

## Opponent report on the habilitation thesis of Roman Popovych, D.Sc.

I know Dr. Roman Popovych quite well. I have been reading his publications and following his talks at conferences. I have had many scientific discussions with him, in particular during his visit to the CRM in Montreal where he was invited by my colleague George Patera. His ex-student Alex Bihlo was my post-doctoral fellow for two years. A. Bihlo and I published an article together. That having been said, I have never actually collaborated nor published with Roman Popovych and do not consider myself as being in conflict of interest.

R.Popovych has so far published 47 articles since 1999. All of his publications are on symmetry analysis of differential equations and he is a well-known expert in this field. His habilitation thesis includes the reprints of 5 of his articles, all published in leading international journals. Many of his other publications are mentioned and discussed in PART I of his thesis. Part II is the backbone of the thesis and consists of the reprints of T1,.. T5.

Three of the attached reprints (two of them in collaboration with M.Kunzinger) are devoted to the reduction of partial differential equations (PDEs) to PDEs with fewer independent variables, to ODEs or to algebraic equations. The symmetries he uses in these articles are not the standard Lie point symmetries but “non-classical symmetries” first introduced by Bluman and Cole in 1969. These symmetries became popular in 1989 after Clarkson and Kruskal introduced their “Direct reduction method” and Levi and Winternitz pointed out the relation between the direct method and non-classical symmetries. There are two problems with these non-classical, or “conditional symmetries”.

1. For many PDEs they are equivalent to point symmetries. 2. The determining equations for them are themselves nonlinear PDEs.

These two problems are addressed in the papers [T1], [T2] and [T3] in a mathematically rigorous and fruitful manner. The authors introduce “singular reduction operators” and use them to obtain no-go theorems on the existence and calculability of conditional symmetries. The articles T1 and T2 are devoted to two-variable first and second order PDEs respectively, T3 to systems of PDEs.

R.Popovych has contributed significantly to the fact that nonstandard or conditional symmetries have become a valuable tool in symmetry analysis.

The article T4 published in 2008 is devoted to potential conservation laws introduced by Bluman et al in the context of nonlocal symmetries of differential equations. Popovych rigorously proves a series of rather technical results involving

potential conservation laws and provides examples of their usefulness. In particular this article gives useful and practical criteria for the characteristics of potential conservation laws to depend only on local variables.

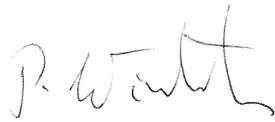
The last article T5 reproduced in the thesis is by R.Popovych and his then student Alex Bihlo. It is more directly an applied mathematics article than the previous ones and is devoted to the parameterization problem in the equations of meteorology and climate research. The physical problem is to replace some unknown or poorly measured quantities figuring in the equations of meteorology by their better measured average values.. Popovych and Bihlo propose to do this in a very innovative manner that preserves the Lie point symmetry group of the original equations, or at least some physically important subgroup. This work and related papers by R. Popovych and collaborators are highly relevant for numerical solutions of nonlinear equations and lie within the realm of “geometric integration”.

My overall impression is that Roman Popovych is becoming one of the leading figures in symmetry analysis. He is quite prolific (47 articles in 20 years). His articles have a lot of substance and impact. The impact is best measured by references to his work. Again according to Web of Science his most quoted article (published in J.Math.Phys. 37, 7547, 2004 and not included in the habilitation thesis) has 88 citations, 5 of his articles have more than 60 citations and his h-index is 19 i.e. 19 of his articles have more than 19 citations. This is a very respectable record for a mathematical physicist of his age.

Further impact is in his students. At least two of the students he has produced or coproduced, namely A.Bihlo and Olena Vaneeva have distinguished careers of their own. For instance Alex Bihlo is now a regular faculty member at Memorial University in Canada and holder of a very prestigious and much coveted Canada Research Chair. Roman Popovych is also one of the associate editors and founders of one of the leading electronic journals in mathematical physics, namely SIGMA.

His scientific achievements, originality, physical intuition and enthusiasm make him an excellent candidate for a position in any university department interested in applied mathematics, theoretical physics or computer science.

I strongly recommend that he be awarded the rank of “Docent”. Moreover I hope that this is a meaningful procedure and that he actually becomes a Docent in the Silesian University or some other institution in the Czech Republic.



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