

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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Potential competing interests: No potential competing interests to declare.

Non-linear electrodynamics is increasingly popular as a field of study in gravitational physics, in part because it yields different spacetime structures. This paper works within this vein, and as such is well-motivated. However the paper could be improved in a number of ways that I shall now outline.

First, it is not clear why a magnetic charge is required. An electric charge yields the same result if the sign of β is flipped. This point should be commented on. Likewise some commentary as to the reason for the particular choice (2) of NED would be helpful.

It is also not clear what is meant by the magnetic energy in (11), nor by the magnetic mass. The authors have computed this quantity, but have not explained its meaning or origin.

Third, the authors show that the metric is non-singular. This is correct, and is an interesting feature of non-linear electrodynamics. However the metric also has an inner horizon. This is known to be generally unstable to a mass-inflation singularity. I expect this cannot be prevented for this class of black holes; at the least it should be investigated, and comments about the non-singular nature of the metric should be made cautiously in view of this.

Concerning the equation of state and phase behaviour, the upper right panel of figure 2 indicates that there is a phase transition for a certain choice of parameters within a narrow range. Although there is a swallowtail in figure 1, there is not a phase transition since the global minimum of the Gibbs free energy is on the part of the curve beneath the swallowtail. That said, the authors have missed an opportunity here — as the pressure increases from .001 to .002 (panel 1 to panel 2), there will be a large - small - large reentrant phase transition. The authors should explicate this behaviour.

Finally, the english grammar is in need of some improvement, though I recognize that this is not the first language of the authors.