1)

Notes for Paper 51, Part Two: Superconductivity

The structure of the wave equation is:

$$\Box A^\mu = -k^2 A^\mu = \mu_0 J^\mu. \quad -(1)$$

This is exactly the structure of the wave equation that leads to the Meissner effect and superconductivity, and the London equation:

$$\underline{J} = -k^2 \underline{A}. \quad -(2)$$

If $\underline{A}$ is time independent:

$$\underline{E} = -\partial \underline{A} / \partial t = 0. \quad -(3)$$

Ohm's Law is:

$$\underline{E} = R \underline{J}, \quad -(4)$$

so $\underline{E} = \underline{0}$, $\underline{J} \neq \underline{0}$, so $R = 0$. The resistance to a finite electric current $\underline{J}$ is zero, defining a superconductor. This kind of theory (Ryder, pp. 297 ff.) is similar to Bardeen Cooper Schrieffer electron pair theory, and also to Higgs / GWS theory. The extra insight given by ECE theory is that A^μ, k and J^μ are identified as spacetime properties. Under certain circumstances it is conceivable that a current J^μ, originating in spacetime, produces a superconductor.