# Report of the Evaluation Committee for the promotion of **Doc. Roman O. Popovych, D.Sc.,**

to full professorship in the area Mathematics – Mathematical Analysis

The promotion procedure was started at the Mathematics Institute in Opava on September 5, 2022, in accordance with § 74 Art. 2 of the Czech Republic Law no. 111/1998 Coll. (the University Law). On September 15, 2022, the Scientific Council of the Mathematics Institute in Opava approved the Evaluation Committee consisting of

Prof. RNDr. Miroslav Engliš, DrSc., Silesian University in Opava – chair Prof. RNDr. Josef Mikeš, DrSc., Palacký University in Olomouc Prof. dr. hab. Adam Doliwa, University of Warmia and Mazury, Poland Prof. Robert Milson, Dalhousie University, Halifax, Canada Prof. Michael Oberguggenberger, Universität Innsbruck, Austria.

The Committee was subsequently appointed as approved. The Committee observed that the proposal fulfils all the requirements as stated in § 74 of the University Law, as well as all other conditions. The Committee proceeded to assess the qualifications of the applicant and issues the following report.

# 1. Personal data of the applicant

Name, surname:	Roman Omelyanovych Popovych
Affiliation:	Mathematics Institute, Silesian University in Opava
Born:	October 24, 1967
Address:	Komárovská 25, 74601 Opava
Citizenship:	Ukraine

University in Mariupol, Ukraine

# Educational history:

1989	equivalent of M.Sc. in Mathematics, Kyiv State University, Ukraine
1992	equivalent of Ph.D. in Mathematics, Institute of Mathematics,
	National Academy of Sciences of Ukraine, Kyiv, Ukraine
2009	D.Sc. in Mathematics, Institute of Mathematics,
	National Academy of Sciences of Ukraine, Kyiv, Ukraine
2017	Professor in the area of Mathematics, Institute of Mathematics,
	National Academy of Sciences of Ukraine, Kyiv, Ukraine
2019	habilitation (Doc.), Mathematics Institute of Silesian University in Opava,
	Czech Republic

# Employment history:

1992 – present	Junior Researcher / Researcher / Senior Researcher / Leading Researcher at the
	Department of Mathematical Physics (formerly Department of Applied
	Research), Institute of Mathematics, National Academy of Sciences of Ukraine,
	Kyiv, Ukraine
1993 – 1996	Senior Assistant Professor / Associate Professor, Pryazovskyy State Technical

2006 – present	Principal Investigator / Researcher / Visiting Research Fellow, Faculty of
	Mathematics / Wolfgang Pauli Institute, University of Vienna, Austria
2012 - 2013	Visiting Professor, Brock University, St Catharines, Canada
2016 - 2017	Visiting Researcher, Mathematics Institute, Silesian University in Opava
2018 - 2019	Visiting Researcher, Mathematics Institute, Silesian University in Opava
2022 - present	Docent, Mathematics Institute, Silesian University in Opava, Czech Republic

# 2. Pedagogical activity

Since 1993, the applicant has taught a number of regular courses during his employment at the Pryazovskyy State Technical University in Mariupol, Ukraine (1993 – 1996) and later at the Brock University in Canada (2013) in bachelor and master programs. He has been the supervisor or co-supervisor of 10 successful Ph.D. theses (7x in Kyiv, 2x in Vienna and 1x in Linköping), currently he is supervising 2 PhD theses in Kyiv and co-supervising another 2 at the University of Rwanda. A number of his doctoral students have achieved a very successful mathematical career (for instance A. Bihlo, a holder of Tier II Canada Research Chair, successfully defended his habilitation at the University of Vienna in 2020 and at present holds the position of Associate Professor and Canada Research Chair at the Memorial University of Newfoundland).

The applicant has also supervised 2 successful theses for the title of "Doctor of Sciences" (D.Sc.) at the National Academy of Sciences of Ukraine. In 2017, he was awarded the title of Professor in the area of Mathematics by the Mathematics Institute of the National Academy of Sciences of Ukraine.

In addition to his students, the scientific circle of collaborators, followers and other people whom the work of the applicant has significantly influenced includes also many authors from all over the world (D. Huang, M. Kunzinger, S. Meleshko, M. Oberlack, or C. Sophocleous, to name at least a few).

The applicant also gave numerous lectures at various scientific institutions abroad (e.g. in the last 5 years: Krakow, Poland; Trieste, Italy; St John's, Canada).

#### 3. Scholarly and research activities

The main field of research of Roman Popovych are Lie algebras and the symmetry analysis of differential equations, as well as related areas of mathematical analysis, differential geometry and mathematical physics.

His work is extremely aptly described in two of the recommendation letters, by Prof. Hydon and Prof. Olver. Dr. Popovych's most extensive research contributions lie in the application of group analysis to classification and solution of nonlinear partial differential equations. He wrote notable papers on the symmetry-based simplification of physical models and derivation of interesting explicit solutions, with a wide range of applications, including fluid mechanics, nonlinear waves, reaction-diffusion equations, meteorology, and turbulence modeling. One of his most interesting and innovative pieces of research lies in the construction of symmetry-based parametrization schemes and numerical solution methods for large scale systems arising in meteorology and turbulence modeling. Popovych and his collaborators argued that such parametrization schemes should, in addition, preserve intrinsic geometric structures, e.g. symmetries and conservation laws, enjoyed by the original physical system. This is an important insight, as confirmed by their analysis of some of the resulting models, and one that can be systematically exploited using the recently created mathematical machinery of equivariant moving frames. For example, their scheme for modeling the energy cascade in two-dimensional turbulence leads to new invariant models that exhibit noticeably better agreement with the experimentally measured energy spectrum. This is a remarkable achievement, bringing a new, promising mathematical theory to bear on an outstanding problem of contemporary science.

Another area where R. Popovych has made important contributions is the theory and classification of properties of low-dimensional Lie algebras. Most notably, he introduced the idea of megaideals, which are related to but different from the widely-used characteristic ideals. Megaideals greatly simplify the analysis of symmetries and equivalence transformations. Roman Popovych and his group have developed a megaideal-based approach that has at last made it possible to carry out a complete point symmetry analysis of equations that admit a Lie pseudogroup. This approach has revolutionized the classification of equivalence transformations; indeed, R. Popovych is currently regarded as a world-leading authority in such classifications. He has an unmatched publication record in symmetry-related classifications, with a strong focus on systems that have physical applications, particularly in fluid dynamics.

Yet another field where the applicant has left prominent mark is the problem of building given conservation laws into a non-variational system; this problem is an order of magnitude more difficult than building in symmetries. In 2020, R. Popovych and his collaborator A. Bihlo made the first substantial breakthrough in this hard but important problem. Their approach opens up the possibility of modelling dissipative systems (which include all systems in which entropy features) in a similar way to non-dissipative systems; this is a major advance, which is likely to result into a fruitful research direction for many years to come.

Symmetry analysis of partial differential equations includes the construction of reduced equations, which can yield exact solutions. An alternative route to constructing a reduction is to impose extra equations that make the combined system over-determined. If this system is nonlinear (as in the analysis of nonclassical symmetries), the analysis commonly becomes formidable. Dr. Popovych has developed a powerful way of dealing with such problems by classifying singular reductions. These fully take into account the complexities of the system, and produce a clear answer (for the first time) as to when reduction is possible without first solving the original problem. This new approach resolves a longstanding question in symmetry analysis.

The papers of Dr. Popovych are notable for their clear, careful exposition and impressive feats of calculation.

The applicant gave talks about his research results on numerous international conferences, including 17 where some or all the expenses were covered by the organizers (10x Cyprus, 2x Poland, Iran, Romania, Bulgaria, Serbia, Czech Republic). He is a member of editorial board of 3 international impact-factor journals published abroad, and his long-standing activities as journal editor have garnered international recognition and have contributed to the evolution of JMAA and SIGMA to the rank of top-tier publications in mathematical physics. He has also served as a member of organizing or scientific committee of international conferences in several countries, as

an opponent or committee member for habilitation procedures and Ph.D. or DrSc. defenses in Czech Republic and abroad (Ukraine, Austria), and as referee of many international journals.

#### 4. Publications

Dr. Popovych has authored or co-authored 78 papers in international journals, of which many are considered as prestigious by the mathematical community (e.g. J. Phys. A, Physica D, J. Math. Anal. Appl.), as well as 22 more papers in international conference proceedings. His papers earned more than 1100 citations according to WoS (without self-citations or citations by co-authors) and over 900 citations according to the MathSciNet database of the American Mathematical Society. These include more than 50 so-called qualified citations, where the citing author uses the cited result in an essential way.

## 5. Recommendations of independent experts

The applicant submitted recommendations in written form by the following experts:

Prof. Stephen Anco, Brock University, St Catharines, Canada Prof. Peter J. Olver, University of Minnesota, U.S.A. Prof. Peter E. Haydon, University of Kent, U.K.

*S. Anco* in his recommendation writes: "... He is widely recognized as one of the top leaders in mathematical analysis of partial differential equations, specifically in application of group methods, symmetry methods, and broadly related topics. ... Dr. Popovych can be expected to continue working at a world-class level for many years. He has many interesting ongoing projects that will lead to important advances in his field. His work has had a major impact, leading to several new directions of activity, which will continue to result in very strong publications and supervisions of excellent students.

Overall, I give my strongest possible recommendation for Dr. Popovych in the position that he is seeking."

From the recommendation of *P.J. Olver*: "… In summary, Popovych is a highly regarded and original researcher in symmetry methods for differential equations and their use in an impressive range of applications. In my opinion, his research contributions constitute one of the most exciting and innovative enterprises in contemporary applied symmetry methods. He has spearheaded a productive and innovative research team, producing many important papers. He will be a wonderful asset for the faculty in Opava, and hence his application for a professorship has my complete support."

From the recommendation of *P.E. Hydon:* "... Over the last three decades, Prof. Popovych and his group have produced a remarkable body of work, principally classifications for systems that are used widely around the world. Such classifications can be highly complex; indeed, he has uncovered errors in the literature where others have been less careful. His research activity covers the whole scope of symmetry analysis, so my comments have focused on highlights rather than everything he has achieved.

I recommend Roman Popovych most strongly for the title of Professor at your university. Someone with his research achievements alone (not taking into account his services to the academic community) would certainly merit that title at my university."

#### Conclusions

The Committee observes that the promotion of Doc. Roman O. Popovych, D.Sc., to full professorship was started in accordance with § 74 of the Czech Republic Law no. 111/1998 Coll. (the University Law). The applicant submitted written supporting recommendations from three outstanding scholars. The Committee further observes that R. Popovych has gained international recognition for his scholarly work in the area of mathematical analysis. He has long been active as university teacher and Ph.D. supervisor or co-supervisor both in his home country and abroad. The Committee observes that R. Popovych fulfils all the requirements as stated in §74 of the University Law as well as the conditions for promotion to full professorship in mathematical disciplines set by the Scientific Council of the Silesian University in Opava. Therefore,

# the Committee unanimously recommends to promote doc. Roman O. Popovych, D.Sc., to Full Professor in the area of Mathematics - Mathematical analysis

and presents this proposal to the Scientific Council of the Mathematics Institute in Opava for further proceedings.

Opava/Olomouc/Olsztyn/Halifax/Innsbruck, December 19, 2022

Prof. Miroslav Engliš

Prof. Josef Mikeš

Prof. Robert Milson

Prof. Adam Doliwa

Prof. Michael Oberguggenberger