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Thermodynamics, magnetic properties, and global U(1) symmetry breaking of the S-type Gubser-Rocha model

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We study an explicit formula for the thermodynamic potential of the AdS dyonic black brane solution with an axio-dilaton hair, which was discovered in an extension of the (3+1)d Gubser-Rocha model enjoying S-duality. From the thermodynamic potential, we compute the magnetization and the magnetic susceptibilities of the dyonic solution. The result of the magnetization is negative implying that the system is diamagnetic. Subsequently, we consider a specific neutral limit of the dyonic solution. In this setup, we find that the system exhibits spontaneous breaking of a global U(1) symmetry. The order parameter is given by a complex operator which is dual to the axio-dilaton field in the bulk. Interestingly, the system has a finite Hall conductivity even in the absence of the external magnetic field, and it is related to the phase of the complex operator.

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