WAVE ESSENCE OF PARTICLES

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Abstract

We state several ideas based on the view-point of particle behaviour of matter to explain wave character of photon and elementary particles. By using Newton's suggestion of light ray, we clarify integrally the behaviour of light "wave". And "wave" character of particles is also explained by the view-point of particle.

1 Introduction

Today everybody believes that the matter has both particle character and wave character.

Following belief up to now, wave is understood as continuous change of any quantity in period in space and in time with its immanent cause. With the view-point of particle the periodic property puzzled everybody, and it is looked as a presence of wave.

Now, we think that there is still an other way to understand nature more accurately and more consistently: we use still Newton's ideas "along with ray of light there must be a manifestation of some periodicity" to explain wave phenomena of the light and elementary particles.

The article is organized as follows. In Section 2, we show an explanation intuitionally of interference of the light. And the interferential phenomenon of electron is illustrated in Section 3. Conclusion is given in Section 4.

2 Interferential picture of the light

The electromagnetic field can exit independently and so it includes invariant structures (particles). The electromagnetic field has periodicity and so this periodicity either goes with particle by anyway or manifests in the distribution of particles in space and this squadron of particles fly along a fixed ray,

$$\begin{array}{lr} |\!-\!\!-\,\lambda\,-\!| & \qquad\qquad\qquad \vec{c} \\ \bullet\!-\!-\!-\!-\bullet\!-\!-\!-\!-\bullet\!-\!-\!-\!-\bullet & \;-\,-\,-\!\longrightarrow \end{array}$$

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This picture is similar to the so-called wave.

Let us use this imagination of the light to explain how the interferential picture is created.

Suppose that there is a gun, and after each fixed interval of time Δt it shoots one ball. Balls are alike in all their aspect. They fly with the same velocity v in environment without resistance force and their gravities are ignorable.

The "wave-length" - i.e. the distance between two balls - is $\lambda = v.\Delta t$. All balls are electrized weak charge of the same sign, and they are covered with a sticky glue envelope so that electrostatically propulsive force between them cannot win stickiness of glue envelope when they touch together with small sufficient meeting angle. A target with two parallel interstices in the vertical is set square with the axis of the gun and is also electrized weak charge but different from the sign of balls. The distance between two interstices is not too large in comparison with the wave-length λ. And assume that sticky glue of balls does not effect on the target.

Thus, probability in order that any ball flies through one interstice or the other is identical. (The interstices are enough large that balls can fly through easily).

After flying past, balls are changed flying direction with all possible angles in the horizontal plane with definite probability distribution.

With such initial conditions, balls are in 'dephasing' with each other and, after overcoming the target, balls that do not fly through the same interstice are able to meet together with a some non-zero propability. If meeting angle is enough small in order that stickiness has effect, two some balls will couple together to be a system, then change direction and fly on the bisector of meeting angle.

If behind the target and distant from the target a space $d \gg \lambda$, a reception screen is set parallel to the target, then on this screen we will harvest falling point locations of single balls and couple balls.

Argumentation and calculation show that single balls (missed interference) form a monotonous background of falling points, and couple balls (caused by interference) fall concentratively and create definite veins on the background, depending on dephasing degree of interfered balls.

Hence, from Newton's idea and using quantities such as "wave-length", "dephase", and so on results obtained is fitted in ones calculated using wave behaviour. Furthermore, they explain why, when amount of balls is not enough large (the time to do experiment is short), the picture of falling points seems chaotic, randum. Only with a large number of balls (the time to do experiment is long), interferential veins are really clear. This is one that, if using wave behaviour, is impossible to explain.

Thus, if we consider the light as a system of particles that, in the most rudimentary level, are similar above balls: they are attractable together and radiated periodically, then the interference of the light is nothing groundless or difficult to understand when we refuse to explain it by using wave behaviour. Moreover, without wave conception the phenomena of the light is very bright, clear, and more unitary.

Such a view-point of the light requires to imagine again many problems, simultaneously brings about new effects that need to prove in experiment.

If there is a source that radiates continously separately light pulses of a fixed thickness and with a fixed distance between pulses (Fig. 1), we can carry out a following experiment (Fig. 2).

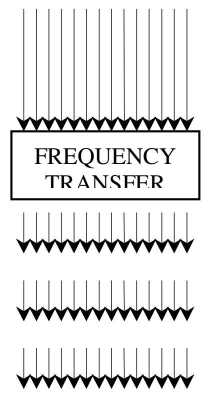

Figure 1: Frequency transfer.

With two continously radiative sources we direct light pulses together with an intersecting angle α. Interference presents only in the area ABCD of Fig. 1. If the light is wave, then to see interference we should set a photographic plate in the area ABCD, because outside this area interference is impossible to present. Two light sources are independent from each other, the stable condition of interferential veins is not ensured, position of vains is changed incessantly, and the consequence is that on the photographic plate we cannot obtain interferential veins.

But if the light is particle, then we always obtain interferential veins (in suitable polarization condition) though the photographic plate is set inside or outside the area ABCD.

Carrying out experiments according to this diagram we can check interferential ability of the light of different wave-lengths. Given two radiative sources of different frequencies by that way, we are able to see whether photons of different frequencies is identical.

A consequence of particle behaviour is that we can make mirror-holography with any reappear light source. This is drawn from the phenomenon that two photons interfered together change direction and fly on the the bisector of meeting angle.

In the conception of particle, frequency of a light wave is understood as number of photons radiated in a unit of time to a definite direction. The photo-electric effect, therefore, is understood as follows: the more number of coming photons that collide to

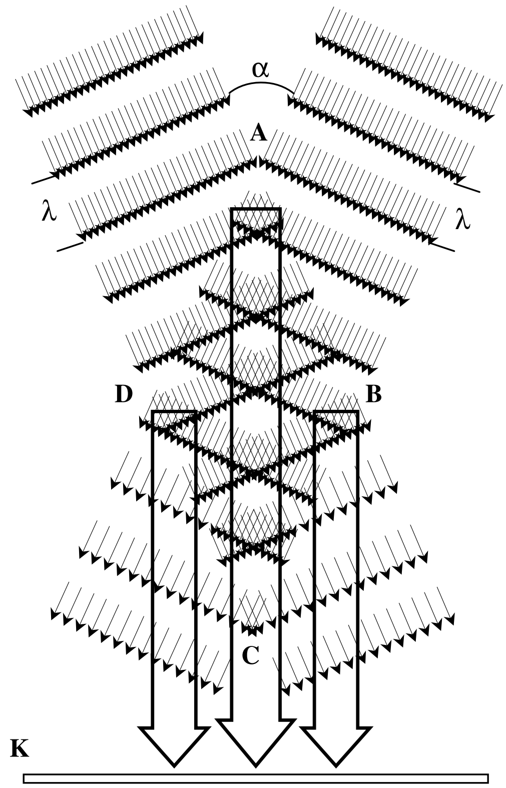

Figure 2: Interference of the light quanta.

electrons in a unit of time is, the higher energy that electrons gain is. If momenta of all photons are of the same value, then it is possible that number of photons electrons gain is proportional to light frequency, and thus momentum of each photon is proportional to Plank's constant $\hbar$. With such understanding, energy that electron gain from interfered photons is higher than one from non-interferential photons.

With wave behaviour and imagined that atom sends spherical waves, then the photoelectric effect is impossible to explain as shown. But if thought that atom radiate directly light, then because radiation is a wave process, in radiation process atom does not keep still a place in space, thus it is difficult to maintain that all energy quanta is transmitted out space in a definite ray. Situation is the same for absorbing process of energy quanta. For instance, electron is impossible to keep still a place to await absorbing all energy quanta then moves to other position.

Thus, there is not any firm basis to say that energy is absorbed piecemeal quanta $E = \hbar\nu$.

3 Interferential picture of elementary particle

Let us consider interference of electron.

First of all we can confirm that there would not be any experiment we gain interference of electron if we used conditions as already stated for the light. Because with actual experience electrons are not like as above balls with stickiness that lack of this ability there is not any presence of interferential couples.

Interference of electron is completely different, if using the word "interference".

Suppose that there is an electron flying to a block of matter made up from particles heavier very much than electron. Each heavy particle in the block of matter is a scattering center. Because of interaction, after flying out of influential region of scattering center electron is changed direction with an angle α in comparison with initial direction.

Assume that the deviation angle α is dependent on the aim distance ρ obeying on the law a or b as on the figures.

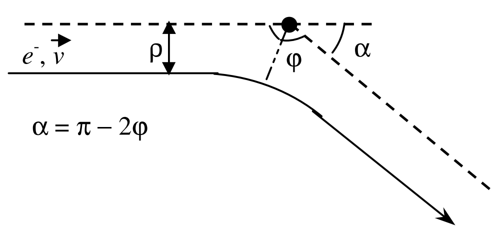

Figure 3: Scattering of electron.

Derivative of α with respect to ρ is equal to 0 at $\rho = \rho_0$.

If all values of the aim distance ρ is the same probability for e, then the probability in order that the particle e is deviated from the coming direction an angle (α_0) is "infinitely large" in comparison with any other angle: $\frac{\partial\rho}{\partial\alpha}\Big|_{\alpha=\alpha_0} = \infty$.

It is necessary to say that α_0 is inversely proportional to the momentum of e. The higher the momentum of e is, the higher the direction conservability of its momentum vector is, then the smaller the deviation angle α is. (That is just the basis of Broblie relation.)

We bring in a quantity ϵ called the maximum divergence that measurement is acceptable, that border rays deviated in comparison with the angle α a value ϵ belongs to still that angle α. Thus, we can establish a function of probability density having the following form, (Fig. 5),

The greater the sharpness of this distribution is, the greater the contrast of probability densities between the angle α and its neighbouring angles.

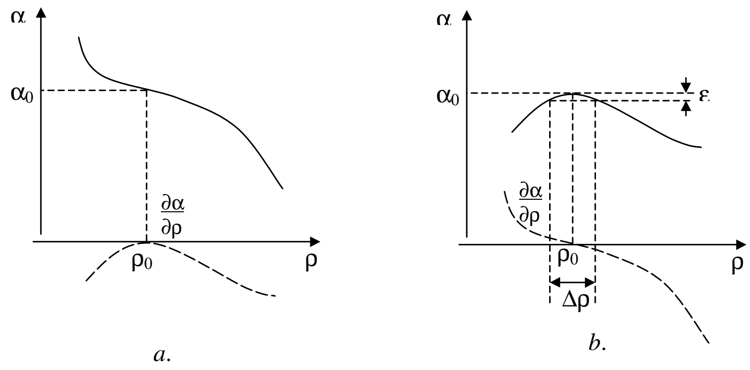

Figure 4: α-dependence of the aim distance ρ.

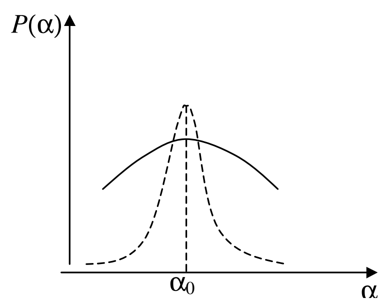

Figure 5: Probability density.

Call average distance between two scattering centers $2R$, then influence space of any center (in the field of the aim distance) is πR^2.

The space, where the particle e is falled into and deviated an angle $(\alpha \pm \epsilon)$, is proportional to $\pi\left[(\rho+\Delta\rho)^2-(\rho-\Delta\rho)^2\right] \approx 4\pi\rho\Delta\rho$.

The probability in order that e scatters into the angle α is $\frac{4\pi\rho\Delta\rho}{\pi R^2}=\frac{4\rho\Delta\rho}{R^2}$ (Fig. 6).

The probability density that e scatters into the angle α in a some direction is $\frac{4\rho\Delta\rho}{R^2}\frac{1}{2\pi}=\frac{4\rho\Delta\rho}{\pi R^2}=P_{(\alpha)}$.

However, using the above method to estimate the probability density with all directions in the space for all scattering processes of particles is very completed and unwieldy. For this reason, here we are only interested "relative" probabilities of variety directions,

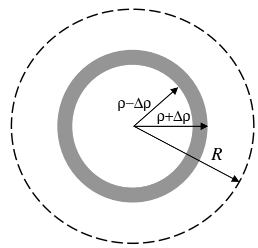

Figure 6:

namely events: the probability in order that e scatters into the angle α_0 is "infinitely"[2] large in comparison with that for all other angles. In that correlation, all deviation angles that are different from α_0 should be ignored because they form only a monotonous background. This has not influence on the qualitative accuracy of the law.

Consider i-th scattering experiment (each experiment there is only one e attended with a constant momentum, the same for all experiments.)

Assume that all scatterings are elastic. The scattering process of e is easy to imagine as Figures 7 and 8.

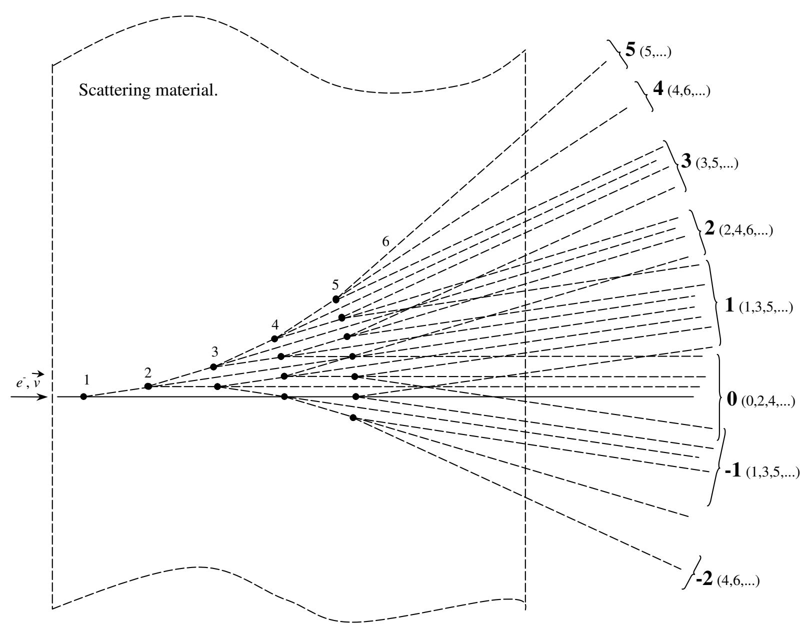

Figure 7: Projection outline of highest-probability diffraction beam on the vertical space.

[2]It means $\epsilon \to 0$.

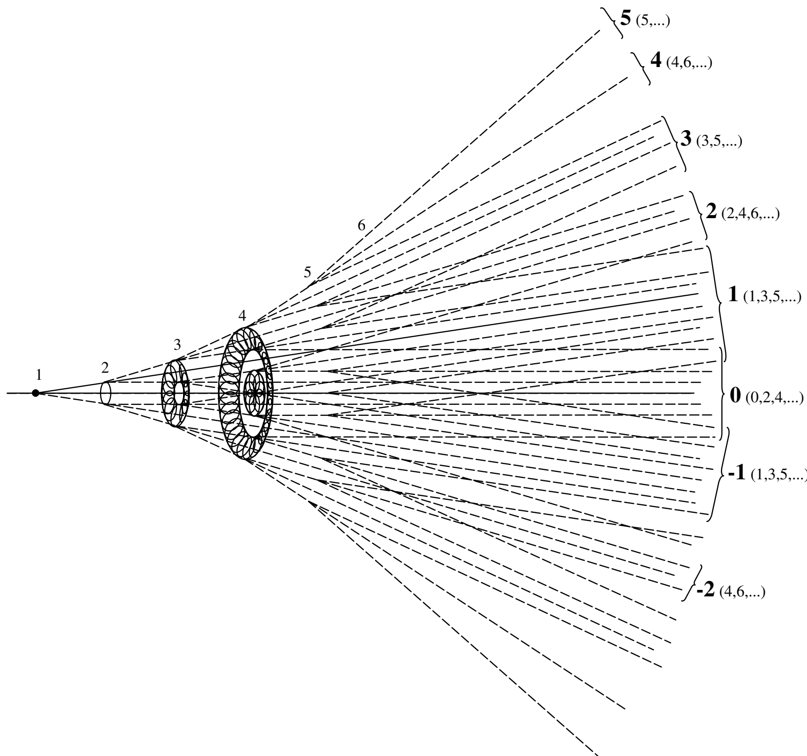

Figure 8: Reproduction of the formation of electron's diffraction veins.

After the 1-th scattering, e can be deviated with any angle and fly with any direction, but all directions with highest probability ($P_{\alpha_0} = \infty$) form a cone with the top at the scattering center and an arrangement angle ($2\alpha_0$).

In the 2-nd scattering, the directions with highest probability of e's trajectory form the cones with angles (0, $2(2\alpha_0)$). This is explained as follows.

Scattering centers in the block of matter distribute at random for e's trajectory and this random is always maintained by thermic fluctuations, inelastic scatterings, ... So, on the conic surface (1-2) there forms a brim - the locus of probability of 2-nd scattering centers, is plotted as the brim (2-2) in the figure. At each point of the brim there exist 2-nd scattering centers with some probability.

Thus, in the 2-nd scattering at each point of the brim there forms a new probability cone, similar to fomation at the 1-th scattering center. These probability cones interfere with each other forming two collective cones with open angles 0 and $2(2\alpha_0)$ respectively.

Indeed, if we put a spherical surface of enough large radius and center coincident with the 1-th scattering center, then cones intersect the spherical surface and form circles as given in Figure 9.

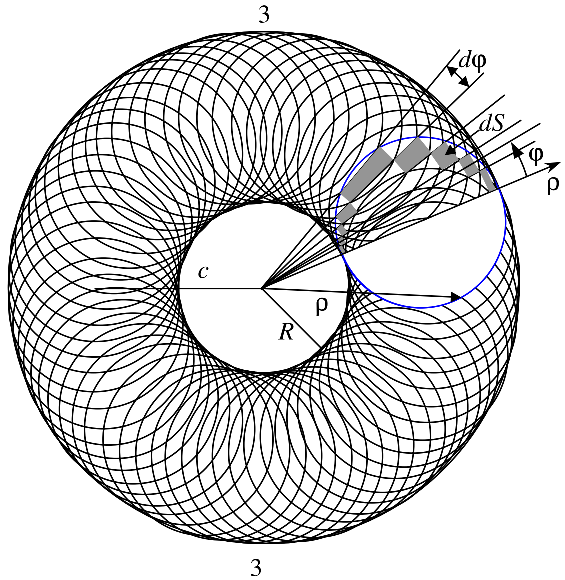

Figure 9:

For simplification, we are not concerned with curvature of the spherical surface. The probability in order that the particle falls into any point of circles is identical.

Let us find the probability density of e's falling points on this surface. In the figure, it is clear that this density is proportional to the ratio $\frac{\Delta\ell}{\Delta S}$, where $\Delta\ell$ is the total length of circles in an elementary surface ΔS (dS).

Solve this problem in the pole coordinate, the equation of circles in this coordinate is

$$\begin{aligned}
\rho &= C\cos\varphi \pm \sqrt{R^2 - C^2\sin^2\varphi}, && (1)\\
d\rho &= -C\sin\varphi\left(1 \pm \frac{C\cos\varphi}{\sqrt{R^2 - C^2\sin^2\varphi}}\right)d\varphi, && (2)\\
dS &\cong \rho d\rho d\varphi, &&\\
\Delta\ell &\cong 2\sqrt{d\rho^2 + \rho^2 d\varphi}, &&\\
M_\rho &= \frac{\Delta\ell}{\Delta S} = \frac{2\sqrt{d\rho^2 + \rho^2 d\varphi}}{\rho d\rho d\varphi}. && (3)
\end{aligned}$$

By differentiating of M_ρ over ρ then putting this derivative zero or substituting values of ρ and $d\rho$ into (3) and approach $\varphi \to 0$ we also obtain $M_\rho \to \infty$.

Thus, at maximum and minimum values of ρ the probability density M_ρ is infinitely large (in comparison with other values of ρ).

The surface dS is equivalent to the volume angle $d\Omega$, and $\Delta\ell$ is equivalent to the probability in order that the particle scatters into that volume angle.

Therefore, we obtain that in the 2-nd scattering all possible directions with highest probability of trajectories form two cones with open angles 0 and $2(2\alpha_0)$.

With similar argument we realize that at the 3-rd scattering the directions with highest probability of e's trajectories form cones with open angles $3(2\alpha_0)$, $1(2\alpha_0)$, $1(2\alpha_0)$, $-1(2\alpha_0)$.

Generally, up to the n-th scattering there form probability cones of possible directions of e's trajectories with open angles $n(2\alpha_0)$, $(n-2)(2\alpha_0)$, ..., $(n-2m)(2\alpha_0)$.

Put a spherical surface as a catching screen with its axis coincident to the initial direction of particle before coming to the target, and its radius much larger than the thickness of the target. The center of the spherical surface is on the target and in the coming point of scattering particle.

Hence, the probability cones forming at the last scattering intersect the catching screen and form circle brims - These are locus of falling points with e's maximum probability.

If n is even, we obtain an even number of brims; n is odd, we have an odd number of brims. And in all times of experiment e always scatters n times, then on the catching screen we obtain either an even number or odd number of brims, depending on even or odd value of n. Of course, in one time of experiment, n has only value. Thus, the probability intensity of obtained brims after total experiment Σ is dependent not only on decreasing law from inner to outer but also on frequence of n, i.e. on the ratio $\frac{i_n}{\Sigma}$; i_n is frequency (number of occuring times of n) in total experiment Σ.

It is difficult to define this frequency for every possible value of n. However, at the most rudimentary, it is sure that spectrum of n's values is not large[3] and probability in order that n has even or odd value is identical, then spectrum of differaction brims is complete from (0) to ($n_{\max}$).

From conditions of experiment we realize that the larger the matter density of the target is the tickness is, the larger $n_{\max}$ is.

Here, once again we find out that the differaction picture is only clear since the number of particles taking in scattering are enough much. If they are is too little, on the screen we see only a chaotic distribution of e's marks, but on the contrary, if they are too much and the catching screen is a photographic plate, then all points on the screen are saturated and differaction brims are hidden.

The scattering of light particles in a radial field is described in mechanics as follows

$$\varphi = \int_{r_0}^{r} \frac{M}{mr^2} \frac{dr}{\sqrt{\frac{2}{m}\left(E - \frac{M^2}{2mr^2} - U(r)\right)}},$$

where φ is the angle made by radius vector of particle's position on the trajectory and radius vector of particle's extremal point ($\vec{r}_0$), M is the momentum of the particle, E is the energy and m is mass of the particle, and $U(r)$ is the potential of the field.

[3] We are only interested particles that overcome through the target.

If the potential of the field $U(r)$ has the form $U(r) = \pm\frac{A}{r}$, then from the above formula we can express φ as a function of the aim distance ρ since the upper bound approaches to infinity, thus the deviation angle $\alpha = \pi - 2\varphi$ is also a function of ρ.

Calculations give the result that the derivative of $\varphi(\rho)$ with respect to ρ is not equal to zero at any position. That proves that the condition to have "wave-like" differaction is not satisfied.

If in fact the potential of nuclear field had the form as above, then the ability in order that electron would fall into nucleus has a very large probability. This is not compatible with the fact[4].

We can suppose a supplement (not interested in quantum mechanics) as: far from the attracting center a distance a there is a surface L. This surface changes trajectory of scattering particles. Because it is not absolutely hard (in the present region of the surface, the potential field has some form), there happens a slippery effect of particle on the surface. This softens variation of deviation angle of trajectory α, and then α is still a continous function of ρ. Thus, the momentum of scattering particle is unsurpassed a some value in order to unbreak elasticity of the surface. Otherwise, the momentum of scattering particle is larger than a supposed criterion, the surface L is broken to form the light radiation. Some radiation forms can belong to Trerenkov or Compton effect.

In summary, with this supplement, α is a function of ρ with dependence as Figure 10.

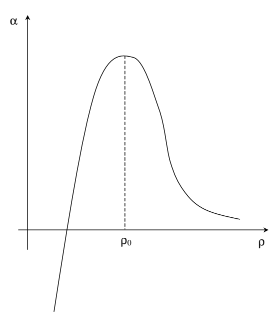

Figure 10:

where $\rho_0 \approx a$ and hence, the condition to have the "wave-like" differaction is satisfied.

4 Conclusion

Thus, we show in rather detail some ideas based on the particle behavour of matter. By using Newton's model of light ray we have explained rather completely "wave" behaviours of the light. The polarization of the light is a effect of particle behaviour: two photons

[4] To avoid this there was a quantum mechanics.

interfere with each other forming a system with axisymmetry. The experiment set as Figure 1 is important. Carrying on this experiment will take part in confirmation of light's particle behaviour. Its detailed results will open up new ideas, and new directions of research.

The wave character of elementary particle, electron is typical, can be explained by pure particle behaviour. This give us a similarity between the wave function in quantum mechanics and the vector function of particle behaviour.

The motion of any particle can be expressed as a vector, whose direction points out particle's motion direction at a given point of trajectory, and whose module expresses probability amplitude of particle flying in that direction. Thus, the probability trajectory of particle is completely able to expressed as a vector function

$$\psi = A(\alpha_{(t)})e^{i\alpha_{(t)}},$$

$\alpha_{(t)}$ is the deviation angle in comparison with the initial direction, is a function of time; $A(\alpha)$ is the probability of particle flying with the angle α.

But this does not mean that the particle expressed as above will have a really wave character.

If we find a way to express the value of $\alpha_{(t)}$ by the value of energy-momentum of scattering particle, parameters of scattering environment, and simplification: $\alpha_{(t)}$ is continously independent of time but discontinously dependent on time (due to the fact that scattering centers are discontinous), then the vector function is not basically different from the wave function in quantum mechanics. Doing with appropriate operators for probability function, we can obtain correlative quantities.

Hence, from the natural idea of particle behaviour of matter we can discover further natural phenomena. One of the most host problems today is inflation of the universe affirmed from the red-shift of Doppler's effect. However, if the space between observer and light source is vacuum, then the explanation of the red-shift based on Doppler's effect is fully satisfactory. But in fact the universe is filled with gravitational fields, macrometric and micrometric objects as stars and clusters. Therefore, these problems had been re-examined in further detail by us, with consideration actual influences of interstellar environment on frequency shift. This is only realized by foundation of particle behaviour of the light. The existence of cosmic dusts as motional scattering centers is an essential condition to happen scattering-interference processes of the light when it flies through the interstellar environment. In turn, these scattering-interference processes lead to the shift of light frequency. Our results give a reliable confirmation that the red-shift is not exhibit of the inflation of the universe.

Acknowledgments

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[1] D. M. Chi, *The Equation of Causality*, (1979), (available in web site: www.mt-anh.com-us.com).