On the current flow in superconductors: universal trends and holographic analysis

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The superconducting state can be destroyed by the increase of temperature, magnetic field or current flow beyond their critical values. The critical current I_c is of special interest as most of the practical applications of superconductors crucially depend on its limiting value. Recent analysis of experimental data in many families of superconductors have discovered [1] an interesting universal relation between critical current, critical magnetic field H_c and the penetration depth λ. Using the holographic analogy we have calculated the temperature dependence of the critical current in strongly coupled superconductors [2]. It turns out that the calculated critical current dependence on temperature in 2d systems is $I_c \propto (T_c - T)^{3/2}$ and agrees with observed in thin films. Similar calculations for 3d systems reveals linear T-dependence $I_c \propto (T_c - T)^1$.

References:

[1] E. F. Talantsev and J. L. Tallon, *Universal self-field critical current for thin film superconductors* Nat. Commun. **6**, 7820 (2015).
[2] M. Rogatko and K. I. Wysokiński *Condensate flow in holographic models in the presence of dark matter* J. High Energy Phys. **10**, 152 (2016).