Chapter 15 Gravitational Expression of Faraday's Law

Although electrodynamics and the dynamics of gravity are very well alike, there is a point which is slightly different. Although it will find out about this difference in this chapter, a different interesting result from electrodynamics can be obtained in the dynamics of gravity by this slight difference. According to the result, about the dynamics of gravity, energy is not conserved, there is, and it affirms existence of a perpetual motion. Moreover, if this result is used, it will be able to reply to the question why the ring of the Saturn which is an unsolved problem from the time of Galileo is made.

The composition of this chapter will also describe electrodynamics in the first half, and I will carry out it to taking the method of applying to the dynamics of gravity in the second half.

15.1 Electrostatic Polarization

If an electric charge is brought close to the conductor which has not been charged, the deviation of the electric charge of positive/negative will arise in a conductor. This is called electrostatic polarization. As to why such a phenomenon happens, since the electric charge of the positive/negative of the same number inclines toward a conductor which has not been charged macroscopically, it exists in it that there is nothing and the electric charge of positive/negative negates an electric field mutually, respectively, are observed so that there may be no electric charge in a conductor as a whole, but. If an electric charge is brought close to this conductor from the exterior, deviation will arise in the electric charge of a conductor according to the newly added coulomb force.

It can also be said for current to have arisen in the conductor that deviation arises in an electric charge. If it stops moving the electric charge brought close, the current of a conductor will be lost and polarization will be maintained. The electric charge by which polarization was carried out builds an electric field. I will call this electric field the polarization electric field $\boldsymbol{E}'$. If the electric field currently added from the outside is set to $\boldsymbol{E}$, a superposition principle will be realized and the whole electric field $\boldsymbol{E}_a$ will be the sum of $\boldsymbol{E}$and$\boldsymbol{E}'$. namely

$$\boldsymbol{E}_a = \boldsymbol{E} + \boldsymbol{E}' \tag{15.1}$$

In the inside of a conductor, since there is no movement of an electric charge, it is $\boldsymbol{E} + \boldsymbol{E}' = 0$,

$$\boldsymbol{E} = -\boldsymbol{E}' \tag{15.2}$$

and an electric field and a polarization electric field have a the same size, and their direction is opposite. When $\boldsymbol{E}$ and $\boldsymbol{E}'$ negate the place inside a conductor mutually, a synthetic electric field becomes zero.

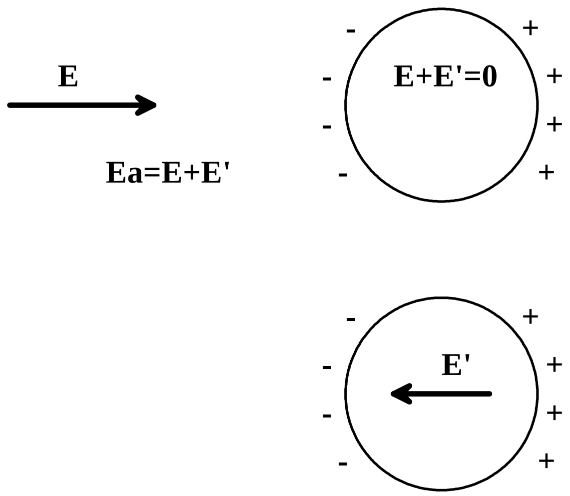

Fig. 15.1 Polarization

15.2 Magnetic Induction

If a substance is placed in a magnetic field, a magnetic pole will appear in the both ends of the substance. Such a phenomenon is called magnetic induction. At this time, it is thought that the magnetic field $\boldsymbol{B}$ added from the outside and the reverse magnetic field $\boldsymbol{B}'$ produce inside a substance, and the whole magnetic field $\boldsymbol{B}_a$ is given as the sum of these magnetic fields. namely

$$\boldsymbol{B}_a = \boldsymbol{B} + \boldsymbol{B}' \tag{15.3}$$

Since it is thought that a magnetic field produces by current, it is the inside of a substance placed in the magnetic field, and it can be considered that current arose inside the substance that the induction magnetic field $\boldsymbol{B}'$ produced. Since $\boldsymbol{B}'$ and $\boldsymbol{B}$ are reverse, $\boldsymbol{B}'$ works so that $\boldsymbol{B}$ may be weakened. setting inside a conductor, if a substance is not magnetized for the substance placed in the magnetic field with a conductor and $\boldsymbol{B}$ does not change, $\boldsymbol{B}_a = 0$, namely

$$\boldsymbol{B} = -\boldsymbol{B}' \qquad (15.4)$$

It must become. It is because the current which is not negated with the conductor will exist and the conductor will have electromotive force, if a conductor will be placed in a magnetic field since there will be current in the inside of a conductor supposing it is $\boldsymbol{B}_a \neq 0$.

Such a phenomenon bears a strong resemblance to the phenomenon of electrostatic polarization. It is because the electric field was in the inside of a substance that the magnetic field produced by current, and the induction magnetic field produced inside the substance placed in the magnetic field since current arose by the electric field. What produces an electric field could be considered to also produce the phenomenon of magnetic induction with the fundamental character of an electric charge since it is based on the fundamental character of the electric charge given with the law of coulomb.

15.3 Magnetic Flux

As electric flux was considered in the electric field, I will consider the quantity of the magnetic field which passes through arbitrary section. The quantity of the magnetic flux density which passes through arbitrary section is given by the surface integral, and can be written to be

$$\phi = \int_S \boldsymbol{B} \cdot d\boldsymbol{S} \qquad (15.5)$$

This ϕ is called magnetic flux.

Supposing this curved surface is a closed surface which included the source of magnetic field generating inside, it is

$$\int_S \boldsymbol{B} \cdot d\boldsymbol{S} = 0 \qquad (15.6)$$

S ;closed surface

and the quantity of the whole magnetic flux is zero. It is because a thing like the magnetic charge equivalent to an electric charge does not exist in a magnetic field but there is no source like an electric charge in it.

From the emission theorem of a gauss

$$\int_S \boldsymbol{B} \cdot d\boldsymbol{S} = \int_V \nabla \cdot \boldsymbol{B} dv$$

a formula (15.6) is

$$\int_V \nabla \cdot \boldsymbol{B} dv = 0$$

it can be written to be

$$\nabla \cdot \boldsymbol{B} = 0 \qquad (15.7)$$

This equation shows that there is no source point in a magnetic field.

15.4 Faraday's Law

There are the two circuits A,B placed close mutually, the ammeter is connected to circuit A and the switch with the battery is connected to circuit B. Here, if circuit B is switched on and current is sent, it can observe that the ammeter of circuit A sways, but the deflection of an ammeter is momentary and the deflection of an ammeter stops immediately. Next, if the switch of circuit B is turned off, the ammeter of circuit A will sway momentarily, but the deflection of the time of turning on a switch and an ammeter is opposite. Thus, since current flowed in the circuit A near it when sending or cutting the current of the circuit B, it is possible in the circuit A that there was momentary electromotive force. If the size of this electromotive force is proportional to the size of the electromotive force of the battery of the circuit B and big current is sent through the circuit B, it can observe that the ammeter of the circuit A sways more greatly.

Moreover, even when keep the switch of the circuit B put in, and it brings close to the circuit A or it detaches, it can observe that the ammeter of the circuit A sways. The same thing can be observed even if it uses a permanent magnet instead of the circuit B.

From such an experiment, it is possible "When the magnetic flux which intersects a certain circuit changes in time, the electromotive force proportional to change of magnetic flux arises in the circuit." Faraday discovered such a phenomenon and this phenomenon is called Faraday's law or the law of electromagnetic induction.

Moreover, it can also say "the electromotive force which arises by electromagnetic induction occurs in direction which produces the current which bars a flux change." Such a method of a phrase is called Lenz's law.

If such a phenomenon is denoted by expression, it can write as follows.

$$e = -\frac{d\phi}{dt} \tag{15.8}$$

e ;Electromotive force which arises in a circuitϕ ; Magnetic flux

A negative mark is expression with the expression of Lenz's law.

This formula can be rewritten with

$$e = -\frac{d}{dt}\int_S \boldsymbol{B} \cdot d\boldsymbol{S} \tag{15.9}$$

from a formula (15.5). The circumference curvilinear integral of the tangent can write that the sum total of the electric field $\boldsymbol{E}$ in alignment with the closed circuit c is as follows.

$$\oint_c \boldsymbol{E} \cdot d\boldsymbol{s}$$

Since the electromotive force e can be considered to have produced with this electromotive force, it can be written to be

$$e = \oint_c \boldsymbol{E} \cdot d\boldsymbol{s} \tag{15.10}$$

From a formula (15.9) and a formula (15.10), it becomes below.

$$\oint_c \boldsymbol{E} \cdot d\boldsymbol{s} = -\frac{d}{dt}\int_S \boldsymbol{B} \cdot d\boldsymbol{S} \tag{15.11}$$

This equation is expression by the integration form of Faraday's law.

If $\frac{d}{dt}$ is rewritten to $\frac{\partial}{\partial t}$ using Stokes's theorem

$$\oint_c \boldsymbol{E} \cdot d\boldsymbol{s} = \int_S \nabla \times \boldsymbol{E} \cdot d\boldsymbol{S}$$

it can be written as

$$\int_S \nabla \times \boldsymbol{E} \cdot d\boldsymbol{S} = -\int_S \frac{\partial \boldsymbol{B}}{\partial t} \cdot d\boldsymbol{S}$$

If it transposes, it will be set to

$$\int_S (\nabla \times \boldsymbol{E} + \frac{\partial \boldsymbol{B}}{\partial t}) \cdot d\boldsymbol{S} = 0$$

and will be

$$\nabla \times \boldsymbol{E} = -\frac{\partial \boldsymbol{B}}{\partial t} \tag{15.12}$$

This equation is expression by the differential form of faraday's law.

When the magnetic flux density $\boldsymbol{B}$ does not change in time in this equation, it is set to

$$\nabla \times \boldsymbol{E} = 0 \tag{15.13}$$

and electromotive force will not arise, but there is not no current which flows through a circuit at this time necessarily. It is the same as the state of the magnetic induction described by 15.2, the induction magnetic field has produced in the circuit, this induction magnetic field and the magnetic field $\boldsymbol{B}$ added from the outside negate this state mutually, and the magnetic field in a circuit of it is lost. In a stationary state, the magnetic field currently added from the outside in the circuit is $\boldsymbol{B}$, and if the magnetic field inducted is written to be $\boldsymbol{B}'$, since the sum is zero, it will be

$$\boldsymbol{B}' = -\boldsymbol{B}$$

and will be considered with electromotive force stopping arising.

That is, it is thought that a formula (15.13) can be formally written to be

$$\nabla \times \boldsymbol{E} = -\boldsymbol{B} - \boldsymbol{B}'$$

A formula (15.12) can be written to be the following if this clause is used.

$$\nabla \times \boldsymbol{E} = -\frac{\partial \boldsymbol{B}}{\partial t} = -\boldsymbol{B} - \boldsymbol{B}' - \frac{\partial \boldsymbol{B}}{\partial t} \qquad (15.14)$$

15.5 Vector Potential

(1) The definition of vector potential

In the magnetic field, the relation

$$\nabla \cdot \boldsymbol{B} = 0$$

is always realized. According to a mathematical theorem and the formula (11.60), $\boldsymbol{B}$ is rot of other vectors at this time. If this vector is written to be $\boldsymbol{A}$, it can write as follows.

$$\boldsymbol{B} = \nabla \times \boldsymbol{A} \tag{15.15}$$

This vector $\boldsymbol{A}$ is called vector potential. If div is given and checked both the neighborhoods of this formula, since it is set to

$$\nabla \cdot \boldsymbol{B} = \nabla \cdot (\nabla \times \boldsymbol{A}) = 0$$

it is possible to express a formula (15.7) in the form of a formula (15.15).

Generally this vector $\boldsymbol{A}$ is not decided as one. For example, when $\nabla\varphi$ which conservative vector makes $\boldsymbol{C}$ a constant vector and places $\boldsymbol{A}$ as follows,

$$\boldsymbol{A} = \boldsymbol{A}_0 + \nabla\varphi + \boldsymbol{C}$$

If this is substituted for a formula (15.15), since it will be set to

$$\begin{aligned}\boldsymbol{B} &= \nabla \times (\boldsymbol{A}_0 + \nabla\varphi + \boldsymbol{C}) = \nabla \times \boldsymbol{A}_0 + \nabla \times \nabla\varphi + \nabla \times \boldsymbol{C} \\ &= \nabla \times \boldsymbol{A}_0\end{aligned}$$

$\boldsymbol{A}_0$is also vector potential. Thus, there will be a value which vector potential can take innumerably. Since it will be said that there is a result innumerably even if it calculates something using vector potential if there is a value which can be taken innumerably, the result is almost meaningless. Then, conditions will be given to a value which vector potential can take. This is a problem of selection or a definition and can give suitable conditions. Generally the following conditions are given to vector potential.

$$\nabla \cdot \boldsymbol{A} = 0 \tag{15.16}$$

Ampere's law,

$$\nabla \times \boldsymbol{B} = \frac{\boldsymbol{j}}{c^2 \varepsilon_0}$$

If $\boldsymbol{B} = \nabla \times \boldsymbol{A}$ is substituted for $\nabla \times \boldsymbol{B}$ in the left side of this formula,

$$\nabla \times \boldsymbol{B} = \nabla \times \nabla \times \boldsymbol{A} = \nabla(\nabla \cdot \boldsymbol{A}) - \nabla^2 \boldsymbol{A}$$

Conditional expression (15.16),

$$\nabla \times \nabla \times \boldsymbol{A} = -\nabla^2 \boldsymbol{A}$$

Ampere's law can be written to be

$$\nabla^2 \boldsymbol{A} = -\frac{\boldsymbol{j}}{c^2 \varepsilon_0} \tag{15.17}$$

If this formula is divided into each ingredient and written,

$$\nabla^2 A_x = -\frac{j_x}{c^2 \varepsilon_0}$$

$$\nabla^2 A_y = -\frac{j_y}{c^2 \varepsilon_0}$$
$$\nabla^2 A_z = -\frac{j_z}{c^2 \varepsilon_0}$$

These equations are of the same shape as the equation

$$\nabla^2 \varphi = -\frac{\rho}{\varepsilon_0}$$

of poisson, and it can solve them.

(2) The physical meaning of vector potential

Although it is called this vector potential that what gave rot to a vector called vector potential becomes a magnetic field also with the concept of a magnetic field although a physical meaning is quite unclear, what is a physical meaning?

When calculated by having placed with

$$\boldsymbol{X} = \boldsymbol{v} \times \boldsymbol{E}$$
$$\boldsymbol{X} = c^2 \boldsymbol{B}$$

by mathematical derivation of the magnetic field of 14.5, it was shown that Ampere's law can be drawn. From these two equations, it can be written as

$$c^2 \boldsymbol{B} = \boldsymbol{v} \times \boldsymbol{E} \tag{15.18}$$

The electric field $\boldsymbol{E}$ is set with

$$\boldsymbol{E} = -\nabla\varphi$$

and it substitutes for a formula (15.18), and it will be set to

$$c^2\boldsymbol{B} = \nabla\varphi \times \boldsymbol{v}$$

if cautious of it being subtracted if an order of a vector product is changed. It will become below if rot is given both neighborhoods.

$$c^2\nabla \times \boldsymbol{B} = \nabla \times (\nabla\varphi \times \boldsymbol{v}) \tag{15.19}$$

Here according to the formula (11.55) of a vector operation,

$$\nabla \times (\varphi\boldsymbol{v}) = \nabla\varphi \times \boldsymbol{v} + \varphi(\nabla \times \boldsymbol{v})$$

The vector $\boldsymbol{v}$ will be $\nabla \times \boldsymbol{v} = 0$ from a formula (11.52), if it is considered as a fixed speed. Therefore, it can be written as

$$\nabla \times (\varphi\boldsymbol{v}) = \nabla\varphi \times \boldsymbol{v}$$

If rot is given both the neighborhoods of this formula,

$$\nabla \times \nabla \times (\varphi\boldsymbol{v}) = \nabla \times (\nabla\varphi \times \boldsymbol{v})$$

If this formula is substituted for a formula (15.19),

$$c^2\nabla \times \boldsymbol{B} = \nabla \times \nabla \times (\varphi\boldsymbol{v})$$

If the relation of $\boldsymbol{B} = \nabla \times \boldsymbol{A}$ is substituted,

$$\nabla \times \nabla \times \boldsymbol{A} = \nabla \times \nabla \times (\frac{\varphi \boldsymbol{v}}{c^2})$$

That is, vector potential can be written to be

$$\boldsymbol{A} = \frac{\varphi \boldsymbol{v}}{c^2} + \nabla \psi + \boldsymbol{C} \tag{15.20}$$

ψ is arbitrary scalar functions $\boldsymbol{C}$ is a constant vector

If it places with $\psi = 0, \boldsymbol{C} = 0$,

$$\boldsymbol{A} = \frac{\varphi \boldsymbol{v}}{c^2} \tag{15.21}$$

will be one vector potential. When it writes in this way, it turns out that vector potential is a thing proportional to the product of potential and its movement. That is, if a conservative place like an electric field moves, potential movement (vector potential) will arise in surrounding space.

15.6 Another Expression of Stationary Form Faraday's Law

I will rewrite Ampere's law and will consider another expression of the stationary which does not change in time form of Faraday's law.

Ampere's law is written to be

$$\nabla \times \boldsymbol{B} = \frac{\boldsymbol{j}}{\varepsilon_0 c^2}$$

If rot is given,

$$\nabla \times \nabla \times \boldsymbol{B} = \frac{1}{\varepsilon_0 c^2} \nabla \times \boldsymbol{j} \tag{15.22}$$

Here, the formula of a vector operation

$$\nabla \times \nabla \times \boldsymbol{B} = \nabla(\nabla \cdot \boldsymbol{B}) - \nabla^2 \boldsymbol{B}$$

is used, since it is $\nabla \cdot \boldsymbol{B} = 0$, a formula (15.22) becomes the following.

$$-\nabla^2 \boldsymbol{B} = \frac{1}{\varepsilon_0 c^2} \nabla \times \boldsymbol{j}$$

Although it cannot say that the law of Ohm

$$\boldsymbol{j} = \delta \boldsymbol{E}$$

is generally realized with an approximate experiment law, it may be able to be considered that it is realized. In such a case, it is possible that this relation can be substituted and can write as follows.

$$\nabla \times \boldsymbol{E} = -\frac{\varepsilon_0 c^2}{\delta} \nabla^2 \boldsymbol{B} \tag{15.23}$$

This equation is an equation in the inside of the vacuum of the magnetic field by current. If $\boldsymbol{B} = \nabla \times \boldsymbol{A}$(vector potential) is substituted for this equation and $\boldsymbol{j} = \delta \boldsymbol{E}$ is substituted for it, the following of the equation known well can be obtained.

$$\nabla^2 \boldsymbol{A} = -\frac{\boldsymbol{j}}{\varepsilon_0 c^2} \qquad \text{re-(15.17)}$$

Therefore, a formula (15.23) is another expression of a formula (15.17), and it turns out that the magnetic field by stationary current has the electromotive force denoted by a formula (15.23) in a vacuum.

If a conductor is put on the surroundings of this stationary magnetic field $\boldsymbol{B}$, the place inside that conductor will serve as stationary form of Faraday's law, and will be written to be the following.

$$\nabla \times \boldsymbol{E}_a = 0 \qquad (15.24)$$

Although there was a magnetic field denoted by a formula (15.23) in a vacuum, in a conductor, it turns out that the magnetic field is lost. As 15.2 and 15.4 described as to why a magnetic field is lost, this synthetic electric field $\boldsymbol{E}_a$ is composition with the polarization electric field vector which arose by the electric field $\boldsymbol{E}$ and the magnetic field, and if it thinks that it is denied by the effect of being contrary, it can be explained. If this polarization electric field vector will be written to be $\boldsymbol{E}'$, it is $\boldsymbol{E}_a = \boldsymbol{E} + \boldsymbol{E}'$ and a formula (15.24) can be written to be

$$\nabla \times (\boldsymbol{E} + \boldsymbol{E}') = 0 \qquad (15.25)$$

From a formula (15.23) and a formula (15.25), the polarization vector by a magnetic field is expressed as follows.

$$\nabla \times \boldsymbol{E}' = -\frac{\varepsilon_0 c^2}{\delta}\nabla^2 \boldsymbol{B}' = \frac{\varepsilon_0 c^2}{\delta}\nabla^2 \boldsymbol{B} \tag{15.26}$$

The magnetic field which appeared here and $\boldsymbol{B}'$ Becoming is a induction magnetic field generated according to the polarizing current by a magnetic field.

Therefore, it is possible that another expression of the stationary form of the law of approximate Faraday who can consider that the law of Ohm is realized is an equation group denoted by the equation (15.23), the equation (15.25), and an equation (15.26).

15.7 Fundamental Difference between Electricity and Gravity

Although electrodynamics has been described until now, from now on, I will describe the dynamics of gravity based on the knowledge of this electrodynamics.

Although there was a phenomenon like electrostatic polarization in electrodynamics, it is dependent on distinction of the positive/negative of an electric charge and the direction of power which are denoted by the law of the Coulomb clearly as to why such a phenomenon happens. That is, there is the following feature in an electric charge.

- Repulsive force commits an electric charge to the electric charge of a same sign.
- Attractive force commits an electric charge to the electric charge of an opposite sign.

It is thought that the phenomenon of polarization happens according to this effect of being contrary.

How is it in the case of gravity? The fundamental feature of gravity,

- Attractive force commits the object with mass on an object with the mass of the same sign.

An effect like an electric charge of being contrary does not exist in gravity. That is, while there are two kinds of roles in an electric charge, there is only one kind of role in an object with mass. This can be considered that the effect of polarization does not exist in the dynamics of gravity. Such an effect is not actually observed.

Moreover, it is fundamentally possible that the phenomenon of magnetic induction is another side of a phenomenon like electrostatic polarization. Therefore, it is possible that the phenomenon of magnetic induction does not exist in the dynamics of gravity, either.

15.8 Rewriting of Ampere's Law in Gravitational Field

Ampere's law in a gravitational field can be rewritten by the same method as having rewritten Ampere's law by 15.6. Ampere's law in a gravitational field was written to be the following.

$$\nabla \times \boldsymbol{B}_g = \frac{\boldsymbol{j}_g}{G_0 c^2}$$

If it calculates like 15.6, it can write as follows.

$$-\nabla^2 \boldsymbol{B}_g = \frac{1}{G_0 c^2} \nabla \times \boldsymbol{j}_g \tag{15.27}$$

Also in a gravitational field, it may be able to write in form like the law of Ohm. For example, if the speed of the object which moves in the inside of the air is small enough, it is known experientially that it can be considered that resistance of air is proportional to speed. If the proportionality factor of resistance is set to k and speed is set to $\boldsymbol{v}$. the resistance $\boldsymbol{F}$ can be written to be

$$\boldsymbol{F} = km\boldsymbol{v}$$

If resistance force is set to $\boldsymbol{F} = m\boldsymbol{E}_g$, flow of mass is set to $\boldsymbol{j}_g = m\boldsymbol{v}$, it will become below.

$$m\boldsymbol{E}_g = k\boldsymbol{j}_g$$

If it places with $\delta_g = \frac{m}{k}$, it can be written as

$$\boldsymbol{j}_g = \delta_g \boldsymbol{E}_g$$

and can write in the same form as the law of Ohm.

Since the positive direction of the gravitational field $\boldsymbol{E}_g$ is turned to the point at infinity from the source of the gravitational field and the movement direction of the object by the spot is reverse, the gravitational field $\boldsymbol{E}_g$ and the direction of flow of mass $\boldsymbol{j}_g$ are opposite to the case of electricity. If it is cautious of this and a sign is defined, the law of Ohm in a gravitational field can be written to be the following.

$$\boldsymbol{j}_g = -\delta_g \boldsymbol{E}_g \tag{15.28}$$

When such a relation is realized approximately, it can substitute for a formula (15.27) formally, and it can be written as the following.

$$\nabla \times \boldsymbol{E}_g = \frac{G_0 c^2}{\delta_g} \nabla^2 \boldsymbol{B}_g \tag{15.29}$$

In the dynamics of gravity, since it is possible that a phenomenon like electrostatic polarization or magnetic induction does not exist like electrodynamics, when considering stationary form of Faraday's law in a gravitational field, it is thought that rot of $\boldsymbol{E}_g$ is not zero.

15.9 Faraday's Law in Gravitational Field

We wrote Faraday's law to be the following formally.

$$\nabla \times \boldsymbol{E} = -\boldsymbol{B} - \boldsymbol{B}' - \frac{\partial \boldsymbol{B}}{\partial t} \qquad \text{re-(15.14)}$$

It is because I thought that I would try analogical application in the dynamics of gravity as to why it wrote in this way. The fundamental difference between electricity and gravity is the point of having stated by 15.7, and if it says conversely, it will be thought that there is no difference in the mathematical formulization of those other than this point.
If it rewrites using $\boldsymbol{B} = \nabla \times \boldsymbol{A}$,

$$\nabla\times\boldsymbol{E}=-\nabla\times\boldsymbol{A}-\nabla\times\boldsymbol{A}'-\tfrac{\partial}{\partial t}\nabla\times\boldsymbol{A} \tag{15.30}$$

because it comes out,

$$\boldsymbol{E}=-\nabla\varphi-\boldsymbol{A}-\boldsymbol{A}'-\tfrac{\partial\boldsymbol{A}}{\partial t} \tag{15.31}$$

is the one solution to a formula (15.30). If this equation is rewritten in the form in a gravitational field, since a phenomenon like magnetic induction does not exist in the case of gravity, the thing equivalent to $\boldsymbol{A}'$ will be zero. Since it pays well to a same sign by gravity while an electric charge repels the relation of the direction of a magnetic field and an electric field to a same sign, the direction is opposite.
Therefore, the sign of $-\boldsymbol{A}$ and $-\frac{\partial\boldsymbol{A}}{\partial t}$ becomes opposite, it could be written as

$$\boldsymbol{E}_g=-\nabla\varphi_g+\boldsymbol{A}_g+\tfrac{\partial\boldsymbol{A}_g}{\partial t} \tag{15.32}$$

Like electrodynamics, also in the dynamics of gravity, the relation of

$$\nabla\cdot\boldsymbol{B}_g=0 \tag{15.33}$$

is realized clearly, and vector potential can be defined like electrodynamics,

$$\boldsymbol{A}_g=\tfrac{\varphi_g\boldsymbol{v}}{c^2} \tag{15.34}$$

is one vector potential in a gravitational field. If this is substituted for a formula (15.32), it can be written as the following.

$$\boldsymbol{E}_g = -\nabla\varphi_g + \frac{\varphi_g \boldsymbol{v}}{c^2} + \frac{\partial\varphi_g \boldsymbol{v}}{c^2 \partial t} \tag{15.35}$$

If rot is given to a formula (15.32), it can be written as the following.

$$\nabla \times \boldsymbol{E}_g = \boldsymbol{B}_g + \frac{\partial \boldsymbol{B}_g}{\partial t} \tag{15.36}$$

This formula is considered to be Faraday's law in a gravitational field. The stationary form of this equation becomes the following.

$$\nabla \times \boldsymbol{E}_g = \boldsymbol{B}_g \tag{15.37}$$

Although Faraday's law was obtained by experiment, as 15.8 described, when Ampere's law in a gravitational field was rewritten, it was expected that the stationary form of Faraday's law in a gravitational field is not zero. That is, it can be said that the stationary form of Faraday's law in a gravitational field is not zero theoretically. It is thought that this equation is a thing corresponding to that.

15.10 Force Received by Moving Gravitational Field

Supposing the object with mass is moving at the fixed speed $\boldsymbol{v}$, the object will build the moving gravitational field, and supposing the gravitational field is $\boldsymbol{E}_g$, it can be written as the following from a formula (15.35).

$$\boldsymbol{E}_g = -\nabla\varphi_g + \frac{\varphi_g \boldsymbol{v}}{c^2} \tag{15.38}$$

Since it is the force which multiplied $\boldsymbol{E}_g$ by mass, if the object of the mass of m is in $\boldsymbol{E}_g$, the force in which it is added to the object can be written to be the following.

$$\boldsymbol{F} = m\boldsymbol{E}_g = m(-\nabla\varphi_g + \frac{\varphi_g \boldsymbol{v}}{c^2}) = -m\nabla\varphi_g + m\frac{\varphi_g \boldsymbol{v}}{c^2} \tag{15.39}$$

It will be shown that the 2nd clause of the right-hand side has a potential flow in the surroundings of it, and power will be applied to an object by this flow. For example, a planet which is rotating will build the potential flow of a rotation state around. Suppose throws an object like a sufficiently light meteorite compared with a planet at the initial velocity $\boldsymbol{v}_0$ to the center of this planet from a distant place to the extent that the gravity of the planet can disregard almost. It is for not giving the initial quantity of motion under the influence of planetary to a meteorite to drop a meteorite from the point at infinity. What kind of orbit does a meteorite take and fall to a planet at this time?

If the planet is not rotating, a meteorite falls towards the planetary center straight. It is because the 2nd clause of the right-hand side of a formula (15.39) becomes zero at this time. If a clause like the 2nd clause of the right-hand side of a formula (15.39) does not exist, even when the planet is rotating, a meteorite will fall straight towards the planetary center and a surrounding gravitational field will not change regardless of rotation of a planet. If a clause like the 2nd clause of the right-hand side of a formula (15.39) does not exist, it will be said that neither a gravitational magnetic field nor gravitational magnetism also exists, but. It is already confirmed by the experiment that such a concept exists, and if the gravitational field which is not rotated is the same as the gravitational field to rotate, you have to conclude that a movement state does not necessarily change with the rotating gyroscope and the gyroscope not rotating.

Such a thing is clearly wrong, a clause like the 2nd clause of the right-hand side of a formula (15.39) exists, and it is thought that a meteorite is dragged in the planetary hand of cut, takes a spiral orbit and falls.

On an object by which the speed of the 2nd clause of the right-hand side of a formula (15.39) is moving together with the source of a gravitational field, the relative velocity is zero, and since power is not added, when observing by the coordinate system etc. which were fixed on the earth, such a clause will be lost.

Moreover, if the 2nd clause of the right-hand side of a formula (15.39) is used, it will be able to be explained why a ring is made to Saturn. Although it is a huge star which the diameter of Saturn has those of the earth with about 10 times, and has mass also about 100 times, revolving speed is about 2 times as quick as the earth, and one day of Saturn is half-a-day grade of the earth. Such a huge star is building the huge gravitational field, and the effect of the 2nd clause of the right-hand side will show up more notably, since revolving speed is quick. If the effect of the 2nd clause of the right-hand side is compared near the planetary surface, it is clear that its near the axis of rotation becomes the minimum at the maximum in near the equator. For example, it is because those who are present in the North Pole will not almost move although it means that those who are present in the equator had moved in one day by the perimeter of the earth if it is regarded as that in which the earth does not revolve around the sun. Therefore, the object in which near the equator is the maximum as for the surrounding place of a revolving planet and which has the pole in the surroundings of a planet by becoming the minimum very much will be brought together in the surroundings of the equator.

15.11 Energy of Moving Gravitational Field

The 2nd clause of the right-hand side of the formula (15.39) also shows that the energy of the moving gravitational field is not conserved. When an object is accelerated, the object's continuing moving forever, unless power's is applied from the exterior is being able to say from the law of inertia, but the object which moves is also a source of the moving gravitational field. The 2nd clause is not conservative force although the power by the gravitational field moved at a fixed speed is denoted by a formula (15.39), and the 1st clause of the right-hand side of this formula is what is called conservative force. For example, if an object is rotated, that object will continue rotating forever, unless power is applied from the exterior, but the surroundings of that object serve as a rotation gravitational field, and if another object is put on the surroundings of that object, this another object will receive the power about the hand of cut of the 2nd clause. It does not become zero even if it carries out circumference integration of such torque. Therefore, the power is not conservative force.

Moreover, the object of the source of a rotation gravitational field cannot think that the rotational energy is lost by having applied power to the surrounding object. For example, if the water wheel which is on the water surface when it thinks to the analogy of a stream is rotated, surrounding water will begin to move in response to the rotational energy of a water wheel. If another object is brought to the field of this stream, that object will begin to move in response to the power by a stream. Although it means that the object had been accelerated by the energy of the field of a stream at this time, it is not concerned with whether the energy of the field of this stream is used, and the energy made to require for rotating a water wheel does not change. In the case of a gravitational field, energy is unnecessary for continuing rotating an object. The revolving gravitational field can give energy to a surrounding object like the field of this stream. Therefore, this energy is not conserved, but if this power is used, it can take out infinite energy.

It is shown that the law of conservation of energy is not realized about the moving gravitational field. A law of the conservation of energy to which the special status was given in some conservation laws which exist in the world of physics is a thing of the contents of including all the conservation laws about energy. Although it seems that a law of conservation of energy is considered that a physicist is a very important physical law, this law was not described by something to the specific phenomenon, and everyone is just going to admit being philosophical rather. That is, it was not obtained, either, when the existing knowledge was constituted theoretically, if this law was not obtained by the experiment fact. There are not those who can actually prove that this law is right. It is because it is the law of being realized even if it includes the strange thing for which a physicist does not know this law yet.

Can it be said that this law is a law of physics? This law does not have a physical basis which can be claimed at least that the thing according to this law is not true physics. In order to try to build the law of physics rather so that the law of this fancy may be followed, the evil from which the physics which should reflect the real world is the physics in the fancy world is seen in the knowledge of physics.

15.12 Gravity Use Type Permanent Energy Device

As Chapter 14 described, this whole gyroscope can be propelled by rotating a gyroscope in external gravitational fields, such as the earth (Fig. 14.7). This will have taken out the energy of the conservative force place. Chapter 12 described that a conservative force place is locally convertible at a dissipative forces place using a windmill like a propeller for taking out energy from the conservative force place of a wind. The gyroscope is carrying out a role like this windmill, by rotating a gyroscope, a rotation gravitational field and an earth's gravity field with this gyroscope are piled up, and a local dissipative forces place is built. The revolving speed of a gyroscope will not fall, if mechanical resistance is disregarded. Probably, energy from the outside is not needed for the impelling force by this propulsive engine. It is because there is no effect of lowering the revolving speed of a gyroscope. Therefore, energy will be able to be taken out if this impelling force is used. It is confirmed by the experiment that this equipment already promotes and whether energy can be taken out or it cannot take out have started the mental element called whether which for people to be free for the prejudice of the law of conservation of energy, and to be able to be in it.

Moreover, the propulsive engine with the cone type gyroscope considered in Chapter 14 could demonstrate impelling force, without using energy.

The law of conservation of energy says that it is proved that the object does not promote in the fixed direction, even if it moves internal weight. However, since such actually equipment promotes, it is shown that the law of conservation of energy is not realized in this experiment.

15.13 Interaction in Relative Motion

A linear object long to the infinity of equal mass distribution is put on 2 parallel, and each will be called A and B. Introduction A and B are standing it still in the inertial coordinate system S, and presuppose that only A is moved along the line of a line object at the fixed speed v. According to the conclusion obtained in the main subject, B will be dragged in the movement direction of A and will begin to move.

It motion in this way, then it was said that the law of conservation of energy is not realized again and again. Here, I will consider whether what happens in relative motion.

When it observes from the coordinate system S_A which moves together with A, B will look at and observe moving to the counter direction at the rate of v from this coordinate system. According to a physicist's general view, since how to choose coordinates is arbitrary, it is undistinguishable whether B is moving whether A is moving. Being made to a problem is only both relative velocity. If it thinks in this way and the conclusion of this book will be followed, A is dragged by movement of B and must begin to move. It means this and that the speed of A seen from S falls. After all, it will see from the speed of A and B, and S, both will be v/2, and energy should be conserved. Therefore, it may be claimed that a conclusion which was described in this book is not right. We can prove that such an idea is mistaken. It is because it can say that it is A that will move if inertia speed (speed using the accelerometer inside an object) is used, and it is not B. Probably nobody have doubt in this, since this was already explained in detail, but in order to explain plainly, I will describe the analogical fact about fluid.

It is made the thing with the fin which can start or receive a wind for which a linear long stick is infinitely put on 2 parallel like the thought experiment of a line object, and each is called A and B. Introduction A and B assume that it is stood still in the approximate inertial coordinate system S which accepted existence of air. Suppose that only A is moved along the line of a linear stick at the fixed inertia speed v by next continuing supplying energy from the exterior. At this time, B will receive the wind by A, will be dragged in the movement direction of A, and will begin to move. When it observes from the coordinate system S_A which moves together with A, B will look at and observe moving to the counter direction at the rate of v from this coordinate system. However, A does not receive the wind from B. Therefore, the speed of A does not change in response to the influence by B. Affecting the speed of A is based on resistance of the air which is not related to the existence of B.

In order to make breeze, resistance of air is required, and wind force will become small if resistance of air is reduced. At that point, resistance of wind force and air is proportional and energy is saved by this. It is the law of inertia that resistance does not exist although the flow of the gravitational field compared to the wind of gravity is maintained on the other hand. And if they say that a surrounding object receives force by the flow of this gravitational field, energy will not be conserved about gravity.

15.14 It is that Energy is Conserved

Energy is required to continue applying power to a stationary object as 8.8 described. For example, according to the place of a wind in this power, since the kinetic energy of air falls, the energy of the place of the wind as the whole decreases at the place of a wind. The particles of air collide with the object in which this is standing it still, the kinetic energy of the particles of this air is added to a stationary object, and the particles of air lose kinetic energy according to reaction.

It is a reactionary effect to make energy conserve. For example, it is assumed that there is no reaction in the experiment which makes two balls collide. If the ball B which is moving to the stationary ball A collides, B will exert power on A and will give the quantity of motion of B. Although B receives this power and the power of a counter direction and quantity of motion is lost according to reaction in real world, when it assumes that there is no reaction, B will have the same quantity of motion as collision before. Here, since it means that the quantity of motion of B was applied to A, the whole quantity of motion becomes twice the quantity of motion of B, and from collision before, energy is after a collision and increases by the quantity of motion of B. Energy is not conserved at this time.

There is a method of judging whether reaction was exerted on the effect accelerated by the object accelerated. When inertia acceleration (acceleration by an accelerometer) works on the object accelerated, reaction is done, and when inertia acceleration does not work, it is possible that reaction is not done. Power could not be exerted on the object of the direction which pushed the object without reaction by an object being pushed. Since a quantity called this reaction is inertia acceleration, when an object has inertia acceleration, it is possible that reaction is there.

Although the inertia acceleration of the object usually pushed when the object was pushed certainly changes, when accelerated by gravity, inertia acceleration does not change. This shows that there is no reactionary effect, when accelerating an object with gravity. Although the energy added by the reactionary effect decreases, since there is no effect of this reaction in the case of gravity, it is possible that it is not decreased even if the effect of gravity applies power to an object. It is actually thought that it is not decreased even if the effect of gravity exerts power on an intermediate object. If it decreases, earth gravity will hardly be transmitted to the surface.

A gravitational field is a power place fundamentally, and since power can be transmitted, the gravitational field can transmit energy. Since the object in a gravitational field is accelerated, energy is added to the object. In order to conserve energy, only the part of energy of the place of a wind which accelerated the object like the place of a wind must decrease. However, even if a gravitational field accelerates an object, energy on that field does not decline. This shows that energy is not conserved about gravity. A gravitational field is a source of supply of infinite energy.