Phase transitions for charged planar solitons in AdS

Andrés Anabalón [1], Patrick Concha [2], Julio Oliva [3], Constanza Quijada [3*], Evelyn Rodríguez [2]
[1] Departamento de Ciencias, Facultad de Artes Liberales, Universidad Adolfo Ibáñez, Av. Padre Hurtado 750, Viña del Mar.
[2] Departamento de Matemática y Física Aplicadas, Universidad Católica de la Santísima Concepción, Alonso de Ribera 2850, Concepción.
[2] Departamento de Física, Universidad de Concepción, Casilla 160-C, Concepción.
*constanquijada@udec.cl

Abstract

The AdS/CFT correspondence plays an important role in the study of phase transitions in strongly coupled field theories. As shown by Hawking and Page in [1], there is a phase transition between spherical AdS black holes and the thermal AdS spacetime. In the field theory side, the Hawking-Page transition has been shown to capture many features of the confinement-deconfinement phase transition [2]. It has been shown in [3] that there are no phase transitions between the AdS black hole with Ricci-flat horizon and the global AdS spacetime, if the latter is taken as the background. Using the AdS soliton of Horowitz and Myers as the thermal background, it was found that there is a phase transition for AdS black holes with Ricci-flat horizon [4].

We investigate the phase transitions that occur between the four-dimensional charged planar black holes and charged planar AdS solitons. For this purpose, we consider the planar soliton as the thermal background. The aforementioned soliton is obtained as a double analytic continuation of the metric of the planar charged black hole, which also involves analytically continuing the electric charge. We show that, in four dimensions, there are phase transitions between both solutions depending on the electric potential ϕ, magnetic flux Φ and temperature β^{-1}. Interestingly, we show that there is a critical value for each of the aforesaid quantities for which the phase transitions can take place. Naturally, for a vanishing magnetic flux we recover the results presented in [5] in which a phase transition at zero temperature occurs for a particular value of the electric potential. The novelty of our result appears when the magnetic flux is switched on. Indeed, a phase transition also occurs at zero temperature between the charged AdS soliton and the uncharged AdS black hole for a particular value of the magnetic flux. Interestingly, in presence of both electric potential and magnetic flux, we show that there are phase transitions at zero temperature for a family of values of both quantities. In particular, we obtain a first order phase transition curve at zero temperature depending on the magnetic flux and electric potential.

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