

Referee report on the doctoral thesis

Title: Application of algebraic classification and related methods to problems of higher-dimensional relativity

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In his doctoral thesis, Tomáš Tintěra studies two interesting applications of the higher-dimensional Newman-Penrose formalism and the Weyl tensor algebraic classification extensively developed in the past two decades.

The thesis consists of a brief introduction summarizing the crucial concepts, two chapters representing the original results, a conclusion with the outlook of possible further extensions, and an appendix deriving specific useful results.

The first original part is devoted to the Kaluza–Klein reduction which relates two spacetimes of different dimensionality. For vacuum spacetimes and reduction by one spatial Killing direction, the mutual relations between geometric quantities of both spacetimes are found. The main achievement is the formulation of necessary and sufficient algebraic conditions under which the Kaluza–Klein lift preserves the Weyl alignment type. A minor part of this chapter's results was published in conference proceedings, while their complete form has recently appeared on the arXiv together with the submission for publication in a scientific journal.

In the second original chapter, the author provides constraints on the optical matrix of a null geodesic congruence in the algebraically special six-dimensional Einstein spacetime. This generalizes the results of the classical four-dimensional Goldberg–Sachs theorem. However, the author had to deal with enormously higher amounts of technical difficulties and the necessity of employing more advanced mathematical concepts. The results were published in the *General Relativity and Gravitation* journal.

The thesis is carefully written with a minimum number of only minor typos. The style is formally mathematic which is sometimes at the expense of readability, however, it is fully appropriate to present the obtained results. I have not found any mistakes.

In my opinion, the performed research and its presentation are of high quality, and the thesis fully satisfies the requirements for a doctoral thesis at the Faculty of Mathematics and Physics of Charles University. I am thus happy to recommend its acceptance as the doctoral thesis.

I would like to ask the following questions:

- In section 2.5, there is a remark about a Kaluza–Klein lift of Kundt spacetimes. Could you comment on a lift of the Robinson–Trautman spacetimes?
- To extend the results of chapter 3 for algebraically more special type III will require other Bianchi equations. Could one anticipate that they remain algebraic constraints for the optical matrix, or should we expect some additional difficulties?

In Prague, March 5, 2023

RNDr. Robert Švarc, Ph.D.