16 May 2022

Report on the PhD thesis by Eliska Polaskova, "Properties and interpretation of black hole spacetimes"

The thesis studies several limits of the Kerr-NUT-(A)dS spacetime, where some or all spin parameters are equal. By introducing an appropriate notation, the author explains the limiting procedure clearly and provides the explicit form of the metric obtained by the limit. The author also shows that the spacetime obtained by the limiting procedure has an enhanced symmetry.

For experts in this area, it seems natural from a physical point of view that taking the limit of equal spins of a rotating black hole leads to an enhanced symmetry. The case when all spin parameters are equal was shown by Gibbons, Lu, Page, and Pope (see Ref. [15]). Yet, it is valuable to clarify and perform the limiting procedure and to show an enhanced symmetry explicitly. It is especially emphasized that coordinates employed in the present thesis are rather complicated to take the limit of equal spin parameters. Nevertheless, the calculation is well organized.

The present thesis is interesting from the aspect of hidden symmetry. In the limit of equal spin parameters, the principal tensor degenerates. Spacetimes admitting a degenerate principal tensor were studied by Houri, Oota, and Yasui (see Ref. [53]), where it was shown that the complete integrability does not hold in general. However, the author reconstructs Killing vectors and tensors on the limiting spacetime and shows that by performing the limit of equal spin parameters, the complete integrability inherits. The originality of this result is sufficient for a PhD thesis.

I would like to ask the author the following questions:

(i) In Chapter 4, the author focuses on the case when all spin parameters are equal in $D=2N$. This looks the same as [15]. However, the author does not give any comment on Ref. [15]. Is there any difference between the results of the present thesis and Ref. [15]?

(ii) I guess the $D=2N+1$ case could be studied quite similarly to the $D=2N$ case. I would like to ask why the author did not work on the $D=2N+1$ case? I think the author should have addressed the case.

However, the questions above do not affect the quality of the present thesis. And, throughout the thesis, no inaccuracies were found. Therefore, I can recommend that this thesis deserves a PhD thesis.

Dr Tsuyoshi Houri

National Institute of Technology, Maizuru College

234 Shiroya, Maizuru, Kyoto, 625-8511 JAPAN