Review of: "Filtering Out Electromagnetic Noise Caused by the Interaction of the Classical Field with the Fiber Phonons from the Quantum Field in an Optical Fiber"

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Potential competing interests: No potential competing interests to declare.

The author addresses the challenge of filtering out electromagnetic noise in an optical fiber, which arises from the interaction between a classical electromagnetic field and the fiber's vibrating atoms (phonons), affecting the quantum field. The author, Harish Parthasarathy from NSUT, Dwarka, New Delhi, India, proposes two methods to mitigate this noise: an optimal control algorithm that generates a control potential to guide the system towards a desired noiseless state, and a quantum filtering theory approach by Belavkin, which models classical photons as quantum Bosonic white noise and uses non-demolition measurements to estimate and control the system's evolving state in real time.

The manuscript delves into the quantum mechanical model of the electromagnetic four-potential within the fiber, assuming no charges and adopting the Coulomb gauge. It outlines the classical interaction Hamiltonian of the field with atomic phonons and the Hamiltonian of the quantum field, including the interaction energy between the quantum and classical fields.

The author presents a detailed mathematical framework for the problem, including the decomposition of the magnetic vector potential into classical and quantum components, and the equations of motion for the phonon lattice within the fiber. The document discusses alternative approaches to noise removal and introduces the concept of a control potential to cancel the interference component from the quantum field dynamics.

Furthermore, the manuscript explores the application of quantum information theory to analyze the rate of information transmission through the optical fiber channel, using the Cq channel capacities. It touches on the transmission of other particles like non-Abelian matter and gauge particles, and the role of superstring theory in correcting the Yang-Mills action.

The manuscript also discusses the use of the quantum effective action of a field when it interacts with other fields and random current sources, providing a foundation for corrections to the classical action by quantum effects.

In summary, the manuscript presents a comprehensive study of noise reduction in optical fibers using quantum control and filtering methods, with implications for improving the transmission of quantum information through such channels.

Here, I am suggesting some improvements to the manuscript.

What is the significance of the wave function expression in equation (13a), and how does it relate to the Schrödinger equation in (14a)?

How does the document describe the transformation of a general quantum mechanical amplitude into a vacuum-to-vacuum amplitude, and what is its relevance?

What are the implications of the total Hamiltonian of the quantum electromagnetic field interacting with matter as expressed in terms of creation and annihilation operators?

How does the Feynman diagrammatic method contribute to the computation of scattering, absorption, and emission amplitudes in quantum electrodynamics?

What is the role of the classical random electromagnetic field in the interaction Lagrangian as mentioned in the document?

How does the document define the initial probability distribution of the positions and velocities of the phonons in the lattice at temperature T?

What is the significance of the Jacobian determinant in the context of the joint probability density of the phonon positions and velocities?

How does the document outline the procedure for obtaining all the terms of the quantum correlation function to all orders?

What is the purpose of canceling the interference component from the state dynamics of the quantum field as described in equation (35)?

How does the document suggest achieving the cancellation of the interference component using optimal control and filtering methods?

What is the relevance of the interaction field energy between the quantum field Aq and the scattered classical field Ac as expressed in equation (34)?

How does the document approximate the evolution of the density matrix ρ(t) for small τ when δH(t) behaves like zero-mean white noise?

What does the document imply by neglecting O(τ^2) terms in the statistical average of ρ(t+τ)?

How does the document express the statistical average of the density matrix ρ(t) in terms of the interaction Hamiltonian H0 and the white noise term δH(t)?

What is the significance of the Hermitian matrix K in the context of the interaction Hamiltonian's statistical average?

How does the document describe the expansion of the quantum correlation function in terms of the sum of Wn(s,t) for n ≥ 0?

What is the role of the classical electromagnetic field in the interaction Lagrangian L13 and L23 as mentioned in the document?

How does the document define the unperturbed Lagrangian of the quantum electromagnetic and quantum Dirac fields in the presence of classical electromagnetic fields?

What is the significance of the state variable form of the differential equation (51a) in the context of the phonon lattice within the optical fiber?

How does the document express the solution $\xi(t)$ in terms of the state transition matrix $\Phi(t,s)$ and the initial state $\xi(0)$?

What is the relevance of the Gaussian density $ft(\xi)$ in the context of the probability density of the phonon positions and velocities?

How does the document describe the interaction between the quantum electromagnetic field and the quantum Dirac field through the interaction Lagrangian L12?

What is the purpose of the references listed in the document, and how do they contribute to the understanding of quantum information theory and quantum electrodynamics?

How does the document relate the bitrate of data transmission to the viewpoint of quantum electrodynamics, considering the fiber as a collection of electrons and positrons?

What is the significance of the Dyson-Schwinger equations in the context of the photon and electron propagators?

How does the document express the total scattering probability from the initial state |i> to the final state |f> as linear combinations?

What is the role of the path integral in calculating the matrix element for the transformation of a general quantum mechanical amplitude?

How does the document describe the interaction between the quantum Dirac field and the classical electromagnetic field through the interaction Lagrangian L23?

What is the significance of the Jacobian determinant $J\psi^{(-1)}$ in the context of the joint probability density of the phonon positions and velocities?

How does the document suggest using the methods of optimal control and filtering to address the issue of noise in optical fibers carrying quantum information?