Report on "Selected exact spacetimes in Einstein's Gravity" by RNDr. J. Ryzner

Referee: David McNutt

The focus of the doctoral thesis is to construct exact solutions of Einstein-Maxwell and Einstein-Maxwell-dilaton equations which admit axial symmetry along with a discrete translational symmetry along an axis. Two possible approaches are presented to construct these solutions. The first examines the Einstein-Maxwell equations and employs the metric anzatz for the Majumdar-Papapetrou (MP) spacetime and Weyl spacetime. In the second approach the solutions are found via dimensional reduction from a higher dimensional spacetime, in this case five dimensions, using the higher dimensional metric form of the MP spacetime. Following the construction of the solutions, the author examined their geometries, horizons, singularities and the motion of charged test particles within the solutions.

The results of this doctoral thesis are an important contribution to the study of locally non-homogeneous spacetimes which necessarily recover homogeneity at large scales. Due to the non-linear nature of the field equations the determination of such exact solutions is a difficult matter. Although the solutions themselves are rather idealized, they provide an avenue to explore the implications of local inhomogeneity on the asymptotic structure of spacetime. While the approaches used in the thesis have been discussed in the literature, the author has found new and interesting solutions. In addition, the construction of these solutions and the examination of their properties proves the author's ability for creative scientific work.

The thesis is well-written and the calculations leading to the results are clearly explained. However there are some minor points that could be clarified. These points are attached on the following page.

Dr. David D. McNutt, Ph. D
16th of August, 2020

Technical Points

- On page 3, footnote 1, The author should clarify the term 'degenerate' or mention that the sources are expected to be Reissner-Nordstrom solutions with M=Q.

- On page 6, in the sentence following equation (24), the origin of the lapse function should be clarified.

- On page 17, what does "extremally overcharged" mean in this context?

- On page 54, following equation 4.10, μ is defined but the symbols do not appear in 4.10.

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Typographical Issues

- The author should consistently use either Ric_{ab} or R_{ab} to denote the Ricci tensor.

- The scalar $\mathcal{K}$ in equation 39 should be named. Is this the Kretschmann invariant?

- What is ∇_{n_δ} in equation 1.8?

- Page 70, in equation 5.10, is this little o or big o notation?