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In memoriam Professor Vladimír Knichal

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IN MEMORIAM PROFESSOR VLADIMÍR KNICHAL

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VLADIMÍR KNICHAL was born in 1908. It was already during his secondary school years when his profound interest in mathematics, physics and chemistry became apparent. He studied mathematics and physics at Charles University in Prague in 1925–1930, devoting most of his time to the study of mathematics.

After graduating from the university he was till 1939 lecturer at the Department of Mathematics, Charles University. When Czech universitites were closed by the nazis during the World War II, he became teacher at secondary schools in Prague.

After the war he was appointed Professor and was affiliated with Brno University in 1945–49 and with Czech Technical University in Prague in 1949–53. In this period he was also scientific worker of the Mathematical Institute of the Czechoslovak Academy of Sciences, being appointed its director in 1954. In the year 1961 he was elected corresponding member of the Czechoslovak Academy of Sciences. Nonetheless, even during this period Prof. Knichal devoted much effort to the education of future mathematicians and engineers and to the solution of all problems connected with it. His close collaboration with universitites, especially with the Czech Technical University in Prague, took much of his time end energy.

His contribution to scientific, educational and organizing work in mathematics was appreciated by the Order of Labour in 1968. In 1973 he was awarded Bolzano Silver Plaque for his merits in the development of mathematics. Vl. Knichal remained head of the Mathematical Institute till 1972. Even then, when his vital power was being corroded by a severe illness, he devoted all his interest and effort to mathematics and to the institute.

He died suddenly on 1 November, 1974.

Scientific papers published by Vl. Knichal supply only a very incomplete and imperfect view of the span of his scientific interest and activities as well as his results.

Papers [A2] and [A5] concern the metric number theory and use Hausdorff measure to study number sets defined in terms of dyadic expansions.

Other three papers deal with the set A of continuous mappings of the interval $[0, 1]$ into itself with respect to the operation of superposition of mappings. Let us define that a set $X \subset A$ has Property $\mathcal{U}_i$ if to every sequence of functions $f_j \in X$,

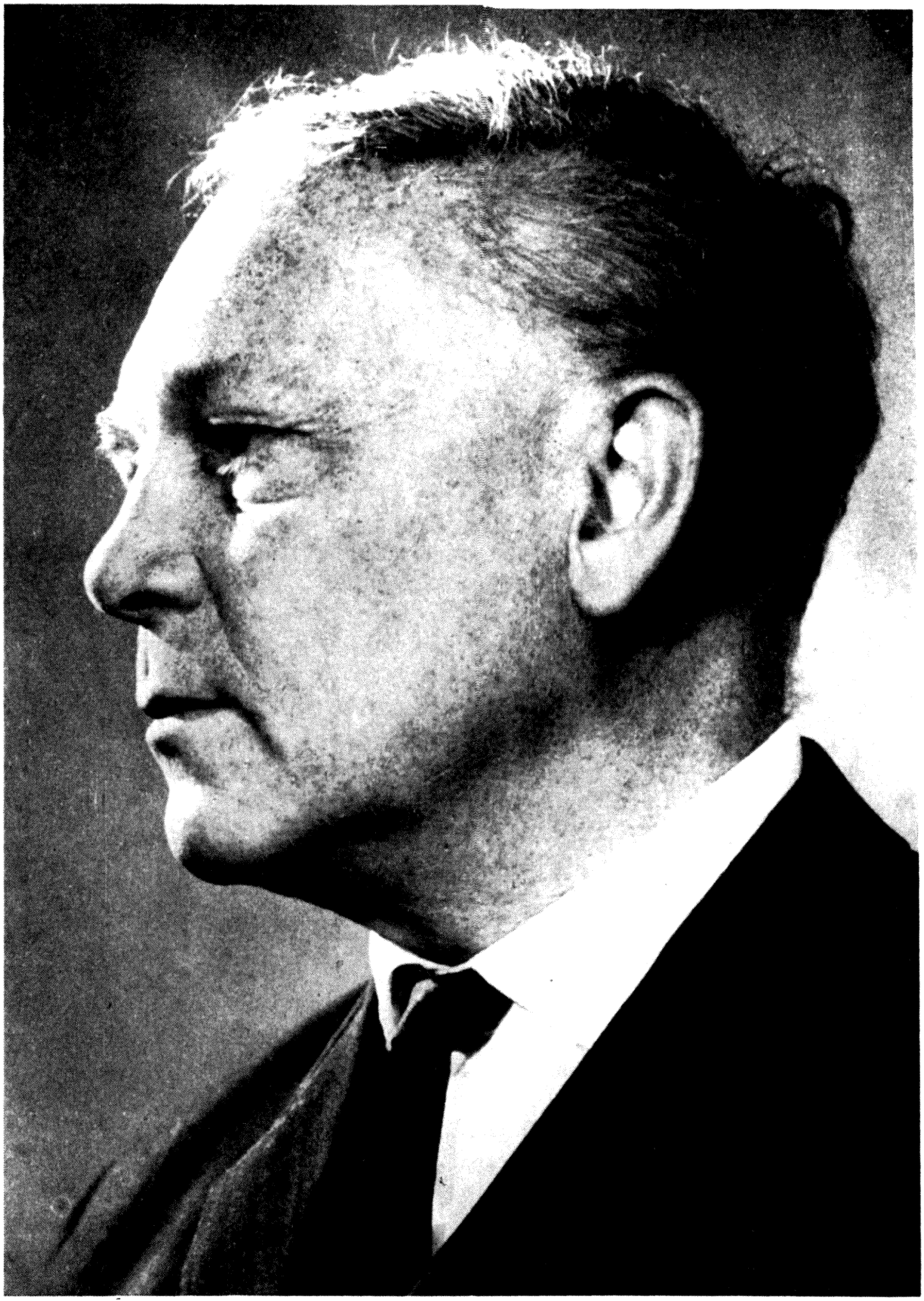
$j = 1, 2, 3, \ldots$ there exist functions $\varphi_1, \varphi_2, \ldots, \varphi_i \in X$ such that every function f_j of the given sequence is the superposition of a finite sequence formed of the functions $\varphi_1, \varphi_2, \ldots, \varphi_i$. A set $X \subset A$ has Property $\mathscr{V}_i$ if there exist functions $\varphi_1, \varphi_2, \ldots, \varphi_i \in X$ so that every function $f \in X$ can be approximated with arbitrary accuracy by a suitable superposition formed of $\varphi_1, \varphi_2, \ldots, \varphi_i$. It is easy to show that X has Property $\mathscr{V}_i$ if it has Property $\mathscr{U}_i$. The problem whether A has Property $\mathscr{V}_i$ for some i was answered by Schröder and Ulam in 1934: they proved that A has Property $\mathscr{V}_5$. Yet in the same year their result was strengthened by W. Sierpiński: he showed that A has Property $\mathscr{U}_4$. The final solution is given in [A3] by V. Jarník and Vl. Knichal: A has Property $\mathscr{U}_2$ but not Property $\mathscr{V}_1$. The same authors studied in [A4] the sets B, B_1 and C_1. B is the set of non-decreasing functions from A, B_1 is the set of functions from B possessing finite derivatives both from the right and from the left at every point, and C_1 is the set of increasing functions from B_1. It is proved in [A4] that both the sets B and B_1 behave analogously to the set A: they have Property $\mathscr{U}_3$ but not $\mathscr{V}_2$. Further, the authors show that C_1 has Property $\mathscr{U}_i$ for no i. Let finally D be the set of increasing functions from A with $f(0) = 0$, $f(1) = 1$. Schreier and Ulam proved that D has Property $\mathscr{U}_5$. Vl. Knichal went back to this result in [A6]; he proved that there exist φ, $\psi \in D$ such that every $f \in D$ can be approximated with arbitrary accuracy by a superposition of φ, ψ of the form $\varphi^n \psi^m$.

Papers [A8], [A9] and [A10] belong to the geometry of numbers. In [A8] Knichal found the abstract core of the theorem that to every λ, $0 < \lambda < 1$ and $M \subset R^n$ with positive inner Lebesgue measure $m_i(M)$ there exists $x \in R^n$ so that the number of lattice points included in the translated set $M + x$ is greater than $\lambda m_i(M)$. This theorem is due to H. F. Blichfeldt, a more general result was proved by C. Visser. (The function assigning to every set $M \subset R^n$ the number of lattice points included in M is obviously a measure.) Let us introduce only one of the number of results proved in [A8]: "Let T be a metric separable group. Let σ, τ be measures defined on the system of Borel subsets in T, $\sigma(T) = \tau(T) = 1$ and let Γ be a Borel subset in T. Then there exist elements α, β, α', β' from T so that $\tau(\Gamma\beta) \leqq \sigma(\alpha\Gamma)$, $\tau(\Gamma\beta') \geqq \geqq \sigma(\alpha'\Gamma)$."

An analogous result is shown in [A9] for the case when the group T of isometric transformations acts on the n-dimensional sphere $S_n \subset R^{n+1}$ and the Lebesgue measure is compared with an arbitrary measure on S_n.

The paper [A10] written together with V. Jarník considerably generalizes the fundamental theorem of geometry of numbers: the assumption of convexity of the set considered is omitted. Given $A \subset R^n$, let $\frac{1}{2}\mathfrak{B}(A) = \{x = \frac{1}{2}(u - v) \mid u, v \in A\}$. For $B \subset R^n$, $j = 1, 2, \ldots$ let $\tau''_j(B)$ denote the greatest lower bound of numbers $\alpha > 0$ such that the set $\bigcup_{\beta < \alpha} \beta B$ includes at least j independent lattice points. Let $m_i(B)$ denote the inner Lebesgue measure of B. The Minkowski theorem for convex symmetric bounded closed sets C such that $m_i(C) > 0$ implies

$$\tau''_1(C)\, \tau''_2(C) \ldots \tau''_n(C)\, m_i(C) \leqq 2^n .$$



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(Obviously $\tau''_j(C) = \inf \{\alpha > 0 \mid \alpha C$ includes at least j independent lattice points$\}$. In [A10], the inequality

$$(1) \qquad \tau''_1(\mathfrak{B}(A))\, \tau''_2(\mathfrak{B}(A)) \ldots \tau''_n(\mathfrak{B}(A))\, m_i(\mathfrak{B}(A)) \leqq 2^{2n-1}$$

is proved for any set $A \subset R^n$ with $0 < m_i(A) < \infty$. The estimate (1) is even a little strengthened and, on the other hand, an estimate from below for the least upper bound of the left-hand side with respect to the set A is found (this l. u. b. being greater than 2^n for $n > 1$). Knichal's results from the geometry of numbers are still referred to in literature: [A8], [A9], [A10] are quoted in the monograph Geometry of numbers (Wiley 1969) by C. G. Lekkerker, [A10] is quoted in O. H. Keller: Geometrie der Zahlen (Teubner 1954).

Uniqueness and existence of solutions of the system of linear algebraic and linear differential equations describing the behaviour of currents and voltages in a general electric net whose branches include linear elements of resistance, capacitance, inductance and mutual inductance as well as sources of alternating current, is proved in [A11].

Since his secondary school years, Vl. Knichal was deeply interested in understanding the essence of natural phenomena, particularly physical ones. During his university years he preferred the study of mathematics since he did not find the interpretation of foundations of physics exact enough at that time. However, he came back to reflect upon the mathematical approach to physical phenomena when teaching at secondary schools during the World War II, armed by both extensive and deep knowledge of mathematics. Systematically and during a long period he was engaged in the study of foundations of the theory or relativity. In the late 50's, he proved the following result: *In the space* R^{r+s}, $r, s = 1, 2, \ldots$ *let us introduce a quadratic form* ϑ *by*

$$\vartheta(x) = x_1^2 + \ldots + x_r^2 - x_{r+1}^2 - \ldots - x_{r+2}^2\,;$$

the number $\varrho^2(a, b) = \vartheta(a - b)$ *let be called the distance of* a, b.

Let $r + s \geqq 3$. *Let* f *be a one-to-one mapping of the space* R^{r+s} *onto itself preserving the nullity of the distance* (i.e., $\varrho^2(a, b) = 0 \Leftrightarrow \varrho^2(f(a), f(b)) = 0$). *Then* f *is a linear mapping.*

It is worth noticing that the assumption of continuity of the mapping is not present in any form. This theorem together with its detailed proof was given by Knichal in the Seminar on foundations of the theory of relativity held by himself in 1961 at the Faculty of Nuclear and Physical Engineering of the Czech Technical University. In the special case $r = 3$, $s = 1$ we obtain the characterization of Lorentz transformation. A communication presented on this special case at the World Mathematical Congress at Amsterdam in 1954 attracted well-deserved attention. However, Vl. Knichal never considered his work in this field completed and therefore it was never published. His aim was a general theory concerning essentially unique determination of the metric in curved spaces. Axiomatic approach to the theory of relativity, starting with simple axioms directly verifiable, should have been a special case.

Unpublished have remained also his original exposition of k-dimensional integrals on n-dimensional manifolds which was a topics of his lectures already at the Brno University in 1945–49, as well as his very interesting lectures on the conformal mapping read at Charles University in Prague.

Knichal devoted much time and painstaking labour to a number of problems from the field of applied mathematics. He tackled the problems always in all essential relationships. He studied patiently technical literature concerning the problem and had an extraordinary ability to find common language with the research workers who dealt with the problem from the technical view-point. He solved a number of problems from the theory of electric nets and contributed considerably to the solution of certain difficult problems from the theory of radiolocation. He investigated numerical methods suitable to determine the conformal mapping of a given domain and dealt with the application of computers even in those cases when the topological structure is not known in advance.

In the years 1973–74, Vl. Knichal was head of a group in the Mathematical Institute which designed the translator from FORTRAN for the Czechoslovak computer "Aritma 1010". This activity of his is an interesting and convincing evidence how Knichal kept himself up-to-date with modern methods, how he managed to use his mathematical versatility fruitfully even in such a specialized field of system programming as is the design of a compilator for which he devised a number of programs.

Vl. Knichal was appointed director of the Mathematical Institute of the Czechoslovak Academy of Sciences about a year after the foundation of the Academy. This was the period of creating and building of the institutes of the Academy and of their rapid growth. Knichal with full devotion absorbed himself in solving problems connected with the development of the Mathematical Institute. He was deeply convinced that the institute should be a research centre of the highest scientific level, working simultaneously on both the basic research within mathematics itself and on non-standard problems originated by the needs of other fields, and that it is this union of mathematical mind and creative work with the tasks coming from other domains of human activity which guarantees healthy development as well as the significance of mathematics.

Even during the period of his directorship of the Mathematical Institute, Vl. Knichal closely collaborated with the Prague Technical University. He was a co-author of a voluminous textbook of mathematics, delivered lectures, led seminars and, in 1961–64, was head of the Department of Mathematics, Faculty of Nuclear and Physical Engineering. He collaborated on curricula and syllabi which have been still used at the Faculty of Electrical Engineering. His activities as member of a number of scientific and applied-research boards and committees, as well as his participation in editing mathematical publications, represented a great amount of organizing work in science.

Vl. Knichal was an extremely modest man; he found time, advice, encouragement and often a joke for anybody who approached him. His passion to get at the bottom of things manifested itself even in practical details: he had the ability to force to obedience all sort of everyday technical stuff. His great love was the mountain-climbing. Also here he was one of those with "know-how". Rocks were the place where he found again freshness and strength to work. Czechoslovak mathematics and Czechoslovak science generally suffered a severe loss by his departure.

LIST OF PUBLICATIONS OF PROFESSOR VLADIMÍR KNICHAL

[A 1] Počet členů determinantů neobsahujících určité prvky, Časopis pro pěstování matematiky a fysiky, *55* (1926), 333—342.

[A 2] Dyadysche Entwicklungen und Hausdorffsches Mass, Věstník Královské české společnosti nauk, *14* (1933), 19 p.

[A 3] Sur l'aproximation des fonctions continues par les superpositions de deux fonctions (jointly with *V. Jarník*), Fundamenta mathematicae *24* (1935), 206—208.

[A 4] Sur les superpositions des fonctions continues non décroissantes (jointly with *V. Jarník*), Fundamenta mathematicae *25* (1935), 190—197.

[A 5] Dyadische Entwicklungen und Hausdorffsches Mass, Časopis pro pěstování matematiky a fysiky *65* (1936), 195—210.

[A 6] Sur les superpositions des automorphies continues d'un intervalle fermé, Fundamenta mathematicae *31* (1938), 79—83.

[A 7] O simultánním invariantu dvou kvadrik (jointly with B. Bydžovský), Rozpravy České akademie věd a umění, tř. II, *50* (1941), No. 21.

[A 8] Sur une généralisation d'un théoreme des MM. Blichfeldt et Visser dans la géometrie des nombres, Časopis pro pěstování matematiky a fysiky *71* (1946), 33—44.

[A 9] Sur la distribution des mesures sur une sphère à *n* dimensions, Časopis pro pěstování matematiky a fysiky *71* (1946), 45—54.

[A 10] a) K hlavní větě geometrie čísel (jointly with *V. Jarník*), Rozpravy České akademie věd a umění tř. II, *53* (1943), No. 43, 1—15.
b) Sur un théoréme de M. Minkowski dans la géométrie des nombres, Bulletin international de l'Academie des Sciences de Bohême, 1946, 15 p.

[A 11] O Kirchhoffových zákonech, Matematicko-fyzikálny sborník Slovenskej akadémie vied a umení, *2* (1952), 13—29.

[B 1] Matematika I, II (jointly with *A. Bašta, M. Pišl, K. Rektorys*), SNTL 1965, 1966.

[C 1] Cíle modernizace výuky matematiky z hlediska pokroku v matematice a z hlediska matematických aplikací, Matematika ve škole *15* (1964/65), 297—305.