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Holographic SQUID and detection of dark matter

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The gauge/gravity duality has constituted as a powerful tool for analysis of strongly coupled condensed matter systems on a weakly coupled gravitational side in AdS spacetime.

It has been shown that the holographic theory reproduces several properties of superconducting/superfluid state known from conventional quantum mechanical considerations and experiments.

This has been extended by possibilities of modeling Josephson junctions in a holographic approach in various scenarios – different pairing types or in modified gravity, which opened a new branch of research that can be named as Applied AdS/CFT.

Treating these efforts as an inspiration we propose bringing the superconducting devices into the field of the detection of specific kind of dark matter (DM), namely the dark photon.

In our model we construct a holographic SQUID (superconducting quantum interference device) whose one of Josephson junctions is affected by the dark sector. This interaction is realized by kinetic mixing term resulting a photon-dark photon coupling.

We have shown that mixing has an impact on properties of Josephson junction such as current-phase relation. Our results show that proposed SQUID remains trivial with zero signal when the DM is not affecting it, however if DM is present in the system an interference occurs and possible signal is created.

Furthermore we have investigated the dependence of the DM wavepacket length on the critical current serving as a sensitivity of SQUID for particular mass of a dark particle.

We find that the analyzed properties of the device may be used in the future experiments aimed at the detection of the dark sector of our Universe.

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