The Electroweak Theory vs. the Notion of the Equations of Motion

The action of a given quantum theory is

$$I(\psi) = \int d^4x \mathcal{L}(\psi, \psi_{,\mu}), \tag{1}$$

where $\mathcal{L}(\psi, \psi_{,\mu})$ is the theory's Lagrangian density. Here is a quotation proving that this approach is agreed by the mainstream community: "All field theories used in current theories of elementary particles have Lagrangians of this form" (see [1], p. 300).

The Euler-Lagrange equation of (1) are

$$\frac{\partial \mathcal{L}}{\partial \psi} - \frac{\partial}{\partial x^\mu} \frac{\partial \mathcal{L}}{\partial(\partial \psi / \partial x^\mu)} = 0 \tag{2}$$

(see [1], p. 300). These differential equations are called the theory's *equations of motion.*

The Noether theorem is a vital element of the theory because it guarantees the validity of important conservation laws. This theorem depends on the fact that the quantum function satisfies the equations of motion (see e.g. [2], pp. 17-19; [3], pp. 17, 18).

A primary element of an acceptable particle's theory says that the theory should provide consistent equations of motion whose solutions adequately fit relevant experimental data. The Dirac theory is a convincing example of this issue. Thus, it is well known that every textbook on the Dirac theory of a spin-1/2 massive particle shows the explicit form of the Dirac equation, which is a partial differential equation. Some textbooks also show specific solutions of the equation that adequately fit experimental data (see e.g. [4], pp. 52-61).

Unfortunately, the Standard Model electroweak theory is a notable exception. It turns out that no textbook on the electroweak theory shows the *explicit* form of its particles' equations of motion. A fortiori, these books also do not show how solutions of these equations fit experimental data. Furthermore, it is quite strange to realize that these textbooks do not tell readers about this unusual omission. The general community simply ignores this matter. For example, it is not mentioned in the List of Unsolved Problems in Physics [5].

References

[1] S. Weinberg, *The Quantum Theory of Fields,* Vol. I (Cambridge University Press, Cambridge, 1995).

[2] J. D. Bjorken and S. D. Drell, *Relativistic Quantum Fields* (McGraw-Hill, New York; 1965).

[3] M. E. Peskin and D. V. Schroeder, *An Introduction to Quantum Field Theory* (Addison-Wesley, Reading Mass, 1995).

[4] J. D. Bjorken and S. D. Drell, *Relativistic Quantum Mechanics* (McGraw-Hill, New York, 1964).

[5] https://en.wikipedia.org/wiki/List_of_unsolved_problems_in_physics