

# The Second Quantization of Natural Electromagnetic and Electron-Positron Oscillatory Systems

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**Abstract:** *A statistical second quantization method for natural electromagnetic (NEMOS) and electron-positron (NEPOS) oscillatory systems is described. The spatial (spatio-temporal) localization of NEPOS and NEMOS wavepackets is supposed to be a result of their permanent interaction, i.e., the exchange with random momentum (energy-momentum) quanta between those systems. The absence of “zero-point oscillations” of natural distributed oscillatory systems is asserted.*

**Keywords:** De Broglie wave; distributed oscillatory system; energy-momentum; second quantization; zero-point oscillation; zero-point energy.

## Introduction

The further development of vacuum electronics, in our opinion, is linked with the progress in nanotechnology. Solitary microwave “monsters” are staying in the past. Instead, clusters of coherent nonlinear microscopic oscillators penetrated by “blood vessels” of power suppliers and heat sinks as well as “nervous system” of control circuits will form phased arrays of intricate shapes used as some “radiating materials”. The integrated power of such devices is proportional to their volumes, so, is not limited.

Because a characteristic size of the oscillators is much less than 1 micrometer (this enables their normal functioning at the atmospheric pressure without evacuation), the design of those must be performed according to the laws of quantum mechanics and electrodynamics. However, in spite of striking achievements in the engineering applications of these disciplines, there is no consensus in understanding of the theoretical bases of quantum world behavior yet.

Concepts of natural electromagnetic (EM) and electron-positron (EP) oscillatory systems (NEMOS, NEPOS) as real physical bases for the De Broglie matter waves were proposed in [1] and [2] respectively. Those are alternatives to the “quantum vacuum” of the known interpretation of the quantum electrodynamics [3]. The second quantization of NEMOS and NEPOS is described in this paper.

## Interaction between NEPOS and NEMOS

Let’s generalize both the EM potential 4-vector and the De Broglie EP wavefunction as some real-valued aleph-functions  $\aleph^y(t, x, y, z)$  and  $\aleph^e(t, x, y, z)$  respectively. EM aleph-function  $\aleph^y$  is a 4-vector constrained with the Lorenz gauge  $\nabla \cdot \aleph^y = 0$ , where  $\nabla \cdot \aleph^y$  is the 4-divergence ( $\aleph^y$  differs from EM potential only in the measure unit). EP

aleph-function  $\aleph^e$  is also 4-vector constrained with both the Lorenz gauge  $\nabla \cdot \aleph^e = 0$  and a spatial solenoidality (“incompressibility”) condition:  $\aleph^e \equiv 0$  in the rest system of coordinates. In contrast to  $\aleph^y$ ,  $\aleph^e$  has no “potential” eigenfunctions (with spin zero) in its Fourier expansion for “rest particle”, so, spins of NEPOS modes are of  $\pm 1/2$ , not of  $-1, 0, +1$ . The physical senses of  $\aleph^y$  and  $\aleph^e$  are the local deviations of NEMOS and NEPOS respectively from their “undisturbed” states. Both  $\aleph^y$  and  $\aleph^e$  are gauge-dependent (tend to zero far off from a matter). “Rigidity” factors  $R_y, R_e$  couple the local deviations of NEMOS and NEPOS respectively with the 3-density of energy-momentum (like  $1/\mu_0$  factor does for the EM potential).

Our postulate is: the energy-momentum conservation is a basic law of the Universe; any objective “uncertainty” for ones is impossible. E.g., for a closed physical system “charged particle in its EM potential”, the total energy-momentum is objectively strictly defined. The uncertainty has a place only in what part of this energy-momentum may be found as located in NEPOS and what part of one as reside in NEMOS at the measurement.

The interaction process cannot be determined in the time domain in quantum electrodynamics [3]. So, the Lagrange equations for NEMOS and NEPOS (the wave equation and the Klein-Gordon equation respectively) can be written only for their non-interacting (free) vibrations. But free oscillations of NEMOS and NEPOS do not occur at all. “Pure” eigenmodes of these systems cannot be excited as having infinite spatio-temporal spread. On the other hand, harmonic components of localized wavepackets are not independent (because energies-momenta of taken separately the components do not satisfy the quantization principle). So, any NEPOS wavepacket (“electron”) is linked together by permanent interaction of its spectral components with each other by means of NEMOS.

Thus, the spatial localization of NEPOS wavepackets and the Heisenberg’s “uncertainty principle” both are results of NEPOS and NEMOS interaction. E.g., a sole NEPOS wavepacket in its “own” EM potential stochastically exchanges with NEMOS by random quanta of momentum (not energy) producing continuous  $\aleph^e$  spectrum of finite width in the spatial domain. The energy spectral density describes the probability that respective ( $m$ -th) eigenmode has a non-zero occupation number  $K_m$ . An “associated”

NEMOS wavepacket has similar (mirrored) spectrum envelope ensuring total energy-momentum conservation. After the inverse Fourier transform, both spectra provide spatially localized functions  $\mathfrak{N}^e$  and  $\mathfrak{N}^y$ . If there are two or more “electrons” in their “common” EM potential, NEMOS performs exchange with momentum quanta between those, i.e., “the Coulomb repulsion”. Similar process in the time domain transfers both energy and momentum and is known as “radiation-absorption”. The magnetic moment of “electron” is, probably, also similar result of the “uncertainty” in its own angular moment.

A new physical sense must be supposed for the electric current density 4-vector  $\mathbf{j}^q(t, x, y, z)$ . It is treated as a factor (rate) of energy-momentum interchange between NEPOS and NEMOS localized wavepackets, not as real physical object. After the second quantization of NEPOS and NEMOS,  $\mathbf{j}^q$  turns into a part of an operator “shifting” the nonzero occupation number between different their eigenmodes. Each act of such “shift” is the “mirror” event for NEPOS and NEMOS. So, the spectrum of  $\mathfrak{N}^y$  is the mirrored spectrum of  $\mathfrak{N}^e$  transferred to the zero “central” wavenumber, and  $\mathfrak{N}^y$  is the “slow envelope” of  $\mathfrak{N}^e$ . An imaginary “pure” NEPOS eigenmode does not create  $\mathbf{j}^q$ .

### Zero-Point Oscillations

The above concept quite adjusts with [3] except for a one point. Our hypothesis does not assume existence of the zero-point oscillations for neither NEPOS nor NEMOS taken separately. Respectively, the energy-momentum levels of their  $m$ -th eigenmodes start from zero, not from  $h\mathbf{k}_m/2$ , where  $h = c\hbar$ . To explain this mismatch, let’s remember the second quantization of EM potential in [3]. Using the wave equation for  $\mathfrak{N}^y$  and the Fourier method

$$\mathfrak{N}^y(t, x, y, z) = \sum_{m=-\infty}^{\infty} u_m(t) \mathfrak{N}_m^y(x, y, z),$$

a Lagrange equation  $d^2 u_m / dt^2 + k_{mt}^2 u_m = 0$  is derived for  $m$ -th eigenmode instantaneous value  $u_m$  ( $t \equiv ct$ ). This equation is similar to the mechanical quantum harmonic oscillator (QHO) Lagrange equation, therefore the  $m$ -th eigenmode Hamilton function is written as

$$H_m \left( u_m, \frac{du_m}{dt} \right) = \frac{R_y}{2} \left[ \left| \frac{du_m}{dt} \right|^2 + k_{mt}^2 |u_m|^2 \right] \int_V |\mathfrak{N}_m^y|^2 dx dy dz.$$

where the integral is taken over all 3-volume of the Universe. The Hamilton operator for  $m$ -th eigenmode

$$\hat{H}_m (\hat{U}_m, \hat{P}_m) = \frac{R_y}{2} \left[ (\hat{P}_m)^2 + k_{mt}^2 (\hat{U}_m)^2 \right] \int_V |\mathfrak{N}_m^y|^2 dx dy dz$$

is similar to the Hamiltonian of mechanical QHO. For this reason, the energy spectrum of  $\hat{H}_m$  is “declared” as coincident with the spectrum of mechanical QHO:

$$W_m(K_m) = h k_{mt} (K_m + 1/2).$$

An error has a place in such reasoning. In order to the eigenvalue spectrum of  $\hat{H}_m$  coincides with the spectrum of mechanical QHO, the generalized momentum operator for  $m$ -th eigenmode must be written as  $\hat{P}_m = -i\hbar \partial / \partial u_m$ . But such expression is not the generalized momentum operator. Moreover, there is no any physical sense in one because there is no function undergoing this operator.

A formal cause why the Hamilton operators mismatch, while the Hamilton functions are similar, is as follows. Generalized coordinates of mechanical QHO are the spatial coordinates; respective wavefunction is a function of  $x, y, z$ . On the contrary, wavefunctions of NEMOS  $\mathfrak{N}^y$  and NEPOS  $\mathfrak{N}^e$  are their generalized coordinates also.

The zero-point oscillations exist only in “mechanical” oscillatory systems, where the generalized and the spatial coordinates coincide. Such systems (e.g., crystal lattices) always are based on the interaction between NEPOS and NEMOS. The zero-point energy  $h k_{mt} / 2$  is “inserted” into mechanical QHOs during the creation of ones. An attempt of the Casimir effect interpretation without using the zero-point oscillations of vacuum is made in [4]. If this is right, the experimental observations of the Casimir effect do not imply the reality of the zero-point energy.

If the cancellation of the vacuum zero-point energy is done, quantization rules for energy-momentum of natural oscillatory system eigenmodes may be expressed in a obvious form: shift of the system in any spatio-temporal direction over the respective wavelength must cause the action of  $h$ , changing the aleph-function phase by  $2\pi$ .

### Conclusion

The existence of spatio-temporally localized wavepackets in the natural EM and EP oscillatory systems is possible due to the permanent interaction between NEPOS and NEMOS widening spectra of their vibrations and causing those to be forced, not natural. The zero-point oscillations of NEPOS and NEMOS do not exist; this effect is a specific trait only of “mechanical” oscillatory systems.

### References

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