

Posudek vedoucího disertační práce

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The thesis is a compilation of the last 4 years of our joint work with Jiří Ryzner. Jiří's starting point was an attempt to find a discrete structure where one could tune its parameters in such a way that in the limit the corresponding solution of Einstein-Maxwell equations would approach a field that we had studied previously—an infinitely thin and long string with an equal charge and mass per unit length. Since this spacetime belongs to the Majumdar-Papapetrou class it is natural to start from the same group of solutions, which describes a static equilibrium between electric charges and masses. For a finite number of black holes, the problem has been studied and solved by Hartle and Hawking in 1972 but Jiří had to deal with an infinitely long structure consisting of extremally charged black holes, basically an infinite string of black-hole beads. He investigated several cases involving identical or alternating black holes and also a distribution of charged dust. He showed that the infinite sums appearing in the metric were uniformly convergent so that Einstein-Maxwell equations were satisfied. He then proceeded to explore the geodetic structure, horizons, singularities, and asymptotic properties of these solutions. In the final chapters he used a different approach that allowed him to avoid the infinite sums: the method of dimensional reduction enables one to produce a 4D spacetime starting from a symmetrical 5D solution of Einstein-Maxwell equations. Jiří applied it to a 5D Majumdar-Papapetrou solution describing again a string of extremally charged black holes. Remarkably, the corresponding infinite sums have a closed form which translates into 4D as well, at the expense of an additional scalar field. Jiří again explored the geodesics, singularities, and asymptotics of the resulting 4D spacetime. He concluded the thesis with a comparison of all the studied spacetimes and an appendix summarizing the definitions and theorems required to treat the mathematical aspects of the discussed solutions.

During our collaboration Jiří was always able to come with innovative solutions to the problems we faced, applying mathematical theorems he had learnt during his studies years before then, but never losing sight of the underlying physics. I believe Jiří complied with the assignment and submitted an interesting work, proving his capacity to work independently and to contribute to the future scientific research.

Based on the above assessment and my personal experience working with Jiří Ryzner, I recommend accepting the presented work as a doctoral thesis at the Faculty of Mathematics and Physics of Charles University.

V Praze dne 16.8.2020

