

On the Occasion of the 70th Birthday of Vladimir Maz'ya

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This volume includes a selection of lectures given at the International Workshop “Analysis, Partial Differential Equations and Applications”, held at the Mathematical Department of Sapienza University (Rome, June 30th–July 3rd, 2008), on the occasion of the 70th birthday of Vladimir Maz'ya.

Besides Italy, twenty seven countries were represented there: Belarus, Canada, China, Colombia, Croatia, Czech Republic, Finland, France, Georgia, Germany, Greece, Israel, Mexico, New Zealand, Poland, Portugal, Rumania, Russia, Saudi Arabia, South Korea, Spain, Sweden, Taiwan, The Netherlands, Turkey, United Kingdom, and United States of America.

It is not surprising that the decision of the Italian National Institute for Advanced Mathematics “F. Severi” (INDAM) to dedicate a Workshop to Vladimir Maz'ya was crowned by such great success. The scientific and human endowments of Maz'ya are well known.

He has inspired numerous researchers in Analysis and its applications, among them many in Italy. Maz'ya gladly acknowledges that this inspiration has been mutual. The Italian school of Analysis and PDEs has played an important role in his development, starting with his undergraduate years 1955–1960 and continuing to this day. As a third year student, through S. Mikhlin's lectures, he became acquainted with Tricomi's pioneering work on multi-dimensional singular integrals [37], [38], a topic of Maz'ya's keen interest in the future ([14], [21] and others). A year later, Vladimir discovered the equivalence of various Sobolev type inequalities with isoperimetric and isocapacitary inequalities, which strongly influenced functional analysis and partial differential equations in subsequent years. In particular, he found the sharp constant in the E. Gagliardo inequality between the $L_{n/(n-1)}$ norm of a function and the L_1 norm of its gradient [10]. Later Gagliardo's results on boundary traces of Sobolev functions were developed by Maz'ya and his colleagues in various directions (see, for example, [24], [33], [34]).

Following Mikhlin's recommendation, Maz'ya read the Russian translation of Carlo Miranda's “Equazioni alle Derivate Parziali di Tipo Ellittico” [36], which had appeared in 1957 in Moscow. This comprehensive survey of the Italian contribution

to the field, which at that time was undergoing a major expansion, became the first book on PDEs to be read by the young Maz'ya. Miranda's book strongly influenced the shaping of Vladimir's professional interests. An evidence to this is his first publication which appeared in [9] exactly 50 years ago.

The year 1957 saw the appearance of the seminal article by E. De Giorgi on the Hölder regularity of solutions to elliptic second-order equations with measurable bounded coefficients, which had a tremendous impact on the theory of PDEs, not least the work of Maz'ya. In the article [11] of 1961, he solved a problem posed by G. Stampacchia on an estimate of weak solutions to the equations just mentioned. One of the original traits of this short paper was a characterization of the boundary in terms of an isoperimetric function introduced by the author, which enabled him to study the sharp dependence of the regularity properties of solutions to the Neumann problem on the behaviour of the boundary. A detailed exposition of this work, containing a wealth of new ideas, was published in [18], 1969.

In [12], 1963, Maz'ya obtained his famous estimate of the continuity modulus of a solution to the Dirichlet problem near a boundary point, formulated in terms of the Wiener integral (see also [15], [16]). Later, a result of the same nature was obtained by him for nonlinear equations including the p -Laplacian [19]. It is noteworthy that the classical paper by Littman, Stampacchia and Weinberger [8] on the Wiener regularity of a boundary point was translated into Russian by Maz'ya for the Moscow collection of translations "Matematika" from a preprint, even before its publication in a journal.

Of exceptional importance were Maz'ya's counterexamples relating to the 19th and 20th Hilbert problems for higher-order elliptic equations which appeared in [17], 1968, independently of and simultaneously with analogous counterexamples of E. De Giorgi and E. Giusti–M. Miranda.

The results of L. Cesari, R. Caccioppoli and especially E. De Giorgi on generalization of the notion of the surface area on nonsmooth surfaces played an important role in the pioneering research of Maz'ya and his coauthors in the theory of harmonic potentials on nonsmooth domains as well as in the theory of spaces of functions with bounded variation [1], [13], [2], [3].

Influence of G. Cimmino's results of 1937 [4] on the Dirichlet problem with boundary data in L_p as well as G. Fichera's unified theory of elliptic-parabolic equations [5] can be traced in Maz'ya's breakthrough work on the generic degenerating oblique derivative problem [20].

One of the fundamental results in the theory of partial differential equations, the C. Miranda–Sh. Agmon maximum principle for higher-order elliptic equations, was crucially developed by Maz'ya and his collaborators in several directions: polyhedral domains [23], sharp constants [22], parabolic systems [7].

The above, by necessity a rather incomplete survey, clearly shows that the Italian school stimulated the early work of Maz'ya in spite of the iron curtain. With time the contacts became bilateral and even personal. At the moment, Maz'ya is collaborating with a number of Italian mathematicians which can be seen, for instance, in some papers included into the present volume.

It is impossible in this short article to recall all Maz'ya's important achievements. In order to give an impression of the phenomenal variety of his results and without aiming at completeness we would like only to list certain fields he contributed to:

1. Equivalence of isoperimetric and integral inequalities
2. Theory of capacities and nonlinear potentials
3. Counterexamples related to the 19th and 20th Hilbert problems
4. Boundary behaviour of solutions to elliptic equations in general domains
5. Non-elliptic singular integral and pseudodifferential operators
6. Degenerating oblique derivative problem
7. Estimates for general differential operators
8. The method of boundary integral equations
9. Linear theory of surface waves
10. The Cauchy problem for the Laplace equation
11. Theory of multipliers in spaces of differentiable functions
12. Characteristic Cauchy problem for hyperbolic equations
13. Boundary value problems in domains with piecewise smooth boundaries
14. Asymptotic theory of differential and difference equations with operator coefficients



Accademia Nazionale dei Lincei, Rome. From left to right: Ennio De Giorgi, Gaetano Fichera, Vladimir Maz'ya and Giorgio Salvini (President of the Accademia).

15. Maximum modulus principle for elliptic and parabolic systems, contractivity of semigroups
16. Iterative procedures for solving ill-posed boundary value problems
17. Asymptotic theory of singularly perturbed boundary value problems
18. “Approximate approximations” and their applications
19. Wiener test for higher-order elliptic equations
20. Spectral theory of the Schrödinger operator
21. Navier-Stokes equations
22. History of Mathematics

On the occasion of Maz’ya’s 60th birthday, two international conferences were held, at the University of Rostock in 1998 and at the École Polytechnique in Paris in 1998. We mention also the Nordic-Russian Symposium which was held in Stockholm in honor of his 70th birthday in 2008.

The initiative to dedicate an INDAM Workshop to Vladimir Maz’ya came from the authors of this paper, former students of Gaetano Fichera. Maz’ya and Fichera first met in the USSR in the early seventies. A story of their friendship and mathematical interaction was recounted in Maz’ya’s article [25]. Together they wrote an article in honor of S. Mikhlin on the occasion of his birthday in 1978 [6]. Because of Maz’ya’s ability to give complete solutions to problems which are generally considered as unsolvable, Fichera once compared Maz’ya with Santa Rita, the 14th century Italian nun who is the Patron Saint of Impossible Causes.

We are sure that Vladimir Maz’ya has kept the energy of his younger age, and after nearly thirty published volumes and more than four hundred scientific articles, he is able to deal with his “impossible” problems. During the last decade he published five new books (see [B2], [B4], [B5], [B8], [B9] in the list of Maz’ya’s books), and more than 130 papers. In particular, recently Maz’ya obtained a breakthrough necessary and sufficient condition of Wiener type for regularity of a boundary point for higher-order elliptic equations [26], he had found several deep analytic criteria in the spectral theory of second-order differential operators [27], [30], [31], and solved a long-standing Gelfand’s problem concerning the discreteness criterion for the Schrödinger operator [28]. He has also found sharp two-sided estimates for the first eigenvalue of the Laplacian formulated in terms of the capacitary interior diameter [29], obtained a new class of uniform asymptotic approximations of Green’s kernels for singularly perturbed domains [32] and proposed an ingenious method for the asymptotic treatment of boundary value problems in perforated domains [35]. A joint book with A. Soloviev on boundary integral equations in domains with peaks will be published soon by Birkhäuser [B1] and an extended version of Maz’ya’s classical monograph on Sobolev spaces will appear in Springer.

We congratulate Vladimir Maz’ya with his birthday and wish him every joy, happiness and great fulfillment in the years to come.

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