p-wave Holographic Superconductors and five-dimensional gauged Supergravity

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We explore five-dimensional ${\cal N}=4$ $SU(2)\times U(1)$ and ${\cal N}=8$ SO(6) gauged supergravities as frameworks for condensed matter applications. These theories contain charged (dilatonic) black holes and 2-forms which have non-trivial quantum numbers with respect to U(1) subgroups of SO(6). A question of interest is whether they also contain black holes with two-form hair with the required asymptotic to give rise to holographic superconductivity. We first consider the ${\cal N}=4$ case, which contains a complex two-form potential $A_{\mu\nu}$ which has U(1) charge ± 1. We find that a slight generalization, where the two-form potential has an arbitrary charge q, leads to a five-dimensional model that exhibits second-order superconducting transitions of p-wave type where the role of order parameter is played by $A_{\mu\nu}$, provided $q \gtrsim 5.6$. We identify the operator that condenses in the dual CFT, which is closely related to ${\cal N}=4$ Super Yang-Mills theory with chemical potentials. Similar phase transitions between R-charged black holes and black holes with 2-form hair are found in a generalized version of the ${\cal N}=8$ gauged supergravity Lagrangian where the two-forms have charge $q\gtrsim 1.8$.

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