LEAST ACTION PRINCIPLE AND QUANTUM MECHANICS

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I. INTRODUCTION

Returning to the classical mechanics in the age of "*Theory of everything's*" with "*membrane*", "*super-string*", "*super-symmetry*" etc. is a sterile work for many people. However, it is weird that Nature has always put us in challenges of never-one-answer. There are issues we find out that we were wrong after hundreds of years. Therefore, the returning to "too old" issues is never superfluous. Hereinafter comes one of those cases. As we know, when considered that thermo-radiation is not continuous but discrete by each small portion $\varepsilon = hf$, where f is the frequency of the thermo-radiation energy and h is some ratio coefficient, Max Planck has found out the formula of thermo-radiation intensity of absolute blackbody corresponding to the experiment. The coefficient h later is referred to as the “Planck constant”. In the micro-world, the Planck h constant played a role as the threshold of the least angular momentum when Bohr set out the condition of orbit quantum of electrons in atoms:

$$M_n = m_e V_n r_n = nh/2\pi, \qquad (n = 1, 2, 3 \ldots) \tag{1}$$

here M_n, V_n, m_e - the angular momentum, velocity and mass of electrons on the n^{th} orbit, respectively; r_n - the radius of the n^{th} orbit of electrons. Later h appeared in the theory of quantum field as a parameter indispensable in Schrödinger equation, expressions of angular momentum and magnetic moment of fundamental particles which has strongly demonstrated Planck's prediction. As for dimension, it fits to the dimension of H action in the *least-action principle* or “*Hamilton principle*”. The H action function is peculiarity of the energy state for motion of the mechanical system. It may be written in two forms:

+ Hamilton – Ostrogratsky

$$H = \int_{t_0}^{t_1} L\, dt. \tag{2}$$

+ Maupertuis – Lagrange:

$$H = \int_{t_0}^{t_1} 2E dt\,. \tag{3}$$

here L and E - Lagrangien and the kinetic energy of the mechanical system, respectively; t_0 and t_1 – initial and final moments of time of motion of the mechanical system, respectively, from point A to point B. The problems is that:

-According to its definition, function H must be the total energy of the mechanical system obtained in the duration of time from t_0 to t_1, should we understand this as *cause* or *consequence*? Is it *action* or *effect*?

-What happen if the *action* doesn't reach the least action threshold?

-What could the mechanical energy state of the micro objects under the action of an external force be if this *least effect* is taken into account?

-Is the so called "wave-corpuscular dualism" the cause of quantum property of electron orbit in atoms or do they both have other similar causes since they are both associated to h Planck constant?

These issues will be thoroughly discussed in this work.

II. THE LEAST-ACTION PRINCIPLE.

1. Basis concepts.

a) Actions among physical objects and effect of them.

Firstly, it may be seen from documents including the original one are written in English that the concept of "*action*" is often used confusedly with the concept of "*effect*". Hereinafter, we strive to differentiate these two concepts from the orthodox mechanical point of view.

Supposing that one physical object (PO) with mass m moves freely at the velocity V_0 from point A to point B in the duration of time from t_0 and t_1, then the H physical size defined pursuant to Eq. (2) and Eq. (3) is the actual energy state of the PO during that period of time. We should, therefore, recall H the *effect* of the PO not the *action* among them.

It is due to this reason that the author suggests changing the name of Hamilton principle or the normally ever used "least *action* principle" to "least *effect* principle". The concept of action itself should be redefined and re-quantified. For this to be done, we need to add action force with the assumption of unchanged force F. Replacing the kinetic energy expression of the given PO into Eq. (3) we have:

$$H = \int_{t_0}^{t_1} mV^2 dt = \int_{t_0}^{t_1} m(V_0 + at)^2 dt = \int_{t_0}^{t_1} m(V_0^2 + 2V_0 at + a^2t^2)dt =$$

$$= \int_{t_0}^{t_1} mV_0^2 dt + 2\int_{t_0}^{t_1} ma(V_0 t + at^2/2)dt = \int_{t_0}^{t_1} 2T_0 dt + \int_{t_0}^{t_1} 2FS(t)dt = H_0 + H_t,$$

here: $$H_0 = \int_{t_0}^{t_1} 2E_0 dt, \quad (4)$$

$$H_t = \int_{t_0}^{t_1} 2FS(t)dt = \int_{t_0}^{t_1} 2A(t)dt. \quad (5)$$

It may be seen immediately that $A(t)=FS(t)=ma(V_o+at^2/2)$ is the work of the action force $F=ma$, where m and a is mass and motion acceleration of the PO under the *action* of F force , respectively. It is clear that if there is no force (F=0), then H_t=0 and $H=H_0$ will be the *effect* component of the PO in free state (uniform rectilinear motion at velocity V_0). The component H_t is resulted from the *action* of the force F on the given PO. In other words, in order to have H_t *effect* there must be the corresponding *action* in the sign of D.

On the other hand, the time for energy exchange among PO is never zero. Moreover, the process of changing from this energy state to other requires a limited period of time. That is the reason why D *action* needs to get ahead of H_t *effect* for a period of time equal to τ. Similar to effect, we can write the formula for action as follows:

$$D = \int_{t_0-\tau}^{t_1-\tau} 2E(t)\, dt, \quad (6)$$

here $E(t)$ - energy exchanged between the two PO to cause changes in Energy states, i.e. to produce the existence of H_t *effect*. In case the $E(t)$ energy is transformed into work $A(t)$ with the efficiency of η we shall have:

$$H_t = \eta D. \quad (7)$$

Normally, when $E(t)$ is really difficult to be defined, possibly we only need to define the work $A(t)$ or the change in energy ΔE of the PO to replace $E(t)$ based on the Eq. (7) with η=1. Then actually we define H_t *effect* not D *action* .

b) *Least effect and least action.*

As recognized above, there cannot be any effect smaller than the h least effect value. This also means that H effect function pursuant to Eq. (4) is not continuous and it can only be the multiple number of h:

$$H = nh, \quad (n = 1, 2, 3\ldots) \quad (8)$$

On the other hand, any occurring physical processes are associated with the energy exchange. That exchange occurs on every small portion. Thus, corresponding to the *least effect* h is the *least action* d:

$$h = \eta d. \quad (9)$$

Finally, when referring to the *least effect* of a PO, we not only refer to an occurred event or a possibly occurred event pursuant to Eq. (2) or (3) but also to imply a completely defined relationship that has maintained existing energy state of the PO. This has caused this tardiness. Therefore, in terms of principle, the value of the *least effect* on a different PO can be different, and thus Plank constant h=6,63×10^{-34} Js is not universal. However, this issue has to be discussed more in another research.

2. **Content.**

As known, the research into the motion of fundamental particles within the classical mechanical scope has fully failed. The main reason rests with this scope, H effect function has become comparable to the h *least effect*, which means the expression (8) has promoted its effect. The problem will be different if we take this into account.

Recognizing the cause and effect relation between D *action* and H_t *effect* pursuant to Eq. (7) and considering Eq. (9), it may be said that:

"*For a physical object to change its energy state, the action on it must not be smaller than the least action*".

$$D=\int_{t_0-\tau}^{t_1-\tau} 2E(t)dt \geq d = h/\eta. \qquad (10)$$

This is called "*least action principle*" (LAP). Thus different from LEP (Hamilton principle), the LAP lays condition on *action* D (cause) but not on *effect* H (consequence). Furthermore, that condition doesn't aim at optimizing various types of *action* functions, but it makes it possible for all *actions*. The in-equation (10) is also called the *effect* condition. In the time interval from (t_0-τ) to (t_1-τ) and $E(t)=E$=const, Eq. (10) may be rewritten as:

$$D=2E(t_1- t_0)=2E\Delta t \geq h. \qquad (11)$$

It can be seen from Eq. (11) that if E energy is really great, the *action time* Δt can be short but enough to remain the *effect*. On the contrary, if the exchanging energy E is too small, the time interval of *action* Δt has to be long enough. However, this time interval may not be too long and must be limited by some conditions:

- In case the living time of the given object is equal to τ_1, $\Delta t \leq \tau_1$;

- In case the possible time interval for the two objects to exchange their energy is equal to τ_2, $\Delta t \leq \tau_2$;

- In case the object under the *action* is moving in the period of time T, $\Delta t \leq T$ because if within the time interval equal to one period T, the exchange process brings *"no effect"*, then if the *action* prolongs in the successive periods, the exchange process remains "*no effect*".

From here emerged a concept “effect radius”. As already known, gravitational and electro-magnetic forces, in principle, are action forces from far distance to infinity. Yet, whether that effect could cause action or not is another problem. The distance from which the action by one PO might cause a least effect to another PO is called “effect radius”. This radius is clearly much greater than the effect radius of force Val der Vals which can be understood as the distance from which atoms may be associated together. Whereas, the effect radius mentioned above may be understood as the distance from which there appears a least effect *h*. If the PO consists of many atoms the total potential fields will be in a much longer period than that of each single period since the potential fields of each atom are not of the same phase.

The effect radius will be much greater as a result. Only at the distances much bigger than this *effect radius*, atoms or any other PO can be “neutralized” in electricity.

II. CONSIDERATION OF SOME PHENOMENA ON THE BASIS OF LAP.

1. The motion of the particle under the action of a force.

a*) The action direction of a force coincides with the direction of PO motion.*

In the classical mechanics as well as the relative mechanics, Newton’s second law is used in form: "the velocity changing the momentum *p* of the particle is equal to *F* force on it:

$$F = d(mV)/dt \quad \text{or} \quad F = dp/dt\,, \tag{12}$$

here *m* and *V* is respectively the mass and movement velocity of the particle. If the movement velocity is not really big compared with the velocity of light, it can be considered that *m*=const; thus, (12) can be written in form:

$$mdV/dt = ma = F, \tag{13}$$

here $a=dV/dt$ - referred to as instantaneous acceleration of particle motion."

Both Eq. (12) and (13) have shown that under the action of a force *F*=const, the motion velocity of the particle will vary continuously, which does not correspond to the least *action* principle. For clarifying this, we will see the concept of derivative of the velocity *V* based on time *t*:

$$a = dV/dt = lim_{\Delta t\to o} (\Delta V/\Delta t) = lim_{\Delta t\to o} a_{tb}, \tag{14}$$

here a_{tb}=ΔV/Δt - is the average acceleration; a is the instantaneous acceleration. As the energy exchanged during the interval of time Δt is limited, if Δt→0, EΔt will also advance to zero and the least action principle will be violated. Thus, if the effect condition (11) is accepted, the concept of instantaneous acceleration calculated pursuant to Eq. (14) is non-sense as Δt can not be smaller than the value: $h/E\neq 0$, let alone Δt→0. In other words, Eq. (12) or (13) are mathematic expressions reproducing roughly the motion of the particle or physical entities. Then what is the so called "real motion" of a particle under the *action* of constant F force? To make it simple, we just consider the case m=const and replace the motion equation bearing the derivation of the velocity (13) with the equation of limited addition numbers:

$$ma_{tb}=m(\Delta V/\Delta)=F \quad \text{or} \quad a_{tb}=\Delta V/\Delta t=F/m=\text{const}. \qquad (15)$$

If before the particle is acted upon by F force at the point of time $t=t_o=0$, it is in state of rest $V_o=0$, then after it is acted upon by F force within the time interval $\Delta t_1=t_1-t_o=t_1$ satisfying effect condition (11), the particle will move at the velocity of V_1. The energy gained by particles is equal to the difference of its kinetic energy in two states:

$$\Delta E_1 = E_1 - E_0 = mV_1^2/2 - mV_o^2/2 = mV_1^2/2. \qquad (16)$$

Replacing Eq. (16) into Eq. (11) gives: $\quad mV_1^2.\Delta t_1 \geq h. \qquad (17)$

On the other hand, similar to Eq. (15) we can write:

$$a_{tb}=\Delta V_1/\Delta t_1=F/m, \qquad (18)$$

of which $\Delta V_1=V_1-V_o=V_1$. Taking Δt_1 from Eq. (17) to put into Eq. (16) then change it we have:

$$\Delta V_1=V_1\geq \sqrt[3]{ha_{tb}/m} = \sqrt[3]{hF/m^2}\,. \qquad (19)$$

Replacing (19) into (18) then draw Δt_1 from it we have:

$$\Delta t_1= t_1\geq \sqrt[3]{hm/F^2}\,. \qquad (20)$$

With motion problem of particles from (17) in general:

$$a_{tb} = \Delta V_n/\Delta t_n = F/m, \qquad (21)$$

here $\Delta V_n=V_n-V_{n-1}$; $\Delta t_n=t_n-t_{n-1}$; n=1, 2, 3,… is positive integral number. The relation between V_n and t_n can be established by forming a rate:

$$(\Sigma\Delta V_n)/(\Sigma\Delta t_n) = V_n/t_n. \qquad (22)$$

On the other hand, we draw ΔV_n from Eq. (20), then put it into Eq. (22) and change it we find:

$$V_n = a_{tb}t_n,\tag{23}$$

Expressions (21) and (23) bring us the relation between *n* value of discrete velocity V_n and *n* discrete moment of time t_n. In all cases, we can write:

$$2\Delta E_1\Delta t_1=2\Delta E_2\Delta t_2= \dots =2\Delta E_n\Delta t_n=h. \qquad .(24)$$

Replacing: $\Delta E_n=E_n- E_{n-1}=m(V_n^2- V_{n-1}^2)/2$, and Δt_n from Eq. (21) into Eq. (24) then change it we obtain:

$$m(V_n^2- V_{n-1}^2)(V_n- V_{n-1})/a_{tb}=h.\tag{25}$$

Replacing V_1 from Eq. (19) into Eq. (25), then change it back into (*n*-1), the equation takes the form:

$$V_n^3-V_{n-1}V_n^2-V_{n-1}^2v_n+V_{n-1}^3-V_1^3=0.\tag{26}$$

Solving set of Eq. (26) we have (*n*-1) velocity value from V_2 to V_n subject to V_1. Replacing V_n from Eq. (23) into Eq. (26) then change it we obtain (*n*-1) the equations corresponding to time variation from t_2 to t_n:

$$t_n^3-t_{n-1}t_n^2-t_{n-1}^2t_{n+} t_{n-1}^3-t_1^3=0\ .\tag{27}$$

The graph demonstrating the velocity variation subject to the time of motion of the particle is shown in the fig. 1a. It may clearly be seen that the particle may only move in jerky steps with the gradually increased velocity for each "*step*". When considering the tardiness of the motion of the particles after the time interval Δt_1, the distance obtained by the motion of particles after each time intrval Δt_{n+1} will be: $\Delta S_n=V_n\Delta t_{n+1}$. Hence, equation of motion of particles is a broken line:

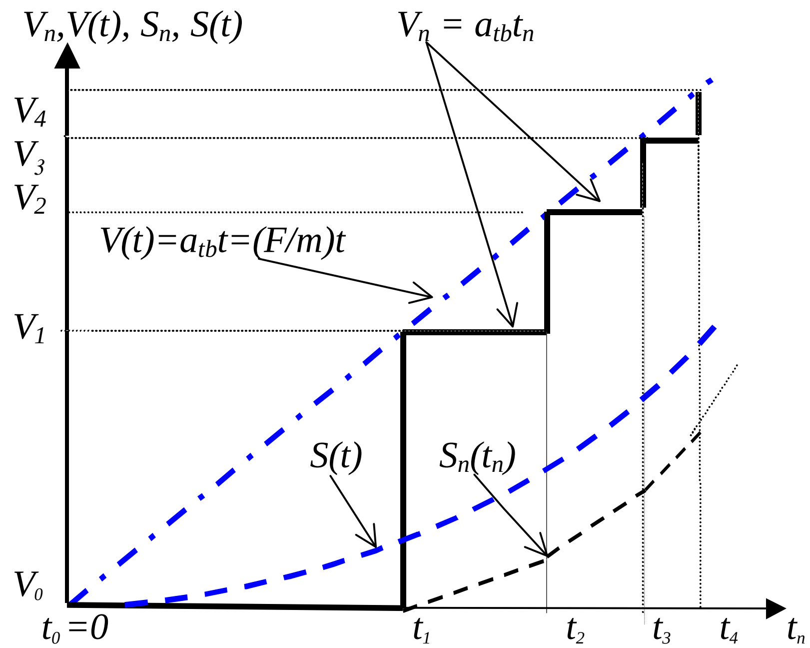
$$S_n=\Sigma\Delta S_n=\Sigma V_n\Delta t_{n+1}.\tag{28}$$

Replacing V_n from Eq. (23) into Eq. (28) gives:

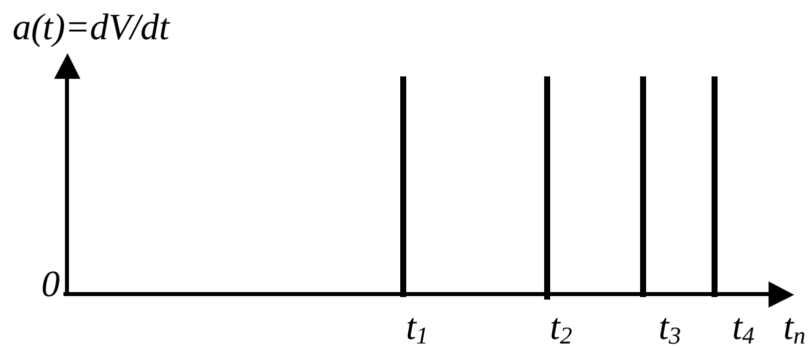
$$S_n=a_{tb}\Sigma t_n\Delta t_{n+1}= a_{tb}\Sigma t_n(t_{n+1}- t_n),\tag{29}$$

To compare, we write the expression of path obtained by the motion of the particle at the time interval *t* as in usual path: $S(t)=at^2/2=Ft/m$ and demonstrate it in fig. 1a. We can take an example for illustration from quantum mechanics. Supposing an electron with m_e mass moves under the action of an *E* electric field. The force acting on the electron is *F*. Replacing the obtained values into Eq. (19) and Eq. (20) we have:

$V_1\approx(6,63\times10^{-34}.\ 1,6\times10^{-17})^{1/3}/(9,1\times10^{-31})^{2/3}\approx2,35\times10^3$m/s.
$t_1\approx(6,63\times10^{-34}.\ 9,1\times10^{-31})^{1/3}/(1,6\times10^{-17})^{2/3}\approx 1,34\times10^{-10}$ s.



a/ Graph demonstrating the variation of velocity $V_n(t_n)$, $V(t)$ and distance S_n, $S(t)$.



b/ Graph demonstrating instantaneous acceleration $a(t)$.

Fig.1. The interruption of motion parameters of particle.

At the moment of time $t_1 \approx 1{,}34\text{x}10^{-10}$s, the electrons begin moving at the initial velocity of $V_1 \approx 2.35\text{x}10^3$m/s. However, according to former theory, the motion of electron should have gained a certain distance at this moment of time: $S_1 = at^2/2 = Ft^2/2m_e \approx 1{,}6\times10^{-17}(1{,}34\times10^{-10})^2/2.9{,}1\times10^{-31} \approx 1{,}33\times10^{-5}$m, since if we consider that velocity $V(t)$ varies continuously, instantaneous acceleration determined on the basis of Eq. (14) will be F/m_e. This path is 100 thousand times greater than the dimension of an atom, and the time interval t_1 is long enough for electron to revolve around the nucleus one million times. It is not small at all! For instantaneous acceleration, the situation is much worse.

The graph demonstrating the development of instantaneous acceleration a in this case is described in fig. 1b. At the moments of time $t=t_n$ then $a=\infty$, and at the moments of time $t\neq t_n$ then $a=0$. It may be concluded that the concept of instantaneous acceleration is non-sense!

b*) The action direction of a force is perpendicular to the motion direction of PO.*

If the PO is moving freely at the velocity V, at the time interval t_0 under the action of such force (see fig. 2), according to LAP, it will have to change its motion direction after the duration of time $\Delta t_1=t_1-t_0$. But this new motion direction can't be deflected at an optional angle; it depends on the amount of energy that it receives within the time interval Δt_1, that is, pursuant to a specified angular quantum.

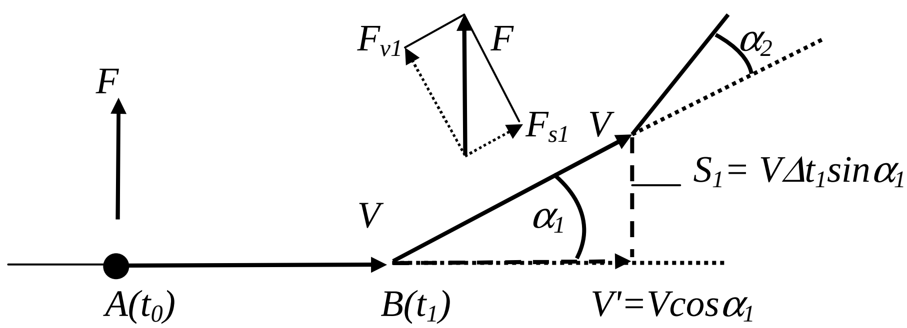


Figure 2.

The energy received by PO in the time interval $\Delta t_1=AB/V=S_1/V$ is:

$$\Delta E=E-E'=mV^2/2-mV'^2/2=(mV^2\sin^2\alpha_1)/2. \qquad (30)$$

On the other hand, this energy level equals to work of action force:

$$A_1=FS_v=FV\Delta t_1\sin\alpha_1. \qquad (31)$$

Replacing Eq. (30) into Eq. (11) with sign "=" we have:

$$D=H_{t1}=mV^2\Delta t_1\sin^2\alpha_1=h. \qquad (32)$$

Compare Eq. (30) with Eq. (31) then reducing:

$$\Delta t_1=(mV\sin\alpha_1)/2F. \qquad (33)$$

Replacing this Δt_1 into Eq. (32) then gives:

$$\sin\alpha_1 = \sqrt[3]{2hF/m^2V^3} =V_0/V \qquad (34)$$

where $V_0 = \sqrt[3]{2hF/m^2}$ – comparing with Eq. (18) shows that there is just velocity component of PO coincided with the direction of action force . Replacing Eq. (34) into Eq. (33) with changes, we obtain:

$$\Delta t_1 = mV_0/2F = V_0/2a_{tb1,} \qquad (35)$$

where $a_{tb1}=F/m$ - average acceleration of motion under force coincided with the motion direction of PO. The path $AB=S_1$ could be defined if Eq. (35) is taken account:

$$S_1 = V\Delta t_1 = V.mV_0/2F = V.\sqrt[3]{hm/4F^2}, \qquad (36)$$

On the new path BC, the action on the PO includes 2 parts: one part is tangent to the motion direction F_{s1} and the other is perpendicular to the motion direction F_{s1}. If within the time interval $\Delta t_2=t_2-t_1$, the action condition (11) is satisfied, the F_{s1} will lead to a velocity leap ΔV_1 as the one mentioned in III.a). F_{v1} is the cause to the deflection of the motion direction. In that case, the equation to define F_{v1} is similar to Eq. (31) providing that F is replaced by F_{v1}.

Deflection angles and the successive paths can be defined in the same way. There is a fact that α_1 is often very small, so F_s may be neglected, that is, V is equal to constant.

2. "Wave property" of fundamental particles.

The concept *"matter wave"* was introduced by de Brookline and was verified by experiment by Davison and Germen: each particle is combined with a wave-length specified according to relation:

$$\lambda = h/p = h/mV. \qquad (37)$$

In fact, there has never been an expression of "*wave property*' and *"particle property"* at the same time, and "*wave property*" is only expressed when encountering obstacles on their way like narrow slits, small holes or crystal planes of some solid taking roles as a diffraction grating .

So how will these particles entering the objects' *effect* radius R are affected? According to Eq. (11), if after the interval of time Δt_1, the particle receives action D_1 in the perpendicular direction to its motion direction which is equal to or bigger than *least effect h*, it will carry one *effect*. Under such an *action*, its velocity may not change. So the *effect* now will change its motion direction to an angular quantum specified α_1. If the next *action* $D_2 \geq h$ is performed, it will change its direction the second time at deflection angle α_2. If it does not receive the next *action* after that, it will remain the motion direction.

As it is, after passing obstacles, an initial beam of particles is split into beams of particles deflecting from initial direction of different angles fully specified. If we put a screen at some distance from there, we will have a diffraction pattern like a wave. This phenomenon is described in fig. 3a. The key matter is that the particle does not deflect from that direction at any angle, but only on the basis of specified and limited angular quantum. The result is when after several times of deflection the total deflection angle is only limited and specified too (see fig. 3b). From here, we can refer potential field *E(t)* at the margin of the object or of a narrow slit as defocusing lenses composed from the collection of side by side pieces of lenses with different focus distance f_1, f_2...to deflection angles α_1, α_2,..., respectively, as demonstrated in fig. 3c. To quantify the deflection, we consider the process of motion deflection of particle having the mass *m*, velocity *V*. Particles falling into potential field of narrow slits of curtain at the places *a, b, c*…and fly to corresponding places *a', b', c'*...

+Firstly, for particles flying along passage *aa*' and it has deflected once with angular quantum α_a defined by Eq. (34) too. We have Eq. (32) too and change it:

$$S_a sin^2\alpha_a=h/mV=h/p. \qquad (38)$$

+ For particles flying along passage *bb'* they deflect twice.

<u>In the first time,</u> when particle is flying from *b* to b_1 in the time interval Δt_{b1} it receives energy ΔE_{b1}. On the basis of LAP, when Eq. (11) is satisfied, particles can have moved in new direction with the deflection angle α_{b1}. It receives energy in the time interval $\Delta t_{b1}=bb_1/V=S_{b1}/V$:

$$\Delta E_{b1}=E_b-E_{b1}=mV^2/2-mV_{b1}{}^2/2=mV^2(1-cos^2\alpha_{b1})/2=mV^2sin^2\alpha_{b1}/2$$

Similar to Eq. (32) we can write:

$$D_1=H_{t1}=2\Delta E_{b1}\Delta t_{b1}=mVS_{b1}sin^2\alpha_{b1}=h. \qquad (39)$$

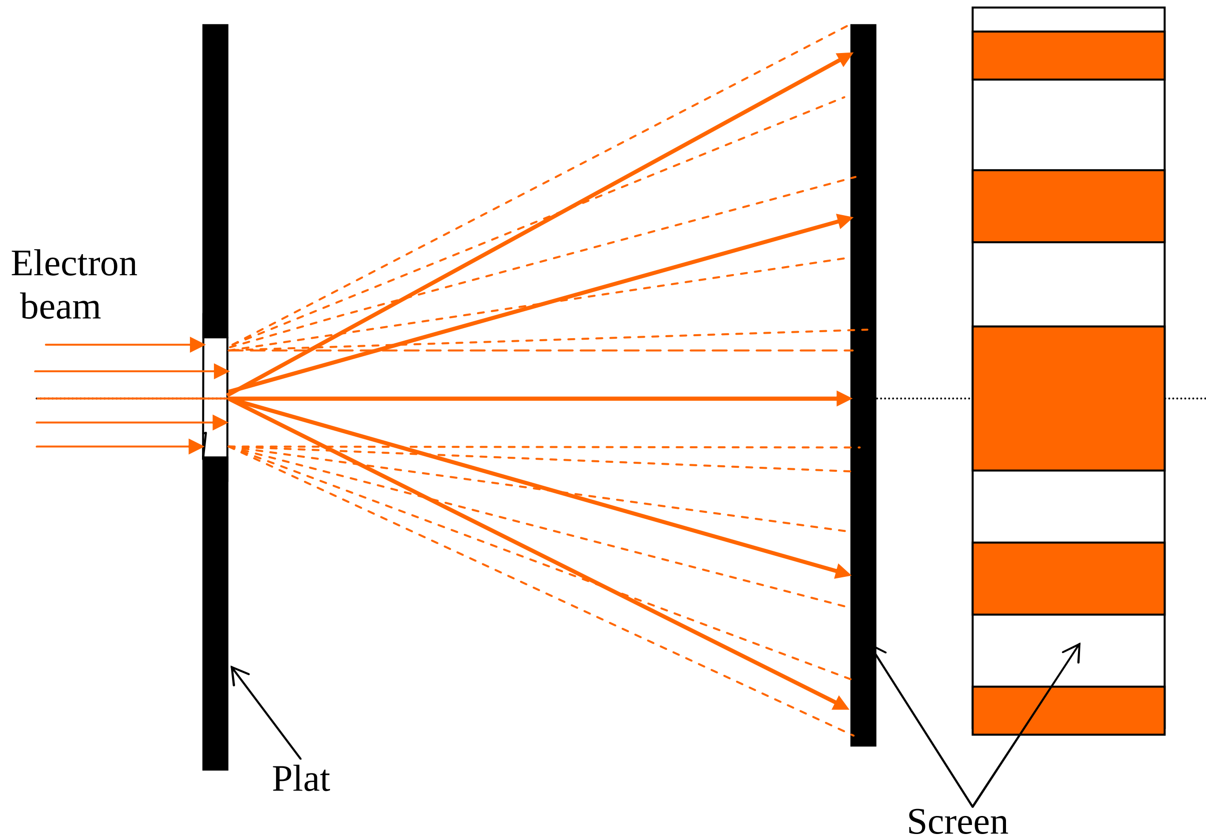
<u>In the second time,</u> when particle is flying on the distance $b_1b'=S_{b2}$ in the time interval $\Delta t_{b2}=b_1b'/V=S_{b2}/V$, it deflects from α_{b2} since it receives the energy: $\Delta E_{b2}=E_{b1}-E_{b'}=mV^2/2-mV_{b2}{}^2/2=mV^2(1-cos^2\alpha_{b2})/2=mV^2sin^2\alpha_{b2}/2.$

Similar to Eq. (32) we may write:

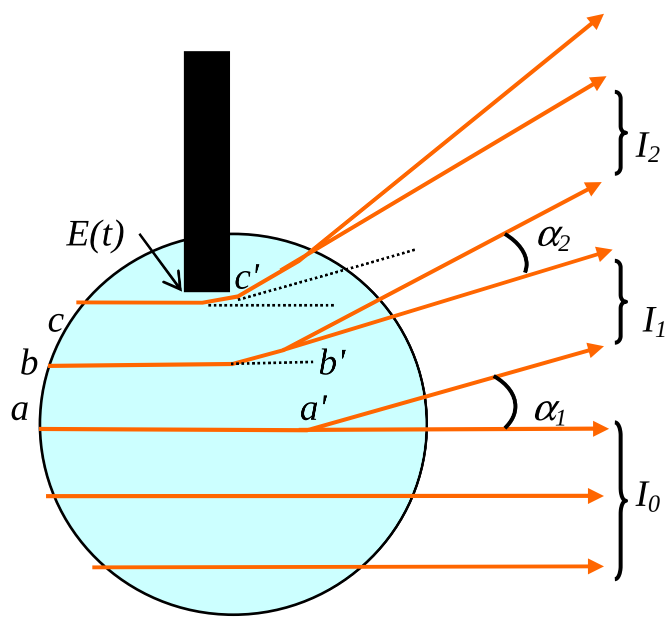
$$D_2=H_{t2}=2\Delta E_{b2}\,\Delta t_{b2}=mVS_{b2}sin^2\alpha_{b2}=h. \qquad (40)$$

Adding Eq. (39) to Eq. (40) according to each corresponding position:

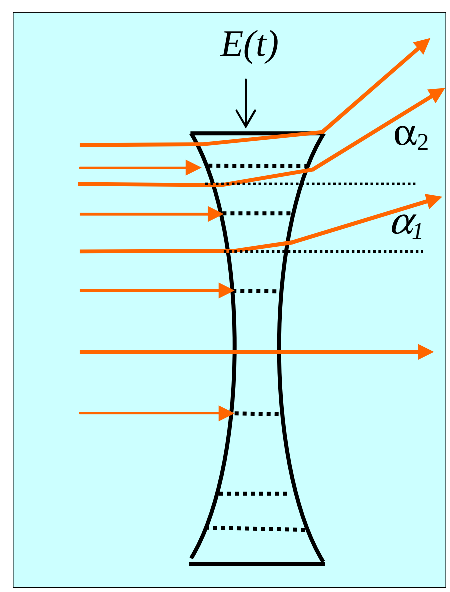
$$mV(S_{b1}sin^2\alpha_{b1}+S_{b2}sin^2\alpha_{b2})=2h$$



a/ Overview of electrons diffraction.



b/ Potential field of narrow slit.



c) Defocus lens model of potential field.

Figure 3. Overview of electrons diffraction.

or we rewrite it in the form:

$$S_{b1}sin^2\alpha_{b1}+S_{b2}sin^2\alpha_{b2}=2h/mV=2h/p.$$

For particles moving on passage *cc'* with three times of deflection, we can write:

$$S_{c1}sin^2\alpha_{c1}+S_{c2}sin^2\alpha_{c2}+S_{c3}sin^2\alpha_{c3}=3h/mV=3h/p.$$

Generalizing some particles "*k*" deflecting "*n*" times, we have:

$$\Sigma S_{kn}sin^2\alpha_{kn} = n(h/mV) =n(h/p). \quad (41)$$

The left member of Eq. (41) is parameters related to potential field in the slit, and the right member of Eq. (41) is only related to the particle, to be more specific, to momentum *p* of the particle. The number of angular quantum "*n*" and angles α_{kn} themselves are limited and specified.

We may freely to put $h/p=\lambda$ similar to Eq. (37). It is "*wave - length*" de Brookline, but in fact, no wave exists at all. The sole thing existing here is particle and no more. By doing the same we can obtain the "interference" pattern when beam of particles passing through two narrow slits of the screen or "diffraction" pattern when beam of particles falling into crystal planes of some solid. In this case, it is necessary to consider 2 other factors:

+ First, the action by the particle on the potential field according to Newton's third law which was often neglected in the past, that is, the potential field of slits will change when it is similar to the number of the least effect caused to the particles.

+ Second, the phenomenon of electro-static conduction occurs at the margin of the slit and the separating strip between the two slits results in the interaction of potential field of the 2 slits. In other words, each particle flying over the slit in the deflected direction will leave its mark on both two slits, and it is this mark that will directly influence the deflection degree of successive particles, which according to modern quantum field theory, they seem "to be aware of" this!(?).

For particles containing too big momentum, the energy of potential field of molecule on the slit margin of screen is not big enough to make it deflect from direction unless they strike against directly. Therefore, they have no "*wave-property*". For particles having no electricity like neutrons, is it possible for them to deflect from the direction in potential field? The answer is that, neutrons, not without reason, have electricity but they are neutralized similarly as atoms are, but due to its too tiny dimension, only at very small distance can it express. Therefore, it is possible for us to understand why "*wave property*" of fundamental particles only expresses when encountering obstacles, but not in free space.

Finally, to put it more exactly, particles have no "*wave property*" as there has never been "addition of amplitude when in the same phases and elimination of amplitude when in opposite phases" as a real wave does. We can only say that "*particles have wave-like manifestation*" and no more! Therefore, the so-called "*wave-corpuscular dualism*" does not exist!

3. Orbital angular momentum of an electrons.

Supposed that the electron is at point *A*, far from nucleus a distance of r_n and is moving at the velocity V_n to the point *B* as shown in fig. 4; and supposed that the electron is moving around a self-contained orbit. In this case, we symbolize quantity with index "*n*" as quantity corresponding to n^{th} orbit of electrons in the orbit order from internal to external side of nucleus. Smallest orbit r_1 corresponds to n=1. The motion of this type has been mentioned in III.1b) with a slight difference that Coulomb force is always perpendicular to the motion direction of electrons. So Eq. (32) is always correct. Motion of electron in nucleus under the *action* by Coulomb force only deflects from direction when *effect* condition (11) is ensured. In order to have a closed orbit in the form of regular polygon inscribing circle radius r_n, after k_n quantum angle α_{on}, electron must come back right to point *A*, it means:

$$k_n.\alpha_{on}=2\pi\,. \tag{42}$$

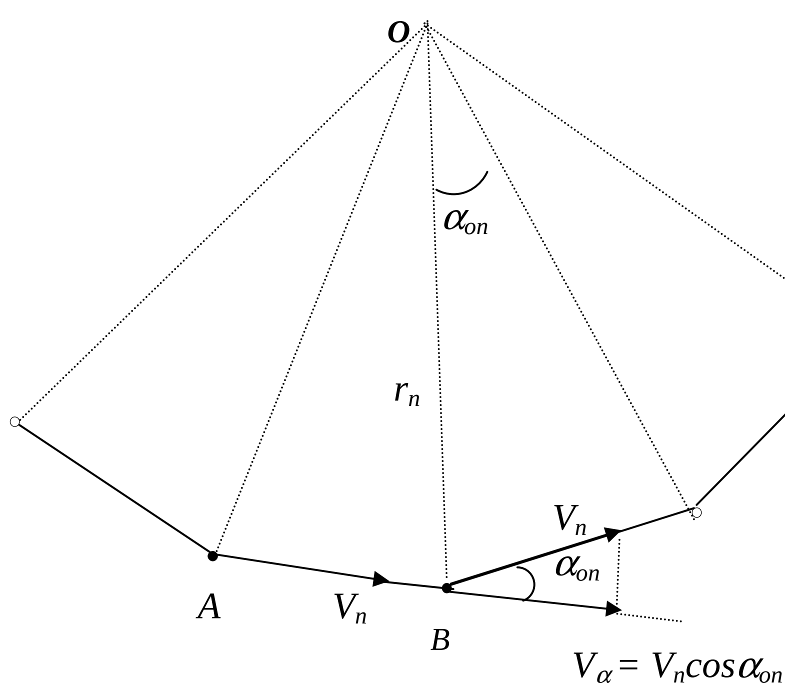


Figure 4. Motion orbit of electrons may only be a broken line.

In this case, n^{th} orbit must have k_n *least effect* quantum h:

$$H_{tn}=k_nH_{to}=k_n2\Delta E_n\Delta t_n=2\Delta E_nT_n=2k_nm_eV_nr_nsin2\alpha_{on}sin(\alpha_{on}/2)=k_nh, \qquad (43)$$

here $T_n=kn\Delta t_n$- revolving period of electron on the orbit variety "n'. Basing on this, we can invent the expression of orbital angular momentum:

$$M_n=m_eV_nr_n=h/(2sin^2\alpha_{on}sin(\alpha_{on}/2)). \qquad (44)$$

From Eq. (42) we see that, a *least effect* quantum is not enough for the existence an orbit of electron, but it needs k_n quantum h. Next, because the motion direction cannot deflect from direction at optional small angles, motion orbit of electron has never been a curve or even circle, but is an open or closed broken line.

V. CONCLUTION.

1. Fundamental particles cannot move gradually faster or more slowly in a continuous way, but in jerky steps with velocity leaps. The concept of instantaneous acceleration with fundamental particles is non-sense.

2. "Matter wave" does not exist! And particles do not have "wave property" but just "wave-like manifestations". There exists only one new property of particles that "their motion is only deflected on limited and specified "angular quantum", and that can not be as small as wanted".

3. If the motion deflection of electrons in atoms occurring under the action by Coulomb force with the same angular quantum and their sum is always the multiple number of 2π, the orbit with sides of a regular polygon inscribing circle with radius of r_n will be formed. From here, it is possible to draw out the orbit quantized condition of electrons in atom.

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