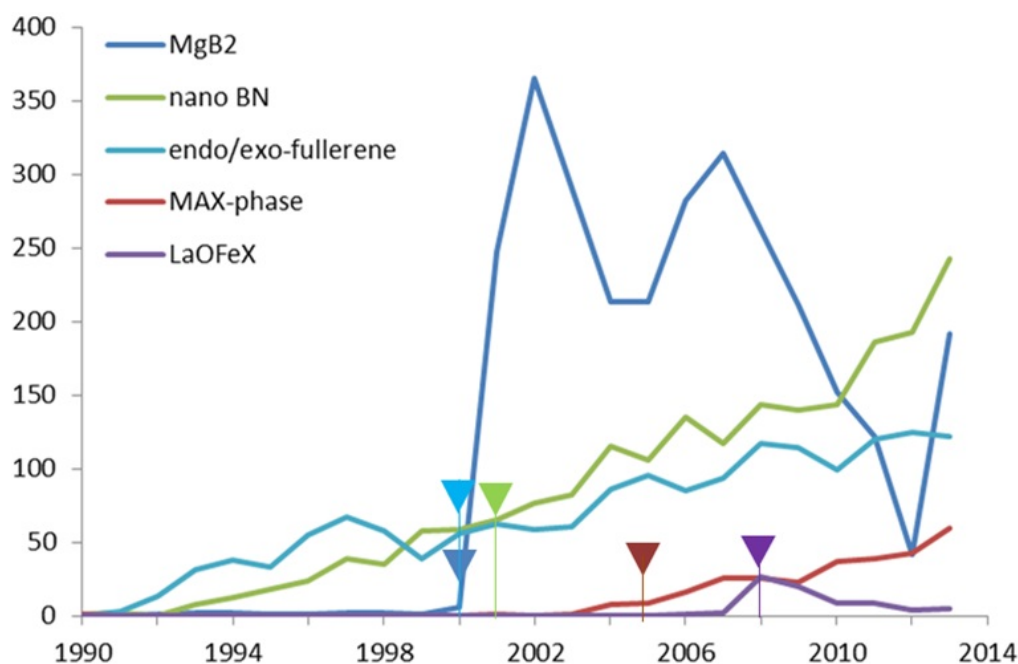


FIG. 4. The number of articles and review papers published in the world during one year on various topics (Scopus). The first works of A. L. Ivanovskii devoted to these topics are marked by arrows with vertical lines

reinforced with post-graduates. This period is a peak of publication activity with maxima of 37 and 39 publications in 2006 and 2008 according to WoS, 37 and 38 publications according to Scopus and 83 publications according to RSCI. The main drawings up of scientific work are considered by A. L. Ivanovskii as a paper published in a scientific journal. It should be noted again that most of his articles are written by two or three co-authors. The review papers hold a special place, and here, A. L. Ivanovskii often acts as the sole author. Although the majority of his papers are published in the Russian journals, the works of A. L. Ivanovskii are recognized and known worldwide in the scientific community.

It is significant that A. L. Ivanovskii often anticipated the growth of interest in new hot topics. Figure 4 demonstrates the number of the world publications (Scopus) in the main areas, where A. L. Ivanovskii investigated. As is seen, his papers represent avant-garde studies. This is most visually illustrated both by the abrupt boom in the investigations of magnesium diboride (MgB_2 curve) and by the growing interest in MAX phases (MAX-phase). The works of A. L. Ivanovskii devoted to nano-dimensional boron nitride (nano BN) and special endo- and exohedral forms of fullerenes (endo/exo-fullerene) are at the very beginning of the uprising trend. Naturally, the preliminary searches do not always end successfully. So, a growth in the interest to the oxypnictides (LaOFeX) as new promising superconducting materials is almost gone today. On the one hand, such analysis reveals a large insight of the scientist and his ability to foresee, if the interest in a topic in the world scientific community grows. On the other hand, with the erosion of interest in the topic, it illustrates the relevance of search and high complexity of potential topicality assessment. However, such work requires supreme organization since all resources in this direction should be mobilized over a short period of time. Besides, personal volitional powers of scientist are of much importance, since the already explored research areas have to be sacrificed for the

development of a new topic. In the judgment of his colleagues, it is exactly these qualities that were exemplified by A. L. Ivanovskii.

The presented bibliometric indices analysis of A. L. Ivanovskii's research activities is preliminary and is based only on the examination of statistical data from the global scientific and technical information resources. Undoubtedly, comprehensive evaluation of activities of a scientist calls for a more thorough and profound examination, compilation of a detailed bibliographic index of works, as well as analysis of scientific and organizational activities, involvement in grants (projects) and teaching experience. On the whole, the performed analysis reveals the pronounced characteristic features of Prof. A. L. Ivanovskii as a scientist – the ability to generate new ideas, to arrange team work and to organize effective cooperation. The publication activity of A. L. Ivanovskii shows that he was at the peak of possible work capacity and reached the maximum efficiency of his work as a scientist and an organizer. Unfortunately, many other problems of computational materials science will not be addressed by the researcher: his sudden and untimely death ended this important scientific activity.

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