The quantization of flux in the "superconducting ring" calibrating," physicality "or" geometricity "electromagnetic field

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The topic of the report concerning the development of ideas about the geometrization of the force fields. In particular, the question of shielding of an electromagnetic field in superconductor in a view of the quantization of the magnetic flux trapped by a superconducting ring is discussed.

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The possibility of geometrization of the gravitational field in the sense of replacing the gravitational forces by "equivalent" distortion of flat space / time follows from the equivalence of gravitational and inertial masses $m\ m_G =_I$. This approach has older roots than the General Theory of Relativity and the original idea of the 4-dimensional pseudo-euclide Poincare space / Minkowski. The origins of the geometrization of the gravitational date to age of variation mechanics of Hertz, and its principle of least curvature should, apparently, be considered a true prototype of general relativity. In electrodynamics the possibility of geometrization occurs under replacement of the formal equality $mm_G/_I = 1$ by the condition of constant charge to mass ratio *q / m = const* of the particles of one kind. Turning of their trajectories in a region, where there is a magnetic field, traditionally considered as the result of the physical fields' impact on the charge movement in a flat Euclidean space. But this change can be attributed to the curvature of the space itself. The degree of curvature for the particles of the current class corresponds to the field intensity, which is excluded from consideration under such approach. Additional increment of contravariant (ie "normal" superscript numbered) components of the vector p caused by the change of the coordinate system as it moves on δx in nonplanar Riemannian space is expressed in the form $\delta p^i = \left(\frac{\partial p^i}{\partial x^j} + \Gamma^i_{kj} p^k \right) \delta x^j \Big|_{\sum j,k}$. In this case, in the same form can be presented Lorentz $\delta \overline{p} = \left(\frac{\partial \overline{p}}{\partial t} + \frac{q}{m} [\mathrm{p} \times \mathrm{B}] \right) \delta t$ **force effect.** The role of the geodesic line under such approach plays the Larmor radius of the circle, and the radius Shvartsschilda $r_s = \frac{2\gamma m}{c^2}$ is replaced by $r_s = \frac{c}{qB}$.

Of course, the development of ideas about the geometrization of the force fields is accompanied by "counter-movement" in the direction of gravity give the status of the physical field [1], which, despite its complex tensor character will act now in the flat Minkowski space. Usage of the flat space / time as the stage for a event with the participation of gravity allows within a physical approach with more confidence to talk about saving energy of the gravitational field. In question about choosing approach should not be dual representation in the spirit of the particle / wave duality (which is in relation to the classical physics is about the same heresy as Manichaean Cathars cults against the languor Christianity [2]). In the gravity theory framework mathematically close to the "regular" GRT Hilbert / Einstein "physical" approach is a most consistent approach, as used Gilbert / Einstein action functional

$$S_{G/E} = \int L_{G/E}\sqrt{-g}\,d\Omega = \int R\sqrt{-g}\,d\Omega = \int g^{ij}R_{ij}\Big|_{\sum_{ij}} \det\left|\frac{\partial(\tau,\chi,\gamma,\zeta)}{\partial(t,x,y,z)}\right| dtdxdydz$$

leads to noncalibrated gravitational field as opposed to sequentially geometrization Weyl gauge theory (in pursuit of the covariance of their theories of gravitation and Albert Einstein and David Hilbert missed calibrating and, that this omission brought difficulties in applying the standard procedure of gravity field quantization). In the basis of the non-Einstein gravitation theory, including the principle of calibration, developed by Hermann Weyl, lies the quadratic in the curvature tensor Richie $L_W = -\frac{1}{4}R_{\mu\nu}R^{\mu\nu}$ Lagrangian, and varying variables instead of the metric tensor δg_{ij} are connectivity $\delta\Gamma^i_{kj}$ (ie old / good Christoffel $\Gamma^i_{kj} = \frac{1}{2}g^{il}(\frac{\partial g_{lk}}{\partial x^j} + \frac{\partial g_{lj}}{\partial x^k} + \frac{\partial g_{kj}}{\partial x^l})\Big|_{\sum l}$ symbols).However, evidence-choice between "geometrized" and "physical" versions of gravity is beyond all conceivable possibilities of modern experiment. At the same time, electrical interaction is stronger in comparison with the gravitational, and may be more convenient to use in choice between "geometrize" and "physical" approach in field theory.

Consider the effect of shielding an electromagnetic field in a superconductor in parallel with the effect of the quantization of the magnetic flux trapped by superconducting ring. Many authors (eg [3]), apparently, is not accidental deny parallel consideration. The effect of the displacement of the magnetic field of the metal during its transition to St / n state was discovered by Meissner and Ochsenfeld (in 1933)., And his explanation of the theory of screening offered by Londanami (in 1935).. The original statement of the theory is that the superconductor is not identical to an ideal conductor R = 0 (that Faraday's law would lead instead to preserve the displacement field), and along with nondissipativity has an ideal diamagnetisity χ = 1. The displacement field in the London theory is modeled assymptotically complete screening $\overline{B}(z)=\overline{B}_0 e^{-z/\lambda}$ at a depth z from the outer surface of a lot more $\lambda_L=\sqrt{\dfrac{m}{\mu_0 e^2 n}}$:

$\overline{B}(z)=\overline{B}_0 e^{-z/\lambda_L}\xrightarrow[z>>\lambda_L]{}0$. In accordance with Maxwell's electrodynamics such screening is possible only under $\overline{A}=\mu_0\lambda^2\overline{j}$, or something equivalent to that diamagnetic condition. Indeed, replacing Maxwell equation $rot\overline{B}=\mu_0\overline{j}$ induction rotor field vector / capacity $rot\overline{B}=rot(rot\overline{A})=\nabla^2\overline{A}=\mu_o\overline{j}$ and taking into $\overline{A}=\mu_0\lambda^2\overline{j}$ account,we obtain differential. $\nabla^2\overline{A}=\lambda^{-2}\overline{A}$ equation having the desired exponentially decaying $\overline{A}(z)=\overline{A}_0 e^{-z/\lambda}$ solution from which it decays exponentially according to induction $\overline{B}(z)=rot\overline{A}=\overline{B}_0 e^{-z/\lambda}$ and the density of the diamagnetic $\overline{j}=\dfrac{1}{\mu_0\lambda^2}\overline{A}=\overline{j}_0 e^{-z/\lambda}$,currents. As a result, the Meissner effect within the concept of the electromagnetic field as a "physical" explains the fact that the field is able to penetrate into the only microscopic surface layer of superconductor thickness of λ_L,where there is diamagnetic non-dissipative shielding currents, the occurrence of which can not be determined (unlike the ideal conductor model) by previous history of St / n junction. Traditional [3] explain of the quantization of the magnetic flux trapped by a superconducting ring (from the standpoint of "physical" field) is based on the rule of Bohr $\oint\overline{\wp}d\overline{r}=2\pi n$. Sommerfeld,wherein the generalized momentum is $\overline{\wp}=\overline{p}+q\overline{A}$,and $p = m_q v$ - «normal pulse" of charge carriers in the superconductor (ie of the Cooper pair $m_q= 2m_{e-})$, qA - «field agent." The integral is split into a couple of $2\pi n=\oint\overline{\wp}d\overline{r}=I_1+I_2=\oint m_q\overline{v}d\overline{r}+\oint q\overline{A}d\overline{r}=\dfrac{m_q}{qn}\oint\overline{j}d\overline{r}+q\oint\overline{A}d\overline{r}$ terms,and followed by "move" [3], where it is poposed to "lay" the path of integration at a depth greater λ_L,where all diamagnetic currents already "well damped out," leading to the "desired" nullification of the first integral. The remaining I_2 transformed by Stokes' theorem into magnetic flux and, thus is an integer multiple of the quantum of action $2\pi\hbar$. *There is a* "Latent trouble" that diamagnetic $\overline{A}=\mu_0\lambda^2\overline{j}$ communication still exists, which nullified second integral. We can certainly take a naive attempt to replace the diamagnetic relation by equivalent ratio $\overline{A}=\mu_0\lambda^2\overline{j}+\nabla\varphi$

type.Integration at the same depth again leads to the nullification of the first $I_1 = \oint m_q \overline{v} d\overline{r} \to 0$ integral. The second, which was supposed to provide a flux quantization, breaks now

$$I_2 = \oint q\overline{A}d\overline{r} = q(\oint \mu_0 \lambda^2 \overline{j} d\overline{r} + \oint \nabla \overline{\varphi} d\overline{r}) = q\mu_0 \lambda^2 \oint \overline{j} d\overline{r} + q\iint \overline{rot}(\overline{grad\varphi}) d\overline{S}$$

on the sum of two components, the first of which asymptotically vanishes at depths greater than λ_L,and the second is zero, because of the rotor of the gradient.

How to overcome apparent contradiction, in attempts to apply both mechanisms screening field in the superconductor and the magnetic flux quantization in a superconducting ring (i.e. the contradiction, leading eventually to the "quantized" with zero quanta ...). Of course, the experimentally observed capture by superconductive ring of integer flux quanta in case of non-simple topology indicates the presence of topological charge in system. However, this charge characterizes the system globally, in the local sense in order to apply London theory it is neccessary "break up" ring on simple superconductive sets, so that the transition from one to the another would be described to the same parameters as the Christoffel symbols, which take into account the mutual geometry mismatch of neighboring areas. Nondissipative diamagnetic currents points on importance both field and current, and the curvature of the ring that defines the trajectory of the flow of the currents should be "transferred" to the geometrical properties of the field. The introduction of this new "geometrized" electromagnetic field would eliminate the discrepancy between the "flat" screening and "rolled into ring" quantization.

References

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