Self-Field Theory: A Mathematics for Biology

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Abstract

This paper gives a historical perspective behind the recently discovered self-field theory (SFT) and briefly discusses some biological applications. SFT provides analytic solutions to the Maxwell-Lorentz equations. In SFT, the photon possesses two sub-particles of equal mass; in accordance with relativity, two SFT spinors are used to model the photon's internal motions. A wide range of eigensolutions exist due to the photon's internal dynamics including a new class of spectroscopy, a chemistry that sits below atomic chemistry. Simlar solutions apply to the electromagnetic fields of atomic and molecular systems often hidden inside atoms due to shielding by outer shell electrons. With hydrates however, the internal electromagnetic field is more exposed to outside fields and interacts via these photons. These predicted solutions agree with observations of weak streams of photons emitted by strands of DNA by Popp et al. There are other biological applications of SFT such as the dynamics of populations of cells, of proteins within a cell's membrane and of DNA strands within the cytoplasm.

Keywords: self-field theory, quantum field theory, maxwell equations, DNA, photon, biological mechanism.

1. Introduction

Recently, Fleming discovered a novel analytic solution for the hydrogen atom using EM self field theory (EMSFT) [1]. This solution was derived by direct substitution of the appropriate mathematical form of rotational motion termed a field spinor[1] in SFT into the ML equations. The system is a dynamic balance of rotating particles and fields. The relative time-varying radial distance of a rotating charge $\boldsymbol{q}$ is given by the spinor $\sigma(\omega,\tilde{\boldsymbol{r}}) = \tilde{\boldsymbol{r}}\boldsymbol{e}^{j\omega t}$. For the electron in the hydrogen atom, the electron's distance from the proton is assumed to be a sum of two spinors $\tilde{\boldsymbol{r}}_{ep} = \tilde{\boldsymbol{r}}_e \boldsymbol{e}^{j\omega_e t} + \tilde{\boldsymbol{r}}_p \boldsymbol{e}^{j\omega_p t}$ where $\boldsymbol{p}$ refers to the proton. The analytic expression for each particle motion has four unknowns $(\boldsymbol{r}_o, \omega_o, \boldsymbol{r}_c, \omega_c)$ where the subscripts $\boldsymbol{o}$ and **c** refer to two types of rotation, orbit and cyclotron. In the generalized SFT, the analytic form and number of spinors is unique for each region, such as the strong and weak nuclear regions, the electromagnetic region, and various gravitational regions, depending on the energy density within each region. The analytic form specifies how many degrees of freedom a particle possesses and how many rotations it can perform. There is no analytic upper limit on this ability to move in rotations, only the amount of energy the particle possesses and how many other particles are involved. For instance inside the strong nuclear region, three particles

[1] The physical nature of the SFT spinors apply to a particle's centres of motion and differ to the Dirac spinors that serve a more mathematical use being of unit magnitude and applying to potential functions.

rotate in three orthogonal directions involving three different fields, the electric field, the magnetic field and another field Fleming termed the nuclear field. Associated with such regions are modified systems of Maxwell's equations. For the strong nuclear region two more equations above the usual ML equations govern the motions.

The photon, a quantum of the EM field in the domain of a single atom, is considered a particle in its own isolated domain. SFT was recently used to investigate a photon with non-zero mass having a substructure [2]. In photonic self-field theory there is an analytic similarity to the hydrogen atom; the photon possesses a spectroscopy with Balmer-like frequencies. Further, a 'photon chemistry' has been predicted [3] in which compounds of the ordinary photon occur depending on the energy density in a region, for instance inside the nucleus, or near the centre of the nucleus. These photonic compounds create fields that mediate the EM, strong, and weak forces. Each field-type supports a particle-type and its motions. For instance near the centre of the nucleus the energy density is raised above that in the EM region outside the nucleus but not as high as in the strong nuclear region wherein gluons can exist. This permits the existence of the W+, W- and Z0 bosons, and the weak forces can bind the weak electron near the centre of the nucleus with a binding energy equal to that of the neutrino.

1.1 Historical Perspective of the Mathematics of Self-Field Theory

Till recently the main mathematical tools of the theoretical physicist have been general relativity (GR), quantum field theory (QFT) and the standard model of particle physics which is based on QFT [4] [5] [6]. GR and QFT suggest another mathematics applicable to both large and small scales. There is a perceived theoretical conflict between GR for the large and QFT for the small as there is no reason for the difference. At the same time no mathematics serves the biophysical community. Biophysics domains of scale tend to fall between the ends of the size spectrum. Neither GR nor QFT is appropriate. This is reminiscent of an earlier episode in physics 100 years ago, in the 1890's when quantum physics was first observed. The photon's discrete behaviour emerged with the failure of science to provide a single consistent theory for the energy of a blackbody radiator. Both Wien at short wavelengths and Rayleigh and Jeans at long wavelengths had experimentally obtained differing analytic equations for the energy. The mathematics indicated an 'ultraviolet catastrophe". Planck resolved the situation by modelling the blackbody's walls, its atoms, as EM dipoles using the potential theory formulated by Hertz along with the concepts of probabilistic thermodynamics. Planck had first acted in an "act of desperation" but slowly came to realize the theoretical implications of the effect that needed to be treated as a series of discrete frequencies rather than a continuously analytic function of frequency.

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

$$\frac{8\pi\nu^2}{c^3}kT \tag{1.1}$$

Planck's quantum law is

$$\frac{8\pi\nu^2}{c^3}\frac{h\nu}{e^{\frac{h\nu}{kT}}-1} \tag{1.2}$$

Planck substituted a series expansion for the exponential

$$e^{\frac{h\nu}{kT}} = 1 + \frac{h\nu}{kT} + \frac{\left(\frac{h\nu}{kT}\right)^2}{2!} + \frac{\left(\frac{h\nu}{kT}\right)^3}{3!} + \dots \tag{1.3}$$

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

In 1905 Einstein via the photo-electric effect observed that the radiation itself, not just its frequency, acted as discrete quanta or particles of energy $E/h\nu$ termed photons. Bohr recognising that the Plank-Einstein equation $E = h\nu$ held for emitted as well as absorbed energy put forward a quantum theory of atomic spectroscopy in which angular momentum must be whole numbers of Planck's quantum number $\hbar = h/2\pi$. 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.

$$A = \sum_{\lambda}\left(q_\lambda A_\lambda + q_\lambda^* A_\lambda^*\right) \tag{1.4}$$

This process of breaking the field up into a series of plane waves is often called the *first* quantization. Dirac also generalized the non-relativistic Schrödinger equation

$$i\hbar\frac{\partial\psi}{\partial t} = \frac{\hbar c}{i}\left(\alpha_1\frac{\partial\psi}{\partial x^1} + \alpha_2\frac{\partial\psi}{\partial x^2} + \alpha_3\frac{\partial\psi}{\partial x^3}\right) + \alpha_4 mc^2\psi \tag{1.5}$$

The addition of the term on the extreme RHS, created a connection between relativistic motion and particle spin. A second quantization is also applied to the ψ-functions of the Dirac equation (1.5) and is used in many-electron and many-atom problems. The mathematics continues by defining a Hamiltonian or more generally a Lagrangian.

Relativistic quantum mechanics (QM) became *the* tool for mathematical physicists. But there were problems left-over from the earlier ultraviolet catastrophe. The lessons from the early blackbody days had not been learnt and are *still* uncorrected. In all QM and QFT, the field, actually a potential, is treated more or less as an analytic continuous function; SFT shows that the field acts as a discrete series of tiny impacts like gas hitting a wall. It is little wonder then that numerical infinities dominate QM's history. Hole theory grew out of another difficulty that free electrons may assume any energy state in principle from $-mc^2$ to $-\infty$. Hole theory led to the discovery of the positron and has other far-reaching consequences including the creation and annihilation of particles in an energy-rich vacuum. Zero-point energy is an effect upon the radiation field itself. Both hole theory and zero-point energy involve subtracting energies from the overall Hamiltonian. The concept of eliminating '*virtual*' particles arises.

From the prism of QM, such heuristic mechanisms might appear quite valid. Their roots within the early days of blackbody radiation have been long forgotten. But the problems of using continuous functions to describe the fields are still there imbedded inside QM. It is here that the centre-of-motion fields used within SFT can assist to update QM and QFT. Also, this enables actual orbits and not just probabilistic orbital densities to be obtained.

Heisenberg's uncertainty principle states that the process of measuring the position *x* of a particle disturbs its momentum *p*, so that **Dx Dp = h/2** . To Heisenberg and QM it is impossible to look inside the photon. Yet SFT *does* examine the photon's structure. This is not an actual observation, but an application of our scientific intelligence.

1.2: The Equations

The following equations are written more or less in an historical form first and then in a more modern 4-form where appropriate.

Maxwell-Lorentz

The Maxwell-Lorentz equations for particles is written

$$\vec{F} = q\vec{E} + q\vec{v} \times \vec{B} \tag{1.6}$$

$$\nabla \times \vec{E} + \mu_r \frac{\partial \vec{H}}{dt} = 0 \tag{1.7}$$

$$\nabla \bullet \vec{H} = 0 \tag{1.8}$$

$$\nabla \times \vec{H} - \varepsilon_r \frac{\partial \vec{E}}{dt} = \frac{\pi}{s_q} q\vec{v} \tag{1.9}$$

$$\nabla \bullet \vec{E} = \frac{4\pi}{v_q} q \tag{1.10}$$

In 4-form of the EM field tensors $F_{\mu\nu}^{EM}$ and $G_{\mu\nu}^{EM}$

$$F_{\mu\nu}^{EM} = \begin{bmatrix} 0 & E_x/c & E_y/c & E_z/c \\ -E_x/c & 0 & B_x & -B_y \\ -E_y/c & -B_x & 0 & B_y \\ -E_z/c & B_y & -B_x & 0 \end{bmatrix}; \; G_{\mu\nu}^{EM} = \begin{bmatrix} 0 & B_x & B_y & B_y \\ -B_x & 0 & -E_x/c & E_y/c \\ -B_y & E_x/c & 0 & -E_x/c \\ -B_z & -E_y/c_y & E_x/c & 0 \end{bmatrix}$$

(1.11)

Tensors are algebraically independent of coordinate system.

$$\frac{\partial F^{EM\,\mu\nu}}{\partial x^\nu} = \mu_\alpha ; \frac{\partial G^{EM\,\mu\nu}}{\partial x^\nu} = 0 \tag{1.12}$$

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

$$\square^2 A^\mu = -\mu_\alpha J^\mu \tag{1.13}$$

Einstein

Einstein's equation [5] relates stress-energy to curvature of spacetime

$$G_{\mu\nu}^{GR} = 8\pi T_{\mu\nu} \tag{1.14}$$

where $G_{\mu\nu}^{GR}$ is the GR tensor, $T_{\mu\nu}$ is the stress-energy tensor. The tensors $G_{\mu\nu}^{GR}$ and $T_{\mu\nu}$

which is a 4 dimensional space having 3 spatial and one temporal coordinates.

Dirac

Because Dirac's equation [5] 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.

$$i\gamma\partial\psi = m\psi \tag{1.15}$$

(1.15) is derived from (1.13) being potential equations derived from the scalar and vector potentials A^{μ} and J^{μ}. Gauge conditions are implicit in QM in addition to Maxwell's field equations. In the conventions of the time and this still holds today, the equations of both Einstein and Dirac are written in abbreviated form where detail is left out 'for simplicity' or 'for elegance'. Unfortunately, this tends to hide the mathematics and hence both equations (1.14) and (1.15) remain at the two ends of the size spectrum.

Standard Model

The Standard model is an extension of Dirac's equation where ψ becomes a matrix of Dirac spinors instead of a column matrix [6].

$$\gamma_0\left(i\partial_\mu\gamma_\mu - M\right)\psi = 0 \tag{1.16}$$

Self-Field Theory

In the EM version of SFT, the ML equations (1.6) to (1.10) are used to write a matrix equation where each particle has two spinor motions σ_i and a current κ_j.

$$\mathrm{M}_{ij}^{EM}\sigma_i = \kappa_j \tag{1.17}$$

Thus EMSFT has four unkowns per particle. In general (1.17) is specific to each region

$$\mathrm{M}_{ij}^{f}\sigma_i = \kappa_j \tag{1.18}$$

(1.18) represents a dynamic balance across the forces acting on an object at any scale, whether EM, weak or strong nuclear, or the various SFT gravitational forces [1]. The direct substitution of spinors into the ML equations used by SFT compared with the methods of gauge theory and Lagrangians is similar to the comparison between the numerical methods known as the finite difference method and finite element method.

3. Some Biological Applications

Although cell dynamics is extremely complex and involves layers of interaction, recent experiments and computations have begun to piece together how chromosomes and cells move and change shape during the cell cycle [7]. SFT can assist to understand these processes since it seeks actual motions. Charge in biology has many forms such as dipolar proteins that diffuse within the plasma membrane, cytoplasmic microtubules that link together to overcome Debye screening, chromosomes that morph or diffuse within the cytoplasm forming lattices within the membrane, or cells themselves which can assume positions relative to each other. There are biophysical fields that either translate or rotate as SFT spinors.

Gaglioli has found that despite Debye screening, nanoscale electrostatics plays a major role in cell spindle assembly and motion, and in the generation of forces at kinetochores and chromosome arms during mitosis. During various stages, chromosome movement is dependent on kinetochore–microtubule dynamics: A chromosome can move towards a pole when its kinetochore is connected to microtubules emanating from that pole [8].

Popp et al observed low levels of photon emission from various biosystems, including a strand of DNA [9]. The photons originate from a coherent field within living organisms with their function intra and intercellular regulation and communication. These non-classical findings require a theory to support them. SFT does predict energy states associated with DNA's spine of hydration. As the hydrated protein changes energy, photons of specific energy can be emitted and received in a two-way exchange by other hydrated ionic messengers within the cytoplasm. Since the internal field of a water molecule is exposed to other external fields, they can interact to assume field states according to the particular photon chemistry. This forms a theoretical mechanism by which cell-cell communications occur. Photon chemistry also provides a theoretical basis by which DNA stores data such as photons and phonons within its nuclei.

5. Conclusion

From their empirical observations, the ancient Chinese derived a concept of "chi" that has two form of "energy" called yin and yang. The basis of acupuncture and the body's circulation, Chi went beyond the body and included geomagnetic fields through houses and cities. It was an empirical observation concerning dynamic equilibrium of the yin and the yang. SFT, a mathematics of dynamic equilibrium based on the ML system of equations concerns electric and magnetic fields at the level of the EM field. SFT, applying widely across both the physical and biophysical domains, relies on the observation that rotations occur across wide levels of scale. SFT has a direction of rotation of energy giving negative and positive forces acting through any point in space. Prior to SFT, no single mathematical theory had been found to treat the very big and the very small scale. SFT sees beyond the fog of quantum inaccuracy, the uncertainty principle, able to see the physical and biophysical processes clearer than before now.

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