ACADEMICIA

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# ACADEMICIA

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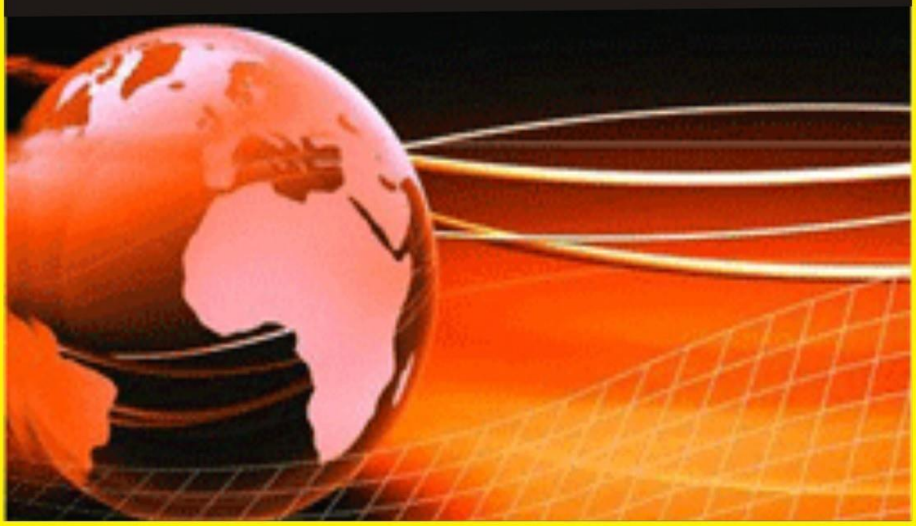

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# KEY FACTORS OF SUSTAINABLE USE OF WATER RESOURCES IN CENTRAL ASIA

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**ABSTRACT**

*Water resources are a vital strategic and closely interdependent factor in Central Asia. They are connected by common river basins of the Syr Darya and Amudarya rivers, a single ecological system. The countries of the region have large proven reserves of gas, oil, coal and uranium. An industrial base for the extraction of energy resources has been created, sufficient for the stableeconomic development of all the countries of Central Asia.*

*For more than 50 years, the scale negative environmental and socio-economic consequences of the drying up of the Aral Sea for the Central Asian region are widely known throughout the world. The Republic of Uzbekistan makes a significant and tangible contribution to mitigating the impact of the Aral catastrophe on the environment and health of the population of the Aral Sea area. However, the scale of existing problems requires drawing the attention of the broad world public to measures aimed at restoring the ecosystems of the region and achieving its sustainable development.*

**KEYWORDS**: *Water Use, The Aral Sea, Water Resources, Biodiversity, Collector-Drainage Networks, Transboundary Rivers, Water Resources Protection.*

## INTRODUCTION:

In the Central Asian region, characterized by aridity, effective water management is one of the most important elements for ensuring sustainable development and poverty reduction in the region. The main sources of water resources linking all five countries of the region are the two large rivers of the Aral Sea basin - the Amudarya and the Syr Darya. The creation of a large-scale and ineffective system of irrigated agriculture in the states located mainly in the lower reaches of the rivers became the root cause of the Aral catastrophe. In addition, a system of water-energy interdependence inherited the five former Soviet republics. The ecological catastrophe in the Aral Sea region is a consequence of the extensive management of irrigated agriculture in the basins of the Syr Darya and Amudarya rivers. As a result of the forced input of irrigated areas of water losses during transportation and irrigation, the river flow of the Aral almost ceased. The sea level fell from 53 m in 1960 to 40.9 m in 1987, the area of the sea decreased from 67 to 41 thousand km2, and the volume - from 1,064 to 404 km2.

The Aral Sea is a drainless salt lake in Central Asia, on the border of Kazakhstan and Uzbekistan. Before the beginning of shallowing, the Aral Sea was the fourth largest lake in the world. Excessive water intake for irrigation of agricultural land has transformed the world's fourth-largest lake-sea, formerly rich in life, into a barren desert. What happens to the Aral Sea is a real environmental problem. The Aral catastrophe directly affected five states of the Aral Sea

region: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. The first to suffer from it were residents of the territories that used to be coastal. At the present time, the drying Aral Sea is 100 km from its former coastline near the city of Muynak in Uzbekistan. Collector-drainage water coming from the fields into the mainstream of the Syr Darya and Amu Darya rivers caused deposits from pesticides and various other agricultural pesticides, appearing in places on 54 thousand km of the former seabed covered with salt. Dust storms carry salt, dust and pesticides up to 500km. Sodium bicarbonate, sodium chloride and sodium sulfate are transported through the air and destroy or slow down the development of natural vegetation and crops.

Today, due to the Aral Sea crisis, the following number of problems arose:
- A sharp deficit and high contamination of river waters used for drinking water supply and irrigation;
- Degradation of soil and vegetation cover, desertification, land degradation and salinization, reduction of crop yields and quality of crops, decline in pasture productivity, severe impoverishment of the animal world;
- A serious deterioration in the health of the population, an increase in infant mortality;
- loss of fishing and water transport value of the sea, liquidation of fish processing enterprises.

Restoration of the entire Aral Sea is impossible. For this, it would take four times to increase the annual inflow of the Amudarya and Syr Darya waters in comparison with the current average of 13 km3.

At the moment, the only significant measure to maintain sea level used by the states of Central Asia and Kazakhstan is the transfer to the Aral Sea of a certain amount of fresh water provided by Western countries. However, this costly event has no economic, social or political prospects. It is also less effective from the ecological point of view: the region will continue to develop along an extensive route, which means that the fence from the rivers will continue to grow.

**Materials and methods**: Water is a key factor in the socio-economic well-being of the Central Asian country. It is also not a secret that in the long term its deficit will increase, especially taking into account the rate of climate change, which puts at risk the sustainable development of not only individual desert zones, but the entire region as a whole. Most of the surface waters of the region flow through the territory of several states, which leads to the need for cooperation in the management of transboundary rivers.

Worldwide, there is growing recognition that inequalities in access to water resources, competition in the control of their distribution and use, can lead to conflicts at the local and regional levels. The sad fate of the Aral Sea begins to be repeated by other major water bodies in the world - primarily Lake Chad in Central Africa and Lake Salton Sea in the south of the US state of California. Because of the excessive intake of water to irrigate the fields, the water in it becomes more salty. Various plans for the desalination of this lake are being considered. As a result of the rapid development of irrigation since the 1960s. Lake Chad in Africa has decreased to 1/10 of its former size. Farmers, shepherds and locals from four countries adjacent to the lake often fiercely fight among themselves for the remains of water (bottom right, blue), and the depth of the lake is today only 1.5 m.

Cooperation in the field of rational use and protection of water resources can become an instrument for solving transboundary water problems. The International Fund for Saving the Aral Sea is the only regional organization in this direction. It is impossible to fully resolve the environmental problems that have accumulated for decades in the region without effective

interaction of all countries in the region and effective support of the international community. At the same time, Uzbekistan's position on the use of transboundary watercourses is as follows:

- The issues of transboundary rivers of Central Asia should be solved taking into account the interests of the entire population of the region;

- any actions carried out on transboundary rivers should not have a negative impact on the existing ecological and water balance of the region;

- The norms of international water law should become the main joint use of the resources of the transboundary rivers of the Central Asian region;

- Implementation of projects on transboundary rivers should be carried out on the basis of a constructive approach and a compromise that does not infringe the interests of other interested states and guarantees two necessary conditions for flow in the territory of the downstream countries;

- Preservation of ecological and water balance in the region.

**Results and Discussion** The Aral Sea problem today is considered very multidimensional. First, the parties and the expert community for many years of cooperation and study of the problem have developed very concrete measures that can improve the situation around the Aral Sea crisis. Such measures include, for example, the planting of plants on the dried bottom, which reduces the removal of salt, because dust and salt from the dried bottom is carried by dust and sand storms throughout the Aral basin. According to experts on the cultivation of seedlings of desert and fodder plants will be a unique scientific and educational base for the training of specialists in demand. Participants of some projects repeatedly attempted to sow the saxaul in the bottom of the Aral Sea, which helps to moisten the desert and stop dust and salt storms. Another effective measure is the creation of small local reservoirs in the delta of the Amu Darya, what scientists from Uzbekistan are currently engaged in. Also, conservation of individual parts of the reservoir is effective, as it happened with the so-called "Small Sea" in Kazakhstan, because there is no need to speak about the unified Aral Sea in 2018 - it was divided into two non-communicating reservoirs. All these measures at the local level due to certain engineering efforts will improve the situation.

Another problem hampering the stabilization of the ecological situation in Uzbekistan is the poor alignment of the interests of the states included in the Aral Sea region. The main disagreements on this issue in Uzbekistan arose with Tajikistan. Tajiks are smaller than other states of the Aral Sea area, because they live in foothills, in the headwaters of rivers. Therefore, they have no interest in saving and maintaining the purity of the water used by rivers. Moreover, the question of selling water to Uzbekistan remains open in Tajikistan, while the public of Uzbekistan suggests that all the waters of the Syr Darya, the Amu Darya and their tributaries are the property of the Aral Sea and require stopping the plundering of waters in the upper reaches of these rivers and stopping the dumping of production waste. This is a very tangible source of tension between states.

An agreement on the use of water resources in the Aral Sea basin should be concluded between Kazakhstan, Uzbekistan and other Central Asian states, in which it is clearly stipulated how much water each state uses and how much water and what quality it conveys to its neighbors. On the basis of this agreement, it will be possible to develop a system of compensation or determine the share of the contribution of states to investments in eliminating the consequences of the Aral

catastrophe.
In 1994, the International Fund for Saving the Aral Sea, established by the "Central Asian Five", was established. The main source of the fund's resources were one-percentage deductions from the national income of the founding countries.

The population of the Priaralie region in Uzbekistan has increased 3.6-fold over the past 50 years - To two billion people. In accordance with the State program for the development of the Aral Sea area for 2017-2021, aimed at improving the conditions and quality of life of the population of the region, it is planned to allocate funds from the state budget and attract investments in the amount of over 8 trillion. sum. The Development Fund of the Priaralie region under the Ministry of Finance of the Republic of Uzbekistan in 2018 plans to increase its income to 323.5 billion soums, preliminary expenses with this amount are projected in the region of 246.9 billion sums. In 2017, the fund's revenues amounted to 189.9 billion soums. Expended the same organization over the past year 123.5 billion soums. It is specified that in 2017 construction and installation works, reconstruction, major repairs and landscaping were completed in 167 facilities, including the development of the water supply system and increasing the population's access to safe drinking water and sewerage services. In Kazakhstan, a joint project with the United Nations to save the Aral Sea was launched. On the revival of the coast of the Aral Sea, the UN allocated $ 3 million. This project is aimed at three areas: social, economic and environmental. With the desiccation of the sea, people who traded in a fishing business can no longer feed themselves, leading such a way of life. The task of this project is to help people find an alternative, how to make a living. In the Priaralie zone, Uzbekistan over the past few years has implemented projects totaling more than 5.5 billion US dollars. These projects are financed by the Government of Uzbekistan and the International Fund for Saving the Aral Sea.

Life shows that people can adapt to any situation, and survive even in an environmental disaster. The tragedy of the Aral Sea is a worthy example of the resilience of the local population. Fisheries are developing in the nearest nearby lakes. The drained bottom of the sea is rich in natural resources - oil and gas. The industrial development of the bottom has already begun. International corporations conduct geological development in this area. And finally, the Aral Sea in the future can become a promising tourist destination. This is facilitated by the decision of the President of the Republic adopted in February 2017 aimed at economic development and employment of the population of the Muynak District in 2017-2018, as well as the Comprehensive Development Program for the Muynak District for 2017-2018.

**CONCLUSION**:

The Aral catastrophe has become the most tragic and vivid example of inexpedient use of water resources. Unfortunately, lessons from this terrible history were not rendered. To date, the volume of water in the Aral Sea has decreased by more than 13 times. Salinity of water has increased almost 10 times. The Aral Sea is not being restored - such is the sad verdict of scientists. But in our power to prevent the recurrence of this disaster, and to attend to the problem of water supply now.

**List of used Literature:**

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# A NEW HYPOTHESIS OF THE RELATION BETWEEN MOMENTUM AND ENERGY

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## ABSTRACT

*The combination of Newton momentum and Einstein's mass-energy relation will cause many difficulties. A new hypothesis of the relation between energy and momentum is proposed to solve these difficulties. At the same time, the relation is validated.*

**KEYWORDS:** *Momentum; Energy; Newton Momentum; Theory Of Relativity; Quantum Mechanics.*

## INTRODUTION

（In this formula, $c$ is the velocity of light, $\lambda$ is the wavelength, $u$ is the frequency, $v$ is the velocity of wave, $E$ is the energy, $h$ is Planck constant, $p$ is the momentum）

### 1. Current difficulties in Newton momentum

### 1.1 Substitution of matter waves into Newton momentum causes the difficulties of infinity

The difficulty of wavelength infinity caused by substituting De Broglie matter wave into Newton momentum is： $\lambda = \frac{h}{p} = \frac{h}{mv}$ When $v$ approaches 0,（the wavelength of matter wave $\lambda \to \infty$）it does not conform to the facts.

### 1.2 Newton momentum does not conform to Einstein's relation between velocity and temperature

Planck -- Einstein temperature transformation formula is

$$T_0 = T / \sqrt{1-(v/c)^2} \qquad (1)$$

This formula shows that the temperature decreases as the velocity increases.

According to $\lambda = h/p$ and Wien's Displacement Law $\lambda T = b$, it can be obtained that: $T = \frac{bp}{h}$,

By substituting Newton momentum $p = mv$, it can be obtained that:

$$T = \frac{bmv}{h} \qquad (2)$$

Formula (2) shows that with the increase of velocity, the temperature of the object increases, which is inconsistent with Formula (1).

**2. Establishment of a new relation between energy and momentum**

In order to establish a new relation between energy and momentum, the following two assumptions must be made:

Assumption one：1. Correspondingly, the velocity of light equals the product of wavelength and frequency, $c = \lambda u$ .

2. The velocity of mechanical wave also satisfies the product of wavelength and frequency, $v = \lambda u$ 。

3. Then, analogous to material waves of matter particles (e.g. electrons, protons, etc.), it is concluded that material waves should also satisfy that the wave velocity is equal to the product of wavelength and frequency, $v = \lambda u$ .

Assumption two. 1. Correspondingly, the photon has no rest mass and there is no rest photon.

2. Then by analogy, it can be obtained that quantum has no rest mass and there is no rest quantum. Since the photon satisfies $E = hu$ , $p = \frac{h}{\lambda}$ ,then the quantum should also satisfy $E = hu$ , $p = \frac{h}{\lambda}$ .

When the matter particle is quantum, then $E = hu$ and $E = mc^2$ are satisfied, then it can be obtained that $hu = mc^2$ . And according to $v = \lambda u$ , $p = \frac{h}{\lambda}$ , it can be obtained that:

$$p = \frac{hu}{\lambda u} = \frac{mc^2}{v} = \frac{E}{v} \qquad (3)$$

According to equation (3), it can be obtained that:

$$E = mc^2 = hu = pv \quad \text{(hereinafter referred to as mass-energy momentum} \qquad (4)$$

$E = pv$ shows that when the matter particle is quantum, it must be explained by Formula (4). Since the quantum has no rest mass, the velocity $v$ of the quantum must be greater than 0. As $v$ approaches $c$ , $p$ approaches $mc$ . And it can be obtained from $E = mc^2 = pv = hu$ that the faster the instantaneous velocity of the quantum motion is, the smaller the momentum of the quantum is.

**3.Explanations of Ji Hao's Three Experiments**

**3.1 Ji Hao's experiments do not conform to the results of substituting Newton momentum into the mass-velocity relation of special relativity.**

Ji hao analyzed the experiments of mass-velocity relation validated by calorimetric method conducted by Bertozzi in the Nuclear Science Laboratory of the Physics Department of Massachusetts Institute of Technology. He found that the theoretical values of Bertozzi's experiments were electrons with five kinds of energy, 0.5MeV, 1.0MeV, 1.5MeV, 4.5MeV and 15MeV. However, only 1.5 MeV and 4.5 MeV electron energy measurements are given in the experimental report, and no 15 MeV electron energy measurements are given. Ji Hao questioned this and re-measured this experiment in the accelerator laboratory. The six nominal energies of the electron beams generated by the accelerator and the corresponding mass-velocity relation calculated by special relativity are shown in table 1. The electrons are injected vertically into a 0.1210T uniform magnetic field using a lead-iron collimator. According to the formula of substituting Newton momentum into the special relativity, the orbit radius of the electron circular motion should fall on the six points of 10.94 cm, 16.41 cm, 24.62 cm, 32.82 cm, 43.76 cm and 54.7 cm. However, Ji Hao's experiments showed that all six types of electrons fell within a small radius of about 18 cm on the photographic film -- the deflection radius of the electrons with different labeled energies did not conform to the prediction of substituting Newton momentum into special relativity (see table 1).

**Table 1 Ji Han's experiments, corresponding Newton's theory prediction & relativistic prediction**

| Labeled energy of electrons , MeV | 4 | 6 | 9 | 12 | 16 | 20 |
|---|---|---|---|---|---|---|
| $\upsilon$ ( Relativistic prediction ) | 0.9908 c | 0.9969 c | 0.9986 c | 0.9992 c | 0.9995 c | 0,9997 c |
| $r$ ( Relativistic prediction ) | 10.94 | 16.41 | 24.62 | 32.82 | 43.76 | 54.7 |
| $r$ ( Newton's theory prediction ) | 1.40 | 1.404 | 1.4057 1 | 1.4075 5 | 1.4079 8 | 1.4086 8 |
| $r$ ( Ji Hao's experiments) | 17.8 | 17.9 | 18.0 | 18.1 | 18.2 | 18.3 |

Ji Hao's experiments were carried out at the 2300C/D linear accelerator made by Varian. In the experiment, when the particle with a static mass of $m_0$ and a charge of $q$ is moving in the electromagnetic field with a velocity of $v$, the following equation can be obtained by substituting Newton Momentum and mass-velocity relation into Lorentz Force Equation:

$$\frac{d}{dt}\frac{m_0\vec{v}}{\sqrt{1-(v/c)^2}} = q\left(\vec{E}+\vec{v}\times\vec{B}\right) \quad (5)$$

Using cylindrical coordinates, the electrons are assumed to move in the Z = 0 plane. In the uniform magnetic field, assume that P is the Newton momentum relation of the particle and R is

the radius of the circular orbit of the particle. The basic formula of accelerator theory can be obtained as follows:

$$R = \frac{m_0 \vec{v}}{\sqrt{1-(v/c)^2}} = \frac{p}{qB} \qquad (6)$$

It can be known from table 1 that the Ji Hao's experiments do not conform to the results of substituting Newton momentum into the mass- velocity relation of the relativity.

### 3.2 Mass-energy momentum conforms to Ji Hao's experiments

Ji hao's experiments [4] re-conducted the experimental research on the Newton momentum and velocity relation, and found that after changing the magnetic field intensity, the results of the experiment did not conform to the Newton momentum predicted by relativity and the results of substituting the Newton momentum into the mass-velocity relation of special relativity. If the mass-energy momentum is used, it can be well consistent with Ji Hao's experiments. When particles with a rest mass of $m_0$ , and a charge of $q$ , move at a velocity of $v$ in the electromagnetic field, the Lorentz Force Motion Equation satisfied by the mass-energy momentum can be obtained:

$$\frac{d}{dt}\frac{E}{\vec{v}} = q\left(\vec{E} + \vec{v} \times \vec{B}\right) \qquad (7)$$

Using cylindrical coordinates, the electrons are assumed to move in the Z = 0 plane. In the uniform magnetic field, assume that R is the radius of the circular orbit of the particle and P is the momentum of the particle's mass-energy momentum relation, then it can be obtained by substituting it into the commonly used formula in the accelerator theory that:

$$R = \frac{p}{qB} = \frac{E}{qBv} \qquad (8)$$

Ji hao's experiments on six kinds of energy electron beams showed that these six kinds of electrons all fell on the radius of about 18cm photographic film, indicating that the electrons with different energies almost all fell on the same circle. In other words, Ji Hao's experiments do not conform to the theoretical value of substituting the Newton momentum into special relativity. If equation (8) is used, the orbital radius of electron's circular motion is about 18cm, which perfectly explains Ji Hao's experiments.

### 3.3 Calorimetric measurement experiments prove that the relativistic momentum does not increase with the increase of velocity after the velocity reaches a certain degree

Ji Hao's calorimetric measurement experiments were carried out in the Accelerator Laboratory of Fudan University and Shanghai Institute of Applied Physics, Chinese Academy of Sciences, using the linear accelerator and five electron energies used in Bertozzi experiments. Ji Hao found that the experimental results were not consistent with the results of substituting Newton momentum into special relativity. For the electron beam with theoretical energy of 15MeV, the temperature measured by Ji Hao's experiment was an increment of 1.03 degrees Celsius. By

substituting Newton momentum into special relativity, the temperature increment should be 6.29 degrees Celsius, which is a five-fold difference (see table 2).

**Table 2. The relationship between the energy of the electron beam and the resulting temperature increment Δt**

| The labeled kinetic energy of the electron MeV | 1.6 | 6 | 8 | 10 | 12 | 15 |
|---|---|---|---|---|---|---|
| $\upsilon/c$( Relativistic prediction ) | 0.97 | 0.9969 | 0.9981 | 0.9988 | 0.9992 | 0.9994 |
| Δt( Relativistic prediction °C) | 0.67 | 2.52 | 3.36 | 4.20 | 5.03 | 6.29 |
| Δt( Value measured by Ji Hao °C) | 0.97 | 1.00 | 1.03 | 1.03 | 1.03 | 1.03 |

According to the calculations in Table 2, if the lead platform is regarded as an isolated metal ball, the temperature increment caused by the electric field is calculated to be 0.89 degrees Celsius. The measured results show that the electron beams with theoretical energy values of 1.6 MeV, 6 MeV, 8 MeV, 10 MeV and 15 MeV can generate temperatures of 0.08, 0.11, 0.14, 0.14, 0.14, 0.14 and 0.14 degrees on lead targets, respectively.

According to Newton's Mechanics formula, the energy is approximately 0.255MeV. The temperature rise of each beam on the lead target is about 0.12 degrees Celsius. Therefore, Ji Hao believes that the experimental results [5] are consistent with the results of Newtonian Mechanics.

When $v$ approaches $c$, it can be known that $p_N$ approaches $mc$ and mass-energy momentum $p_c = \frac{E}{v}$ also approaches $mc$. Then formula (4) also conforms to the measured value of Ji Hao.

### 3.4 Experiments on Electron Lorentz Force and Energy Measurement [6-7]

Ji Hao conducted his experiments [6] in the laboratory of Modern Physics of Fudan University. According to Ji Hao's experiments of Electron Lorentz Force and Energy Measurement, when the motion direction of β-particle is perpendicular to the direction of static uniform magnetic field, it moves in a circle under the action of Lorentz Force of static magnetic field. It can be obtained by substituting formula (6) into Einstein's mass-energy relation that:

$$\frac{mc^2 \cdot v^2}{C^2 R} = evB \tag{9}$$

It can be obtained through experiments [6] that it does not accord with the value of substituting Newton's momentum into relativity. At the same time, it does not conform to the existing

momentum-energy relation $E^2 - c^2 p^2 - m^2{}_0 c^4 = 0$ , which indicates that the momentum-energy relation combined with Newton's momentum and special relativity has applicability.

Ji hao's experiments [2] were carried out on the femtosecond microwave synchrotron of Shanghai Institute of Applied Physics. According to Ji Hao's experiments, the actual effective force of the accelerator on the accelerated electrons depends on the electron velocity. The larger the electron velocity $v$ is, the smaller the actual force of acceleration will be. This indicates that the Ji Hao's experiments [2] do not conform to the Newton Momentum, and also do not conform to the momentum-energy relation of the combination of Newton momentum and special relativity.

According to equation (4) $p = E / v$ , it can be known that the actual effective force of the accelerator on the accelerated electrons [2] depends on the velocity of the electrons. The larger the velocity of the electrons, the smaller the momentum of the energy added on the electrons, and the smaller the actual effective force of the accelerator.

At the same time, substituting equation (4) into Einstein's mass-energy relation can be well consistent with the experiment. The experiment also shows that in the same magnetic field, the greater the motion velocity of electrons, the smaller the Lorentz Force they are subjected to. The correctness of equation (4) is shown.

Ji Hao's three experiments do not conform to Newton momentum, nor do they conform to the results of substituting Newtonian momentum into special relativity. But they conform to mass-energy momentum $p = E / v$. It shows that Ji Hao's three experiments do not conform to the value of substituting Newtonian momentum into Einstein's special relativity, but they conform to the mass-velocity relation and mass-energy relation of special relativity.

**4. One-dimensional square potential well for quantum equation of mass-energy momentum**

The proof is as follows:

Set $E \to \frac{ih}{2\pi}\frac{\partial \psi}{\partial t}$, $P \to -\frac{ih}{2\pi}\frac{\partial \psi}{\partial x}$。

The CZP equation can be obtained from the mass-energy momentum, $E = pv$

Since $v = \lambda u$

$$\frac{ih}{2\pi}\frac{\partial \psi}{\partial t} = \left(-\frac{ihu\lambda}{2\pi}\frac{\partial \psi}{\partial x} + U\right)\psi 。$$

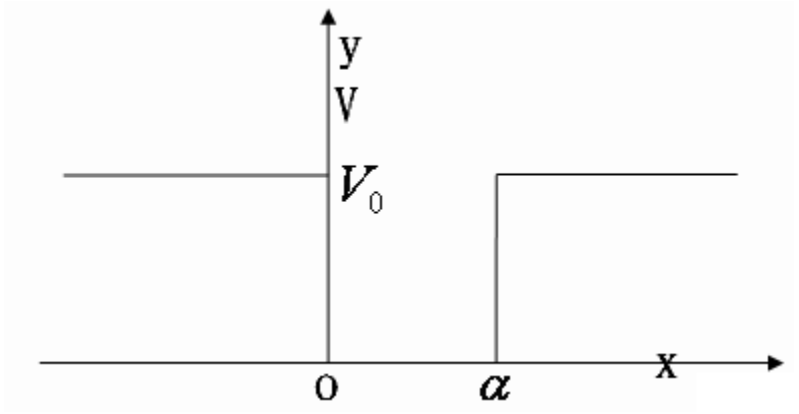
In order to simplify the calculation, the construction equation is $E = \frac{p^2 (u\lambda)^2}{E}$, then it can be obtained that

$$\frac{ih}{2\pi}\frac{\partial \psi}{\partial t} = \left(-\frac{h^2 (u\lambda)^2}{4E\pi^2}\frac{\partial^2 \psi}{\partial x^2} + U\right)\psi \qquad (10)$$

Considering a one-dimensional infinite potential well, the potential energy curve in the well can be expressed as follows:

(I) When $v(x)=0$, then $0<x<a$. (When $v(x)>0$, then $x<0, x>a$)

When only the energy of an infinite potential well is considered to be infinite, the potential energy curves inside and outside the well are shown as follows:




From (11), the quantum equations of steady state mass-energy and momentum inside and outside the well can be written as:

$$\frac{d^2\psi}{dx^2}+\frac{E^2}{(h/2\pi)^2(u\lambda)^2}=0 \qquad (0<x<a)$$

$$\frac{d^2\psi}{dx^2}+\frac{(E-V_0)^2}{(h/2\pi)^2(u\lambda)^2}=0 \qquad (x<0, x>a)$$

Where $E>0$ represents the energy of particles. At $E<V_0$, set

$$k=\frac{E}{(h/2\pi)u\lambda},\quad q=\frac{E-V_0}{(h/2\pi)u\lambda} \qquad (11)$$

From (11) the two formulas above can be written as: $\frac{d^2\psi}{dx^2}+k^2=0 \qquad (0<x<a)$

$$\frac{d^2\psi}{dx^2}+q^2=0 \qquad (x<0, x>a)$$

These are two second order linear differential equations with constant coefficients. Set $(k>0, q<0)$, then the solutions are:

$$\psi(x)=A_1e^{ikx}+A_2e^{-ikx} \qquad (0<x<a) \qquad (12)$$

$$\psi(x)=B_1e^{qx}+B_2e^{-qx} \qquad (x<0, x>a) \qquad (13)$$

In the formula, $A_1$, $A_2$, $B_1$, $B_2$ are specific constants。The first term on the right of equation (10) $B_1e^{qx}$ approaches $\infty$ when $x\to\infty$. The second term $B_2e^{-qx}$ approaches $\infty$ when $x\to-\infty$. In

order to guarantee the finiteness of the wave function, $B_1$ , $B_2$ must be zero when $x<0, x>a$. Therefore, (13) is written as: $\psi(x)=B_1e^{qx} \quad (x<0)$ (14)

$\psi(x)=B_2e^{-qx} \quad (x>a)$ (15)

It can be seen that the intensity of the wave functions in the region of $x<0$ and $x>a$ will not be zero. This indicates that when the energy of the particle is less than the potential energy difference between inside and outside the well, the probability of the particle appearing outside the well is not zero. Constants $A_1$, $A_2$, $B_1$, $B_2$ can be determined by the standard conditions of wave function.

When we just consider the simple case where the well depth is infinite $V_0 \to \infty$.

Then, since when $V_0 \to \infty$, $q \to \infty$. According to (14) and (15), $\psi = 0$ at $x<0, x>a$, which means that the probability of particle occurrence is zero. And since the wave function must be continuous at $x=0$ and $x=a$, that is $\psi(0)=\psi(a)=0$. Substitute into (12) and obtain： $A_1+A_2=0$ and $A_1e^{ika}+A_2e^{-ika}=0$.

It can be obtained through simultaneous equations that: $e^{ika}-e^{-ika}=2i\sin ka=0$

In order to make this formula valid, the constant $k$ can not take any value, but can only take some discontinuous values that satisfy the following formula: $ka=\pm n\pi \quad n=1,2,,3...$ (16)

By substituting (15) into (10), the possible values of particle energy in an infinite deep well can be obtained as follows:

$E=\pm\frac{nhu\lambda}{2a}$, then it can be obtained that $E=\pm\frac{nhu}{2a/\lambda}$ (17)

When $2a=\lambda$, then it can be obtained that $E=\pm nhu$ (18)

For equation(17), it is shown that the one-dimensional square potential well of quantum has three forms, positive, negative, or positive and negative solutions. And the single solution of equation (18) is an integer multiple of $n$. Then in the equation (18), $\frac{n}{2a/\lambda}$ and energy $nhu$ can satisfy the condition only if they have quantization at the same time, where the quantization condition is an integer multiple of $n$, indicating that the particle has de Broglie volatility in motion. (19)

Since equation (17) must satisfy equation (16), then the value of $a$ in formula (17) can only be $\frac{1}{2}\lambda$ or an even multiple of $\frac{1}{2}\lambda$.

For equation (17), it is known that angular momentum $L = R \times P$ satisfies commutation relation $\left[ L_i, L_j \right] = i\hbar \sum \varepsilon_{ijk} L_k$.

And it also satisfies the spin relation $\left[ S_i, S_j \right] = i\hbar \sum \varepsilon_{ijk} S_k$ and so on.

Then the wave-particle duality statement can be obtained: the momentum and angular momentum of each quantum can correspond to the momentum and angular momentum of a quantum with the same frequency respectively.

For equation (17), it can be extended to matter waves.

That is, the energy, momentum and angular momentum of each particle in a de Broglie matter wave can correspond to the energy, momentum and angular momentum of a particle with the same frequency. （20）

**5. Proof of mass-energy momentum by difference of anomalous magnetic momentum of electrons**

I. The mass-energy momentum equation in the electromagnetic field is:

$$i\hbar \frac{\partial}{\partial t} = H\psi$$

$$H = \left( -\frac{ihu\lambda}{2\pi} \frac{\partial \psi}{\partial x} + U \right) \psi \qquad (21)$$

The CZP equation of electrons (charge $-e$) in electromagnetic potential ($A, \varphi$) can be expressed as:

$$\left[ i\hbar \frac{\partial}{\partial t} + e\varphi - u\lambda a(p + \frac{e}{c} A) \right] \psi = 0 \qquad (22)$$

Under the non-relativistic limit, the formula can be obtained.

$$i\hbar \frac{\partial}{\partial t} \chi = ca.(P + \frac{e}{c} A)\varphi - e\phi\chi - 2mc^2 \chi \qquad (23)$$

Under the non-relativistic limit, it can be obtained from (21)

$$\chi \approx \frac{1}{2mc} \sigma. \left( P + \frac{e}{c} A \right) \varphi \qquad (24)$$

Substitute （24） into （22）, it can be obtained that

$$\mu_B = \mu = \frac{e\hbar}{2mu\lambda} \qquad (25)$$

Considering that the velocity of electron was accelerated to about $0.997C$ (about $10^{-3}$) in the experiment, the value of magnetic moment of electron obtained by formula (25) is closer to the measured value.

The solution of the Dirac equation is $\mu_B = \frac{e\hbar}{2mc}$, the calculated value $\mu = 1.00116\mu_B$ is slightly different from the measured value (about $10^{-3}$).

**6. Proof of Mass-energy Momentum by Strict Solution of Hydrogen Atom**

From $i\hbar\frac{\partial}{\partial t} = H\psi$

$H = \left(-\frac{ihu\lambda}{2\pi}\frac{\partial\psi}{\partial x} + \frac{e_1^2}{r}\right)\psi$ （In the formula, $e_1 = e/\sqrt{4\pi\varepsilon_0}$ , $\varepsilon_0$ is dielectric constant of vacuum）

（26）

The eigenvalue $E$ can be obtained from (26),

$$E = \frac{mc^3\varepsilon}{v} = \frac{mc^3}{v\sqrt{1+\frac{a^2}{\left(n-|k|+\sqrt{k^2-a^2}\right)^2}}} \qquad (27)$$

Formula (27) shows that the accurate energy value of hydrogen atom is related to the velocity, and it completely conforms to the experimental value. For Dirac equation, there are slight differences between $2s_{1/2}$ and $2p_{1/2}$, between $3s_{1/2}$ and $3p_{1/2}$, which are the values of hydrogen atom. These differences [7] happen to be the ratio to the Dirac equation $(v/c)$.

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