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The eightieth birthday of Academician Otakar Borůvka

THE EIGHTIETH BIRTHDAY OF ACADEMICIAN OTAKAR BORŮVKA

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On May 10, 1979, OTAKAR BORŮVKA, member of the Czechoslovak Academy of Sciences, an excellent Czechoslovak mathematician, will be eighty.

Having completed his studies at the University of Brno, he became Assistant (in 1921), Assistant Professor (in 1928) and Professor (in 1934) at the same university. From 1926 to 1929 he studied in Paris, at the Sorbonne, with Prof. Elie Cartan and in 1930–1931 in Hamburg with Prof. W. Blaschke. In 1953 he was elected a corresponding member and in 1965 a member of the Czechoslovak Academy of Sciences.

The scientific work of Academician Borůvka covers extensive fields of mathematics. His excellent results and new methods concern the theory of graphs, differential geometry, algebra and the theory of differential equations. He substantially contributed to the development of all these areas and established research schools. During his pedagogical and scientific activity he taught numbers of mathematicians; most of the mathematicians in Moravia and Slovakia are his pupils or pupils of his pupils. His incredible enthusiasm for work inspired them in a very large range of problems especially concerning abstract algebra, differential geometry and the theory of differential equations.

Borůvka's works on classical analysis date mainly from the period 1923–1925. In his paper On a minimal problem (1926) he was a pioneer in transport problems, the area that many years later became an important part of the theory of graphs.

In his momentous works on projective differential geometry O. Borůvka was the first who studied analytic correspondences between two projective planes and discoverd their properties invariant with respect to pairs of transformations of the projective group. He founded a general theory of the normal curvature of surfaces in n-dimensional spaces with constant curvature and extended Frenet formulas for analytic curves in high dimensional parabolic Hermitian space. Borůvka's original study on projective differential geometry is in many respects continued by the research geometrical school in Bologna.

O. Borůvka was one of the main founders of the basic conception of general algebra. He established the theory of groupoids: his basic notions in this field made it possible to form deep and far reaching algebraic theories. He obtained, in a very

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natural way, the main group theorems when group axioms were added to those of the groupoid. This original approach enabled him to discover which notions and theorems on groupoids were suitable for generalization. That was later also accomplished and Borůvka's theory of groupoids has become one of the basic steps in founding the theory of general algebras.

While studying groupoids Borůvka also discovered the set theoretic background of many algebraic constructions and was the first to study set decompositions in such a connection. His theory of decompositions of sets includes basic ideas of a theory of scientific classifications. The results of Borůvka's work on groupoids are summarized in his book: *Foundations of the Theory of Groupoids and Groups*, published in German (1960), English (1974) and several times in Czech.

The essential part of Borůvka's work deals with differential equations. The research seminar he established in 1946 is still up-to-date. There he presented his most original and fruitful theory of global transformations of linear differential equations of the second order. In this theory he made use of his perfect knowledge of algebra and differential geometry to grasp the essence of transformations, to broaden and to deepen numerous classical concepts, to introduce many new ones and to discover, by their means, new and often surprising facts. The result is a qualitative theory of global character with a high degree of geometrization and algebraization, very rich in contents and in methods, yielding extensive applications. Borůvka summarized the basic principles and results of the modern theory in the book *Lineare Differential-transformationen 2. Ordnung*, published in German in Berlin in 1967, then in English in London in 1971. (See also the survey article in Russian [78] in Differencial'nyje uravnenija, Minsk). Numerous Czechoslovak and foreign authors exploit the results of his theory to solve different problems concerning not only equations of the second order but also of the higher ones.

Borůvka has extended and intensified his theory. In the last 10 years he introduced the notions of blocks of differential equations and inverse differential equations that have served him especially to extend Floquet's classical theory in case of equations of the 2nd order. Differential geometrical properties of continuous groups play an important part in his study of continuous one or more-parametric groups of dispersions of differential equations of the second order. This is only a brief review of the vast amount of problems which O. Borůvka has extensively dealt with lately as a leading scientific worker of the Mathematical Institute of the Czechoslovak Academy of Sciences, branch in Brno, and responsible for research work in the field of special properties of differential equations with respect to applications. His seminar on differential equations, where he continuously presents his latest results, is attended by mathematicians from Moravia and Slovakia with much interest as it always yields new ideas of research. O. Borůvka is also an outstanding pedagogue, well-known by his well prepared lectures and winning his auditors by his tireless diligence.

The importance of Borůvka's achievements is testified by the wide response they met with, as well as by a number of honours awarded him not only in this but also

in foreign countries: the medals of the universities in Brussels and Liège (1948), Euler's medal of the German Academy in Berlin (1957), State prize of Kl. Gottwald (1959), Euler's medal of the Academy of Sciences of the U.S.S.R. (1960), the honorary membership of the Czechoslovak Society of Mathematicians and Physicists (1962), the Medal of Jagellon University in Cracow (1964), Order of Labor (1969), the honorary doctorate of Comenius University in Bratislava (1969), Bolzano's golden medal of the Czechoslovak Academy of Sciences (1969), Golden Medals of Comenius University (1965), Palacký University (1968) and J. E. Purkyně University (1969) and the Prize of the Liberation of Brno (1968).

The assistance he was giving to the Bratislava University for more than ten years in addition to his duties in Brno is highly appreciated by the Slovak mathematicians as a substantial contribution to the development of mathematics in Slovakia.

The enumeration of honours should be completed by a number of invitations to universities in different European countries to give lectures on the results of his work: Brussels, Liège (1948); Warsaw, Cracow, Wroclaw (1953); Bucharest, Iaşi (1956, 1963); Paris (1961, 1968); Greifswald, Halle, Rostock (1962); Stuttgart, Tübingen, Giessen (1964); Roma (1967); London, Cambridge, Coventry (1968). In addition, Borůvka took an active part in many international conferences and congresses (U.S.S.R., Italy, England, Austria, Scotland, Rumania, Hungary, Poland, German Democratic Republic).

Academician O. Borůvka has also well deserved of establishing the Institute of Mathematics of the Czechoslovak Academy of Sciences, branch Brno and of founding the well-known mathematical journal, Archivum Mathematicum, issued by the Brno University since 1965.

Great love of work, an unbounded helpfulness, vitality and enthusiasm, originality of ideas and an inexhaustible scientific programme absorbing wider and wider areas, that is a short characterization of always optimistic Academician Otakar Borůvka at eighty.

On behalf of all Czechoslovak mathematicians we wish him favourable conditions, health and happiness for many coming years.

A. SCIENTIFIC PUBLICATIONS DURING THE LAST
TEN YEARS*)

[64] Eléments géometriques dans la théorie des transformations des équations différentielles linéaires et ordinaires du deuxième ordre. Atti del Convegno Internazionale di Geometria Differenziale (Bologna, 18—30, IX, 1967).
[65] Sur les solutions simultanées de deux équations différentielles de Kummer. IVème Congrès des mathématiciens d'expression latine et Commémoration d'Elie Cartan, Bucuresti—Brasov, 1969. Résumés, 3—4.

*) For the scientific publications ([1]—[63]) see Časopis Pěst. Mat. *84* (1959), 248—250 and *94* (1969), 244—247.

[66] Algebraic elements in the transformation theory of 2nd order linear oscillatory differential equations. Acta facultatis rerum naturalium Universitatis Comenianae, Mathematica *XVII* (1967), 27—36 (Bratislava).

[67] Geometric elements in the theory of transformations of ordinary second-order linear differential equations. Symposium of Differential Equations and Dynamical Systems. Mathematics Institute, University of Warwick, 1968—9, 19—22.

[68] Sur quelques propriétés de structure du groupe des phases des équations différentielles linéaires du deuxième ordre. Rev. Roumaine de Math. pures et appl., *XV* (1970), 1345—1356.

[69] Linear Differential Transformations of the Second Order. The English Universities Press, London, 1971, pp. 254.

[70] Základy teorie matic. Academia, naklad. ČSAV, Praha, 1971, pp. 177.

[71] Sur la périodicité de la distance des zéros des intégrales de l'équation différentielle $y'' = q(t) y$. Tensor, N. S., *26* (1972), 121—128.

[72] Foundations of the Theory of Groupoids and Groups. VEB Deutscher Verlag der Wissenschaften, Berlin, 1974, pp. 215.

[73] On central dispersions of the differential equations $y'' = q(t) y$ with periodic coefficients. Lecture Notes in Mathematics, 415. Ordinary and Partial Differential Equations. Proceeding of the Conference held at Dundee, Scotland, 26—29 March, 1974; pp. 47—60.

[74] Sur la structure algébrique de la théorie des transformations différentielles linéaires du deuxième ordre. Acta facultatis rerum naturalium Universitatis Comenianae. Mathematica XXXI (1975), 59—71 (Bratislava).

[75] Sur quelques compléments à la théorie de Floquet pour les équations différentielles du deuxième ordre. Ann. ed Mat. p. ed. appl., S., IV, *CII* (1975), 71—77.

[76] Sur les blocs des équations différentielles $y'' = q(t) y$ aux coefficients périodiques. Rend. di Mat., (2), S. V (1975), 519—532.

[77] Über die Differentialgleichungen $y'' = q(t) y$ mit periodischen Abständen der Nullstellen ihrer Integrale. Wissenschatliche Schriftenreihe der Technischen Hochschule Karl-Marx-Stadt, 1975. (5. Tagung über Probleme und Methoden der mathematischen Physik, 1975), 239—255.

[78] Теория глобальных свойств обыкновенных линейных дифференциальных уравнений второго порядка. Дифференциальные Уравнения, Минск, *12* (1976), 1347—1383.
In English: Theory of the global properties of second order linear ordinary differential equations. Differential Equations, *12* (1976), no. 8, 949—975 (1977).

[79] Contribution à la théorie algébrique des équations $Y'' = Q(T) Y$. Bolletino U.M.I., (5) 13-B (1976), 896—915.

[80] Algebraic methods in the theory of global properties of the oscillatory equations $y'' = q(t) y$. Proceedings of the Conference Equadiff IV. Springer-Verlag, 1979, 35—45.

B. OTHER PUBLICATIONS DURING THE LAST TEN YEARS*)

[42] Vzpomínka na českého matematika Matyáše Lercha. Pokroky mat., fyz. a astron., *XVII* (1972), 130—134.

[43] Několik vzpomínek na matematický život v Brně. Pokroky mat., fyz. a astron., *XXII* (1977), 91—99.

[44] Diferenciální rovnice v rámci dějin matematiky. Matematické obzory, *11* (1977), 1—10.

*) For the other publications ([1]—[41]) see Časopis Pěst. Mat. *84* (1959), 248—250 and *94* (1969), 244—247 where also further details on Acad. Borůvka's activity can be found.