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Editorial

Professor V.S. Ryaben'kii. On the occasion of the 90-th birthday

The work of Victor Solomonovich Ryaben'kii has had a lasting and profound impact on the formation and development of numerical analysis as a mathematical discipline the way we know it today. His distinguished scientific career spans the period of over sixty years during which he has made many fundamental contributions to mathematics and trained a number of PhD students who then went on to having successful independent careers of their own. He has also taught computational mathematics to generations of students at the Moscow Institute for Physics and Technology. This Special Issue of APNUM is dedicated to Professor V.S. Ryaben'kii on the occasion of his ninetieth birthday.

Victor Solomonovich Ryaben'kii was born on the 20th of March, 1923, in Moscow, USSR. In 1940, he went to Moscow State University to study at the Department of Mechanics and Mathematics. However, his studies were interrupted by the Nazi invasion of the Soviet Union in 1941. For more than three years, he fought against the Nazi Germany as a private in the combat armored units of the Soviet Army, and returned to the University in 1945 as a decorated War Veteran. After the graduation in 1949, Victor Solomonovich continued toward a PhD, which he received in 1953 under the supervision of I.G. Petrovsky. Since 1957, he has held various research positions at the Keldysh Institute for Applied Mathematics, Russian Academy of Sciences, where he is currently a Principal Scientist. Between 1964 and 2001, he was also a Professor at the Department of Computational Mathematics, Moscow Institute for Physics and Technology. In 1969, Victor Solomonovich defended a dissertation and obtained the degree of Doctor of Science in computational mathematics.

The main subject of Professor Ryaben'kii's research work in mathematics is the construction and analysis of numerical methods for the solution of partial differential equations (PDEs). In a 1952 paper that has become a part of his PhD dissertation *On the stability of finite-difference schemes and application of the method of finite differences to solving the Cauchy problem for systems of partial differential equations* (1952), he introduced the key concepts of consistency, stability, and convergence of finite-difference approximations to PDEs and analyzed the relations between those. This study has culminated in a famous theorem the simplified formulation of which is nowadays very well known: consistency and stability imply convergence. This apparently simple yet substantially very deep result was a major scientific breakthrough as for the first time ever it has enabled a clear theoretical understanding of the asymptotic properties of the process of error accumulation in numerical computations. It has quickly become a gold standard for the entire discipline of computational mathematics, and can now be found in any textbook on numerical analysis of PDEs. (In 1953–1954, Peter Lax used a somewhat different system of definitions and independently proved that for a consistent scheme stability is equivalent to convergence. The foregoing famous theorem has since been attributed to its originators — Peter Lax and Victor Ryaben'kii.)

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A natural extension of this work was another seminal contribution by Professor Ryaben'kii — the theory of stability for finite-difference approximations to initial boundary value problems that he has developed in the sixties (partially in collaboration with Sergey Godunov). This is a difficult and most delicate study that introduces a principal new concept of the spectrum of a family of operators (or pseudo-spectrum) and uses it to provide a revolutionary theoretical insight into what the notion of stability means for discrete initial boundary value problems (as opposed to pure Cauchy problems) and how it is related to the classical well-posedness results for evolution PDEs.

Victor Solomonovich's PhD thesis also gave rise to his subsequent work in approximation theory. As an instrument for the analysis of finite-difference schemes, he has built an algorithm for the polynomial reconstruction of a continuous function from its discrete data on the grid with a given degree of smoothness. This algorithm has later become a foundation of the method of piece-wise polynomial local smooth interpolation known as Ryaben'kii's local splines. They are used in a variety of applications including computer graphics.

In his Doctor of Science dissertation *Some questions of the theory of difference boundary value problems* (1969), Professor Ryaben'kii has laid the foundation of the entire new branch of computational mathematics — the theory of difference potentials. The method of difference potentials as a numerical method for solving boundary value problems has subsequently been developed by Victor Solomonovich himself and his students, and successfully applied to a broad variety of problems in fluid mechanics, wave propagation, and other areas. This is a very powerful and versatile numerical methodology that can maintain both high order accuracy and computational efficiency when using difference schemes on regular structured grids for solving boundary value problems on the domains of general non-conforming shape. Related to the theory of difference potentials was the pioneering work of Professor Ryaben'kii on the method of lacunae for hyperbolic PDEs. It has subsequently matured into a very efficient technique for the treatment of artificial outer boundaries and for stabilization of other methods over long computational times.

In recent years, the research interests of Professor Ryaben'kii have focused primarily on inverse problems, specifically, the problems of active control of sound. All of his prior accomplishments in the theory of difference schemes — stability, difference potentials, and lacunae, have proven very useful in this area. Their synergy led to the fundamentally new ideas and approaches for the solution of those classical problems.

In addition to his research contributions, Victor Solomonovich Ryaben'kii has developed a very original and elegant course on the foundations of numerical analysis and taught it for many years at the Moscow Institute for Physics and Technology. Altogether, Professor Ryaben'kii has authored and co-authored more than ten monographs and textbooks and over one hundred and forty research papers in computational mathematics and related areas. He has also supervised many MSc and PhD students, and two of his former students have obtained an advanced post-PhD degree of the Doctor of Science. Honoring Professor Ryaben'kii for his outstanding contributions to numerical analysis and great influence on several generations of mathematicians, we are wishing him to remain in good health and continue his interesting and deep work for years to come.

The papers appearing in this Special Issue were presented at the international conference *Difference schemes and applications* organized in May of 2013 at the Keldysh Institute for Applied Mathematics in Moscow, Russia, in honor of Professor Ryaben'kii's ninetieth birthday. The conference has brought together over one hundred fifty participants from different countries and featured about fifty oral and poster talks. It was generously supported by the Russian Academy of Sciences, International Association for Mathematics and Computers in Simulation (IMACS), North Carolina State University (NCSU), US Army Research Office (ARO), US Air Force Office of Scientific Research (AFOSR) via its European Office of Aerospace Research and Development (EOARD), and the Laboratory for mathematical modeling of nonlinear processes in gas media *FlowModellium* at the Moscow Institute for Physics and Technology. The organizers of the conference wish to express their deep gratitude to all the supporting agencies and parties.

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