

Thesis Review

Faculty of Mathematics and Physics
Charles University in Prague

- Supervisor's Review Referee's Review
 BSc. Thesis Diploma Thesis

Author: Martin Krššák
Thesis title: On higher dimensional Kerr-Schild spacetimes
Study program: Physics / Theoretical Physics
Submitted: 2009

Referee: doc. RNDr. Jiří Podolský, CSc., DSc.
Affiliation: Institute of Theoretical Physics, MFF UK

Thesis quality (technical field and expertise):

- excellent very good standard substandard nonconforming

Objective accuracy (error appearance):

- nearly perfect standard frequent, but minor serious errors

Thesis results:

- original both original and compiled productive compilation copied

Thesis length:

- large standard just acceptable insufficient

Thesis quality (style and grammar, and graphic arrangement):

- excellent good standard substandard nonconforming

Misprints:

- negligible acceptable number very frequent

Overall thesis quality:

- excellent very good standard substandard nonconforming

Referee's Comments:

The author investigates the general family of Kerr-Schild spacetimes in an arbitrary dimension. The thesis represents an interesting contribution to the contemporary research on higher dimensional gravity. It is well-written (despite some number of language mistakes and typos) and well-organized. Main results are summarized in useful tables (e.g., the rotation coefficients on page 25, general components of the Riemann and Ricci tensors on pages 28 and 29, review of various notations in Appendix A, etc.).

Chapter 4 contains original results obtained for vacuum Kerr-Schild spacetimes. All non-expanding solutions are shown to be equivalent to type N Kundt class. Using various tricks, Einstein's equations for expanding spacetimes are simplified, and several attempts to solve them are made using certain additional assumptions. In particular, the Schwarzschild-Tangherlini black hole solutions, black strings and black p -branes are recovered for the non-twisting case. Another interesting specific result is the proof that all components of the curvature tensor decay as r^{1-n} , where r is the affine parameter along the privileged null congruence. Therefore, there is no peeling and the spacetimes are not radiative.

Questions raised (and to be answered by the author during the thesis defence):

1. What is the 1-form $d\Theta$ in (1.11)? There also seems to be a missing square in (1.12).
2. Correct the typo in (1.17) and (1.22).
3. Why do the indices in the n -tuple range from 1 to $n-1$ (page 10)?
4. The summation indices with hats have different fonts, e.g., in (2.4), (2.6), (2.13), (2.14), (2.22), (2.26), etc. It would be better to unify them (normal roman fonts with hats?).
5. The functions z_i with the hat above i , introduced in (2.22) and (3.5), are not explained in the table on page 58. In particular, it should be explicitly said, what is the difference (if any) between z_i with a normal index i , and z_i with the hat above i . What is the difference between these function in (4.34) and (4.35)? Similar problem also occurs in expressions (4.125)-(4.131).
6. Is there a summation in the expressions (2.42) and (2.49)?
7. The definitions of u and v in (3.4) are opposite to the definitions given in (1.11).
8. Strictly speaking, the symbols $0, 1, i, j$ in the tables on page 25 should also have hats.
9. There seems to be a missing minus sign in (4.5), see (2.40).
10. Is it true that all vacuum non-expanding Kerr-Schild spacetimes are necessarily type N Kundt spacetimes with vanishing scalar invariants (VSI), as written at the end of Sec. 4.2?
11. One of the headings "Non-degenerate" on page 37 is wrong. This must be corrected.

Supervisor's recommendation on Thesis rating:

excellent very good standard reject

Prague, Sept 6, 2009

doc. RNDr. Jiří Podolský, CSc., DSc.