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Quantum detectors of vector potential and their modeling[1] ARMEN GULIAN, Chapman University, GURGEN MELKONYAN, Chapman University (Affiliated Researcher), ELLEN GULIAN, Chapman University (Intern) — Proportionality of current to vector potential is a feature not allowed in classical physics, but is one of the pillars in quantum theory. For superconductors, in particular, it allows us to describe the Meissner effect. Since the phase of the quantum wave function couples with the vector-potential, the related expressions are gauge-invariant. Is it possible to measure this gauge-invariant quantity locally? The answer is definitely "yes", as soon as the current is involved. Indeed, the electric current generates a magnetic field which can be measured straightforwardly. However, one can consider situations like the Aharonov-Bohm effect where the classical magnetic field is locally absent in the area occupied by the quantum object (i.e., superconductor in our case). Despite the local absence of the magnetic field, current is, nevertheless, building up. From what source is it acquiring its energy? Locally, only a vector potential is present. Is the current formation a result of a truly non-local quantum action, or does the local action of the vector potential have experimental consequences on the quantum system, which then can be considered as a detector of the vector potential? We discuss possible experimental schemes on the level of COMSOL modeling.

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