Stanisław Jaśkowski: life and work

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Abstract. In this brief note we would like to outline the main events of life and the main achievments of Stanisław Jaśkowski (1906–1965) one of the important Polish logician and mathematician of the first half of XX century.

Keywords. Jaśkowski, natural deduction, nonclassical logics, decidability.

1. Life

Stanisław Jaśkowski was born on 22.04.1906 in Warsaw as a son of landowner Feliks Jaśkowski and Kazimiera Dzierzbicka. His family represented high standards of humanistic culture. In particular, his grandfather – Jan Nepomucen Jaśkowski – was a poet and a writer; his father was a musician. It was not surprising that his parents expected him to study on humanistic faculty. Despite family's expectations in 1924 Jaśkowski started studies in mathematic faculty of Warsaw University. As a result he became one of the representatives of Warsaw School of Logic. Among his teachers were Leśniewski, Tarski and Łukasiewicz, who had the strongest influence on his early development. In particular, Łukasiewicz had a direct impact on his first, and one of the most important logical contribution – the invention of natural deduction. It was Łukasiewicz who posed on his seminar a problem of providing a fully formal account of methods of proof applied by mathematicians in their practice. The first results of Jaśkowski concerning this problem were presented in 1926 on the seminar and then announced on the First Polish Mathematical Conference in Lwów in 1927 in: *Księga Pamiątkowa I Polskiego Zjazdu Matematycznego*, Uniwersytet Jagielloński, Kraków 1929 [8].

Because of the serious health problems with lungs Jaśkowski had a lengthy break in his education and scientific career. In 1929-1930 he was cured in Davos in Switzerland. After recovery he participated in the Second Polish Mathematical Conference in Vilnius in 1931 where he presented his first axiomatization of the geometry of solids based on the primitive notion of semispace. This work shows for the early origins of his second passion – foundations of mathematics.

In 1932 Jaśkowski gained his doctor's degree under the supervision of Łukasiewicz. The thesis [9], devoted to the presentation of the first system of natural deduction, was printed in 1934 as the first volume of "Studia Logica", the new journal edited by Łukasiewicz. Strongly delayed publication of his first, and one of the most important, discoveries was very unfortunate since in the same year Gerhard Gentzen published the first part of his own version of natural deduction [7] and Jaśkowski lost the priority. Moreover, in contrast to Jaśkowski's paper, Gentzen's work was soon widely known to logical community and made Jaśkowski's contribution relatively unknown.

In 1935 Jaśkowski took part in the International Congress of Scientific Philosophy in Paris where he presented important results concerning adequate matrix characterization for intuitionistic logic. This event was very important for his scientific development but 1937 was particularly important for his private life. Jaśkowski got married to Aniela Holewińska (1905-1976) a student of mathematics in Warsaw University. In 1939 their daughter Anna was born.

Till the September 1939 Jaśkowski continued scientific work, mainly on modal functions and logical systems based on the notion of dependent variable. This last contribution was very often applied in his later publications as a kind of methodological basis for studies on paraconsistent and causal logics. The Second World War interrupted his work on habilitation. Due to his health problems he was not admitted to the regular army. Still he served as a volunteer in the defence of Warsaw; he gave his car to the disposal of 151st Column of Heavy Trucks. During the Nazi occupation of Poland, he was living in his estate in Wolka near Rawa Mazowiecka and in Warsaw where he worked as a bookkeeper. He was also arrested for a few weeks in 1942. Almost all of his scientific manuscripts were lost during the Warsaw Uprising in 1944.

After the War Jaśkowski came back to scientific work. He was working for half a year as a lecturer in the newly founded Łódź University, then he moved to Toruń in where he lived and worked from 1.10.1945 until his death in 1965. Even when he was proposed to move to Kraków to became the Chair of Logic Department in Jagiellonian University after Professor Zawirski's death in 1949, he decided to stay in Toruń. Through the last 20 years of life he played a very important role as a scientist, a teacher, and an organizer in the development of the new Nicolas Copernicus University in Toruń. Concerning the last issue we list some of the most important facts. In 1945 Jaśkowski organised the Department of Mathematical Logic and was its first Chair. Untill 1965 he was the director of mathematical departments in Toruń University. In 1952-53 he organized the Faculty of Mathematics, Physics and Chemistry and was its first dean in 1953-54. In 1956-59 he was a deputy prorector for science and in 1959-62 the rector of Toruń University. One may also mention that he was a co-founder and the first president of Toruń division of the Polish Mathematical Society. Despite the numerous occupations in Toruń from 1950 he was also a member of the National Institute of Mathematics at the Polish Academy of Sciences.

He was also very active as a teacher. In the early years of its existence Toruń University had serious problems with completing qualified staff sufficient for providing all necessary courses. As a result, in addition to teaching mathematical logic Jaśkowski was forced to provide also courses in analysis, set theory, geometry, probability theory. In the last years of his life he was also strongly engaged in organization of computer laboratory; his last seminar was devoted to the theory of automated deduction.

In the meantime Jaśkowski finished his habilitation concerned with a new definition of real numbers under the supervision of Zygmunt Zawirski. The habilitation colloquium was conducted on 1.10.1945 and confirmed on 7.04.1946. He obtained the title of associate professor in July 1946 and in 1957 he was nominated a full professor.

One should also mention his efforts in preparation of a new modern programm of teaching mathematics in secondary school. The new syllabus was under a great influence of Jaśkowski's ideas of how to teach mathematics and was finally introduced in 1960s. Despite all these organizational and educational duties he was still active on the field of scientific research in logic and mathematics. Some of the most important achievements will be sketched in the next two sections.

Unexpectedly he fell ill with infectious jaundice in 1962 and this caused a lot of health complications. In consequence of postjaundice complications Jaśkowski died on 16.11.1965.

2. Works

The scientific activity of Stanisław Jaśkowski may be roughly divided into two overlaping fields: logic and mathematics. In what follows we briefly characterize his most important achievements. A deeper presentation of his scientific ideas may be found in [33], [35] and [34].

2.1. Logic

The invention of natural deduction systems, presented in [9], is the first of his logical achievements and it is often claimed as the most important contribution of Jaśkowski to logic. We do not attempt to describe his approach here since this is the subject of the special paper presented in this volume.

Jaśkowski was particularly active on the field of investigation on nonclassical logics. Not only he provided some results for already known logics like intuitionistic logic or modal logics. He was also the inventor of many new and important systems, in particular:

1. In his study on natural deduction [9] he constructed the first system of inclusive logic. This is a kind of first-order logic which admits models with empty domains in the semantics. Syntactically it is weaker than classical logic since some theses (valid for nonempty domains only) are excluded. Logics which are inclusive and additionally free, in the sense of having terms which do not denote existing things, are called universally free (see Bencivenga [1]). Such systems are very often

treated as philosophically more neutral basis than classical logic and commonly applied for constructing intuitively sound modal first-order logics (see e.g. Garson [6]). It should be emphasized that the first recognized systems of inclusive and free logics were proposed much later in 1950s by Mostowski, Leblanc, Hintikka, to mention just a few scholars. The fact that Jaśkowski constructed the first inclusive logic (and implicitly also the first universally free logic – see Bencivenga [2]) has gone unnoticed and, surprisingly, is still not very well known even for authors writing on Jaśkowski's achievements. We characterize briefly his approach to first order logic in the paper on natural deduction in this volume.

2. In the field of studies on intuitionistic propositional logic Jaśkowski provided not only a natural deduction system but also an adequate matrix characterization. In his famous result Gödel has shown that there is no adequate matrix for intuitionistic logic with finitely many values. Jaśkowski's study from 1930s shed a new light on this result by providing a recipe for construction of adequate matrix characterization of intuitionistic logic. The construction consists of the infinite sequence of finite matrices. It was presented on the International Congress of Scientific Philosophy in Paris and published in [10].

3. In [13] Jaśkowski provided a philosophical justification and a formal construction of discursive logic which was the first system of paraconsistent logic. In such logical systems the presence of contradictory statements does not lead to trivialization of the system, in contrast to classical logic where, by Duns' law, all propositions follow logically from contradiction. In his system D2, material implication is replaced with discursive implication which may be read: if the antecedent is possibly true, then the succedent is true (with possibility understood as in modal logic S5). This work was then extended in [21] where the notion of discursive conjunction was introduced. Jaśkowski developed discursive logic mainly as a tool for analysing the situation of contradictory views represented in discussion. Soon it appeared that many other serious motivations for developing such systems may be provided and it gave the impact for development of several paraconsistent logics.

4. Jaśkowski provided also the basis for the development of causal logic by means of dependent sentential variables, i.e. variables representing propositions whose truth depends on some arguments. The theory of dependent variables was first developed in [14] and applied to modal functions. In [24, 25] a theory of causal functions is introduced where three notions of causal implication are defined: factorial, efficient and definitive. This work of Jaśkowski is not widely known but the study on causal logic was continued by August Pieczkowski and Max Urchs.

His work on logic includes also some papers on classical logic and their fragments as well as on traditional logic. [15] is devoted to axiomatization of classical logic, definition of ternary connectives and reversible substitution. [30, 31] provides a decision procedure for some fragmentary propositional calculi. Finally [23] contains a new interpretation of Aristotelian syllogistics, where non-Aristotelian terms (empty and universal names) are admitted. In this study he proposed a way of interpetation of categorical statements in the first order-logic which keeps

all classical laws as valid even when non-Aristotelian terms are substituted for variables.

2.2. Mathematics

As a mathematician Jaśkowski was mainly interested in investigations on the foundations of mathematics. In fact, the border between his logical and mathematical works is very light since he always insisted on using logical tools in mathematics. In particular, he was working on the notion of number, foundations of geometry and decidability problems where he obtained both positive and negative results. Namely, he proved in [22] a decidability of the elementary theory of Boolean rings and generalised the method to elementary additive Boolean algebra. Above we also mentioned his decidability result for parts of propositional logic from [30, 31]. As for negative results, in [17] he proved that some interesting classes of formulas of theory of groups and topology are undecidable. He has shown that the theory of free grupoids is undecidable [28]. Also the abovementioned paper [22] contains a theorem of the undecidability of some class of equalities of Boolean algebras. Interesting results on the undecidability of some existential problems in certain system of differential equations are provided in [27]. All these studies show that Jaśkowski was able to apply logical tools to sophisticated mathematical problems of a great importance.

The investigation on the notion of number was the basis for Jaśkowski's habilitation and were summarised in [16]. He has shown that integers and real numbers may be defined in terms of some operations on the classes of sets.

Jaśkowski was also engaged in developing the geometry of solids which avoids ideal objects like points and straight lines. He was strongly convinced that such an approach is better for applications in quantum physics. In [19, 20] Jaśkowski modified Tarski's approach to geometry of solids and introduced the axiomatics based on the notion of "semispace" as primitive term in [12, 18]. He was preparing a book on the foundations of geometries but his premature death interrupted this work.

Last but not least, Jaśkowski was very active in educational sphere. He wrote two popular books on the geometry of ornament [26, 29] and prepared a textbook which may be seen as the first course on logic based on the application of natural deduction [11]. The latter will be treated in detail in the next paper in this volume. As for his books on geometry it must be emphasized that they show a great eductational talent of Jaśkowski. In a popular way, not demanding any mathematical knowledge from the readers, he presented many interesting issues from geometry illustrated with examples taken from science, history and art. He also shows how to apply an abstract mathematical theory of groups to a concrete problem like classification of ornaments.

He actively participated in the work on modernization of the program of teaching mathematics in secondary schools. The problem was widely discussed in several commisions organized by the Ministry of Education, the Institute of Pedagogics and the Polish Mathematical Society. Jaśkowski was very critical with

respect to the present state of the art. In his opinion the content of the present programm corresponds to the level which was obtained in XVIIth century mathematics before the achievements of Newton and Leibniz. The outcome of his activity in this field is a series of papers and communicates where Jaśkowski insisted that teaching mathematics should be based on the application of logical tools and closer to the application in science and technique. His postulates concerning the changes in teaching mathematics were used in the construction of the new syllabus which was put to work in 1960s.

3. Influence

Although Jaśkowski passed away so early and his list of publications is not particularly long[1] he had significant achievements in many fields: logic, mathematics, education and organization of science. The problem of his influence on the development of logic and mathematics is a complicated matter. In Poland Jaśkowski had a number of students (e.g. Lech Dubikajtis, Jerzy Kotas, August Pieczkowski) who continued his work and made at least some of his achievements better known. However, it should be underlined that his contribution to logic is very often not recognized. In addition to his premature death there were some other unfortunate circumstances connected with his scientific achievements. Almost all of his ideas and results become known to logical community in the World much later after they were introduced, sometimes long after his death. We briefly comment on three selected issues.

His invention of natural deduction was not only significantly delayed in print but even after 1934 it was not as widely known as Gentzen's approach. In fact nowadays many logicians writing on, or presenting some systems of natural deduction, even do not mention Jaśkowski. But in fact, his style of presenting proofs, as a series of subordinate derivations with several bookkeeping devices applied to separate the scope of assumptions is widely applied. We discuss these matters in the second paper, here we only mention that Jaśkowski introduced a graphical method of separating subproofs and a technique of prefixes. The former was then popularised by Fitch [4] and is nowadays commonly called Fitch-style natural deduction[2]. The latter may be treated as the first application of labels which is now widely used in logic to construct several kinds of proof systems[3]. Thus Jaśkowski, even if not explicitly mentioned, is the true father of numerous natural deduction systems presented in textbooks and applied in practice. Gentzen's approach, based on the application of trees as proof-structures, is rather connected with theoretical investigations in proof theory.

[1] The full list of Jaśkowski's publications has 48 items and may be found in [3].
[2] In fact Fitch mentioned Jaśkowski in the Preface to his textbook as a source of inspiration.
[3] See e.g. Gabbay's theory of labelled systems in [5].

Similarly, his system of inclusive logic, also presented in [9], was recognized as the first system of this type much later after the advent of studies on free logics[4].

The work on paraconsistent logics was also developed in early stages without any knowledge of Jaśkowski's work; his contribution was recognized much later. Still it seems that his invention of discursive logic is better known than any other of his achievements. In fact, both his papers on discursive logic were written in Polish and published in the journal of local character, so there was no chance to make them known to logical community immediately after publication. However, soon after the works of Jaśkowski, a serious investigations on paraconsistent logics was undertaken by a group of logicians from Latin America, in particular by Newton da Costa in Brazil and Florentio Asenjo from Argentina. Later, in 1960s, a similar research started in United States and in Australia (Michael Dunn, Rober Meyer, Richard Routley (Sylvan), Graham Priest and others), in strong connection with the investigation on relevant implication. Nowadays, paraconsistent logics form one of the most well known group of nonclassical logics with wide spectrum of applications. Fortunately enough Jaśkowski work in this field was continued by Jerzy Kotas who cooperated with Newton da Costa. It seems that this joint work made Jaśkowski's achievements widely known to the community of researchers in paraconsistent logic.

In general, the problem with the lack of propagation of Jaśkowski's achievements was mainly connected with the fact that his papers were published very often in the journal of local character, sometimes written in Polish. After the II World War Polish scholars had in general difficulties with dissemination of their ideas in the World due to the new geopolitical situation. It seems that Jaśkowski's case was not exceptional. Summing up, we can say that he had a strong influence on some domains of research in logic but usually it was not a direct impact. In most cases we may rather say about later recognition of his ideas.

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