Review of: "Einstein-AdS gravity coupled to nonlinear electrodynamics, magnetic black holes, thermodynamics in an extended phase space and Joule—Thomson expansion"

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Review of the article titled "Einstein-AdS gravity coupled to nonlinear electrodynamics, magnetic black holes, thermodynamics in an extended phase space and Joule—Thomson expansion" Preprint v1

This article deals with the study of Einstein gravity coupled to Nonlinear Electrodynamics (NED) in 4-dimensional Anti de-Sitter (AdS_4) spacetime. As a result, a magnetic black hole solution as a correction to Reissner–Nordstrom solution is presented and some thermodynamic properties such as the first law of black hole thermodynamics and also the generalized Smarr relation for the case are confirmed. The similarity of the equation of state of the black hole with the liquid-gas van der Waals equation of state is also shown. The Gibbs free energy and heat capacity are calculated and local stability of the black hole and the first and second order phase transitions are also discussed. In addition, from the Joule–Thomson isenthalpic expansion of the black hole, cooling and heating phase transitions are showed.

A few points about this article are noteworthy:

- Although the topic of the article is interesting and important and it is also written almost well, but it should be noted that this article is a continuation of a series of similar works in the same topic by the author, and especially it is slightly different from the previous published article of the author in "Int. J. Geom. Meth. Mod. Phys. Vol. 20, No. 01, 2350008 (2023)" (arXiv:2210.10627) and so, it seems that it cannot be considered as an independent article. Therefore, I suggest that the author explicitly and clearly specify the difference between this work and the previous similar works of the author, and also define the new results.

-Although the necessary materials have been provided during the extraction of formulas and analysis, it seems necessary to pay attention to the clarity and readability of the text. For examples, what is the quantity "J" in the formulas? Or, regarding the extraction of relation (17) with respect to (15), it seems that a better explanation is needed; Or, a reference for the Hawking temperature (19) is missing and so on.

As the same way, how to realize the claim that the resulting black hole has one or two event horizons is practically ambiguous from the diagrams and so, it is better to clarify how one or two event horizons in Figure 1 are realized, and also the Inflection/critical points and phase transitions in Figures 3-5.

Likewise, the author's claim that the resultant spacetime is non-singular needs further exploration. The dynamical

stability of the black hole and also similarity of black hole thermodynamics with van der Waals liquid-gas thermodynamics seem to need a more detailed and deeper investigation as well.

- It seems better to mention the original motivation for including NED in the introduction. The importance of AdS NED black holes should also be sufficiently explained. It is also better to include references for newer and richer related studies and also possible extensions.

- Especially considering the reference in the introduction about the connection of physics in AdS with CFT and its application to condensed matter physics, it is better to mention references for it. In particular, it is good to future investigate the field theory duals of such solutions in the framework of AdS_4/CFT_3 correspondence, e.g. similar to Reference [10], and also realization of the bulk AdS_4 solutions from a higher dimensional Kaluza-Klein reduction.