The principle of local rotational invariance and the coexistence of magnetism, charge and superconductivity

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In 1950, Vitalii Ginzburg and Lev Landau published their phenomenological theory of superconductivity based on the principle of gauge invariance applied to the general theory of second order phase transitions, proposed earlier by Landau in 1937. A consequence of this principle is that the order parameter has to be complex in order to allow a minimal coupling to the magnetic field. We propose here the principle of local rotational invariance to explain the presence of more than one complex order parameter in superconductors. This is a requirement to describe the coexistence of superconductivity and magnetism through minimal coupling. Our phenomenological theory is based on a formalism long ago developed by Élie Cartan, who in 1923, two years before the discovery of spin, introduced the concept of torsion in space and related it to an intrinsic angular momentum of matter. We find that superconductors, which coexist with magnetism, are the true foreground for Cartan's geometrical theory.