The Stability Analysis of the Relativity Motion of Charged Particles in Electromagnetic Fields and the Possibility to Establish Synchrocyclotron without Radiation Losses

Ping Yu[1] & Xiaochun Mei[2]

[1]Institute of Innovative Physics in Fuzhou, China

[2]Institute of Innovative Physics in Fuzhou, Department of Physics, Fuzhou University, China

Correspondence: Xiaochun Mei, Institute of Innovative Physics in Fuzhou, Department of Physics, Fuzhou University, China. Tel: 86-591-8761-4214. E-mail: ycwlyjs@yeah.net

Received: March 13, 2012 Accepted: March 28, 2012 Online Published: May 1, 2012

doi:10.5539/apr.v4n2p56 URL: http://dx.doi.org/10.5539/apr.v4n2p56

Abstract

According to the classical theory of electromagnetism, charged particles radiate electromagnetic waves when they are accelerated. However, actual situations are not completely the cases. For example, only when electrical current oscillates, antenna radiates radio waves. If parameters are not proper, no radio waves are produced. Although in both situations, electrons do period accelerating and decelerating motions. When electrons collide with atomic nucleus, braking radiation takes place. But electrons do not radiate when they are accelerated in uniform electric field. In synchrocyclotron, electrons radiate, but in electron induction accelerator, no radio radiations were founded (J. Blewett experiment). In fact, in the common loops of alternate or direct currents, as well as in the current loops made from low temperature supper-conductors, no radiations are found. A more foundational fact is that electrons do not radiate when they move around atomic nucleus and atoms are stable. These facts contradict with classical electromagnetic theory. We have no rational explanation for them at present. It is proved in this paper that the forms of forces can not be arbitrary in the dynamic equations of relativity. Otherwise the motions may become impossible. In order to make the motions possible in electromagnetic field, charged particles have to radiate. It is proved that the longitudinal velocities of charged particles in the uniform magnetic fields would exceed light's speed in vacuum, and therefore the motions are unstable and charged particles have to radiate. In the center electric fields, the motions of charged particles may be both stable and unstable depending on the actual situations, and they may radiate or not radiate. Therefore, acceleration is not the real season for charged particles to radiate. The real one is the instability of relativity motion. The essence of antenna radiations is proved to be the braking radiation and the braking radiation is the effect of relativity actually. The radiation damping forces should be added in the motion equations of relativity to describe charged particle's motions in electromagnetic fields when they radiate. The forms of damping forces are deduced. The synchrocyclotron oscillation of electron's obits at longitudinal direction is obtained automatically. It is proved that if a proper electric force is acted at the direction of velocity, the relativity motion of electron in magnetic field will become stable so that it may not radiate. In this way, we can establish high energy synchrocyclotron without or less synchrony radiation losses.

Keywords: special relativity, electronic induction accelerator, synchrocyclotron, electromagnetic wave, synchrony radiation, braking radiation, resistance thermal radiation

1. Introduction

According to the classical theory of electromagnetic field, accelerated charged particles radiate electric waves. This kind of radiation is related to the retarded electromagnetic field and can be propagated to far place, while the electromagnetic field which is unrelated to acceleration decays rapidly in short range. If particle's acceleration is parallel to its velocity, the power of radiation is

$$\frac{dU}{dt} = \frac{1}{4\pi\varepsilon_0}\frac{2q^2a^{*2}}{3c^3(1-V^{*2}/c^2)^3} \tag{1}$$

Here V^* is retarded velocity and a^* is retarded acceleration. If particle's acceleration is vertical to velocity,

the power of radiation is

$$\frac{dU}{dt} = \frac{1}{4\pi\varepsilon_0} \frac{2q^2 a^{*2}}{3c^3(1-V^{*2}/c^2)^2} \tag{2}$$

However, actual situations are not always the cases. In certain situations, charged particles radiate, but in other situations, they do not. For example, we use alternating electric field to drive electrons moving in radio antenna. Experiments show that only when electrical current oscillates, antenna radiates radio waves. If antenna's conditions are not proper so that currents do not oscillate, no radio waves are produced, although in both situations, electrons do period accelerating and decelerating motions.

In fact, electrons do not radiate when they do uniform acceleration and deceleration motions in uniform electric fields. A simple case is the process of producing X-ray. By adding high electric voltage on the both poles of cathode-ray tuber, electrons emitted from negative pole are accelerated. In this case, we can only observe the phenomenon of electric discharge of gas. We can not find electron's radiation. However, if a metal target is placed between positive and negative poles, X-ray is produced when electrons hit on the target. This is so-called braking radiations caused by collisions between high speed electrons and static nucleus. In the process, electrons are decelerated rapidly. The question is why electrons do not radiate when they are accelerated in cathode-ray tuber?

Besides, in electrostatic accelerators and high voltage electrostatic accelerators, electrons do not radiate. Experiments only show that charged particles radiate when they move in synchrocyclotrons where magnetic fields exists. Meanwhile, radiations only appear on the turning parts of electron's obits (Liu zuping, 2009.), not appear in the linear parts of accelerators, unless we use wigglers and oscillators. Why is that? We have no rational explanation at present.

In fact, in wigglers and oscillators, we use magnetic fields with direction alternate variation to produce radiation or free electron laser, rather than using electric fields. However, if electric fields with direction alternate variation are acted at the vertical directions of electron's velocities, the orbits of electrons can also wiggle. Whether or not can free electrons lasers be produced? It seems no report at present. This is a foundational problem for the essences of electromagnetic radiation. Physicists should pay attention to it.

The finding of synchrotron radiation light is dramatic story in the history of accelerators. American General Electric Company had an electron introduction accelerator with energy 100MeV in Schenectady, New York State. Physicists J. Blewett tried to find electron's radiation when he regulated the accelerator in 1944. Blewett used a very sensitive detector with frequency extent from 50Hz to 100MHz. But he found nothing no matter where the detector was placed, insider or outside the vacuum cavity of electron induction accelerator (John, 1946). Although according to (2), the radiation power should be quite large for electron's speed had been very close to light's speed in vacuum.

In same laboratory, Pollack established an electron synchrocyclotron with energy 70MeV in 1947. Because the vacuum chamber of accelerator was transparent, a worker found visible light's radiations accidentally (Xi, 1998). The light was called synchrotron light later with continuous spectrum, though mainly concentrating on visible light band. In theoretical deduction, there should be radio wave's radiations too in electron introduction accelerator. Although the energy of Blewett's accelerator was 30MeV higher than that of Pollack, why Blewett did not find them? No one investigated this problem deeply up to present days. Physicists only explained that the frequencies of Blewett's detector were too low and the frequencies of synchrony radiations exceed the extent greatly so that radiation can not be found.

However, the mechanism of electron induction accelerator is different from that of synchrocyclotron. In synchrocyclotron, electrons are only acted by magnetic force on the curved turning parts of obits where electrons radiate. But in electron induction accelerator, beside the action of magnetic fields, there exists electric field's actions which is along the direction of electron's velocity. Whether or not electron's radiations are affected by electric field? No research was reported. Physicists only thought that visible light's radiations should also exist in electron induction accelerator. But no person practically opened a window in the vacuum chamber of electron induction accelerator to see whether or not there were visible lights really. Physicists need to repeat the experiments of Blewett to make certain whether or not electrons radiate visible light in electric induction accelerator.

In fact, there are many other experiments to reveal that changed particle's radiations do not depend on whether

they are accelerated. For example, in the common loops of alternate or direct currents, as well as in the electric current loops made by low temperature supper-conductors, no radiations are produced (The thermal radiation of resistance is not considered). The radiation described by (2) is concentrated on the direction of electron's velocity mainly. This is different from thermal radiation of resistance with isotropy. Their engineers in Schenectady's laboratory even told Blewett that electrons moved in electron induction accelerators just as they moved in the loops of direct currents, no radiations could be produced.

A more foundational problem is that whether or not electrons radiate electromagnetic waves when they move around atomic nucleus. This problem even bothered Rutherford seriously when he proposed the atomic model. If electrons radiated, atoms would be unstable. After quantum mechanics was established, this problem was considered meaningless, for an electron is simultaneously regarded as a wave without fixed orbit. However, the problem still exists, because we can still ask why electrons do not radiate when they move in macro-loop of electric current? It is calculated that in supper conductor electrical current loop, the electron's radiation is significant according to classical electromagnetic theory so that a stable electric current is impossible. However, this is not true. Why there is such situation? We should have a rational explanation.

Based on dynamic equation of special relativity, the motion stability of charged particles in electromagnetic fields is studied in this paper. It is pointed out that the radiation of charged particle is actually the effect of relativity. The forms of forces can not be arbitrary for the motion equations of relativity. Otherwise, in certain situations, the motions may be impossible in theory and unstable in practice. It is proved that the longitudinal velocity of electron in magnetic fields would exceed light's speed in vacuum and violates the principle of special relativity. In order to make the motion possible, electrons have to radiate. By means of radiations, charged particles change their states so that the motions become possible.

In the synchrocyclotron, as well as in the collision processes with atomic nucleus, electron's motions are unstable and they have to radiate. But in the electronic induction accelerators, electron's motions may be stable and do not need to radiate. In the center electric force fields, electron's motions may be both stable and unstable. Electrons choose stable orbits automatically and do not radiate so that atoms are stable.

The reason to cause the braking radiation is discussed. It is proved that braking radiation is the effect of relativity. When charged particles move in the electric fields of atomic nucleus, the motions may be unstable under some conditions so that electrons have to radiate, that is so-called braking radiation. The essence of antenna radiation is also braking radiations actually.

In the current theory, there are no damping forces in the motion equations of charged particles. The equations can not describe real motions of particles when they radiate in electromagnetic fields. In this paper, the items of damping forces are added in the motion equations of relativity. The concrete forms of damping forces are derived. The synchrocyclotron oscillation of electron's obits in longitudinal direction is obtained automatically. It is proved that we can make electric motion stable in magnetic field by adding a proper electric force at the direction of velocity so that electron does not radiate. In this way, we can establish high energy synchrocyclotron without or less synchrony radiation losses.

We should change our way of thinking in the problem of charged particle's radiation. Not acceleration leads to radiation, but radiation is related to acceleration. If relativity motion of charged particle is stable, accelerated particle does not radiate. If particle does not radiate, the formula of radiation in classical theory of electromagnetism does not apply. And it no longer matter for the statement that acceleration caused radiation. In this way, we can obtain a logically consistent theory which matches well with experiments.

2. Analysis on the Result of Blewett's Experiment

Electrons are acted by both electric field and magnetic field simultaneously in electron induction acceleration. Electron is restrained in the orbit by magnetic field and is accelerated by the induction electric field which is in the direction of electron's velocity. The energy of electron introduction accelerator which Blewett used was 100MeV. In principle, radiation should be observed. But it does not in practices. In order to explain this result, physicists consider the effect of Doppler's effect. When electron's speed is close to light's speed, light's frequency increases several orders of magnitude, so that it can not be detected on the band of low frequency (Liu, 2009.). However, thing is not so simple. According to the Doppler's formula, when light's source moves, although frequencies become smaller in some directions, they become larger in other directions. Suppose that the velocity of light's source is V, the proper frequency of light is ν_0, the frequency observed by observer who is at rest in static reference frame is ν. The Doppler frequency shift formula is

$$\nu = \frac{\nu_0(1 - V\cos\varphi / c)}{\sqrt{1 - V^2 / c^2}} \tag{3}$$

When electron moves around a circler in synchrocyclotron, the power distribution of electromagnetic radiation is shown in Fig.1. According to the kinetic energy formula of relativity, the speed of electron with energy 100MeV is $V = 0.99999c$. In the direction of $\varphi = \pi$, we have $\nu / \nu_0 = 392$. It indicates the blue shift of spectrum. Frequency becomes 392 times larger. But in the direction of $\varphi = 0$, we have $\nu / \nu_0 = 0.002$, indicating the red shift of spectrum. Frequency becomes 500 times smaller.

The frequency extent of radio super-long wave to medium wave is $3\times10^3 Hz \sim 3\times10^5 Hz$. The frequency extent short wave to super-short wave is $3\times10^6 \sim 3\times10^8 Hz$. The frequency extent of microwave is $3\times10^8 \sim 3\times10^{11} Hz$ and the frequency extent of far infrared light is $3\times10^{11} \sim 3\times10^{12} Hz$. According to (3), even the frequencies of medium and long wave band increase several hundred times in the direction of $\varphi = \pi$, they are still located in the extent of short wave and supper short wave bands, far from infrared band, no mention of visible light band. In the direction of $\varphi = 0$, the frequencies of radiations decrease 500 times. The frequency extent of detector which Blewett used is $50Hz \sim 10^8 Hz$. In principle, it was impossible for Blewett that he could not find the radiations of radio waves if they exist really.

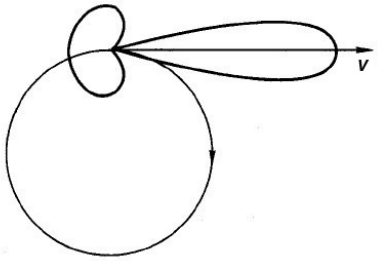

Figure 1. The spatial distribution of radiation power for electron's circle motion

This thing is very strange. It must have same blind area in principle of physics which we have not understood. Physicists should repeat the Blewett's experiment. Not only in the band of radio waves, but also in whole extent of electromagnetic radiations. We need to find truth. This is significant for both theoretical and experimental physics.

3. The Relativity Motion of Electron in Uniform Electric Field

We only discuss the radiations of charged particles based on macro-physics in this paper. The effect of quantum mechanics is not considered. Suppose that electron's charge is $-q$, mass is m_0, velocity is $\vec{V}$ and acceleration is $\vec{a}$. The relativity motion equation in electromagnetic field is

$$\frac{d}{dt}\frac{m_0\vec{V}}{\sqrt{1 - V^2 / c^2}} = -q(\vec{E} + \vec{V}\times\vec{B}) \tag{4}$$

or

$$\frac{m_0}{\sqrt{1 - V^2 / c^2}}\frac{d\vec{V}}{dt} + \frac{m_0\vec{V}V / c^2}{(1 - V^2 / c^2)^{3/2}}\frac{dV}{dt} = -q(\vec{E} + \vec{V}\times\vec{B}) \tag{5}$$

We have

$$\frac{dV}{dt} = \frac{d}{dt}\sqrt{V_x^2 + V_y^2 + V_z^2} = \frac{V_x}{V}\frac{dV_x}{dt} + \frac{V_y}{V}\frac{dV_y}{dt} + \frac{V_z}{V}\frac{dV_z}{dt} = \frac{\vec{V}\cdot\vec{a}}{V} \tag{6}$$

Substitute (6) in (5), we get

$$\frac{m_0\vec{a}}{\sqrt{1 - V^2 / c^2}} + \frac{m_0\vec{V}(\vec{V}\cdot\vec{a}) / c^2}{(1 - V^2 / c^2)^{3/2}} = -q(\vec{E} + \vec{V}\times\vec{B}) \tag{7}$$

Suppose that electron does linear accelerating motion in uniform electric field E along the direction of x

axis, the equation of motion is

$$\frac{d}{dt}\frac{m_0 V}{\sqrt{1-V^2/c^2}} = -qE \tag{8}$$

By taking the differential on the left side of (8), we have

$$\frac{m_0 a}{(1-V^2/c^2)^{3/2}} = -qE \tag{9}$$

Here $a = dV/dt$ is acceleration. On the other hand, by considering $V = dx/dt$, (8) can be written as

$$\frac{d}{dt}\frac{m_0 V}{\sqrt{1-V^2/c^2}} = V\frac{d}{dx}\frac{m_0 V}{\sqrt{1-V^2/c^2}} = -qE \tag{10}$$

Suppose that electron's speed is $V = 0$ when $x = x_0$, taking integration by parts, we get

$$\frac{V}{c} = \sqrt{1-\left(\frac{m_0 c^2}{m_0 c^2 + qE(x-x_0)}\right)^2} \tag{11}$$

When $x \to \infty$, we have $V \to c$. This kind of motion is possible and stable. According to this paper, electrons do not radiate. The conclusion coincides with experiments.

If retarded quantities are used in following calculations, let $a^* = a$ and substitute acceleration shown in (9) in (1), we obtain the radiation power of an electron which does linear accelerating motion

$$P_{11} = \frac{q^4 E^2}{6\pi\varepsilon_0 c^3 m_0^2} \tag{12}$$

Electron's static mass is $m_0 = 9.11\times10^{-31} Kg$, charge $q = 1.60\times10^{-19} C$. Suppose that electric field intensity of linear accelerator is $E = 10^6 V/m$, the distance electron is accelerated is $x - x_0 = 100m$. According to (11), electron's speed is $V = 0.999987c$ finally. According to the formula of relativity, the kinetic energy of electron with speed $V = 0.999987c$ is $T = 3.15\times10^{-9}$. According to (12), the largest radiation power of electron is $P_{11} = 1.75\times10^{-19} W$. Suppose that electron is accelerated from initial speed $V = 0$ to $V = 0.999987\,c$, the average speed is $0.5c$. The time electron expends is $\Delta t_1 = 6.67\times10^{-7}$ when it travels 100m and the energy it radiates is $E_1 = P_{11}\Delta t = 1.17\times10^{-25} J$, which is far less than electron's kinetic energy. According to this rate of radiation, it needs $\Delta t_2 = T/P_{11} = 1.8\times10^{10} s = 571$ years for electron to decrease its speed from c to zero. Suppose that the wave length of light radiated by electron is $7\times10^{-7} m$ (red light) with energy $E_2 = 2.84\times10^{-19} J$, we have $E_1/E_2 = 4.12\times10^{-7}$. It means that photo's number radiated by electron in whole accelerating process is far less than one. Due to quantification of photon, no photon is radiated by electron in the accelerating process actually.

This result coincides with practices. Experiments show that electron's radiation can be neglected in linear accelerator. However, in the processes to product x-rays, when electrons are decreased by metal target, strong breaking radiations are caused. Let's estimate the accelerations in two situations. According to (9), we take electron's average speed as $0.5c$, electron's acceleration is $a_1 = 2.5\times10^{17} m/s^2$. Suppose that thickness of metal target is 0.1m, electrons hit target in a speed nearing light's speed. When they leave the target, the speeds become zero. The average speed is also $0.5c$. So the time electrons pass through the target is $t = 6.67\times10^{-10} s$. According to the formula $l = at^2/2$, electron's deceleration is $a_2 = 4.5\times10^{17} m/s^2$. Both a_1 and a_2 have the same magnitude order. Why do electrons not radiate when they are accelerated in linear accelerator, but have strong radiation when they are decelerated by metal target? The current theory can not explain this problem.

It is discussed below that whether or not electron radiates depends on the stability of relativity motion of charged particles in electromagnetic fields. According to (11), electron's motion is possible and stable, so it is unnecessary for electron to radiate. In fact, if electron radiates, there is radiation damping force. The radiation damping force should be added in the motion equation. However, there are no items of radiation damping forces in (4) and (8), so they can only describe the stable motions of charged particles.

4. The Relativity Motion of Electron in Period Electric Field

4.1 The Relativity Motion of Electron Acted by Period Electric Field in Free Space

Let's discuss antenna radiation and prove that the boundary condition of antenna is very important for electron's radiation. At first, we discuss the relativity motion of charged particles acted by period electric fields in free space. So-called free space is the space without other material besides electrons and electromagnetic fields. Electron's motions are not restrained by the condition of boundary. Under the action of period electric field $E = E_0 \sin \omega\ t$, the relativity motion equation of electron is

$$\frac{d}{dt}\frac{m_0 V}{\sqrt{1-V^2/c^2}} = -qE_0 \sin \omega\ t \tag{13}$$

The integral of (13) is

$$\frac{V}{\sqrt{1-V^2/c^2}} - \frac{V_0}{\sqrt{1-V_0^2/c^2}} = \frac{qE}{\omega\ m_0}(\cos \omega\ t - \cos \omega\ t_0) \tag{14}$$

Suppose that the initial values are $x = x_0$, $V_0 = 0$ and $\theta_0 = \omega\ t_0 = \pi/2$ when $t = t_0$, we obtain from (14)

$$V = \frac{dx}{dt} = \frac{qcE_0 \cos \omega\ t}{\sqrt{(c\omega\ m_0)^2 + (qE_0)^2 \cos^2 \omega\ t}} \tag{15}$$

The integral of (15) is

$$x - x_0 = \int_{t_0}^{t} \frac{qcE_0 d \sin \omega\ t'}{\omega\sqrt{(c\omega\ m_0)^2 + (qE_0)^2(1-\sin^2 \omega\ t')}} \tag{16}$$

Let

$$qE_0 \sin \omega\ t = y \qquad (c\omega\ m_0)^2 + (qE_0)^2 = b^2 \tag{17}$$

(16) becomes

$$x - x_0 = \frac{c}{\omega}\int_{y_0}^{y} \frac{dy'}{\sqrt{b^2 - y'^2}} dy = \frac{c}{\omega}\left(\arcsin\frac{y}{b} - \arcsin\frac{y_0}{b}\right) \tag{18}$$

Because of $\omega\ t_0 = \pi/2$ and $y_0 = qE_0$ when $t = t_0$, we obtain at last

$$\frac{y}{b} = \frac{\sin \omega\ t}{\sqrt{1+(c\omega\ m_0/qE_0)^2}} = \sin\left[\frac{\omega}{c}(x - x_0) + \arcsin\frac{1}{\sqrt{1+(c\omega\ m_0/qE_0)^2}}\right] \tag{19}$$

It can be seen from (15) that we have $V/c < 1$. Because there is no restriction for the value of $x - x_0$, (19) is also possible. So it is unnecessary for electron to change its state through radiation. By taking the differential of (13), we obtain acceleration

$$a = -\frac{qE_0 \sin \omega\ t(1-V^2/c^2)^{3/2}}{m_0} \tag{20}$$

Substitute it in (1) and let retarded quantity with $t^* = t$ approximately, the radiation power of electron is

$$P_{11} = \frac{q^4 E_0^2 \sin^2 \omega\ t}{6\pi\varepsilon_0 c^3 m_0^2} \tag{21}$$

The result is the same as (12). Take $E_0 = 10^3 V/m$ and $\omega = 10^5$. When $\sin \omega\ t = 1$, we have the largest radiation energy $P_{11} = 1.75 \times 10^{-25} W$. The average power is $\overline{P}_{11} = 8.80 \times 10^{-26} W$. According to (15), the maximum speed of

electron is $V = 0.99977c$. Using the formula of relativity to calculate, the maximum kinetic energy of electron is $3.88\times10^{-12}J$ and the average kinetic energy is $T = 1.94\times10^{-12}J$. The time for an electron to radiate out all its kinetic energy is $\Delta t = T/\overline{P}_{11} = 2.20\times10^{13}$ (about 700 thousand years).

We use this result to the transition of alternating current. Suppose the average current intensity is $I = 0.01A$. The average speed of electron is $V = 0.5c$. It means that there are 4.17×10^{8} electrons to pass the cross section of wire in a second, or there are 4.17×10^{8} electrons in a wire of length 1m to do accelerating motions. The total power of radiation is $3.67\times10^{-18}W$. This is a very small value so that there is no radiation actually. In fact, experiments show that if the thermal radiation of resistance is not considered, the transition process of alternating current in a long enough wire has no radio wave radiation.

However, if electrons move in an antenna with limit length acted by period electric fields, we can observe obvious radio wave radiations. For example, for an antenna with length 1m, using $1000V$ transformer as power, we have $E_0 = 10^3 V/m$. The oscillation frequency of LC circuit is $\omega = 10^5$ (radio medium wave with wave length 478m) and the current intensity is $I = 0.01A$. Generally speaking, the equivalent resistance of antenna can be taken as $R = 50\Omega$. Therefore, the radiation power of antenna is $P = IR^2/2 = 12.5W$, 3.41×10^{18} times more than electrons did in free space!

Why the results are so different, there is no explanation in the current theory. However, both are experimental facts. There certainly exist same mechanisms which we do not understand currently. We discuss them below.

4.2 The Radiation of Antenna

It is proved below that in the period electric field with finite boundary; the relativity motion of electron is restricted. The electrons at the ends of antenna with high speeds will be decelerated suddenly to produce breaking radiations. In the medium part of antenna, electrons are also decelerated to produce breaking radiations when they travel nearby atoms fixed in crystal lattices. That is to say, the accelerating motions of electrons in the period electric fields are not the reason of antenna radiations. The breaking radiation is the real reason of antenna radiation. Similarly, taking antenna length 1m, $E_0 = 10^3 V/m$ and $\omega = 10^5$, we have

$$\left(\frac{c\omega\, m_0}{qE_0}\right)^2 = 4.55\times10^{-4} << 1 \qquad \arcsin\frac{1}{\sqrt{1+(c\omega m_0/qE_0)^2}} \approx \arcsin 1 = \frac{\pi}{2} \tag{22}$$

By considering (22), (19) can be simplified as

$$\sin\omega t \approx \sin\left[\frac{\omega}{c}(x-x_0)+\frac{\pi}{2}\right] \tag{23}$$

Let x_0 be the medium point of antenna, we have $|x-x_0| = 0.5m$ and

$$\frac{\omega}{c}|x-x_0| \le 1.67\times10^{-4} << \frac{\pi}{2} \tag{24}$$

The extent of values on left side of (23) is $-1\sim+1$, but the values of the right side is nearby $+1$. Therefore, (23) can not be tenable. For example, when $t = \pi/\omega$, we have $\sin\omega t = 0$ on the left side of (23). But the right side of (23) can not be zero, unless $\omega|x-x_0|/c \sim \pi/2$. It means $|x-x_0| = 471m$, greatly exceeds the antenna's length 1m. If $t = 3\pi/(2\omega)$, $\sin\omega t = -1$, we should have $|x-x_0| = 942m$. Therefore, (23) can not describe the normal motions of electrons in the antenna with length lm.

We suppose $\theta_0 = \pi/2$ in the discussion above. If $\theta_0 \neq \pi/2$, (16) can not be integrated. However, because physical process has nothing to do with the selection of initial phase, the conclusion still holds in general situations. For example, if we neglected the second item in the bracket on the right side of (19), by considering the magnitude order of (22), (19) becomes

$$\sin\omega t \approx \sin\left[\frac{\omega}{c}(x-x_0)\right] = -0.0085 \sim +0.0085 \tag{25}$$

The formula is still untenable. However, the antenna with length 1m, $E_0 = 10^3 V/m$ and $\omega = 10^5$ can be made practically. So we have to describe electron's movement in this antenna in following forms.

When $\sin\omega t > 0$, the direction of electric force is positive. Electrons in the antenna move along positive direction. When they arrive at one end of the antenna, the motions are obstructed so that all electrons are stopped on the end of antenna. Corresponding positive charges appear on another end. Until the time when the direction of electric field is reversed with $\sin\omega t < 0$, all electrons move along the opposite direction and stopped on

another end of antenna at last. These processes are repeated so that oscillations are caused and the radio waves are radiated. In fact, experiments indicate that if there are no oscillations, there are no antenna radiations (thermal radiations of resistances are not considered), even though electrons actually do accelerating motions acted by period electric field. If antenna is long enough, electron will not be accumulated on the ends of antenna. In this case, it is only the motion of alternating current in wire. It is not the oscillations of antenna and no radio waves are radiated.

From microscopic point of view, electrons can not break away from wire when they move to the ends of antenna. Acted by the electric fields of atoms on the ends of antenna, electrons are suddenly decelerated. The radiations are produced which are just breaking radiations. In the medium part, electrons can also be decelerated suddenly to produce breaking radiations when they travel nearby atoms fixed in crystal lattices. If antenna is long enough, electrons do not reach the ends of antenna when they are acted by period electric fields. The breaking radiations will be greatly decreased. According to (19), the radiation of radio antenna should satisfies following relations

$$\frac{c\omega\ m_0}{qE_0} << 1 \qquad \text{and} \qquad \frac{\omega}{c}\left|x - x_0\right| < \frac{\pi}{2} \tag{26}$$

For the antenna with $E_0 = 10^3 V/m$ and $\left|x - x_0\right| = 0.5m$, the biggest frequency is $\omega = 9.42 \times 10^8$. If it is exceeded, the motion will is normal without electrons being decelerated suddenly at the ends of antenna. For example, taking $\omega = 10^{10}$, we have

$$\frac{\omega}{c}\left|x - x_0\right| = 16.7 \qquad \frac{c\omega\ m_0}{qE_0} = 1.71 \times 10^4$$

$$\sqrt{1 + \left(\frac{c\omega\ m_0}{qE_0}\right)^2} \approx 1.71 \times 10^4 \qquad \arcsin\frac{1}{\sqrt{1 + (c\omega\ m_0 / qE_0)^2}} = 5.85 \times 10^{-5} \tag{27}$$

(19) becomes

$$\sin\omega\ t = 1.72 \times 10^4 \sin\left[\frac{\omega}{c}(x - x_0) + 5.85 \times 10^{-5}\right] \tag{28}$$

The formula is tenable, so electrons have no radiations. This is the reason why common radio antenna can not radiate infrared and visible lights. It is obvious that accelerations are not the essential reason of radiation. The braking radiation taking place at the ends and the medium part of antenna is the real reason of antenna radiations. We will prove below that breaking radiations are caused by the instability of relativity motions of electrons in electromagnetic fields.

5. The Relativity Motion of Electron in Uniform Magnetic Field

5.1 The Instability of Motion in Magnetic Field

Suppose that magnetic fields are uniform along the direction of z-axis, according to (4), the relativity motion equation of electron is

$$\frac{m_0\vec{a}}{\sqrt{1 - V^2/c^2}} + \frac{m_0\vec{V}(\vec{V}\cdot\vec{a})/c^2}{(1 - V^2/c^2)^{3/2}} = -q(\vec{V}\times\vec{B}) = \vec{F}_B \tag{29}$$

The second item is peculiar to relativity, we have $\vec{V}\cdot\vec{a} \neq 0$ in general. It means that the motion is described by three vectors. Their directions are the same with $\vec{V}$, $\vec{a}$ and $\vec{F}_B$. Charged particles do spiral motion, in stead of circular motion in magnetic fields. As shown in Fig. 1, we have two forms of vector additions. The first one is $\theta < \pi/2$ to make the orbit radius of electron becoming smaller. The second is $\theta > \pi/2$ to make the orbit radius of electron becoming greater.

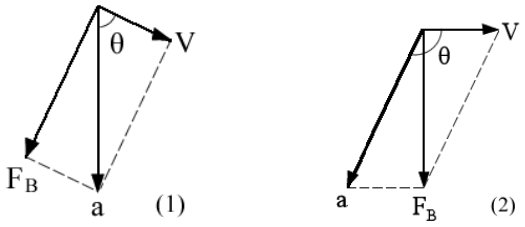

Figure 2. Electron's motion in uniform magnetic field

Writing (29) in the forms of partial quantities along two orthogonal directions $\vec{V}$ and $\vec{F}_B$, we have

$$\frac{m_0 a\cos\theta}{\sqrt{1-V^2/c^2}}+\frac{m_0 V^2 a\cos\theta/c^2}{(1-V^2/c^2)^{3/2}}=0 \qquad \frac{m_0 a\sin\theta}{\sqrt{1-V^2/c^2}}=F_B \tag{30}$$

Because of $\cos\theta\neq 0$ in general, from the first formula, we get

$$1+\frac{V^2/c^2}{1-V^2/c^2}=0 \qquad \text{or} \qquad \frac{1}{1-V^2/c^2}=0 \tag{31}$$

This result is impossible unless $V\to\infty$, which indicates that the longitudinal motions of electrons in magnetic fields violate the basic principle of special relativity with speed exceed light speed limit. We see that magnetic force $\vec{F}_B$ can not match with the motion equation of special relativity. So charged particles have to radiate. The radiation damping force changes particle's states to make the motion possible in magnetic field.

5.2 Radiation Damping Force and Longitudinal Oscillation of Electron's Orbit in Magnetic Field

In the current theory of accelerator, we assume that electrons do circle motion in synchrocyclotron with $\vec{V}\cdot\vec{a}=0$. The motion equation (29) becomes

$$\frac{m_0\vec{a}}{\sqrt{1-V^2/c^2}}=-q(\vec{V}\times\vec{B}) \tag{32}$$

Let R represent the radius of circle, p represent electron's relativity momentum, because $a=V^2/R$ and $\vec{B}\perp\vec{V}$, we obtain from (32)

$$R=\frac{m_0 V}{qB\sqrt{1-V^2/c^2}}=\frac{p}{qB} \tag{33}$$

The acceleration is

$$a=-\frac{qVB\sqrt{1-V^2/c^2}}{m_0}=\frac{F_B\sqrt{1-V^2/c^2}}{m_0} \tag{34}$$

According to the discussion of (31), if $\vec{V}\cdot\vec{a}=0$, the problem of electron's speed infinite does not exist. That is to say, if electrons do strict circle motions in magnetic fields, they do not radiate.

However, strict circle motion is only an idea situation. It is similar to erect an egg which is possible in theory but is impossible in practices. Due to many disturbing factors, for example, the uneven magnetic field, residual gas in the vacuum cavity of accelerator, interactions between charged particles in particle beam, electromagnetic perturbations caused by other part of accelerator as well as the dispersions of initial velocities in different directions, charged particles can not do circular circle motions in synchrocyclotron. As long as electron slightly departs from circular motion, the problem of (31) will appear immediately. So in general situations, electron will radiate continuously, until its kinetic is completely exhausted.

Suppose that radiation damping force is $\vec{F}_f$, the real motion equation of electron in synchrocyclotron is

$$\frac{m_0\vec{a}}{\sqrt{1-V^2/c^2}}+\frac{m_0\vec{V}(\vec{V}\cdot\vec{a})/c^2}{(1-V^2/c^2)^{3/2}}=-q(\vec{V}\times\vec{B})+\vec{F}_f \tag{35}$$

Suppose that $\vec{V}\perp\vec{F}_B$ and the direction of $\vec{F}_f$ is the same as $\vec{V}$ with $\vec{V}\cdot\vec{F}_f=VF_f$. Taking dot product (35) by $\vec{V}$, we obtain

$$\frac{m_0a\left[1-V^2/c^2(1-\cos\theta)\right]\cos\theta}{(1-V^2/c^2)^{3/2}}=F_f \tag{36}$$

Taking cross product (35) by $\vec{V}$, we obtain

$$\frac{m_0a\left[1-V^2/c^2(1-\cos\theta)\right]\sin\theta}{(1-V^2/c^2)^{3/2}}=-qVB=F_B \tag{37}$$

From the formulas above, we get

$$F_f=F_B ctg\,\theta=-qVB ctg\,\theta \tag{38}$$

This is just the relation between damping force and magnetic force. Because of $\theta\neq\pi/2$, the orbit of electron in magnetic fields is not a circle. But it can be very close to a circle. We take $\theta=\pi/2\pm\delta$ and δ is a very small quantity. We have $\sin\theta=\cos(\pm\delta)\approx 1$ and $\cos\theta=\sin(\pm\delta)\approx\pm\delta$. Substitute them into (38), we get

$$F_f=\pm\delta F_B=\pm\delta qVB \tag{39}$$

The force $F_f\propto\pm\delta$ leads to the longitudinal motion of electrons, called as the longitudinal oscillation of synchrocyclotron which has been verified in experiments. By introducing radiation damping force, we obtain the result of longitudinal oscillation of synchrocyclotron automatically. The value of δ can be determined by experiments. Because δ may be vary small, radiation damping force is very small comparing with magnetic force. The greater δ is, the greater the radiation damping force is. If $\delta=0$, electron does strict circle motion without radiation. Substitute $\sin\theta\approx 1$ and $\cos\theta\approx\pm\delta$ in (37), we get

$$a=\frac{F_B(1-V^2/c^2)^{3/2}}{m_0\left(1-V^2/c^2(1\pm\delta)\right)}\approx\frac{F_B\sqrt{1-V^2/c^2}}{m_0} \tag{40}$$

It is approximately equal to (34). So after radiation damping force is considered, the radiation power of electron is basically unchanged.

It can be imagined that if we introduce a force with the form of (38) to replace radiation damping force, electron's motions can also be possible and stable so that they do not radiate in magnetic field. In this way, we may establish synchrocyclotron without radiation loss. We will discuss it in the end of this paper.

The results above also tell us that the forms of forces can not be arbitrary in the motion equations of special relativity. If the forms of forces are improper, the motions may become impossible due to the restriction that particle's speed can not exceed light's speed in vacuum. Electron's motion in magnetic field is exactly the case. Physicists should pay attention to this problem which has been ignored since special relativity was established.

6. The Relativity Motion of Electron in Electric Center Force Field

6.1 The Stability and Instability of Motion

Suppose that the charge of atomic nucleus is Q, the relativity motion equation of an electron in the electric center force field of atomic nucleus is

$$\frac{m_0\vec{a}}{\sqrt{1-V^2/c^2}}+\frac{m_0\vec{V}(\vec{V}\cdot\vec{a})/c^2}{(1-V^2/c^2)^{3/2}}=-\frac{qQ\vec{r}}{r^3}=\vec{F}_E \tag{41}$$

Due to the existence of second item on the left side, electron's obit is not a circle. In fact, in the Newtonian mechanics, the orbit of an object in the center force field is an elliptic in general. Taking cross product (41) by $\vec{r}/r$, we obtain the projection equation in the direction orthogonal to $\vec{r}$

$$\frac{m_0(\vec{r}\times\vec{a})}{r\sqrt{1-V^2/c^2}}+\frac{m_0(\vec{r}\times\vec{V})(\vec{V}\cdot\vec{a})/c^2}{r(1-V^2/c^2)^{3/2}}=0 \tag{42}$$

As shown in Figure 3, by using the polar coordinate and let the angle between $\vec{V}$ and $\vec{e}_\theta$ be α, between $\vec{a}$ and $\vec{e}_\theta$ be β. The direction of $\vec{F}_E$ is opposite to that of $\vec{e}_r$. We have $\vec{V}\cdot\vec{a}=Va\cos(\beta-\alpha)$, $\vec{r}\times\vec{a}\sim ra\sin(\beta-\pi/2)=-ra\cos\beta$ and $\vec{r}\times\vec{V}=-\vec{V}\times\vec{r}\sim -Vr\sin(\pi/2-\alpha)=-Vr\cos\alpha$. Substitute them in (42), we get

$$-\cos\beta-\frac{\cos\alpha\sin(\beta-\alpha)V^2/c^2}{1-V^2/c^2}=0 \tag{43}$$

or

$$\frac{V^2}{c^2}=\frac{1}{1-\cos\alpha\sin(\beta-\alpha)/\cos\beta} \tag{44}$$

Because of $V/c<1$, we should have

$$\frac{\cos\alpha\cos(\beta-\alpha)}{\cos\beta}=\cos^2\alpha(1+tg\alpha\ tg\beta)<0 \tag{45}$$

Or

$$tg\alpha\ tg\beta<-1 \tag{46}$$

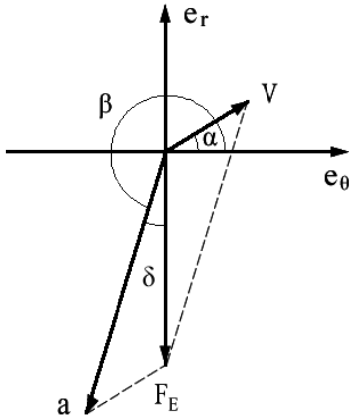

Figure 3. Impossible mode1 of electron's motion in center electric force field, electron radiates

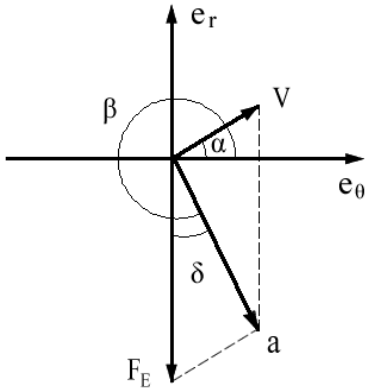

Figure 4. Possible model 1 of electron' motion in center electric force, electron does not radiate

When α is located in the first and third quadrants, we have $tg\alpha>0$. When α is located in the second and fourth quadrants, we have $tg\alpha<0$. So in order to make (46) tenable, if α is located in the first and third quadrants, β should be located in the second and forth quadrants. If α is located in the second and fourth quadrants, β should be located in the first and third quadrants. Otherwise, electron's motion will be unstable so that they have to radiate.

Suppose α is located in the first quadrant, the motion shown in Figure 2 is unstable and electron has to radiate. The motion shown in Figure 3 is possible but (46) should be satisfied. Let $\beta=270^0+\delta$, $tg\beta=-ctg\delta$, (46) becomes $tg\alpha\ ctg\delta>1$ or $tg\alpha>tg\delta$, i.e., $\alpha>\delta$. If $\alpha<\delta$, electron's motion is still unstable and has to radiate.

If α is located in the forth quadrant, the motion shown in Fig.4 is unstable and electron has to radiate. The

motion shown in Figure 5 is possible but (46) should be satisfied. Let $\beta = 270^0 - \delta$, $\alpha = -\delta$. We have $tg\beta = ctg\delta$, $tg\alpha = -tg\delta$. (46) becomes $tg\Delta\ ctg\delta > 1$ or $tg\Delta > tg\delta$, i.e, $\Delta > \delta$. If $\Delta < \delta$, electron's motion is still unstable and has to radiate.

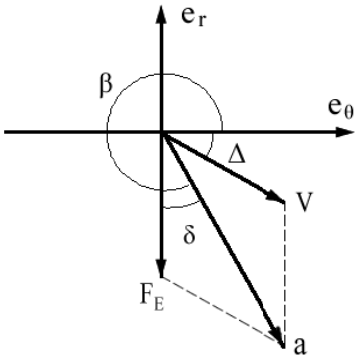

Figure 5. Impossible mode1 of electron's motion in center electric force field, electron radiates

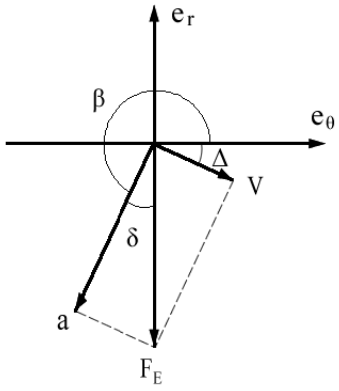

Figure 6. Possible model 1 of electron' motion in center electric force, electron does not radiate

In addition, if $\vec{V} \cdot \vec{a} = 0$, electrons do circle motions and not radiate. Because there are two free degrees δ and Δ for electrons to choose, the motions are generally possible for electrons in center electric fields. So they do not radiate and atoms are stable in general. Only in some special situations, the relativity motions of electrons are unstable when they are very close to nucleus so that they have to radiate, i.e., breaking radiation.

6.2 Radiation Damping Force in Electric Field

If the motion of relativity is unstable in center electric force field, electrons will radiate. By considering radiation damping force, the motion equation of an electron becomes

$$\frac{m_0\vec{a}}{\sqrt{1-V^2/c^2}} + \frac{m_0\vec{V}(\vec{V}\cdot\vec{a})/c^2}{(1-V^2/c^2)^{3/2}} = \vec{F}_E + \vec{F}_f = -\frac{qQ\vec{r}}{4\pi\varepsilon_0 r^3} + \vec{F}_f \tag{47}$$

Let the angle between $\vec{r}$ and $\vec{F}_f$ be φ and take cross product (47) by $\vec{r}$, similar to (43), we get

$$-\frac{m_0 a\cos\beta}{\sqrt{1-V^2/c^2}} - \frac{m_0 V^2\cos\alpha\cos(\beta-\alpha)/c^2}{(1-V^2/c^2)^{3/2}} = F_f\sin\varphi \tag{48}$$

Taking dot product (47) by $\vec{r}$, we have

$$\frac{m_0 a\cos(\beta-\pi/2)}{\sqrt{1-V^2/c^2}} + \frac{m_0 V^2\cos(\pi/2-\alpha)\cos(\beta-\alpha)/c^2}{(1-V^2/c^2)^{3/2}} = F_E + F_f\cos\varphi \tag{49}$$

Let $\varphi = \pi/2 + \varepsilon$, ε is a small quantity. We have $\cos\varphi = -\sin\varepsilon = -\varepsilon$ and $\sin\varphi = \cos\varepsilon = 1$. Substitute them in (48) and (49), we get

$$F_f = -\frac{m_0 a\left[(1-V^2/c^2)\cos\beta + V^2/c^2\cos\alpha\cos(\beta-\alpha)\right]}{(1-V^2/c^2)^{3/2}} \tag{50}$$

$$\varepsilon F_f = -F_E + \frac{m_0 a\left[-(1-V^2/c^2)\sin\beta + V^2/c^2\sin\alpha\cos(\beta-\alpha)\right]}{(1-V^2/c^2)^{3/2}} \tag{51}$$

Substitute (50) in (51), we get acceleration

$$a=\frac{F_E(1-V^2/c^2)^{3/2}}{m_0\left[(1-V^2/c^2)(\varepsilon\cos\beta-\sin\beta)+V^2/c^2(\varepsilon\cos\alpha+\sin\alpha)\cos(\beta-\alpha)\right]} \tag{52}$$

For electron's obit near to be a circle, we write $\beta=3\pi/2\pm\delta$. Because δ and α are small quantities, we have $\cos\alpha=1$, $\sin\alpha=\pm\Delta$, $\cos\beta=\pm\sin\delta\approx\pm\delta$, $\sin\beta=-\cos\delta\approx-1$ and $\cos(\beta-\alpha)=\cos(3\pi/2\pm\delta\pm\Delta)$ $\approx\pm\delta\pm\Delta$. Substitute them into (52), we get

$$a=\frac{F_E(1-V^2/c^2)^{3/2}}{m_0\left[(1-V^2/c^2)(\pm\varepsilon\delta+1)+V^2/c^2(\pm\varepsilon\delta\mp\Delta)(\pm\delta\pm\Delta)\right]}\approx\frac{F_E\sqrt{1-V^2/c^2}}{m_0} \tag{53}$$

The result is the same as (34). If we do not consider electron's motions in this way, the stability of atoms would become a big problem. Substitute (53) in (2), we have

$$p_\perp=\frac{q^6}{96\pi^3\varepsilon_0^3c^3m_0^2r^4(1-V^2/c^2)} \tag{54}$$

For the energy of electron in the ground state of hydrogen atom is $E_1=13.55eV=2.17\times10^{-18}J$, in which half is potential energy and half is kinetic energy. The speed of electron is $V=0.00514c$. Let $r=0.53\times10^{-10}$ be the first Bohr radius, we obtain $p_\perp=4.60\times10^{-8}W$. According to this radiation power, the electron would loss all its energy in time $\Delta t=E_1/P_\perp=4.72\times10^{-9}s$ and falls in nuclear. Of cause, this is impossible.

Some one may think that according to quantum mechanics, electron should be considered as a wave simultaneously. It is meaningless to consider the orbit motion of an electron. However, this statement does not solve the problem. We can consider macro-current circle, for example, the radiation of current loops made by low temperature supper-conductors. Suppose there are 10^{10} electrons with speed $0.00514c$ in a supper-conductor loop. The radius of loop is $R=0.05m$. The total kinetic energy of 10^{10} electrons is $T=1.09\times10^{-8}J$. The current intensity is $I=0.0031A$. The acceleration of electron is $p_\perp=1.84\times10^{-7}W$. According to (2), we have $p_\perp=1.84\times10^{-7}W$ and $\Delta t=T/P_\perp=0.059s$. That is to say, the current in supper-conductor loop can only maintain 0.059 second. However, experiments show that the current in supper-conductor loop is stable. No such great radiation is observed.

In the light source of synchrocyclotron, we use wigglers and oscillators to produce radiations and free electron laser at present. The magnetic fields with direction alternate changes are used in wigglers and oscillators, in stead of the electric fields. If the period electric fields with direction alternate changes are acted in the perpendicular direction of electron's velocities, electron's obits may also wiggle. Can we use them to produce free electron laser? The answer seems not. As mentioned before, electron's motions are stable when they are acted by period electric fields in free space. They do not radiate in this case.

6.3 Braking Radiation

When charged particle moves nearby atomic nucleus, its speed is decelerated and braking radiation is caused. If electron collides with nucleus directly, electron would combine with proton in nucleus and form neutron. In this case, braking radiation may also be caused. In general situations, electron moves in the electric field of atomic nucleus. Because atomic nucleus's charge is positive, the practical situation is that electron is accelerated when it approaches nucleus, then is decelerated when it leaves nucleus.

As shown in Figure 7, if α is located in the first quadrant with $\alpha>\theta$, the motion is possible and stable, electrons do not radiate. In other situations, the motions are unstable and electrons will radiate. If α is located in the fourth quadrant with $\Delta>\delta$ as shown in Figure 8, the motion is possible and stable, electrons do not radiate. In other situations, the motions are unstable and electrons will radiate.

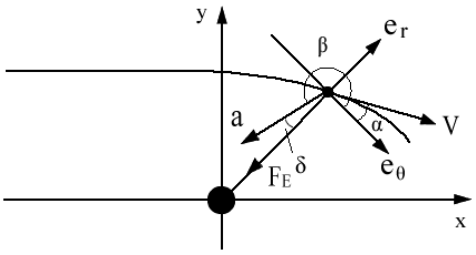

Figure 7. Electron collides with nucleus to produce braking radiation 1

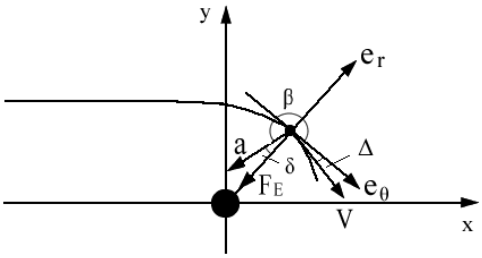

Figure 8. Electron collides with nucleus to produce braking radiation 2

7. The Possibility to Establish Synchrocyclotron without Radiation Losses

As mentioned before, in common situations, electron radiates when it moves in magnetic field. The real motion equation is (35) in which radiation damping force exists. If we use an electric field force $\vec{F}_E$ to replace $\vec{F}_f$, electron in magnetic field may not radiate again.

Electronic induction accelerator may be just this case. As shown in Figure 9, suppose that the direction of magnetic field is along z-axis, the direction of magnetic force $\vec{F}_B$ is pointed to the center of accelerator. The direction of induction electric field force $\vec{F}_E$ is parallel to the direction of electron's velocity (Xu jianming, 1981). Electron's motion may be stable and electron will not radiate. This may be the reason why Blewett had not found radiations in electron induction accelerator. That is to say, in electron induction accelerator, electrons may not radiate, no matter what radio waves or visible light!

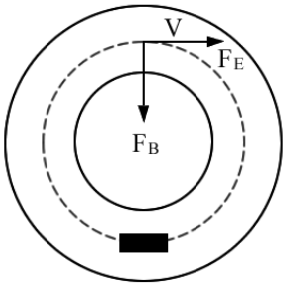

Figure 9. Electronic induction accelerator without radiations

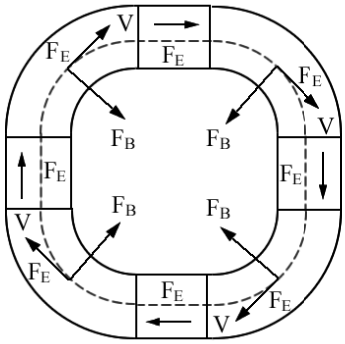

Figure 10. Synchrocyclotron without radiations

This affirmation needs experimental verifications further. If it is true, we can design synchrocyclotron without or less synchrony radiation losses. As shown in Fig. 10, electrons are accelerated in the linear joint parties of synchrocyclotron. Magnetic fields are acted on the turning parties to maintain electron's circle motions. As long as we add an electric field force along the direction of electron's velocity on the turning parties of synchrocyclotron, electron's motion may be stable so that they do not radiate. The directions of electric fields should be changed positive and negative periodically, so that the angle δ of longitudinal oscillation is changed in a small extent around circular motion with $\delta = 0$. To replace $\vec{F}_f$ with $\vec{F}_E$ in (39), we have $F_E = \pm\delta F_B$ or $E = \pm\delta VB$. Because electron's speed is close to light's speed, taking $B = 1T$, we have $E = \pm 3\delta \times 10^8$. By detecting angle δ when electrons radiate, we can determine electric field force we need to replace radiation damping force.

8. Conclusions

According to classical theory of electromagnetic field, accelerated charged particles radiate electric waves. However, actual situations are not the cases. Experiments show that in following processes charged particles with accelerations do not radiate.

1) Electrons are accelerated in uniform electric field without radiations.

2) Electrons do not radiate when they move in the loops of direct currents (including the loops made from low temperature supper-conductors). In the straight line transmission process of alternating current, electrons with

accelerations also do not radiate.

3) If conditions are not proper, radio antennas do not radiate though electrons have accelerations.

4) Electrons moves around atomic nucleus do not radiate.

5) In electron induction accelerator, there are no radio wave radiations. Whether or not there are visible light's radiations, we need further experiments.

6) It seems that we can not use electric fields to replace magnetic fields to produce free electron laser.

In this paper, we prove that the instability of relativity motion is the essential reason for charged particles to radiate in electromagnetic fields. The forms of forces can not be arbitrary in the dynamic equations of relativity. Under certain conditions, if the forms of forces are improper, the relativity motions of charged particles are impossible in theory and unstable in practices. In order to make the motions possible, charged particles have to change their states through radiations.

In order to correctly describe the motion of charged particles which radiate in electromagnetic fields, the radiation damping forces should be added in the motion equation. By introducing radiation damping force, we can obtain a logically consistent theory which agrees with experiments.

For the problem of charged particle's radiation, we should change our thinking form. It is not acceleration to cause radiation, but radiation is related to acceleration. If charged particle's motions of relativity are stable, they do not radiate even they have accelerations. Because they do not radiate, the radiation formula of classical electromagnetic theory does not apply. And it no longer meaningful for the statement that acceleration causes the radiation of charged particle.

The essence of antenna radiation is the braking radiation. In electron induction accelerator, acted by the transverse electric field force and longitudinal magnetic force simultaneously, electron's motions may be stable so they may not radiate. This affirmation needs experimental verification. If it is true, by adding an electric field force in the direction of electron's velocity, the motion of electron can be stable in magnetic field so that electron does not radiate again. In this way, we may establish high energy synchrocyclotron without or less synchrony radiation losses. The following experiments are proposed.

1) Make it certain whether or not electrons radiate infrared light and visible light in electron induction accelerators. Or whether or not the radiations of electromagnetic waves are greatly weaken.

2) Make it certain whether or not electrons radiate the radio waves of low frequencies in synchrocyclotron. If the radiations of low frequencies can be detected, we should ask why they had not been found in electron induction accelerators in Blewett's experiment.

3) Using the electric fields with their directions change alternately to replace magnetic fields in wigglers and oscillators, to observe whether or not free electron laser can be produced.

4) Directly adding an electric field with directions alternately changed on the turning parts of synchrocyclotron in which magnetic fields exist, to observe whether or not synchrony radiations disappear or are greatly weaken.

References

Cao, Changqi. (1979). *Electric Dynamics*. People's Education Publishing Company, p.227.

John, P. Blewett. (1946). Radiation Losses in the Induction Electron Accelerator. *Phys. Rev., 69*, p.87. http://dx.doi.org/10.1103/PhysRev.69.87

Liu, Zuping. (2009). *Introduction to Light Source of Synchrony Radiation*, Chinese Science and Technology University Pubilshing Company, p.1-10.

Xi, Dingchang. (1998). *Magic light-Synchrony Radiation*. Hunan Education Publishing Company, p.16.

Xu, jianming. (1981). *Principle of accelerator*, Science Publishing Company, p.94.