I. DEUTERIUM INTERACTION IN UNITARY QUANTUM THEORY

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ABSTRACT

A unitary quantum theory (UQT) with a new perspective on the problem of particle interaction was developed in the author's papers [1-8]. According to this theory any elementary particle is a condensed group of some unitary field traveling in a packet of partial waves. Dispersion and nonlinear nature of the process spreads the wave packet periodically across space and assembles it; the envelope of the process happens to coincide with the de Broglie wave. The formalism of the theory amounts to the relativistically invariant system of 32 non-linear integral-differential equations from which relativistic quantum mechanics in the form of Dirac's equation follows. On the other hand Hamilton-Jacobi's relativistic mechanics follows strictly mathematically from the theory. We can solve this problem in a different way, though for this purpose we must sacrifice part of the ideology of the UQT, (refraining from dividing particles or wave packets). As a matter of fact we can do this [accept this restriction] if the energies are low when the interactions are elastic (though there are exceptions.) This paper will show that despite the roughness of the approach the results may be outstanding. Even when using this approximation the approach can provide outstanding results. The approximate solution of some of the UQT equations [7,8] gives the value of the electric charge together with the value of a fine structure constant; the data being in very good agreement with experimental results. This achievement allows one to give a heuristic description of a moving particle as a charge oscillation with the de Broglie wave frequency. In other words, in all macro experiments the effective value of a charge is measured, the oscillation being unnoticeable.

INTRODUCTION

Newton's equation for a moving mass point with an electric charge q and a modified equation for the electric force acting on the electric charge oscillating at the de Broglie wave frequency in the field with intensity E are suggested as the basic model equations:

$$F = m\ddot{r} = qE\,2\cos^2(\varphi), \quad \varphi = \frac{m\dot{r}^2}{2h}t - \frac{m}{h}\dot{r}r + \varphi_0 \ . \tag{1}$$

where E = -grad V, V(r) is a potential. Such approach is a natural outcome of (8). Further on only spherically symmetrical potentials will be considered. To simplify the non-linear equation given let us introduce scale coefficients for coordinates, time, and velocity: $r = S_r r_s$, $t = S_t t_s$ and $S_v = S_y/S_t$, respectively.

Assuming $mS_r^2 / hS_t = 1$, $k = qmS_r^3 / h^2$ we will obtain the following normalized equation (omitting "s" indices):

$$\ddot{r} = kE\,2\cos^2(\dot{r}^2 t/2 - \dot{r}r + \varphi_o) \tag{2}$$

which despite the apparent simplicity of the initial premises can drive any mathematician to deep despair. As the first scale coefficients relation provided a simplified expression for the phase, the second relation unambiguously describing S and S will be chosen proceeding from the simplified expression for the potential examined. Let us consider the main properties of equations (1) and (2). For simplicity's sake it will be assumed that the particle can move along the axis of r=(x,0,0) in the field of E(r)=(E(x),0,0).

FIXED CHARGE

If x-0, then the electrostatic force is F = $kE\,2\cos^2\varphi_0$ and $\int_0^{\pi} F d\varphi/\pi = F_{clas}$ is classical electrostatic force.

Averaging a great number of charges results in a force equal to F_{clas}.

UNIFORMLY ACCELERATED MOTION

If E(x)=E>0 is a uniform constant field where a = $kE2\cos^2\varphi_0$ and $\int_0^{\pi} a d\frac{\mathbb{C}}{\pi} = T_{clas}$ is classical particle acceleration aligned with the uniform constant field. If the field acts in a D-size range, the accelerated particle kinetic energy is equal to T=maD and $\int_0^{\pi} T d\varphi/\pi = T_{clas}$ is classical kinetic energy.

As $v(\varphi_0) = \sqrt{2sD} = v(0)\,|\cos\varphi_0|$, then at the uniform phase $\varphi_0 = 0 \ldots \pi$ probability density of velocity distribution after acceleration is equal to $2_{\pi}[v(0)^2 - v(\varphi_0)^2]^{1/2}$.

Motion studies at the constant phase of φ_0 = const show that $\dot{x} = (x/t) \pm [(x/t)^2 - 2(\varphi-\varphi_0)/t]^{1/2}$ and the particular solutions will be $x(t) \approx t^2$ (linearly accelerated) and $x(t) \approx \sqrt{t}$ (diffusive).

Within the force field the particle will move uniformly (due to inertia) at f~p/2 accelerating in all other cases. Such nonuniform motion in respect to average values gives rise to relations similar to uncertainly quantum relations.

TUNNELING

If we take up the problem of particle/bell-shaped potential interaction, all known qualitative quantum-mechanical implications will remain valid. This results from the fact that in a potential step considered above and an accelerating part which does not hinder motion. But, unlike quantum mechanics, there is no above barrier reflection in the model at velocities v over a certain threshold value. As an example, we will consider the way the particle passes a symmetrical potential barrier of the Gaussian type $V(x) = \exp[-(x/6)^2]$. The particle motion should meet equation

$$\ddot{x} = 2(x/\delta^2)\exp[-(x/\delta)^2 J\, 2\cos^2(\dot{x}^2 t/2 - \dot{x}x + \varphi_0),$$

with the initial conditions of x(0) = -4, $\dot{x}(0) = v$, $\varphi_0 = 0 \ldots \pi$.

Fig. 1 shows probability P(v) of particles passing through the potential barrier vs. velocity (energy) v and uniform initial phase distribution = 0... p.

Fig. 2 shows probabilities P(s) of a particle passing through potential barrier vs tunneling distance. It can be seen that the curve has resonance peaks at small v_0. An increase in velocity v_0 leads to a threshold effect when all the particles pass through a sufficiently wide barrier without reflection. The regularities observed in passing through a potential barrier are similar to quantum-mechanical predictions. But in quantum mechanics particle passage probability is proportional to its squared wave function modules and is entirely independent of the phase. So one might ask why some particles reflect from the barrier while some others pass through it. Our model answers the question as follows: the probability of a particle passing through the barrier is dependent of the particle phase. If the phase is such that the charge is small, the particle will fly through the barrier without "noticing" it.

PARTICLE IN THE PARABOLIC WELL

Let $V(x) = fx^2$, $E(x) = -2fx$.

We'll assume 2kf=1 and start examining particle behavior in such a potential well. The initial equation is $\ddot{x} = -x\,2\cos^2(\square^2\, t/2 - \square\, x + \varphi_0)$, the initial conditions are $x(0) = 0$, $\dot{x}(0) = v$, $\varphi_0 = 0...\pi$.

The numerical analysis of the equation leads to four solution types:

1) Unstable periodic solutions. When velocity v goes down, oscillation period approaches 2p asymptotically, as is to be expected.

2) Irregular dying particle oscillation in a potential well. For some initial values the amplitude of particle oscillations first goes down and then infinitely up.

3) Irregular oscillations with an infinitely increasing amplitude. For some initial values the amplitude of particle oscillations first goes down and then infinitely up.

4) Diffusion at which the particle can be tunneling through the potential for an indefinitely long time is similar to the particle behavior in the potential step problem. With a limited depth parameter the particle will leave it by all means, though it might spend sufficiently long time doing it. Periodic and irregular oscillation states can be defined as discrete and continuous (blurred) zones, respectively.

ABOVE BARRIER REFLECTION FROM A POTENTIAL WELL

In considering particles flying through the potential well the following phenomena are observed. Unlike quantum mechanics there is a threshold velocity for flying particles, above which all the particles fly over the potential well without reflection. If the initial velocity v0 is under the threshold value, the particle will get into a potential well and will either tunnel through the barrier or start oscillating in the well. It can "jump out" of the well and go on with its motion (reflection or flight through) or form a bound state similar to the one discussed in the parabolic well problem.

DEUTERON INTERACTION

Let's consider two charged particles (deuterons) moving towards each other along an X axis.

Let's choose a starting point on the reference frame in the center of one of the particles with a charge Q. Let the second particle with a charge q and velocity V_0 move from a coordinate point X_0. If opposite beams collide we can arrive at the above-state situation having introduced the normalized mass. The particles are expected to approach each other at a distance of X_{clas} where their velocity will drop down to zero and then start to accelerate again. In accordance with the classic Coulomb's law this distance can be calculated by the expression:

$$X_{clas} = \frac{2QqX_0}{2Qq + m\,X_0\,V_0^2} \tag{3}$$

If the charge q oscillates by the de Broglie wave frequency, the motion equation could be written using the Gauss's system as

$$m\,\ddot{X} = \frac{2Qq\cos^2\left(m\,\dot{X}^2\,t/2\,h - m\,\dot{X}\,X/h + \varphi_0\right)}{X^2} \tag{4}$$

$$\ddot{X} = -\frac{k}{X^2}\cos^2\left(\frac{\dot{X}^2}{2}\,t - X\,\dot{X} + \varphi_0\right), \text{ where } k = 2Qq \tag{5}$$

THE VALIDITY OF EQUATION

To clarify the physical situation, the digital computation of equation 5 was done by a computer with the initial conditions being provided to make it quicker: with X_0=10, different values were used for the initial velocity and phase variations from 0 to p. It was discovered that the laws of energy and momentum conservation were partially observed. In case of particle reflection at a distance of X0 its velocity ranged about 20-30% higher or lower, respectively. But if we sum up the incident and reflected particles throughout all the phases, the entire energy value will be preserved. As was expected, the effect of particle acceleration occurred at the largest value of the charge.

On the other hand at the last stage of moderating (for a number of values of velocity and phase values) we could observe a fantastic process: the velocity and charge being too small, the repulsive force is also small. This phenomenon can continue for quite a long period of time and the particle has an additional opportunity to penetrate the repulsive potential for an indefinite depth. All that reminds very much of a furtive clandestine penetration upon the enemy territory. This outstanding phenomenon occurs only within some phase range close to p/2 and it can be conveniently called the "phase precipice" as is shown on Fig. 3. The relative depth of the "phase precipice" equals Xmin/Xclas = 10^{-6} to 10^{-9} and is independent of the energy. Under very small energies (0.01 to 1eV) the precipice exists but it is narrow (10^{-10} to 10^{-8}) and not easily traced in terms of digital computation. For instance, the phase change in 10^{-10} may eliminate the precipice. As a matter of fact energy and momentum conservation laws are not observed for an individual particle but they are related by the relations of uncertainty type, though of a different origin.

The regularities observed in passing through the potential barrier are similar to quantum-mechanical predictions. Now the quantum mechanics may be slightly kicked not withstanding its attractiveness. I've never understood why God has not used the phase in any way in his quantum Universe though he hasn't ever been noticed making any surprises before. At least now it is obvious that the phase might be used like that, but nobody has ever guessed it.

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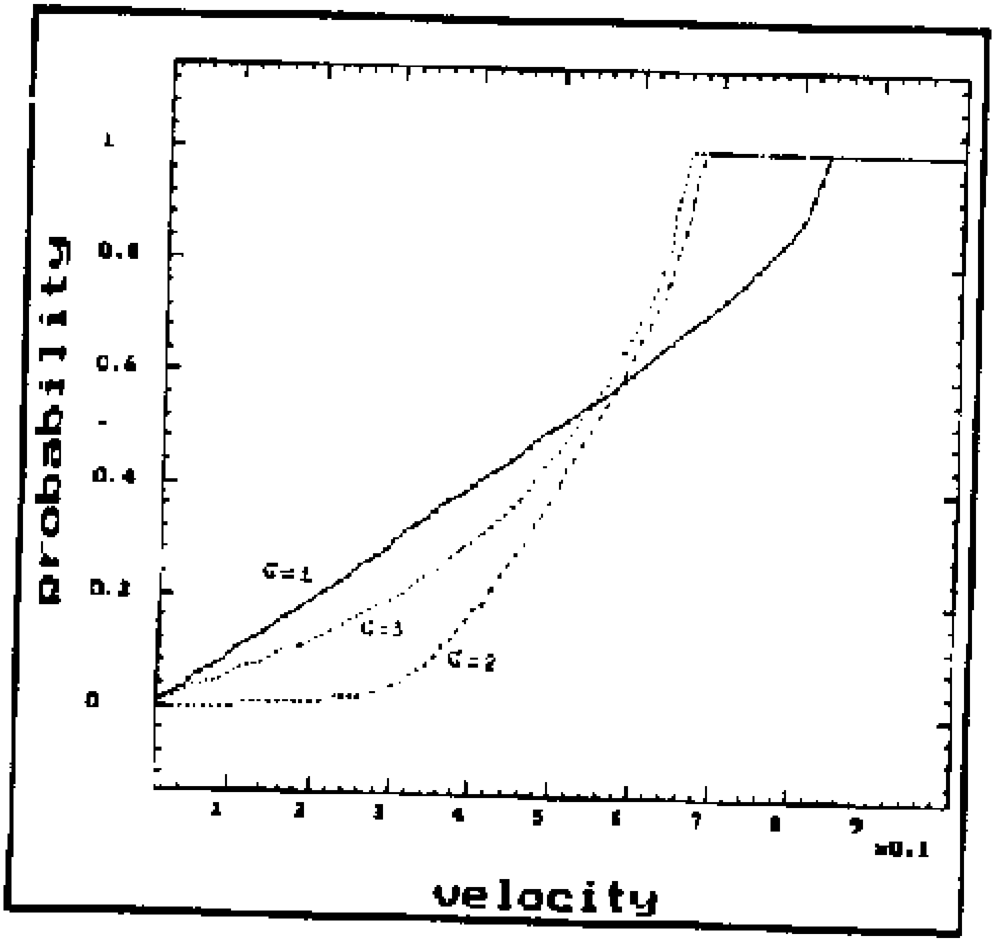
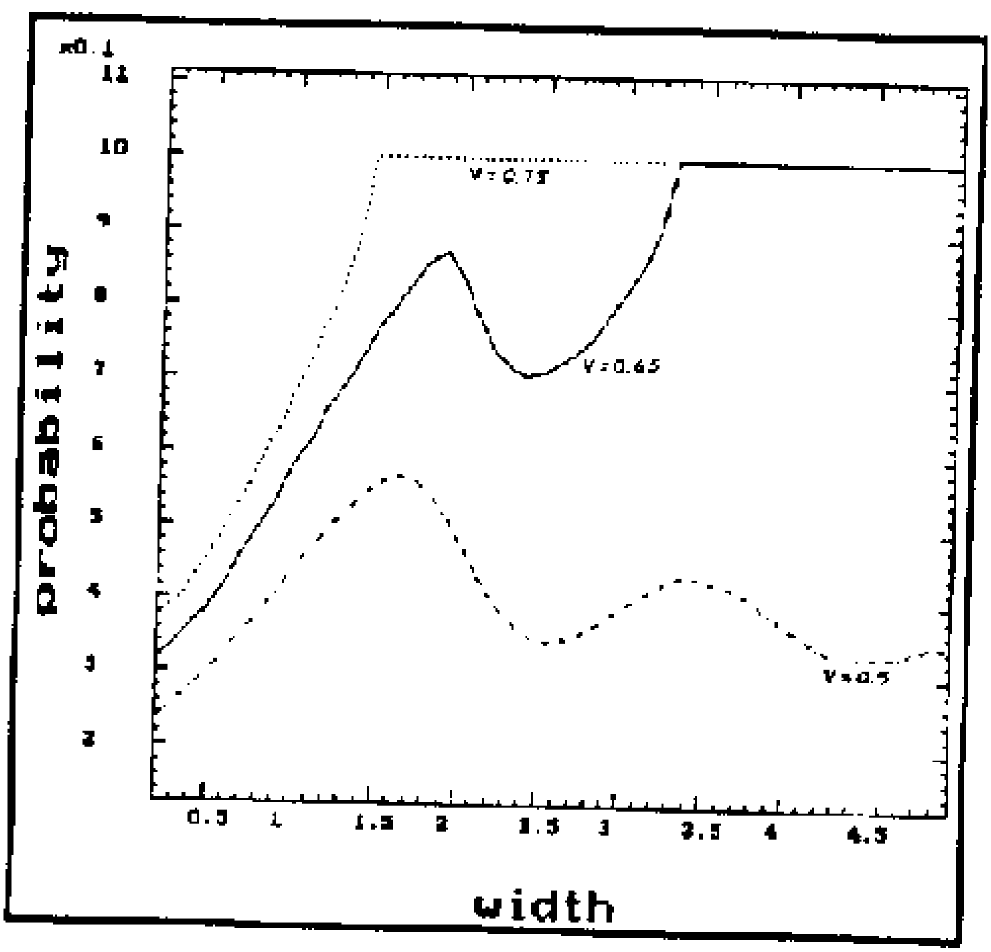
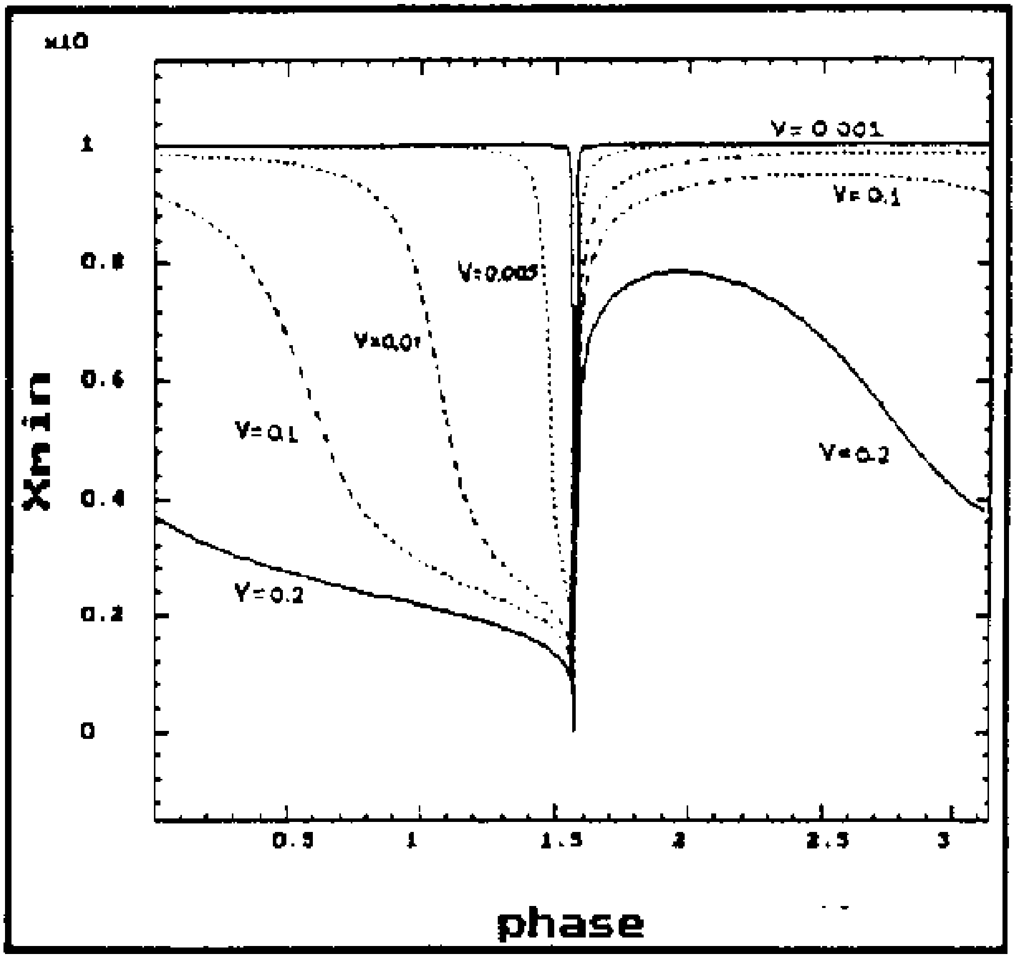


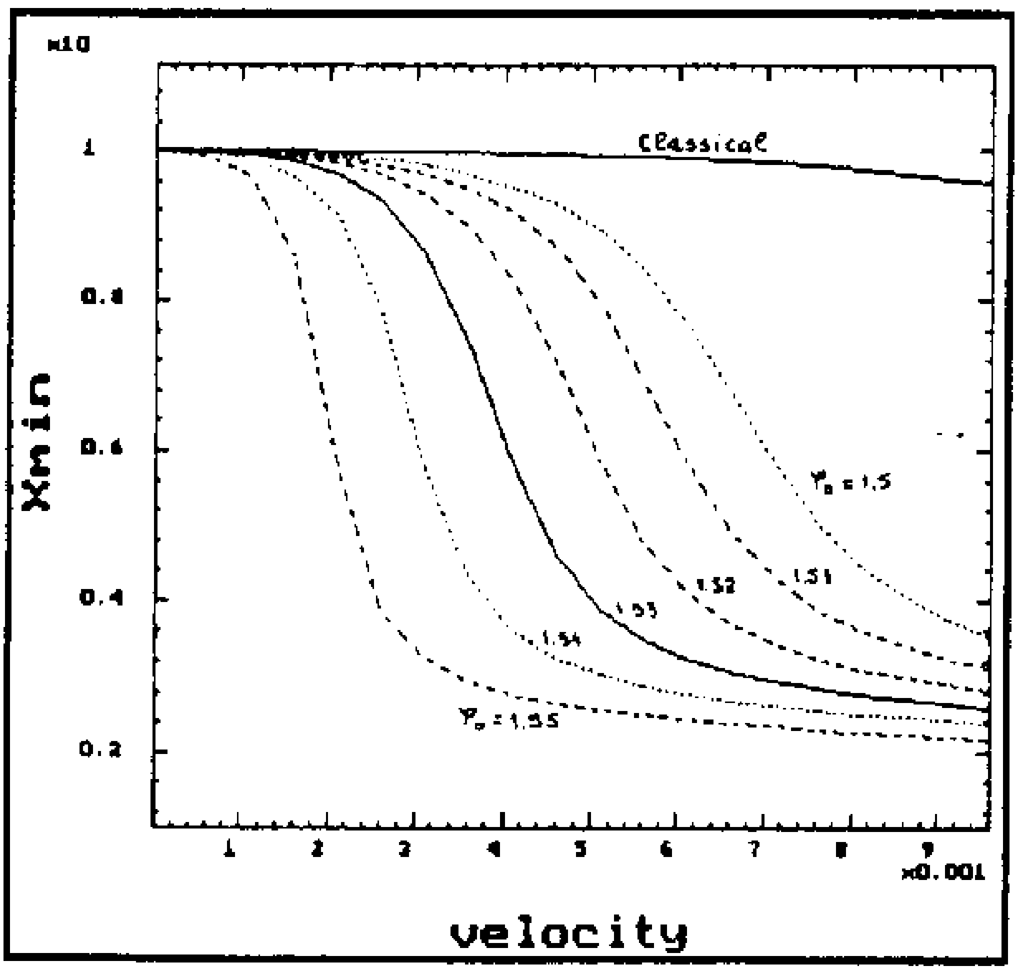
Probability
velocity
C=1
C=3
C=2
x0.1



Probability
width
x0.1
V=0.75
V=0.65
V=0.5



x10
V= 0.001
V= 0.1
V=0.005
V=0.01
V=0.1
V=0.2
V=0.2
Xmin
0.5
1
1.5
2
2.5
3
phase



x10
Classical
Xmin
1.5
1.51
1.52
1.53
1.54
1.55
x0.001
velocity