Maxwell-Dirac-Isomorphism. XI

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Maxwell-Dirac-isomorphism and economy of science.

In the last paper [1] it has been shown that covariant charge-free electrodynamics and covariant wave mechanics possess the same amplitude equation for the case of the usual harmonic time dependence. Thereby the amplitude equation of electrodynamics was obtained in the form [1, (19)]

$$\left[\gamma \cdot \nabla + i\frac{\omega}{c}\begin{pmatrix} \varepsilon \mathbb{1} & \mathbb{0} \\ \mathbb{0} & \mu \mathbb{1} \end{pmatrix}\right]\psi = 0, \tag{1}$$

which evidently agrees with the Dirac-amplitude equation [1, (20)]

$$\left[\gamma \cdot \nabla + \frac{i}{\hbar c}\begin{pmatrix} (\hbar\omega - \Phi + m_0 c^2)\,\mathbb{1} & \mathbb{0} \\ \mathbb{0} & (\hbar\omega - \Phi - m_0 c^2)\,\mathbb{1} \end{pmatrix}\right]\psi = 0. \tag{2}$$

Denote by

$$\left\{\begin{matrix} \operatorname{rot} \boldsymbol{E} + \frac{\mu}{c}\dot{\boldsymbol{H}} = 0 \\ \operatorname{rot} \boldsymbol{H} - \frac{\varepsilon}{c}\dot{\boldsymbol{E}} = 0 \\ \operatorname{div} \varepsilon \boldsymbol{E} = 0 \\ \operatorname{div} \mu \boldsymbol{H} = 0 \end{matrix}\right\}_{\operatorname{div} \boldsymbol{E} = \operatorname{div} \boldsymbol{H} = 0} \equiv \left\{\begin{matrix} \operatorname{rot} \boldsymbol{E} + \frac{\mu}{c}\dot{\boldsymbol{H}} = 0 \\ \operatorname{rot} \boldsymbol{H} - \frac{\varepsilon}{c}\dot{\boldsymbol{E}} = 0 \end{matrix}\right\}_{\substack{\operatorname{div} \boldsymbol{E} = \operatorname{div} \boldsymbol{H} = 0 \\ \boldsymbol{E} \perp \operatorname{grad} \varepsilon,\ \boldsymbol{H} \perp \operatorname{grad} \mu}} \equiv E_0 \tag{3}$$

charge-free electrodynamics and by W wave mechanics, then it has been shown that the two theories are connected by the identity

$$E_0 \cdot \vec{\sigma} \equiv W. \tag{4}$$

In words: Multiplication of charge-free electrodynamics by the Pauli vector yields wave mechanics. – Furthermore it is to be expected that the generalization of (4) is given by the connection

$$E \cdot \boldsymbol{\sigma} \equiv Q \tag{5}$$

(E: electrodynamics, Q: particle physics).

The requirement that the electric and magnetic vectors of the electrodynamics (3) should be source-free is, on the one hand, a formal prerequisite for the connection (4). On the other hand, Mach's requirement for elementary particles being without substance [2] is being met by this absence of sources, thus eliminating from the beginning the particle-imagination "field source". Especially in an electromagnetic hydrogen model there is no room for a particle "orbiting electron", because of $\operatorname{div} \boldsymbol{E} = 0$, i.e., electrodynamics can not use the Rutherford model.

Considering Schrödinger's wave mechanics as a one-component approximation to Dirac's four-component theory, it can be easily understood with its help that electrodynamics describes hydrogen as a two-photon system [3]: Two photon fields refract each other in such a way that their centers of gravity form a Kepler system. The mutual refraction can be directly read off by comparing (1) and (2):

$$\varepsilon_{\text{mut}}^{\text{hyd}} = 1 - \frac{\Phi - m_0 c^2}{\hbar\omega}, \tag{6}$$

$$\mu_{\text{mut}}^{\text{hyd}} = 1 - \frac{\Phi + m_0 c^2}{\hbar\omega}.$$

Here we face the fact that the formalism of a theory which is developed from radiation theoretical and mechanistic basic concepts, now, after half

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a century, turns out to be a special case of the formalism of electrodynamics. In these fifty years the theory not only has developed an interpretation of its own for its solutions, it also has achieved an independence resting on this interpretation, which now stands in the way of a phenomenological return to electrodynamics. Nevertheless, to physics teachers a substantial economic advantage is offered with regard to the well-known difficulties in introducing the basics of quantum physics. They are now able – without having to oppose current doctrine – to introduce wave mechanics via the Pauli vector by simply multiplying our extremely well-founded and well-tried physical theory with the structure constant according to (4). The quantum phenomenon then is immediately evident from the eigen-solutions of the product theory: With de Broglie it is easily shown that standing waves can be put on a circle only according to fixed rules. The probabilistic interpretation according to Born-Jordan may finally be added. – With regard to the Kopenhagen interpretation, no really substantiating consolidation of its position has been given in the past decades. It ultimately seems to have retained its character of an efficient transition stage. Opposing opinions, therefore, merit being called back to mind Schrödinger [4]: "A widespread doctrine has it that an objective picture of reality is altogether impossible in any previously supposed sense. – Only the optimists among us (to whom I count myself) consider this a philosophical eccentricity, an act of despair in the face of a big crisis." – Einstein [5]: "If one wanted to view quantum theory (in principle) as final, then one had to believe that a more complete description would be of no use, since there would be no laws for it. If this were the case, physics could only be of interest to shopkeepers and engineers; the whole thing would be a deplorable botch."

The identity (4) presents the Dirac theory as a four-component approximation to six-component electrodynamics. In the second and fourth component of the Dirac-spinor two electromagnetic components are being combined, respectively [1, (7)]. This gives the spinor both a lack of clarity and renders it more vague than its six-component electrodynamic counterpart.

The lack of clarity has led to the probabilistic interpretation. The vagueness may have contributed essentially to the fact that the output at the forefront of research has become stagnant for a long time. Whereas the expenses for research have grown exponentially in the past 30 years, the gain in knowledge is rather characterized by the inverse function.

[1] H. Sallhofer, Z. Naturforsch. **41a,** 468 (1986).
Corrigenda to [1]: (19) and (20) are reproduced incorrectly. (19) should read correctly

$$\left[\gamma\cdot\nabla+i\frac{\omega}{c}\begin{pmatrix}\varepsilon\,\mathbb{1} & \mathbb{0}\\ \mathbb{0} & \mu\,\mathbb{1}\end{pmatrix}\right]\psi=0.$$

and (20) should be

$$\left[\gamma\cdot\nabla+\frac{i}{\hbar c}\begin{pmatrix}(\hbar\omega-\Phi+m_0c^2)\,\mathbb{1} & \mathbb{0}\\ \mathbb{0} & (\hbar\omega-\Phi-m_0c^2)\,\mathbb{1}\end{pmatrix}\right]\psi=0.$$

Furthermore, Eq. (4) should read as Eq. (20), and (5) should be

$$\boldsymbol{\sigma}\cdot\begin{bmatrix}\operatorname{rot}\boldsymbol{E}+\frac{\mu}{c}\frac{\partial}{\partial t}\boldsymbol{H}=\boldsymbol{0}\\ \operatorname{rot}\boldsymbol{H}-\frac{\varepsilon}{c}\frac{\partial}{\partial t}\boldsymbol{E}=\boldsymbol{0}\\ \operatorname{div}\varepsilon\boldsymbol{E}=0\\ \operatorname{div}\mu\boldsymbol{H}=0\end{bmatrix}_{\operatorname{div}\boldsymbol{E}=0}\equiv[(\partial_\mu\gamma^\mu+q)\,\psi=0].$$

[2] E. Mach, Die Mechanik in ihrer Entwicklung, 8th ed., p. 466, F. A. Brockhaus, Leipzig 1921.
[3] H. Sallhofer, Z. Naturforsch. **35a,** 995 (1980).
[4] E. Schrödinger, Was ist ein Naturgesetz, Oldenburg, München 1962.
[5] K. Przibram, Briefe zur Wellenmechanik, Springer, Wien 1963.