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Quantum-Gravity Thermodynamics, Incorporating the Theory of Exactly Soluble Active Stochastic Processes, with Applications

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Abstract A re-visitation of QFT is first cited, deriving the Feynman integral from the theory of active stochastic processes (Glueck and Hueffler, Phys. Lett. B. 659(1–2):447–451, 2008; Hueffel and Kelnhofer, Phys. Lett. B 588(1–2):145–150, 2004). We factor the lie group "generator" of the inverse wavefunction over an entropy-maximizing basis. Performing term-by-term Ito-integration leads us to an analytical, evaluable trajectory for a charged particle in an arbitrary field given a Maximum-Entropy distribution.

We generalize this formula to many-body electrodynamics. In theory, it is capable of predicting plasma's thermodynamic properties from ionic spectral data and thermodynamic and optical distributions. Blessed with the absence of certain limitations (e.g., renormalization) strongly present in competing formalisms and the incorporation of research related to many different phenomena, we outline a candidate quantum gravity theory based on these developments.

Keywords Statistical thermodynamics · Maximum-entropy · Quantum gravity · Electrodynamics · Stochastic dynamical systems · Clifford algebras

1 Introduction

Recent research into Quantum field theory has displayed a strong analytical link between the functional analysis employed by Feynman and others and the stochastic analysis used in statistical thermodynamics and related fields. The re-emergence of Clifford algebras in some research venues has founded new quantitative understanding of the geometry of Spacetime, black hole mechanics, and Dirac theory (see e.g. [2, 6]). Several reputable theories exist, possibly linking Quantum field theory and gauge-theory general relativity. We will not discuss these developments here but refer the reader to a number of sources. The clear trend, however, indicates astounding progress in the binding together of fundamental loose ends.

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Yet the flurry of activity in applied physics has often failed to take such developments into account, mostly due to their irrelevant, highly mathematical and somewhat speculative nature. Research to provide a bridge between this intricate web of theoretical insights and urgent pragmatic developments led us to an extraordinary theoretical relation with potentially formidable implications in the field of numeric analysis.

Here we outline these results. A re-visitation of QFT is first cited, deriving the Feynman integral from the theory of active stochastic processes [1, 3]. We factor the lie group "generator" of the inverse wavefunction over an entropy-maximizing basis. Performing term-by-term Ito-integration leads us to an analytical, evaluable trajectory for a charged particle in an arbitrary quantum field given a Maximum-Entropy distribution.

We generalize this formula to many-body electrodynamics. In theory, it is capable of predicting plasma's thermodynamic properties from ionic spectral data and thermodynamic and optical distributions. Blessed with the absence of certain limitations (e.g., renormalization) strongly present in competing formalisms and the incorporation of research related to many different phenomena, we outline a gravitational field theory based on these developments.

2 Factoring the Scalar Path-Integral Density

We cite the equivalence proof, as formulated by Hueffel and Kelnhofer [3], between Feynman path-integrals and stochastic quantization; we also cite Hueffel and Glueck [1], who have generalized active Brownian motion to scalar QED. Essentially, the path-integral densities are seen as the equilibrium distributions for some stochastic processes, and the Higgs mechanism is constructed from the resulting field theory.

Our method invokes the gravitational gauge-theory, first outlined as ECSK gravity and later expanded by Lasenby et al. [6], using the Clifford Algebra formalism. Essentially, the exterior algebra is exploited to perform induced geometric transformations using bivector geometry on flat space (in other words, a background-dependent reformulation of general relativity). Perhaps their most invaluable contributions are the inclusion of a bivector-valued gauge tensor and a time-variant "geodesic equation" for the normalized Lorentz rotor. For greater detail the reader is referred to their paper.

We also incorporate the Clifford-spinor form of the real Dirac wavefunction, as published by Hestenes; in this paper, it is suggested that the unit imaginary pseudoscalar is strongly associated with relativistic spin. We in fact confirm this, proposing that it expands the canonical Fourier coefficients into constant-spin terms. We introduce a generalization to spin-2 particles such as gravitons.

We begin, however, with a purely electrodynamic treatment employing scalars. The inverse path-integral

$$x = \int D[s] p e^{-iS}, \tag{1}$$

we will assume represents a stochastic ensemble of maximized entropy. That is, from a Bayesian standpoint, the Von Neumann Entropy is optimized with respect to the geodesic;

$$\partial_s S = \frac{-k_B}{2} \sum \partial_s \log \lambda = 0. \tag{2}$$

The stochastic quantization method equates the thermodynamic distribution with the path-integral density. This way, the series in (1) forms an orthonormal basis for the singlepath distribution, over which we will factor the group generator, giving us

$$x = -\hbar k_B \sum L_k \delta_k s \int D[s] \nabla^2 e^{-iL_k s}, \tag{3}$$

which we are allowed to write, employing the Schroedinger momentum, because the energy as a function of thermodynamic distribution is by definition constant.

We can reduce this equation into an exactly evaluable expression for x. First, because each term is a complex plane wave, apply the classical wave equation;

$$x = \frac{-\hbar}{c^2} k_B \sum L_k \delta_k s \int D[s] \partial_t [e^{-iL_k s}], \tag{4}$$

subsequently integrating per-summand;

$$x = -i \frac{\hbar}{c^2} k_B \sum L_k \delta_k e^{-iL_k s}. \tag{5}$$

Note that (5) is, effectively, an expression for the Fourier coefficients of canonical momentum; as mentioned, the imaginary pseudoscalar expands these, via Euler's identity, into complex sinusoidal and real cosinusoidal terms. Depending on the ratio, the phase-angle required to achieve the same wavefunction may or may not be shifted by half of pi radians, leading to a half-integer change in spin. It is evident, however, that the gravitational field requires a greater spin value. Note, also, that to delimit the energy levels of a system arbitrarily we require a delta-function that evaluates separately at each energy level.

3 Quantizing Gravity

Our theory being itself nonrenormalized and nonperturbative, we may easily quantize general relativity, including it in our theory.

The unit pseudoscalar serves as an accurate spin-representation in Dirac theory. Yet gravitons are widely believed to be spin-2 particles. For this reason, we need either a higher-rank tensor representation, which we deem unwieldy, or an alteration of the wavefunction that omits the i. We choose the second.

There also exists the problem of cosmological expansion. The most widely known explanation for this fact is, of course, the cosmological-constant theory closely related to "dark matter". We, however, propose an alternative explanation. We suppose that the cosmological constant is part of a coupling constant. That is, there is a fundamental "strength" of kinetic interaction, analogous to the fine-structure constant in QED. This would, we hypothesize, require that:

$$i\hbar\omega = \omega - \Lambda\omega, \tag{6}$$

giving the coupling constant (as it appears in the path-integral) a value of

$$\frac{-i}{2\hbar} \frac{(1-\Lambda)}{i\hbar}, \tag{7}$$

or 1.35×10^{-23} the Boltzmann constant. Note also that the imaginary pseudoscalar has been eliminated entirely, making this an adequate fix for both issues.

Finally, we perform the steps in part 1, this time using Clifford Algebra tensors, with an exponential solution to Lasenby, Doran, and Gull's geodesic equation [6], which allows us to form a Dirac wavefunction inclusive of gravity by substituting the Lorentz rotor into Hestenes' wavefunction [2]:

$$x = -i\frac{\hbar}{c^2}k_B \sum\sum e^{\frac{-k_B}{2}L(k,m)s} L(k,m)(1 - iL(k,m)s)\delta_{k,m} e^{\frac{-k_B}{2}\tilde{L}(k,m)s}, \tag{8}$$

where our Lagrangian is,

$$L = (\omega + T) - \frac{k_C}{k_B}\Omega. \tag{9}$$

4 Advanced Optical Phenomena and Quantum Effects

An advantage of the new theory is the direct representation of each individual excitation mode. Citing Jaynes [5], one of the weakest points of QED is its treatment of quantum optical phenomena—for instance, interference between two photons within the field, as has been experimentally observed. Our field theory has built-in support for such a phenomenon because it allows for any number of excitation modes to exist simultaneously and independently of each other. By letting the delta-function take out-of-range values (or, equivalently, copying summands), we can extend this notion to optical interference between two photons (or gravitons) of the same energy and polarization. The excitation modes themselves can be calculated using nonlinear or quantum optics and spectral data.

Clearly this is a quantized field theory; but it is, from a mathematical standpoint, a deterministic system which would seem to conflict with our original intent, to maximize the Jaynes' entropy. It is asserted, however, that the Bayesian viewpoint holds; that is, that entropy is merely a measure of how much can be experimentally known about a system, rather than how much can be rationally known about it [4]. We see the elegance of quantum field theory in light of this, and we also see all of the observed phenomena of quantum mechanics the Higgs' mechanism, as cited, the Heisenberg uncertainty (if we assume a Fourier-theory perspective), and the "probabilistic" (pragmatically unpredictable) motion of quantum particles.

5 Pragmatic Concerns

Because of its strong inherent compatibility with both kinetic and optical effects, our theory is well suited to the applied study of arbitrary substances, on a variety of scales. In fact, it is obvious from (5) that a scalar Fourier-decomposition of the normalized displacement function, divided component-wise by the experimentally determined energy quanta of the relevant ion, will yield the optical distributions necessary to achieve that configuration. That fact can be used either to induce certain optical configurations in a fixed or uncontrollable system, or conversely to impose a desired state on a system by calculating the necessary optical distribution.

6 Conclusion

Our methods employ diverse tactics, giving inherent support to many different phenomena and effects from across the spectrum of physical disciplines. The elegance and completeness of the theory should, if anything, provide a model for future work. It is expected, however, that the universality of the findings presented here will find direct usefulness in both theoretical and applied science.

References

1. Glueck, A., Hueffler, H.: Nonlinear Brownian motion and Higgs mechanism. Phys. Lett. B **659**(1–2), 447–451 (2008)
2. Hestenes, D.: Real spinor fields. J. Math. Phys. **8**, 798 (1967)
3. Hueffel, H., Kelnhofer, G.: QED revisited: proving equivalence between path integral and stochastic quantization. Phys. Lett. B **588**(1–2), 145–150 (2008)
4. Jaynes, E.T.: Probability Theory: The Logic of Science. Cambridge University Press, Cambridge (2003)
5. Jaynes, E.T.: Quantum beats. In: Barut, A.O. (ed.) Foundations of Radiation Theory and Quantum Electrodynamics, p. 37. Plenum Press, New York (1980)
6. Lasenby, A., Doran, C., Gull, S.: Gravity, Gauge theories, and geometric algebra. Phil. Trans. R. Soc. Lond. A **356**, 487–582 (1998)