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Self Field Theory: Mathematical Perspective

Anthony A. H. J. Fleming[1]

0.1. Objective. To give a brief historical perspective of the recently discovered Self-Field Theory (SFT) and compare its analytic form with general relativity (GR), quantum field theory (QFT) and the standard model (SM).

0.2. History. Till recently the main mathematical tools of theoretical physics have been GR, QFT and the SM of particle physics which itself is based on QFT. GR and QFT suggest another mathematics applicable across the size spectrum as no reason is apparent for any difference. At the same time no mathematics serves the biophysics community. Biophysics domains of scale tend to fall between the ends of the size spectrum. Neither GR nor QFT is appropriate.

This situation is reminiscent of physics 100 years ago in the 1890s when quantum physics was first observed. The photons discrete behaviour emerged with the failure of science to provide a single theory for the energy of a blackbody radiator. Planck resolved the issue by modelling the blackbodys walls, its atoms, as electromagnetic (EM) dipoles using Hertzs potential theory. Planck initially used a series of discrete frequencies in an "act in desperation.

The Rayleigh-Jeans classical law for the low frequency radiation is

$$\frac{8\pi\nu^2}{c^3}kT$$

Plancks quantum law is

$$\frac{8\pi\nu^2}{c^3}\frac{h\nu}{e^{\frac{h\nu}{kT}}-1}$$

Planck substituted a series expansion for the exponential

$$e^{\frac{h\nu}{kT}} = 1 + \frac{h\nu}{kT} + \frac{\left(\frac{h\nu}{kT}\right)^2}{2!} + \frac{\left(\frac{h\nu}{kT}\right)^3}{3!} + ...$$

showing that for low frequencies $h\nu \ll kT$ the classical and quantum laws agree.

In 1927 using a similar series expansion as Planck, Dirac quantized the vector potential from which the radiation field in a Coulomb gauge could be obtained.

$$A = \sum_{\lambda} (q_\lambda A_\lambda + q_\lambda^* A_\lambda^*)$$

Dirac also generalized the non-relativistic Schrdinger equation

$$i\hbar\frac{\partial\psi}{\partial t} = \frac{\hbar c}{i}\left(\alpha_1\frac{\partial\psi}{\partial x^1} + \alpha_2\frac{\partial\psi}{\partial x^2} + \alpha_3\frac{\partial\psi}{\partial x^3}\right) + \alpha_4 mc^2\psi$$

The end term on the RHS created a connection between relativistic motion and particle spin.

0.3. The Equations. *Maxwell-Lorentz (ML)* The ML equations for particles are written

$$\vec{F} = q\vec{E} + q\vec{v}\times\vec{B}$$

$$\nabla\times\vec{E} + \mu_r\frac{\partial\vec{H}}{dt} = 0$$

$$\nabla\cdot\vec{H} = 0$$

$$\nabla\times\vec{H} - \varepsilon_r\frac{\partial\vec{E}}{dt} = \frac{\pi}{s_q}q\vec{v}$$

$$\nabla\cdot\vec{E} = \frac{4\pi}{v_q}q$$

In 4-form of the EM field tensors $F^{EM}_{\mu\nu}$ and $G^{EM}_{\mu\nu}$

$$F^{EM}_{\mu\nu} = \begin{bmatrix} 0 & E_x/_C & E_y/_C & E_z/_C \\ -E_x/_C & 0 & B_x & -B_y \\ -E_y/_C & -B_x & 0 & B_y \\ -E_z/_C & B_y & -B_x & 0 \end{bmatrix};\ G^{EM}_{\mu\nu} = \begin{bmatrix} 0 & B_x & B_y & B_y \\ -B_x & 0 & -E_x/_C & E_y/_C \\ -B_y & E_x/_C & 0 & -E_x/_C \\ -B_z & -E_y/_{Cy} & E_x/_C & 0 \end{bmatrix}$$

In 4-form of the scalar and vector potentials A and J,

$$\Box^2 A^\mu = -\mu_\alpha J^\mu$$

Einstein

Einsteins equations relate stress-energy to curvature of spacetime

$$G^{GR}_{\mu\nu} = 8\pi T_{\mu\nu}$$

where $G^{GR}_{\mu\nu}$ is the GR tensor, $T_{\mu\nu}$ is the stress-energy tensor. The tensors $G^{GR}_{\mu\nu}$ and $T_{\mu\nu}$ are symmetric, identical in form to $F^{EM}_{\mu\nu}$ and $G^{EM}_{\mu\nu}$. The equations span space-time which is a 4 dimensional space having 3 spatial and one temporal coordinates.

Dirac

Because Diracs equation introduced the concept of particle spin, his equation is written in terms of (4-entry) column spinors, the Dirac spinors, which span spin space. These are of unit magnitude and thus mathematical in nature.

$$i\gamma\partial\psi = m\psi$$

Diracs equation is derived from the scalar and vector potentials A^μ and J^μ. Gauge conditions are implicit in QFT and would be recognized by Newton as constants of integration, in addition to Maxwells field equations. In the conventions of the time, equations tend to be written in abbreviated form so detail is left out for simplicity or for elegance. Unfortunately, this tends to hide the mathematics and hence both GR and QFT remain at the two ends of the size spectrum.

Standard Model

The Standard model is an extension of Diracs equation where becomes a matrix of Dirac spinors instead of a column matrix.

$$\gamma_0 \left(i\partial_\mu \gamma_\mu - M \right) \psi = 0$$

Self-Field Theory

In the EM version of SFT, the ML equations are used to write a matrix equation where each particle has two spinor motions σ_i and a current κ_j .

$$\mathrm{M}_{ij}^{EM} \sigma_i = \kappa_j$$

Thus EMSFT has four unkowns per particle. In general SFT is specific to each region

$$\mathrm{M}_{ij}^{f} \sigma_i = \kappa_j$$

This equation represents an nth rank tensorial dynamic balance of the forces acting on an object at any scale, whether EM, weak or strong nuclear, or gravitational forces.

0.4. Conclusion. SFT a mathematics of dynamic equilibrium is based on the ML system of equations at the EM level of interaction. SFT, applying widely across both the physical and biophysical domains, relies on the observation that periodic rotations occur across physics.

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(1) biophotonics research institute, Highett, vic, Australia