

M U N I
S C I

Report on the Habilitation thesis

*”Exact spacetimes in theories
beyond general relativity”*

by

Robert Švarc

Robert Švarc’s habilitation thesis has following structure. It contains an introduction text together with the the collection of nine papers that were published in prestigious physical journals. This form of habilitation thesis is in agreement with the paragraph 72 of the law number 111/98 Sb.

In the first section author nicely outlines why he studies exact solutions of Einstein gravity and its generalization. He also explains methodology that is used in his research. Then author reviews basic facts about general relativity and its generalization which are modified theories of gravity and pure quadratic theory of gravity. After this introduction section R. Švarc continues with the presentation of his own treatment of these theories that is original and brings new important results. Explicitly, in the section named ”Geometries admitting privileged null congruences” he introduces the concept of algebraic structure of the Weyl tensor and its algebraic classification scheme that is based on the boost-weight decomposition. Note that this analysis was presented in three papers published in per-reviewed journals. Then it was shown

an importance of geometries that admit non-twisting null affinely parametrized geodesic. These geometries have an interesting property that they can be parametrized by adapted coordinates as a consequence of the null foliation of manifold. Again, this is useful approach how to study various general geometries, where these backgrounds have possible applications in temporary modern physics as for example exact models of gravitational waves.

After this detailed introduction to the null foliation of manifold author continues with the analysis of the exact space-times. In the first part he implements Newman-Penrose formalism to the case of quadratic gravity in four dimensions. This is new and interesting result which was published very recently. Then in the second part he describes an importance of geodesic deviation in the study of gravitational field. He firstly analyses the geodesic deviation equation on general level and then focuses on its analysis in the context of non-twisting geometries. This part is very important for an understanding of possible observable effects in spherically symmetric solutions of quadratic gravity and Kundt spacetimes solutions in the Einstein-Gauss-Bonnet theory.

The introduction part of thesis is finished with conclusion where author outlines his achieved results and suggests possible directions in his further research. I appreciate that author states many new open problems that deserve to be solved which promises new interesting results to be found.

The second part of the thesis is then filled with nine original papers that R. Švarc published with co-authors in journals with high impact factors. These papers are divided into four parts. Section A1 contains three papers that are devoted to mathematical methods and general concepts. Then in section A2 four papers are included where spherical solutions in quadratic gravity are studied. Section A3 contains one paper that studies problem of decreasing entropy of dynamical black holes in critical gravity while the last section A4 contains paper where Kundt spacetimes in the Einstein-Gauss-Bonnet theory are analyzed.

It is no doubt that all these papers are scientific interesting, well written and certainly are very useful for people working in given area. On the other hand there is one important point which should be addressed by author and this is related to his own contribution to these papers. All these papers have been written by more authors and according to order of their names stated below paper's title R. Švarc was the first author in two cases only. For that reason I mean that it would be nice if he could clarify his own contribution to these projects in the discussion during defense of this thesis.

Conclusion

I recommend thesis „Exact spacetimes in theories beyond general relativity“ by Robert Švarc to the Habilitation Committee at the Faculty of Mathematics and Physics of Charles University as a work that fulfills all requirements for habilitation and I support the nomination of Robert Švarc for associate professor. Finally I would like to stress that Turnitin analysis gives 33% overall match that is appropriate for the habilitation thesis of this form.

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