DALHOUSIE UNIVERSITY

DEPARTMENT OF
MATHEMATICS
AND STATISTICS

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Report on the Habilitation Thesis of Dr. Otakar Svítek entitled:
"Beyond symmetric solutions in general relativity"

This Thesis is in the domain of theoretical and mathematical physics and the main focus of the Thesis concerns "less symmetric" exact black hole solutions in general relativity and inhomogeneous cosmologies.

The introduction and connecting materials are very well written, helping to motivate the habilitation thesis and provide a nice (and unifying) connection between all the nine published research papers included in the report, and as listed on p153 (hereafter I will refer to them numerically as papers P1-P9). In general, they are all good papers, comprehensive and well written. They cover a wide variety of topics and are written with a variety of coathors. They all appear in good and very good journals. I am familiar with many of the areas considered in the Habilitation Thesis.

I have gone through the check of originality of the thesis done by the system Turnitin and it is clear that the thesis represents an original work with the negligible overlap with the existing literature written by the author.

In the first part of the thesis a very clear description of Robinson-Trautman (RT) spacetimes is presented, a topic on which the author has done a lot of (extensive) work. In particular, papers P1 and P2 below are very good (and appeared in Phys Rev D). P1, which is quite short, presents an explicit family of solutions within the RT class with a non-aligned scalar field. The mathematical properties of the solutions obtained are studied, which includes a very interesting analysis of the nature of the horizon. P2 is quite technical and considers some interesting special cases not considered in P1 and includes an investigation of their asymptotic behaviour. P3 presents the study to explicit RT solutions with electromagnetic field field satisfying non-linear field eqns using a straightforward extension of the methods in the previous papers. P4 deals with wormholes in RT spacetimes.

The next two papers concern inhomogeneous cosmological models. In P5 a comprehensive analysis of Szekeres models was given, and initial data was presented for such cosmologies that do not lead to a shell crossing singularity (and the behaviour of the density contrast was studied). Although the paper contained a fair amount of review and the analysis was relatively straightforward (and I did not follow all of the results presented), I did find the work very interesting and useful. In P6 (19p in CQG), the quasi-local horizon in inhomogeneous cosmologies (and particularly generalizations of spherically symmetric models to Szekeres-Safron models) was investigated, which included lots of details regarding the existence and the geometry of the horizons. The analysis was technical and comprehensive, but it was difficult to ascertain any real physical conclusions.

There next followed 2 very good papers on averaging in cosmology. In P7 (11p in CQG) a new approach to averaging in GR using Cartan scalars was presented. After an extensive review, which contained a very good and well written introduction (although some statements could have merited a more mathematically rigorous justification), the Cartan scalars of an FLRW and a simple LTB model were computed . The approach was developed very well. I thought that this paper was very good, although perhaps the (simple) applications were a bit disappointing. I don't think I have seen any follow up work building upon this paper. In P8 Buchert's averaging approach was generalized to the LRS class II dust

models (and especially LTB-like models), including again an extensive overview of the background material. A numerical analysis was used to compute the cosmological backreaction, and some qualitative results were presented (e.g., it was found that the averaging of the shear is more important than that of the expansion). I thought that this was also a very good paper, but again the applications were somewhat simplistic.

In the final P9 (18p in CQG -- the most recent paper included), a systematic procedure to retrieve the time like dust metric from a null dust RT metric was presented. This was a comprehensive paper, but rather technical.

In summary, the Habilitation Thesis is well written, and the published papers are well researched and referenced and contain some impressive mathematical and technical results. The papers span a broad range of topics and some of the papers are very good. The citations to the papers are rather modest and support the opinion that the results have had some impact within the mathematical community, but that perhaps they have not led to many new physical insights or applications.

Sincerely yours,

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