Iranian Journal of Physics Research, Vol. 20, No. 2, 2020

Topological black hole chemistry in massive gravity with power-Maxwell invariant field

A Dehghani and S H Hendi

1. Department of Physics,School of Science, Shiraz University, Shiraz, Iran
2. Biruni Observatory, School of Science, Shiraz University, Shiraz, Iran

E-mail: hendi@shirazu.ac.ir

(Received 13 June 2019 ; in final form 26 May 2020)

Abstract

In this paper, asymptotically AdS black hole solutions of massive gravity in the presence of a nonlinear electromagnetic field arising from the power theory of Maxwell invariant are investigated and the associated Euclidean on-shell action is presented. By using the Euclidean on-shell action, the gravitational partition function in the canonical ensemble is computed in arbitrary dimensions; then, thermodynamic quantities of the topological black holes are obtained. By extending the thermodynamic phase space, i.e., treating the negative cosmological constant as thermodynamic pressure, the first law of thermodynamics and the associated Smarr formula are examined. Next, the equation of the state of topological black holes is obtained, proving that the critical point equation of these solutions can exhibit black hole phase transitions similar to those of van der Waals, van der Waals like and solid/liquid/gas (related to triple point) phase transitions in the usual thermodynamic systems. Especially, the van der Waals phase transition is observed in $d \geq 4$; van der Waals type phase transition can also be seen in $d \geq 6$ and phase transitions associated with the triple point, i.e., small/intermediate/large black hole phase transition, may happen in $d \geq 6$ dimensions.

Keywords: black hole chemistry, massive gravity, power theory of Maxwell invariant

For full article, refer to the Persian section