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The Nielsen-Olesen vortex coupled to Einstein gravity in AdS_3

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We consider Nielsen-Olesen vortices (abelian Higgs model in $2+1$ dimensions) under Einstein gravity in an AdS_3 background. We find numerically non-singular solutions characterized by three parameters: the cosmological constant Λ, the winding number n and the vacuum expectation value (VEV) labeled by v. The mass (ADM mass) of the vortex is expressed in two ways: one involves subtracting the value of two metrics asymptotically and the other is expressed as an integral over matter fields. The latter shows that the mass has an approximately n^2v^2 dependence and our numerical results corroborate this. We observe that as the magnitude of the cosmological constant increases the core of the vortex becomes slightly smaller and the mass increases. We then embed the vortex under gravity in a Minkowski background and obtain numerical solutions for different values of Newton's constant. There is a smooth transition from the non-singular origin to an asymptotic conical spacetime with angular deficit that increases as Newton's constant increases. We end by stating that the well-known logarithmic divergence in the energy of the vortex in the absence of gauge fields can be seen in a new light with gravity: it shows up in the metric as a $2+1$ Newtonian logarithmic potential leading to a divergent ADM mass.

In-person participation

No

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