



In Honor of the 60th Birthday of Professor Messoud Efendiev



When Messoud Efendiev was born in Zaqatala, Azerbaijan, in 1953, Mathematics was put into his cradle. That's figuratively speaking, of course, but it comes close to literal truth. His father Arif, a mathematics teacher at Zaqatala Highschool N1, subscribed to the well-known Soviet pedagogical journal "Matematika v Skole" (Mathematics in School), which provided Messoud early on exposure and access to the world of mathematics, and undoubtedly played an important role in his future intellectual development. In this journal, leading mathematicians in the USSR presented their ideas and advice how to enhance the mathematics curriculum in schools across the Soviet Union, and how to stimulate young talents to develop their mathematical interests. This certainly worked very well in Messoud's case. The Journal published Mathematics Olympiad challenges and mathematical questions from the International School Olympiad, which were probably the first serious mathematical undertakings that Messoud worked on, and with

which he primed his analytical thought processes and problem solving skills. Even after his father passed away in 1964, Messoud continued to receive and read this journal until he graduated from Zaqatala Highschool N3 in 1970. This rigorous training paid off and helped Messoud to become a winner of several highschool mathematics and physics olympiads, and he was awarded a gold medal, the highest distinction for highschool students then in the USSR.

It also set the course for his future professional and intellectual development. Upon graduating from highschool Messoud began his studies at Azerbaijan State University in Baku in 1970, but soon, in 1972/73, he moved to Lomonosov Moscow State University where world leading mathematicians such as A. N. Kolmogorov, I. M. Gelfand, O. A. Oleynik, Y. I. Manin, V. I. Arnold, B. V. Shabat, Y. G. Sinai, and M. I. Vishik (to name but a few, this is an incomplete list) were on the faculty at the time and were among his teachers. His diploma thesis on

topological methods in nonlinear analysis was supervised by Mark Vishik and Alexander Shnirelman. Communicated by academician Asraf I. Guseynov, the thesis was published in Doklady Akademii Nauk Azerbaidzhanskoi SSR in 1976, as Messoud's first scientific publication. He then stayed on at Moscow State University also for his Ph.D. thesis, which he wrote under the supervision of Alexander Shnirelman and academician Faramaz G. Maksudov, on topics of global solvability of nonlinear Hilbert problems (a.k.a nonlinear Riemann-Hilbert problems); it was defended in 1980.

In 1990, Messoud was the first Azerbaijani scientist to receive the prestigious Alexander von Humboldt Fellowship which brought him to Germany where he has lived and worked since 1991, first at University of Stuttgart where as a newcomer to the country he was taken under the wing by Wolfgang Wendland and Klaus Kirchgässner. From here he moved to Freie Universität Berlin, where he obtained his habilitation in 1998 with his thesis "*Geometrical properties of nonlinear mapping related to pseudodifferential operators and their topological degree.*" Then back again to Stuttgart, this time as the Managing Director of the DFG Collaborative Research Center 404 on Multifield Problems. From Stuttgart he moved to Munich, first as a visiting professor at the Technical University, and now as a staff scientist at the Helmholtz Zentrum, where his mathematical interests expanded to the applications of analytical methods to modeling problems arising in life sciences.

Over his career so far, Messoud Efendiev has made many important contributions in nonlinear analysis, complex analysis, topological invariants and the global solvability of nonlinear boundary value problems related to pseudodifferential operators, in particular, on the global solvability of classical nonlinear Riemann-Hilbert problems in multiple connected domains. His current research interests include infinite-dimensional dynamical systems (the dimension and asymptotics of Kolmogorov entropy of the attractors), and mathematical modeling in medicine, biotechnology and ecology, and the long-time behavior of these models. In this interface of dynamical systems and biological modeling, Messoud is a pioneer in developing the qualitative theory for parabolic systems of biofilm modeling that comprise porous medium like degeneracy and super-diffusion, the general approach to ODE-PDE coupled systems from the dynamical systems point of view, and some general results about attractors of parabolic systems and homogenization of attractors. He also contributed significantly to the development of a dynamical systems approach for nonlinear elliptic systems in bounded domains. His work on symmetrization and stabilization of solutions, using concepts such as trajectory attractors, is particularly important. Through the co-authorship of more than 160 papers and 5 advanced research monographs,

Messoud has earned his reputation as an international leader with fundamental contributions. The following list of his monographs is only a sample of the scope of his influence:

"Analysis and Simulation of Multifield Problems" (with W. L. Wendland), Springer-Verlag, 2003, 381 pages

"Fredholm Structures, Topological Invariants and Applications," American Institute of Mathematical Sciences, Book series, Vol. 3, 2009, 205 pages

"Finite and Infinite Dimensional Attractors for Evolution Equations of Mathematical Physics," Gakkotosho International Series, Tokyo, Vol. 33, 2010, 239 pages

"Evolution Equations Arising in the Modelling of Life Sciences," ISNM Series, Birkhäuser/Springer, Vol. 163, 2013, 217 pages

"Attractors for Degenerate Parabolic Type Equations," American Mathematical Society; Series Mathematical Surveys and Monographs, vol.192, 2013 267 pages

Messoud has been a main speaker at many prestigious international conferences and workshops including the Annual Meeting of the Japanese Mathematical Society, a rare honor for non-Japanese mathematicians. He has been invited to many research institutions in Asia, Europe and North America. In return, many internationally renowned mathematicians have followed his invitations to visit Germany, these include H. Berestycki, B. Perthame, F. Hamel, C. Stewart, P. Holmes, N. Dancer, M. A. Krasnoselskii, M. I. Vishik, J. F. Toland, M. Otani, C. Stuart, and N. Kenmochi. He has also attracted scientific visits to Munich, of eminent scientists in other fields, such as A. Warshel (shortly after he received the Nobel Prize in Chemistry in 2013). Given Messoud's engaging nature and personality, and his sometimes childlike excitement about almost everything in mathematics, it probably does not come as a surprise that these visits have often turned into fruitful collaborations. Our own experience might actually serve as good illustrations how this "Efendiev System of Unite and Conquer Friendship Based Collaboration" works:

JW met Messoud in Ottawa right after starting his academic career in Canada. They became instantaneously friends, partially because their common interest in nonlinear analysis in differential equations, but more importantly, as they later realized, because of their similar background, growing up in a different culture but not now immersed in an entirely different, namely Western, environment immediately after their PhD degrees. At that time, their poor and broken English did not prevent their sharing exciting observations how different cultures converge under the universal language of mathematics. They soon met again in Berlin, at one of the Equadiff meetings that Messoud

helped organize. Meanwhile, they had an additional tie through their respective fellowships of the Alexander von Humboldt Foundation (AvH), which helped them being connected ever since. Within the last year, through the support of the AvH foundation, JW visited the Helmholtz Zentrum München for several weeks, and Messoud spent three months at the Fields Institute and York University. This scientific exchange led to new collaborative work about the necessary and sufficient conditions for solutions of generic biological models (in the format of parabolic partial differential equations with delay) that might provide an important step to disprove mathematical models. Naturally, Messoud's passion about this issue infected many of the PhD students at York, which was a huge relief for JW at a time when he was fully involved in the thematic program Delay Differential Equations at the Fields Institute. Messoud spent a substantial amount of time working every spare minute on the problem with two of JW's exchange students at the York Institute for Health Research. The Institute actually had to make a special arrangement to allow, for the first time, a visiting scientist to have after hour access to the Institute, as Messoud insisted that he needed the office until 11 pm everyday.

HJE, on the other hand, met Messoud first in the early 2000s when Messoud, who was then working in Stuttgart, visited the Institute of Biomathematics and Biometry of what was then the GSF Research Centre in Munich and would become several years later the Institute of Computational Biology of the Helmholtz Zentrum and Messoud's place of employment. In his work on bacterial biofilms occurred a rather particular, highly nonlinear diffusion-reaction equation, for which even the question of well-posedness was far from being clear. After discussing this for two afternoons, Messoud disappeared, attending a workshop at Oberwolfach or somewhere else. When he returned after two weeks, he grinned and shouted in his clear and distinctive voice down the hallway: "I have great news! I talked to all the other experts in diffusion-reaction theory and nobody has ever seen a problem like this before, so if we find out only a little bit, then we can publish!" This was the beginning of an ongoing collaboration that meanwhile branched out into other problems in Mathematical Biology as well. In the early years, after HJE moved to Canada and before Messoud moved to Munich, parts of this collaboration took place in Messoud's living room in Stuttgart, where HJE would stop by on his visits to Germany, to discuss degenerate diffusion over Azerbaijani caviar and tea. Eventually this collaboration involved Messoud's PhD student at the time, Stefanie Sonner, who after defending her thesis has recently begun working with HJE's doctoral students, which carries this collaboration on into its second generation.

Messoud is known to put tireless efforts into supporting mathematical sciences. He has served on the editorial

boards of many international journals, such as *Advances in Mathematical Sciences and Applications*, *Journal of Coupled Systems and Multiscale Dynamics*, *Mathematical Methods in the Applied Sciences*, *Glasgow Journal of Mathematics*, *Journal of Nonautonomous and Stochastic Dynamical Systems*. He is on the editorial board of the American Institute of Mathematical Sciences book series *Differential Equations and Dynamical Systems*, and he is the Editor-in-Chief of the *International Journal of Biomathematics and Biostatistics*. His editorial appointments also included those for *Mathematische Nachrichten* and *DCDS-S*.

Further to this, Messoud has always played an active role in scientific and organizing committees of numerous conferences and workshops. He was the driving force behind two special joint German-Japanese workshops on "Evolution Equations, Related topics and Applications," jointly sponsored by JSPS and DFG in Munich (2009) and Tokyo (2012). Among his current endeavors is to develop a Canada-Germany training program in differential equations and scientific computation for life sciences, an effort to which with great success a senior partner, Professor Huaxiong Huang, was recruited. But as Messoud never stops, there is already the next-next thing on the horizon, a broad Azerbaijan-China-Germany collaboration.

While Messoud has lived in Germany, his "adopted country" as he puts it, for nearly 25 years by now, Messoud has always remained committed and connected to Azerbaijan, his "home country" of which he remained a citizen, and the people there. Sometimes, however, his allegiances are tested. When, in 2009, Azerbaijan's soccer team was up against Germany in the FIFA World Cup qualifier, he told us that he, a former player of his country's U16 national junior selection team himself, after some lengthy deliberation came to the conclusion that he must root for the underdog, the home country, also in the face of certain defeat in this case (he was right, Germany won twice clearly). More important for science in general and mathematics in particular, Messoud is always there to help and mentor young scientists from his home country, and from other parts of the former Soviet Union, to get a start on an independent and international career. Messoud is very proud of his experience, training, and accomplishments in Moscow, and whenever opportunities arise he tries to build strategic connections involving these countries. Messoud is also, both proud and humbled, to be the first Azerbaijani mathematician to be honored by a rare, week long international conference on the occasion of his 60th birthday, "Nonlinear Phenomena in Biology, Physics and Mechanics," which was held in Munich March 3–7, 2014, and drew speakers from Australia, Austria, Canada, Czech Republic, Denmark, Germany, France, Japan, Oman, Poland, Portugal, Russia, Spain, Switzerland, UK, USA, impressively demonstrating his worldwide network.

Messoud has an encyclopedic knowledge of mathematics, which shows best when he attends a seminar or conference presentation on virtually any mathematical topic. Typically he sits in one of the front rows on the side, from where he asks deep questions and, sometimes to the surprise of the lecturers and audience alike, often gives insightful answers and connects the topic at hand to seemingly unrelated problems in other branches of mathematics.

Messoud Efendiev turned 60 recently, but his childlike passion for mathematics and science remains at the 16 year

old teenager stage and his productivity keeps growing, so there is much more to come.

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