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# A Hidden Variable Model of Hydrogen Energy Spectra

Gianpaolo Bei

*Secondary School Teacher, IISS Charles Darwin, Via Tuscolana 388, Rome, Italy*

***Abstract*** *- We propose a simple deterministic model of hydrogen energy spectra based on the hypothesis that atomic spectra have space-time dependent energy, which depends on a hidden effective vacuum index of refraction. The electromagnetic energy of the atomic states is supposed to be equal to the spacetime-dependent energy shift of the electron rest mass induced by symmetry breaking vacuum fluctuations. We propose an approach by which it is possible to recover Bohr stationary atomic energy spectrum averaging on particular discrete surfaces the hidden time-dependent electron energy.*

**Keywords —** *Hidden variable model, Hydrogen energy spectra, Time-dependent energy states, Vacuum index refraction.*

## I. INTRODUCTION

In recent years there has been a greatly renewed interest in the foundations of quantum mechanics and the search for alternative deterministic formulations inspired by the pioneer ideas of Einstein on hidden variable theories, which were implemented in the famous E.P.R.argument against the Copenhagen interpretation. Independently DeBroglie developed his pilot waves theory which was subsequently adapted by Bohm to the Einstein idea of a hidden variable approach to the statistics of Quantum Mechanics [1], [2]. It was called Bohmian Mechanics since it was a classical model of particle dynamics aimed to convince the scientific community with a concrete counterexample that there was a loophole in the famous no-go theorem of Von Neumann [3]. This alternative approach to Quantum Mechanics subsequently inspired Bell to look for some inequalities, which were discovered by him and constitute the main content of the famous Bell theorem [4]. The main consequence of it was that it allowed conceiving experiments that could discriminate between the standard statistic approach and the deterministic hidden variable theories. Most of the papers since then were based on the conventional identifications of all the deterministic approach to quantum physics with the kind of hidden variable model used in the Bell theorem; consequently, most of the experimental researches on possible violations of Quantum Mechanics were concentrated on the concept of entanglement and the realizations of analogs or generalizations of the original E.P.R. experiments. Notwithstanding, in recent years, have been discovered some loophole in the Bell Theorem, and there is at the moment a great debate on them [5]; few researchers tried to develop a dynamic deterministic model aimed to explain the stability of the atoms and the hidden cause of the statistic of quantum physics. In particular, as far as we know, just one author, G. 't Hooft, has been looking for twenty years for a general realistic and deterministic model of quantum Mechanics, which goes beyond the standard problem of entanglement [6]. On our opinion, this identification of a deterministic approach to quantum physics with a hidden deterministic model of spin and entanglement is misleading since the last ones concern just free states, the entangled states, and not the bound states (which were the historical base of the birth of quantum mechanics from the observed discrete hydrogen spectra). In particular, we think that is missing now a real dynamic deterministic model which explains the electromagnetic forces between atoms; an old unsolved question on this topic is the problem of the electromagnetic radiation emitted from accelerated electron (and the consequent backreaction force on it), and more generally the theoretical justification of the classical Larmor formula [7]. Our proposal is based on the idea that if the accelerated electron (and proton) radiates, then it is possible to conceive the quantum wave function as a particular ensemble average of these hidden real radiated electromagnetic fields. A great difficulty of this approach is that it needs a kind of infinite-dimensional hidden variable that has to be introduced to recover the standard statistics of Quantum Mechanics.

Our simplified proposal introduces the vacuum index of refraction as a "hidden variable" since it is experimentally well known that we always observe an ensemble of interacting atoms, which should, in accord with Maxwell's theory, continuously radiates electromagnetic energy. Our view is that the atomic energy states are emergent stationary states since, what we observe in the laboratory, is just an ensemble average of hidden time-dependent fluctuation. Our model is motivated by the desire to deduce dynamically the discrete energy spectra described by the Bohr formula and suggests an approach that may explain the cause of the statistics of the atomic jumps [8]. Maybe the great efforts on the possible violations of Bell inequalities have obscured the question on the reality of the electromagnetic fields beneath the atomic energy stationary states; consequently, it has been abandoned, as said before, the search of a hidden variable theory of quantum bound states and the real reason of atomic stability [9]. We think that the recent interest in the dynamic vacuum model [10] will open the search for deterministic vacuum fluctuations models, which will free, we hope, atomic physics from the Copenhagen Interpretation of Q..M. and maybe from the Schrodinger unreal wavefunctions. We will try in the next section to propose a realistic approach to the atomic, electromagnetic energies aimed to reproduce, by a temporal average, the stationary hydrogen energy states described by the Bohr formula. The hidden variable of our model is the effective vacuum index refraction caused by the interference of the ensembles of electromagnetic waves continuously emitted and absorbed by the accelerated hydrogen atoms. At the end, we suggest a tentative ensemble reformulation of quantum wave function based on the average of classical electromagnetic potentials in a dielectric medium. Endly we want to remark that, since our hidden variable is infinite-dimensional, our model cannot be encompassed by the Bell Theorem unless one looks for different ensemble averages as, for example, integral path averages over the infinite-dimensional space of variable vacuum index of refraction.

## II. HIDDEN VARIABLE MODEL

We assume that the rest energy of a single atomic state is relativistic formula modified by the presence of the effective vacuum refraction index in the following way

$$E_{Atom} = \frac{m_0 c^2}{n^2} - m_0 c^2 \qquad (1)$$

and that the electromagnetic energy radiated or absorbed continuously is given by

$$\Delta E_{Radiation} = E_{Atom} \qquad (2)$$

which will describe bound time-dependent atomic states if we assume that n be less than one. Since we are interested in reproducing the Bohr formula, we can reformulate dynamically exploit the condition of atomic stability of the orbits by imposing the following condition

$$\nabla E_{Atom} = 0 \qquad (3)$$

which means that the orbit on the corresponding surface will not radiate. The previous formula can be rewritten, deriving with respect to the variable *n*, in the following way

$$\nabla n = 0 \qquad (4)$$

Which exploits the condition on the hidden space time-dependent index of refraction. Finally, assuming that the previous condition determine discrete surface on which the energy depends only on time, we suggest recovering the Bohr energy by the following formula

$$E_k{}^{Bohr} = min E_k(t) \qquad (5)$$

with

$$E_{Atom}(x,t)|_{\nabla E_{Atom=0}} = E_k(x,t) \qquad (6)$$

and

$$\tau = \frac{h}{m_0 c^2} \qquad (7).$$

The second member of equation (5) explicit the idea of the proposal that the stationary states are just the stablest one and that there is a continuum emission rate of the hydrogen atom whole intensity is maybe unobservable or that can be easily confused with an electromagnetic rumor (which has a variable phase velocity). If we want to recover in our approach the success of the Schrodinger equation, we must give a realistic interpretation of the quantum wave function as averages of real electromagnetic potentials. Therefore we propose, supposing that light speed has very fast hidden fluctuations, that the corresponding ensemble averages of classical electromagnetic give the Schrodinger wavefunction by the following formula

$$\psi = \int_0^c \varphi(x,t,c')\rho(c')dc' \qquad (8)$$

Where $c' = \frac{c}{n}$ Is the scalar variable phase light speed, φ is the classical potential solution of the D'Alembert wave equation with variable light speed, and the probability density ρ is unknown? We conjecture that it might be possible to find the unknown density distribution by inserting the class of discrete eigen functions of the Schrodinger equation. We expect more generally that the search of the statistical properties of atomic electromagnetic fields in a medium with a fast variable vacuum index of refraction could pave the way to a deterministic reformulation of Stochastic Electrodynamics, a research program that has been stimulating great interest in recent years [11]. Anyway, we think that at the moment, our proposal is just a tentative model, but to improve, it is necessary to deduce the properties of the Poynting vector of the atom electromagnetic fields with variable light speed, exploiting the analogies with the recent studies on active optical medium with variable dielectric constant [12] ( bibl Leuchs e mimosa) and looking for experimental tests of modified spontaneous emission rate.

## III. CONCLUSIONS

We propose a deterministic dynamic model of atomic spectra caused by a spacetime-dependent effective vacuum index of refraction due to hidden deterministic vacuum fluctuations. We propose a hidden time dependence of Hydrogen energy-bound states and an interpretation of Quantum wave function as averages of classical electromagnetic potentials in space time-dependent hidden dielectric. We expect that a similar spacetime dependence will be experimentally found by studying the environment dependence of the semiclassical Einstein spontaneous emission rate in a nonlinear dielectric medium and the variability of their relative decay rates. We hope that this naif model will stimulate research on infinite-dimensional hidden variables models of quantum states and jumps, which we believe could reveal their possible relationship in the future with the recent theoretical investigations on Unruh effects and the emission rate of accelerated atoms [12].

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