Chapter 14 Concept of Magnetic Field

Magnetism was known from the very old time, and around the B.C. 5th century, when the stone mined near Magnes of Turkey was hung, turning to a fixed direction was known. Moreover, it is said to have been discovered at that time that amber is charged by friction. The time independently studied as phenomenon in which electricity and magnetism are another continued for a long time, according to the general theory by the beginning of the 19th century, electricity and magnetism were completely different and it was out of the question to consider the relation. Physicist Oersted of Denmark discovered the deflection of the magnetic needle by current for the first time in the exhibition experiment before the public in the winter of 1819-1820. Although it is considered that this discovery is an accidental thing, it is known well that this result became the beginning of next electricity-and-magnetism research. Thus, although it became possible to associate electricity and magnetism by experiment, the theory which draws the relevance of electricity and magnetism does not have the present age, either, and a theoretical gap exists between electricity and magnetism. That is, if it asks something what magnetism, and existence of a magnet is not considered, an experiment shows that it is what arises around it by current, but magnetism understands nobody, if it asks why it produces.

About this reason, I will give one answer in this chapter.
This answer is applied as most important portion of our theory of gravitation.

14.1 Current

The thing of the electric charge which is moving is called current. The fixed current $\boldsymbol{J}$ can be expressed with the form of the product of the electric charge Q and its speed $\boldsymbol{v}$ so that clearly from this definition. namely

$$\boldsymbol{J} = Q\boldsymbol{v} \tag{14.1}$$

If it writes using the charge density ρ, since charge density is the amount of electric charges per unit volume, the product of charge density and its speed will be current of the amount of electric charges per unit volume. This current is called the current density $\boldsymbol{j}$ and can be written as follows.

$$\boldsymbol{j} = \rho\boldsymbol{v} \tag{14.2}$$

Generally, current is defined by the amount of electric charges which moved per unit time. For example, when the electric charge of dQ passes in dt seconds in the section of one lead, the current J which passed the section is the following.

$$J = \frac{dQ}{dt}[C/s] \tag{14.3}$$

As for [coulomb/second] which is the unit quantity of current, it is common to be called the [ampere] which is the unit quantity known well. It is converted as follows about unit quantity.

$[A] = [C/s]$

If a formula (14.3) is written with a found the integral type, it is also clear from a definition to become below.

$$Q = \int Jdt$$

The current density $\boldsymbol{j}$ can also be considered to be a thing of the current which passed per unit time to the unit area.

In the current which moves at a fixed speed, there is a relation of displacement = speed x time, and if time is made into unit time, it will become displacement = speed. It is the volume which multipled this displacement and the passed unit area, and is because what devide all the current which passed by volume becomes current density.

Therefore, when the section of the lead of the area S and the fixed current density $\boldsymbol{j}$ cross at right angles and it passes, the whole current serves as total about the area, and is the following.

$$J = \int_S jdS$$

Since it becomes a surface integral like the law of a gauss when a section and $\boldsymbol{j}$ do not cross at right angles, it can write as follows.

$$J = \int_S \boldsymbol{j} \cdot d\boldsymbol{S} \qquad (14.4)$$

According to the emission theorem of a gauss, there are the following relations about the arbitrary vectors $\boldsymbol{A}$.

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

A formula (14.4) can also be written to be the following.

$$J = \int_S \boldsymbol{j}\cdot d\boldsymbol{S} = \int_V \nabla\cdot\boldsymbol{j}dv \quad (14.5)$$

When taking the closed surface which carried out the arbitrary forms of the surface area S and the volume V at the place through which stationary current is flowing and setting charge density of the arbitrary points in the volume V to ρ, the total amount Q of electric charges contained in it was the following as the preceding chapter described.

$$Q = \int_V \rho dv$$

If an electric charge flows out of a closed surface, if the quantity per the unit time is denoted by a formula (14.3) and $\frac{dQ}{dt}$ is written to be $\frac{\partial Q}{\partial t}$ from the definition of partial differential, it can be written as follows.

$$J = \frac{\partial Q}{\partial t} = \frac{\partial}{\partial t}\left(\int_V \rho dv\right) = \int_V \frac{\partial \rho}{\partial t}dv \quad (14.6)$$

Therefore, the amount of electric charges within a closed surface will decrease per unit time only in this quantity. That is, the quantity is the following.

$$J = -\frac{\partial Q}{\partial t} = -\int_V \frac{\partial \rho}{\partial t} dv \qquad (14.7)$$

Moreover, the amount of electric charges which flows out of this closed surface is expressed also with a formula (14.4), and since this quantity and the quantity of a formula (14.7) are equal, there are the following relations.

$$J = \int_S \boldsymbol{j} \cdot d\boldsymbol{S} = -\frac{\partial Q}{\partial t} = -\int_V \frac{\partial \rho}{\partial t} dv \qquad (14.8)$$

It can express as follows from a formula (14.5).

$$\int_V \nabla \cdot \boldsymbol{j} dv = -\int_V \frac{\partial \rho}{\partial t} dv \qquad (14.9)$$

It follows,

$$\nabla \cdot \boldsymbol{j} + \frac{\partial \rho}{\partial t} = 0 \qquad (14.10)$$

This equation is called the equation of continuation.

14.2 Flow of Mass

It is possible to define the concept of the flow of mass completely like current. Although it becomes a repetition, since there are many new definitions, I will write without omitting. I will call the flow of mass the mass which is moving. The mass which moved per unit time can define the flow of mass. For example, when the mass of dM passes in dt seconds in one section, flow of mass J_g which passed the section is defined below.

$$J_g = \frac{dM}{dt}[kg/s] \quad (14.11)$$

If a formula (14.11) is written with a found the integral type, it is clear from a definition that it is the following.

$$M = \int J_g dt \quad (14.12)$$

A quantity called the flow of mass is expression of another form of the quantity of motion of dynamics.

The flow of mass can actually be written as follows.

$$\boldsymbol{J}_g = M\boldsymbol{v} \quad (14.13)$$

If the flow of the mass per unit volume will call it the density of the flow of mass $\boldsymbol{j}_g$ and it will call the mass per unit volume the mass density ρ_g, it can write as follows like the case of current.

$$\boldsymbol{j}_g = \rho_g \boldsymbol{v} \quad (14.14)$$

As well as the case of current when the section of the area S and the fixed flow density of mass $\boldsymbol{j}_g$ cross at right angles and it passes, since flow of the whole mass should just take the total about the area, it is the following.

$$J_g = \int_S j_g dS$$

Since it becomes a surface integral like the law of a gauss when a section and $\boldsymbol{j}_g$ do not cross at right angles, it can write as follows.

$$J_g = \int_S \boldsymbol{j}_g \cdot d\boldsymbol{S} \qquad (14.15)$$

According to the emission theorem of a gauss, a formula (14.15) can also be written as follows.

$$J_g = \int_S \boldsymbol{j}_g \cdot d\boldsymbol{S} = \int_V \nabla \cdot \boldsymbol{j}_g dv \qquad (14.16)$$

If the closed surface which carried out the arbitrary forms of the surface area S and the volume V at the place through which regular mass is flowing is taken and mass density of the arbitrary points in the volume V will be set to ρ_g, the total mass M contained in it will be the following like the case of an electric charge.

$$M = \int_V \rho_g dv$$

If mass flows out of a closed surface, it is expressed with a formula (14.11) and the quantity per the unit time can be written as follows from the definition of partial differential.

$$J_g = \frac{\partial M}{\partial t} = \frac{\partial}{\partial t}\left(\int_V \rho_g dv\right) = \int_V \frac{\partial \rho_g}{\partial t} dv$$

Therefore, the mass within a closed surface will decrease per unit time only in this quantity. That is, the quantity is the following.

$$J_g = -\frac{\partial M}{\partial t} = -\int_V \frac{\partial \rho_g}{\partial t} dv \tag{14.17}$$

Moreover, the mass which flows out of this closed surface is expressed also with a formula (14.15), and since this quantity and the quantity of a formula (14.17) are equal, there are the following relations.

$$J_g = \int_S \boldsymbol{j}_g \cdot d\boldsymbol{S} = -\frac{\partial M}{\partial t} = -\int_V \frac{\partial \rho_g}{\partial t} dv$$

It can express as follows from a formula (14.16).

$$\int_V \nabla \cdot \boldsymbol{j}_g dv = -\int_V \frac{\partial \rho_g}{\partial t} dv \tag{14.18}$$

It follows,

$$\nabla \cdot \boldsymbol{j}_g + \frac{\partial \rho_g}{\partial t} = 0 \tag{14.19}$$

This equation is an equation of continuation. The equation of continuation is materialized also in the dynamics of gravity.

14.3 Law of Right Screw

Although Oersted discovered the magnetism by current, when the relation between direction of this current and direction of a magnetic needle compared direction of current to the right screw and made the N pole positive direction for direction of a magnetic needle from the S pole, it was discovered by experiment that direction of a magnetic needle aims to turn a screw. Direction of this current and the magnetic relation of direction are called law of the right screw. The right is what depends direction of a magnetic needle on having defined the N pole as the positive direction from the S pole in direction of a magnetic needle, If the S pole is defined as a positive direction from the N pole, direction of a magnetic needle will call direction of a magnetic needle the left, if such a definition is carried out, it will be called the law of the left screw and there will be no natural essential meaning in whether they are the right or the left. However, even if direction of a magnetic needle is which of the right or the left, the law of this right screw will have expressed a result which is not symmetrical to the current which is flowing in the fixed direction spatially. For example, if current imagines underwater that magnetism is surrounding water with the long stick which moves and a stick will be linearly moved on the extension of a stick, surrounding water will begin to turn around the surroundings of the movement direction of the stick to either the right or the left. If magnetism is essentially such, it is thought that it is very wonderful and is over the range of man's imaginative power.

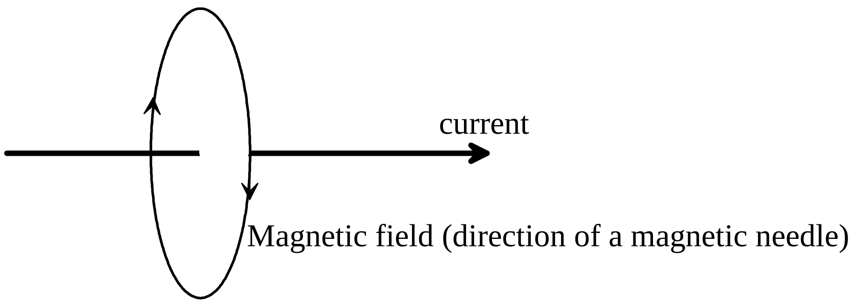

Fig.14.1 Law of right screw

If a stick is actually moved linearly underwater, surrounding water will not begin to turn around the surroundings of the movement direction of the stick to the right or the left, will be dragged in the movement direction of a stick by the viscosity of water, etc., and will begin to move.
Movement of water moves so quickly that it is close to a stick, and it will move slowly, so that it is far. If a water wheel is placed into the flow of this water, that water wheel will rotate (Fig. 14.2). It passes along the axis of rotation of this water wheel, and a size is the revolving speed of a water wheel, and when a direction considers a vector which has a relation of the right screw to the hand of cut of a water wheel, it turns out that this vector has a relation of the right screw exactly to the movement direction of a stick. When this considers that movement of a stick is current, it will say that direction of this vector is the same as direction of a magnetic needle.

Although it is generally thought that the concept of magnetism is a concept peculiar to electricity, such a vector can hardly avoid the conclusion which certainly appears in the phenomenon about fluid, such as a flow of water, and a flow of air, that it is a mathematical quantity. It has become clear by having stated here that such a vector exists, and it can also actually consider the experiment of the stream quoted here that this vector is a magnetic vector in a stream.

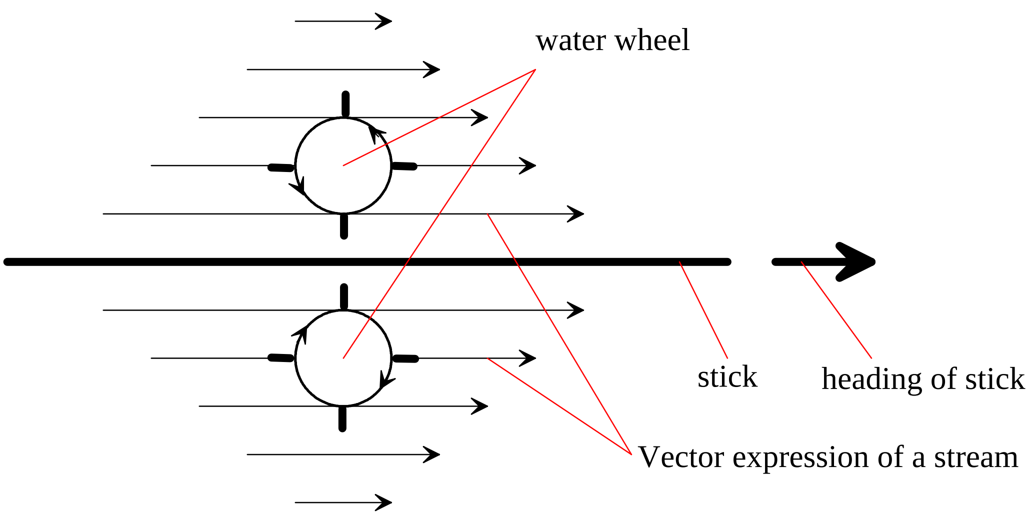

Fig. 14.2 Essence of magnetic field

14.4 Ampere's Law

Although the law of the right screw describes the relation between stationary current and magnetism qualitatively, the experiment law which gives a quantitive relation including this law is called Ampere's law. Although there are various ways to express Ampere's law, the differentiated type is the following.

$$\nabla \times \boldsymbol{H} = \boldsymbol{j} \tag{14.20}$$

$\boldsymbol{H}$;magnetic field, $\boldsymbol{j}$;current density

As another way of writing, if it places with $\boldsymbol{H} = c^2\varepsilon_0\boldsymbol{B}$, it will be written as follows.

$$c^2\nabla\times\boldsymbol{B} = \frac{\boldsymbol{j}}{\varepsilon_0} \tag{14.21}$$

c ;speed of light in a vacuum, $\boldsymbol{B}$;magnetic flux density

Although this physical meaning is a law of the right screw described for the preceding clause and that mathematical expression is a formula (14.20) and a formula (14.21), if it explains dynamically, it will be good to consider a quantity called angular momentum. Angular momentum is defined as follows.

$$\boldsymbol{L} = \boldsymbol{r}\times\boldsymbol{P} \tag{14.22}$$

$\boldsymbol{L}$;angular momentum, $\boldsymbol{r}$;position vector, $\boldsymbol{P}$;quantity-of-motion

To an origin of coordinates, it is a direction about the starting point of this vector $\boldsymbol{P}$. If it unites with the Z-axis,

$$\boldsymbol{P} = 0\boldsymbol{i} + 0\boldsymbol{j} + |\boldsymbol{P}|\boldsymbol{k} = P\boldsymbol{k}$$

When it sets with $\boldsymbol{r} = x\boldsymbol{i} + y\boldsymbol{j} + z\boldsymbol{k}$, it is the following [from a formula (6.35)].

$$\boldsymbol{L} = \boldsymbol{r}\times\boldsymbol{P} = (x\boldsymbol{i} + y\boldsymbol{j} + z\boldsymbol{k})\times P\boldsymbol{k} = Py\boldsymbol{i} - Px\boldsymbol{j}$$

If it places with $\boldsymbol{L} = L_x\boldsymbol{i} + L_y\boldsymbol{j} + L_z\boldsymbol{k}$,

$$L_x = Py, L_y = -Px, L_z = 0$$

If rot of a formula (14.22) is taken here,

$$\begin{aligned}\nabla \times \boldsymbol{L} &= (\tfrac{\partial L_z}{\partial y} - \tfrac{\partial L_y}{\partial z})\boldsymbol{i} + (\tfrac{\partial L_x}{\partial z} - \tfrac{\partial L_z}{\partial x})\boldsymbol{j} + (\tfrac{\partial L_y}{\partial x} - \tfrac{\partial L_x}{\partial y})\boldsymbol{k} \\ &= 0\boldsymbol{i} + 0\boldsymbol{j} + (\tfrac{\partial(-Px)}{\partial x} - \tfrac{\partial Py}{\partial y})\boldsymbol{k} \\ &= 0\boldsymbol{i} + 0\boldsymbol{j} - 2P\boldsymbol{k} = -2\boldsymbol{P}\end{aligned}$$

If it places with $\boldsymbol{L} = -2\boldsymbol{H}_g$,

$$\begin{aligned}&\nabla \times (-2\boldsymbol{H}_g) = -2\boldsymbol{P} \\ &\nabla \times \boldsymbol{H}_g = \boldsymbol{P}\end{aligned}$$

This formula is the same form as a formula (14.20). Since correspondence with the quantity of motion in electrodynamics is current, it turns out that a vector the twice minus of the quantity-of-motion vector in dynamics is the quantity corresponding to rot of the magnetic field in electrodynamics.

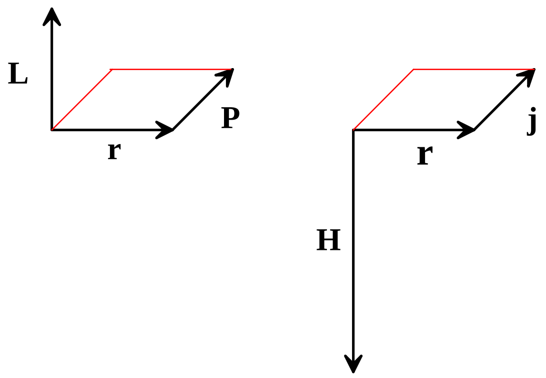

Fig. 14.3 Angular momentum and magnetic field

That is, expression of another form of a formula (14.20) is the following.

$$\boldsymbol{H} = -\tfrac{1}{2}\boldsymbol{r}\times\boldsymbol{j} \qquad (14.23)$$

A magnetic field is the quantity which multiplied $-\frac{1}{2}$ on the vector product of current and its position vector, the vector product of a vector arbitrary for defining a magnetic field vector mathematically and its position vector may be taken, and such a magnetic field vector can give a definition to all vectors.

14.5 Mathematical Derivation of Electric Magnetic Field

Not restricting the concept of a magnetic field to an electric phenomenon was confirmed for the preceding clause. From now on, in order to distinguish from other magnetic fields, I will make the thing of the magnetic field as used in the field of electrodynamics call it an electric magnetic field.

It is thought that generating of an electric magnetic field is started by movement of an electric charge. In electrodynamics, it is greatly treated by the electrostatics of the form which does not include a magnetic field, and the electricity and magnetism of form including a magnetic field by dividing into two. Static electricity study here and electricity and magnetism do not have natural relation theoretically, and the theoretical starting point of electricity and magnetism has stemmed from an experiment called discovery of the magnetism which arises by the current by Oersted.

Although it is clear that generating of a magnetic field takes place by movement of an electric charge, it receives unnatural touch that there is no natural theoretical relation in the static electricity study which is not moving, and the electricity and magnetism which are moving. By understanding this relation can explain generating of a magnetic field theoretically. And it seems that the law of electrodynamics can be made perfect more. The essence of the magnetic field was considered from the phenomenon side, and the magnetic field vector also stated 14.3 that it is a problem of a definition only by 14.4. Therefore, if there is a vector like current, there will be no doubt in the ability to define a magnetic field vector. However, although the magnetic field vector has a spatial spread, current flow in a lead and it cannot be considered that it is what has a spatial spread. Since it is the electric field $\boldsymbol{E}$ which has a spatial spread in electrodynamics, the direction considered that a magnetic field is the quantity about movement of an electric field is excellent in the field of recognition of a phenomenon. Although calculation is slightly troublesome, I will consider an electric field which is moving to the next.

The following two formulas are obtained in the static electric field.

$$\boldsymbol{E} = -\nabla\varphi \tag{14.24}$$

$$\nabla \cdot \boldsymbol{E} = \frac{\rho}{\varepsilon_0} \tag{14.25}$$

$\boldsymbol{E}$; Electric field vector, φ ; Potential, ρ ; Charge density

ε_0 ; The dielectric constant in a vacuum

Let the equation of these be a starting point. It supposes that the electrostatic place in a certain coordinate system S' is $\boldsymbol{E}$, and it is assumed that it sees from another coordinate system S, and S' is moving with the fixed relative velocity $\boldsymbol{v}$. Stating here will carry out whether S' is actually moving or it is not to not using a problem. Stating here is fundamentally mathematical and it does not describe the interaction in relative motion.
When it sees from a train, it is how a station is visible and the same thing, and it is because it is thought that it is materialized in both case.

$\boldsymbol{v} \times \boldsymbol{E}$ is considered as a quantity which looked at S to S'. It will be the following if this vector product is placed with $\boldsymbol{X}$.

$$\boldsymbol{X} = \boldsymbol{v} \times \boldsymbol{E} \tag{14.26}$$

The necessary and sufficient condition for the existence of the quotient of this vector equation is $\boldsymbol{v} \cdot \boldsymbol{X} = 0$, and $\boldsymbol{v}$ and $\boldsymbol{X}$ are when perpendicular.
At this time, that quotient becomes below.

$$\boldsymbol{E} = \frac{\boldsymbol{X} \times \boldsymbol{v}}{\boldsymbol{v}^2} + k\boldsymbol{v} \tag{14.27}$$

k is arbitrary constants, $\boldsymbol{v}^2 = \boldsymbol{v} \cdot \boldsymbol{v}$

A formula (14.27) will become below, if it places with $k = 0$ and this clause is disregarded.

$$\boldsymbol{v}^2 \boldsymbol{E} = \boldsymbol{X} \times \boldsymbol{v} \tag{14.28}$$

If div is given both the neighborhoods of a formula (14.28),

$$\nabla \cdot (\boldsymbol{v}^2 \boldsymbol{E}) = \nabla \cdot (\boldsymbol{X} \times \boldsymbol{v}) \tag{14.29}$$

If it calculates about both the neighborhoods of a formula (14.29), respectively,

$$\nabla \cdot (\boldsymbol{v}^2 \boldsymbol{E}) = \nabla \boldsymbol{v}^2 \cdot \boldsymbol{E} + \boldsymbol{v}^2 \nabla \cdot \boldsymbol{E}$$

Since $\boldsymbol{v}$ is constant, it is set to $\nabla \boldsymbol{v}^2 = 0$

$$\nabla \cdot (\boldsymbol{v}^2 \boldsymbol{E}) = \boldsymbol{v}^2 \nabla \cdot \boldsymbol{E}$$

$$\nabla \cdot (\boldsymbol{X} \times \boldsymbol{v}) = \boldsymbol{v} \cdot \nabla \times \boldsymbol{X} - \boldsymbol{X} \cdot \nabla \times \boldsymbol{v}$$

Since $\boldsymbol{v}$ is constant, [by a formula (11.52)]

$$\nabla \times \boldsymbol{v} = 0$$

$$\nabla \cdot (\boldsymbol{X} \times \boldsymbol{v}) = \boldsymbol{v} \cdot \nabla \times \boldsymbol{X}$$

Therefore, a formula (14.29) becomes below.

$$\boldsymbol{v}^2 \nabla \cdot \boldsymbol{E} = \boldsymbol{v} \cdot \nabla \times \boldsymbol{X} \tag{14.30}$$

Furthermore, since it is $\boldsymbol{v} \neq 0$, this quotient exists, and it becomes below.

$$\nabla \times \boldsymbol{X} = \frac{\boldsymbol{v}v^2 \nabla \cdot \boldsymbol{E}}{v^2} + \boldsymbol{k} \times \boldsymbol{v} \tag{14.31}$$

k is arbitrary constants

It will be a formula (14.31), if it places with $\boldsymbol{k} = 0$ and this clause is disregarded,

$$\nabla \times \boldsymbol{X} = \boldsymbol{v} \nabla \cdot \boldsymbol{E} \tag{14.32}$$

A formula (14.25) is materialized also in the electric field which is moving. Therefore, a formula (14.25) can be substituted for a formula (14.32),

$$\nabla \times \boldsymbol{X} = \frac{\rho \boldsymbol{v}}{\varepsilon_0} \tag{14.33}$$

If it sets with $\boldsymbol{X} = c^2 \boldsymbol{B}$ and the current density $\boldsymbol{j} = \rho \boldsymbol{v}$ is substituted, a formula (14.33) can be written as follows.

$$c^2 \nabla \times \boldsymbol{B} = \frac{\boldsymbol{j}}{\varepsilon_0} \tag{14.34}$$

c is the speed of light in a vacuum.

This formula is of the same shape as Ampere's law, and it is thought from such a calculation result that the vector $\boldsymbol{B}$ is a thing showing a magnetic field.

This is considered that it can draw the related law of current and a magnetic field mathematically by considering the electric field which is moving.

14.6 Gravitational Magnetic Field

Does such a phenomenon other than a hydrodynamic magnetic field or an electric magnetic field exist? If a magnetic phenomenon is a mathematical concept which certainly appears in the phenomenon about fluid, it is possible that such a concept exists also in a gravitational field.

The expression of relations (14.34) of the magnetic field and current which were obtained by 14.5 was drawn from a formula (14.24) and (14.25). The equation (13.24) and (13.25) of a static gravitational field are an equation (14.24) and (14.25) the completely same form as.
Therefore, the following is completely obtained by same calculation.

$$c^2 \nabla \times \boldsymbol{B}_g = \frac{\boldsymbol{j}_g}{G_0} \tag{14.35}$$

c;The speed of light in a vacuum,

$\boldsymbol{B}_g$;The magnetic vector in a gravitational field

$\boldsymbol{j}_g = \rho_g \boldsymbol{v}$;Density of the flow of mass

$c$was merely set for convenience here, in order to unite form. This formula is the same form as Ampere's law in electrodynamics. Therefore, the vector $\boldsymbol{B}_g$ can be considered that existence of a magnetic vector was able to be shown theoretically by expressing the magnetic vector in a gravitational field and considering movement of a static gravitational field. I will call this vector $\boldsymbol{B}_g$ a gravitational magnetic field, and will call this equation (14.35) Ampere's law in a gravitational field.

14.7 Hydrodynamic Magnetic Field

By the argument to the preceding clause, the concept of a magnetic field was somehow mathematical, and it was confirmed that a similar concept exists also in phenomena other than electricity. However, the important phenomenon in electrodynamics is not a magnetic field but magnetism, and is whether a magnetism phenomenon exists also in non-electricity.

If current is sent in the same direction as two leads installed in parallel, two leads will pay well mutually, and if current is sent through a counter direction, it can observe turning each other down (Fig. 14.4).

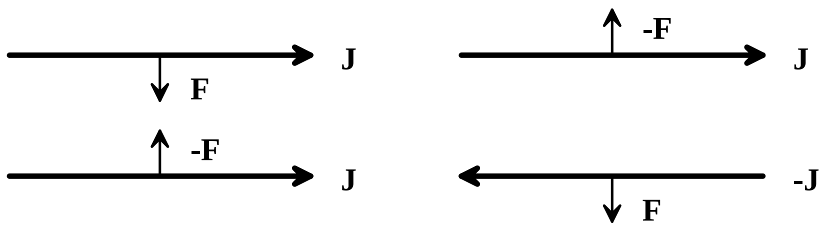

Fig. 14.4 Direction of current and direction of force

Power has arisen between two leads and this power is magnetism.
Moreover, a phenomenon also with same circular coil can be observed.
If an axis is made the same, a circular coil is placed in parallel and current is sent in the same direction, two coils will pay well mutually, and if

current is sent through a counter direction, it can observe turning each other down (Fig. 14.5).

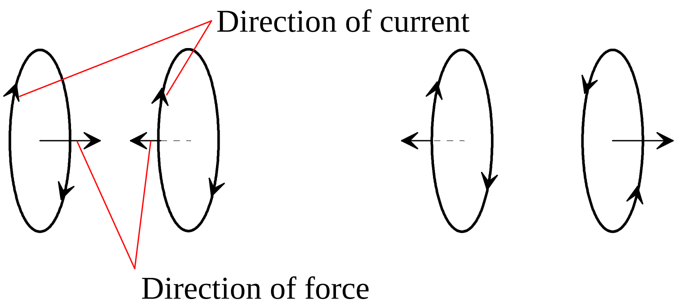

Fig. 14.5 force between circular coils

Such a phenomenon and the completely same phenomenon can observe by the experiment in fluid. If two sheets of papers are hung down in parallel and a breath is sprayed between them, what will happen to paper? It seems that thinking that two sheets of papers probably tend to separate makes sense since paper will be pushed by the wind if it thinks ordinarily, and a breath is sprayed. However, according to the experiment, two sheets of papers try to approach as known well. Why is it? Although the flow velocity of air becomes quick between papers by spraying a breath, since atmospheric pressure falls this and reversely, paper and paper try to approach. It is also that it is known well that the airplane is flying using this principle.

If two light ropes are quickly moved in the same direction in parallel, according to the viscosity of air, surrounding air will be dragged by the rope and will begin to move. Since the air between ropes receives power with both ropes at this time, much power is received from a surrounding place. Therefore, the air between ropes will move quickly. When the air between ropes moves quickly, the atmospheric pressure between ropes becomes lower than atmospheric pressure other than between ropes, and it will be observed that a rope pays well mutually.

If two ropes are moved to a counter direction, since the power of pushing the air of both ropes will be negated between ropes, shortly, conversely, the atmospheric pressure between ropes becomes high relatively from atmospheric pressure other than between ropes, and a rope will be observed so that it may turn each other down.

If similarly two light disks which made the axis the same are rotated in the direction, a disk will pay well mutually, and if a counter direction is rotated, it can observe turning down each other's disk.

These phenomena are almost the same as the case of the magnetism by the current which flows into a lead. To such a phenomenon, hesitation is not felt as it is hydrodynamic magnetism. It can be said that a magnetism phenomenon exists also in a hydrodynamic phenomenon.

Although action-at-a-distance expression that two leads pay well mutually is used by electric magnetism, considering hydrodynamic magnetism, it turns out well that two ropes are not paying well mutually and have received power according to the pressure difference of surrounding air. It is possible that it is because electric pressure difference also with electric magnetism has arisen to space.

An action-at-a-distance idea will use for a usual state the expression which is not essential "each other", and has become the hindrance of the understanding of a phenomenon. For example, although hydrodynamic magnetism is only the pressure difference of surrounding air, it cannot express easily in this way in action at a distance. It can be said in action through medium that hydrodynamic magnetism is the pressure difference of surrounding air.

When thinking why the curb ball of baseball bends, explaining in action at a distance is almost impossible, but explaining in action through medium is easy. By the flow of the air of the surroundings which that the curb ball of baseball bends depends on rotation of a ball, the direction of movement of a ball, and composition of a reverse relative wind, the pressure difference of air arises around a ball and it turns at a ball (Fig. 14.6 and a figure have disregarded the complexity of fluid).

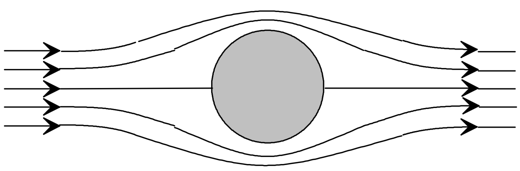

Fig. 14.6 (a) Surrounding flow of the ball which is flying without rotating

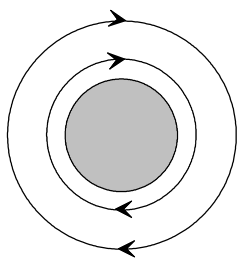

Fig. 14.6 (b) Surrounding flow of a revolving ball

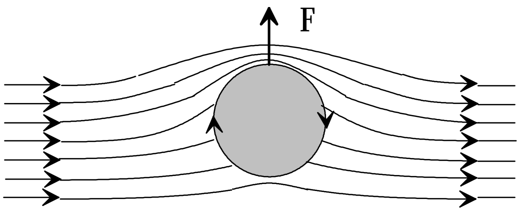

Fig. 14.6 (c) Surrounding flow of the ball which is flying while rotating

Although no word "each other" is used at this time, it is clear that there is no difference essential to the power committed on this ball and the power committed between two ropes. That is, if a phenomenon like the curb ball of baseball is found out, it can be said that the magnetism effect is there.

14.8 Does Gravitational Magnetism Exist?

Vector expressed by the formula (14.35) It was mathematically expressed about the surrounding place when the mass it can only be considered that is one point is moving at a fixed speed, and nothing is physically described about the power (gravitational magnetism) between interesting gravitational magnetic fields. That is, although there was an effect of electric magnetism in an electric magnetic field, existence of such an effect cannot be predicted from a formula (14.35). Conversely, if it says, a formula (14.35) will be materialized regardless of such an effect.

Electric magnetism was confirmed by the experiment and was not obtained theoretically. It will be what should also confirm gravitational magnetism by experiment. Nature has presented the proof which shows that this power exists.

In present-day knowledge, the essential reason does not understand why it carries out the precession movement of the gyroscope. After such a phenomenon is discovered, it is considered that more than what 100 years or it has already passed, but there is a physicist, without the ability to give a reply at all. The phenomenon of the gyroscope was not conventionally treated as a theory of gravity. However, it is thought that the interaction of it is carried out to gravity since a gyroscope tries to maintain fixed direction to the earth, and it can be considered that a gyroscope is one rotation gravitational field. If it thinks in this way, the phenomenon of a gyroscope should be treated as a theory of gravity.

In consideration of the hydrodynamic magnetic field in the preceding clause, the true character of the magnetism was only the pressure difference accompanying the relative velocity differential by composition of the flow of the fluid in space. According to the knowledge of hydrodynamics, power works in the light ball which the influence of gravity which rotates in the wind of a fixed direction can disregard.

This is the same as the curb ball of baseball. If such a phenomenon considers that earth gravity is a ball turning around the fixed wind from a top to facing down, and a gyroscope, existing also in a gravitational field is confirmed by the experiment (Fig. 14.7).

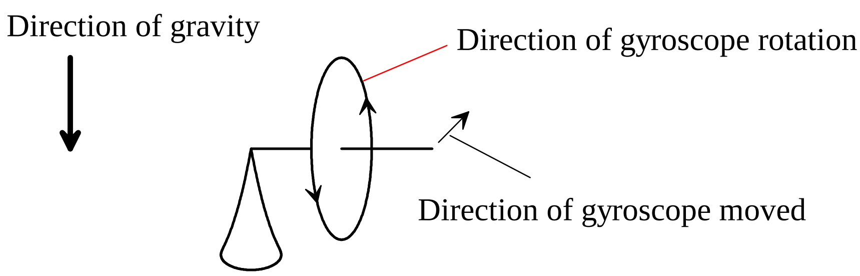

Fig. 14.7 (a) Movement of a gyroscope

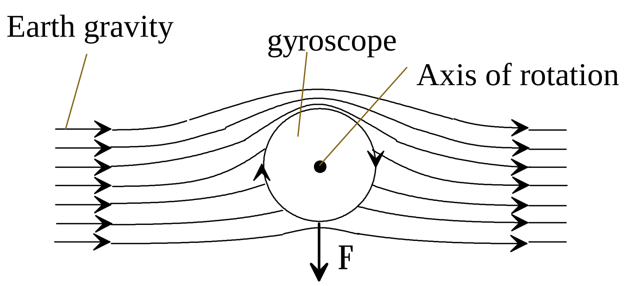

Fig. 14.7 (b) Force committed for the gyroscope in an earth's gravity field

It can explain, if it thinks that the precession movement of a gyroscope is the pressure difference of a certain gravitational field by superposition of a rotation gravitational field with earth gravity and a gyroscope. However, the power in hydrodynamics works relatively to the direction where speed became large, when rotating the axis of a gyroscope in parallel to the level surface of the earth according to the experiment, power commits the power in gravity to a small gravitational field relatively from the direction which a downward earth's gravity field and the hand of cut of the gyroscope piled up hydrodynamic magnetism and contrary, and was amplified.

There are actually some which deserve special mention in the similarity of a hydrodynamic magnetism phenomenon and a gravitational magnetism phenomenon. If the light thing which can disregard influence of gravity like a table tennis ball is rotated and the direction of the axis of rotation is variously changed in a fixed wind, a table tennis ball will receive power in the various directions. The direction of the power which a gyroscope when changing variously the axis of rotation of the direction of this power and the gyroscope on the earth receives is very well alike, if it takes into consideration that the direction of fundamental power is opposite. For example, it will fly straight and a bullet will be stabilized, if the axis of rotation is taken to a direction of movement and parallel and they are rotated, but this of a gyroscope is the same as that of being stabilized more and rotating, if the axis of rotation of a gyroscope is made parallel with the direction of the gravity of the earth. Such an effect is a proof which is one in which gravitational magnetism exists.

Power commits gravitational magnetism towards the smaller one relatively from the direction where gravitational pressure was amplified hydrodynamic magnetism and contrary. Therefore, if two gyroscopes which made the axis of rotation the same are rotated in the same direction, it will turn down each other's two gyroscopes, and it is expected that it will pay well if a counter direction is rotated. However, a prominent effect could not be checked in order that a gyroscope may react to earth gravity more strongly, even if it conducts this experiment on the earth. If you would like to conduct such an experiment strictly, you should carry out in the vacuum of a gravity-free space.

14.9 Propulsive Engine by Gravity

Is there any propulsive engine using hydrodynamic magnetism? Of course, don't use the propeller. The propeller is not using hydrodynamic magnetism.

What is necessary is to set as a like a cone shaped thing the axis of rotation which pierces through the center of a wide circle from a vertex, and, as for such equipment, just to rotate it, for example, as the wings of the airplane were rotated. If it does what and the object of such form is rotated, whether a lift is generated will arise by the difference in the surface area by the side of a conical vertex and a wide circle. That is, it is because the peak side has surface area larger than the wide circle side and so much power can be given to surrounding air. Therefore, the atmospheric pressure by the side of the peak becomes lower than the atmospheric pressure by the side of a wide circle, and a lift generates it towards the peak side from the wide circle side. However, you have to make this equipment light for the reason explained below.

If such a method is applied by gravitational magnetism, what will happen? If mass distribution sets as an object like conical the axis of rotation which pierces through the center of an wide circle and rotates it from a conical vertex, since the direction of power is opposite to hydrodynamic magnetism, it will be expected that gravitational magnetism occurs towards the wide side from the conical vertex side. When actually experimented, this power occurred. When the method of the experiment fixed to one side of the axis of a gyroscope with a diameter of about 5 cm of a commercial toy on the tape about five 5 yen coin which the hole is

opening at the center, it was made to contact centering on the grinder for polish and the high velocity revolution was carried out, the gyroscope moved towards the smaller one from the larger one of mass distribution.
Those who think that it is a lie since this experiment is an easy experiment where a schoolchild can also do it should just do by themselves.

It is from this reason to have said that hydrodynamic equipment had to be made light, and it is because the direction was opposite by hydrodynamic magnetism and gravitational magnetism.

It may seem that it did what just because gravitational magnetism occurred and the gyroscope moved with the gyroscope like this experiment. However, what human beings got for how this controls gravity is meant. Gravity control is possible. This can be declared. It is because it is confirmed by the experiment.

14.10 Ampere Maxwell's Law in Gravitational Field

I will return to Ampere's equation (14.35) in a gravitational field, will extend Ampere's law to Ampere Maxwell's equation $c^2\nabla\times\boldsymbol{B}=\frac{\boldsymbol{j}}{\varepsilon_0}+\frac{\partial\boldsymbol{E}}{\partial t}$ which is unsteady form, and will consider the analogical application to a gravitational field.

Although Maxwell rewrote Ampere's law and got this equation, Ampere's law in a gravitational field can be considered like how to have taken Maxwell. The equation in the gravitational field which is that unsteady form is drawn by this.

(1) Rewriting to the unsteady form of Ampere's law by Maxwell's method (electrodynamics)

Before Maxwell got Ampere Maxwell's equation, the expression of relations of current and a magnetic field was only that there is the following which is Ampere's law.

$$c^2 \nabla \times \boldsymbol{B} = \frac{\boldsymbol{j}}{\varepsilon_0} \qquad \text{re-(14.21)}$$

If Maxwell gives div both the neighborhoods of a formula (14.21),

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

Since it came out, he has noticed that it is strange to become below.

$$\nabla \cdot \boldsymbol{j} = 0 \qquad (14.36)$$

It is actually like the definition of the current $\boldsymbol{j}$ that an equation becomes the following.

$$\nabla \cdot \boldsymbol{j} = -\frac{\partial \rho}{\partial t} \qquad \text{re-(14.10)}$$

The formula (14.21) thought that it was not a general form, and it corrected it as follows.

$$c^2 \nabla \times \boldsymbol{B} = \frac{\boldsymbol{j}}{\varepsilon_0} + \frac{\partial \boldsymbol{E}}{\partial t} \qquad (14.37)$$

If it gives div ,

$$\nabla \cdot \frac{\boldsymbol{j}}{\varepsilon_0} + \nabla \cdot \frac{\partial \boldsymbol{E}}{\partial t} = 0$$

$$\nabla \cdot \boldsymbol{j} + \varepsilon_0 \frac{\partial}{\partial t} \nabla \cdot \boldsymbol{E} = 0 \qquad (14.38)$$

If the law of a gauss

$$\nabla \cdot \boldsymbol{E} = \frac{\rho}{\varepsilon_0}$$

is substituted for a formula (14.38), it becomes the following and is in agreement with a formula (14.10).

$$\nabla \cdot \boldsymbol{j} = -\frac{\partial \rho}{\partial t}$$

A formula (14.37) is considered to be the right thing from this, and the phenomenon contradictory at a ceremony (14.37) even now is not discovered, but, generally the formula (14.37) is accepted.

(2) Application in the dynamics of gravity

Ampere's law in a gravitational field has already been obtained in the same form as electrodynamics, as already stated.
If it writes again,

$$c^2 \nabla \times \boldsymbol{B}_g = \frac{\boldsymbol{j}_g}{G_0} \qquad \text{re-(14.35)}$$

Moreover, since

$$\nabla \cdot \rho_g \boldsymbol{v} = -\frac{\partial \rho_g}{\partial t} \qquad \text{re-(14.19)}$$

is obtained and the equation of continuation can be placed with $\boldsymbol{j}_g = \rho_g \boldsymbol{v}$ from an equation (14.19), an equation (14.19) is the same form as an equation (14.38). Although the conclusion obtained by electrodynamics naturally cannot be carried into the dynamics of gravity as it is, It is thought that the operation are completely the same as that of it of electrodynamics, and same as how to have taken Maxwell mathematically in this case is possible for the mathematics as an equation of a place which an equation (14.35) and an equation (14.19) express. Therefore, if a formula (14.35) is rewritten like Maxwell's method, it can be written as

$$c^2 \nabla \times \boldsymbol{B}_g = \frac{\boldsymbol{j}_g}{G_0} + \frac{\partial \boldsymbol{E}_g}{\partial t} \qquad (14.39)$$

It will be the following if div is given to this formula.

$$\nabla \cdot \frac{\boldsymbol{j}_g}{G_0} + \nabla \cdot \frac{\partial \boldsymbol{E}_g}{\partial t} = 0$$
$$\nabla \cdot \boldsymbol{j}_g + G_0 \frac{\partial}{\partial t} \nabla \cdot \boldsymbol{E}_g = 0 \qquad (14.40)$$

Law of the gauss in a gravitational field Since it is $\nabla \cdot \boldsymbol{E}_g = \frac{\rho_g}{G_0}$, a formula (14.40) is set to

$$\nabla \cdot \boldsymbol{j}_g = -\frac{\partial \rho_g}{\partial t}$$

and is of the same shape as a formula (14.19).

Since it is such, it is thought that Ampere Maxwell's law in a gravitational field is a form of a formula (14.39). Although this equation is the completely same form as Ampere Maxwell's law in electrodynamics, it is not a new thing that the equation expressing a field is the completely same form. In this case, if it restricts and says, since it will be the conclusion obtained using the same mathematics as Maxwell's method, naturally it is the completely same form. I will call this equation (14.39) Ampere Maxwell's equation in a gravitational field.

14.11 Magnetic Field and Theory of Relativity

It may be said that a magnetic field is an effect of the theory of relativity. It could be said that such an idea is a physicist's mainstream.
If it considers that the fundamental idea is what is moving at the speed as an opposite direction in which current has positive charge and the same minus electric charge and will see from a watcher stationary to a lead, the relative velocity of positive charge and a minus electric charge will become zero, and an electric field will become zero, but. If the surroundings of a lead are seen from the electric charge which is moving, the speed of positive charge and a minus electric charge becomes less the same, the density of positive charge and a minus electric charge changes with relativistic shrinkage, if it sees from the electric charge which is moving by this, an electric field will arise there and the electric charge which is moving will receive power in it. This power is just magnetism.

However, if a magnetic field is considered in a relativistic position, inconsistency will arise. Maxwell advocates being able to regard it as

current and actually building a magnetic field, if an electrified object is moved, and it is confirmed by the experiment of Roland. For example, if the electric charge of the same size moves by the same mark of q_1, q_2 at the speed same in parallel, it can be regarded as the two same current j_1, j_2 that flows in parallel. Since the current which flows in the same direction pays well according to the experiment, j_1 and j_2 will pay well mutually in this case. However, if it thinks in a relativistic position, since the relative velocity of q_1 and q_2 is zero, it sees from q_1, and q_2 will stand it still, it will see from q_2, and q_1 will stand it still. Since repulsive force commits the power committed between the stationary electric charges of a same sign according to coulomb's law, q_1 and q_2 will be turned down mutually.
When it thinks relativistically, since q_1 and q_2 pay well to a watcher stationary in the laboratory, q_1 and q_2 seem to approach in him, but for the watcher who moves together with q_1, q_2, q_1 and q_2 will seem to separate.
Although a theory-of-relativity person may affirm such a thing, we can regard it as seriously contradictory.

According to our hydrodynamic idea, such inconsistency does not arise. For example, according to the law of a gauss, can consider that positive charge is the fountainhead which continues emitting water at a fixed rate radiately, but. if the two heads w_1, w_2 with this same burst size are put in order and made to stand it still -- the stream between two heads -- since a denial will be carried out mutually, the speed of the water between heads becomes slow and the pressure of water becomes high relatively from other places. Therefore, repulsive force works in two heads.

Next, if the head w_1, w_2 is moved at the same speed v, the vector of the water which comes out of w_1, and the water which comes out of w_2, and the rate vector of movement will be compounded, between the heads w_1 and w_2 will be amplified most strongly, a stream will become quick, and the pressure between heads will become low relatively from other places. Therefore, attraction works in the head currently moved (Fig. 14.8).

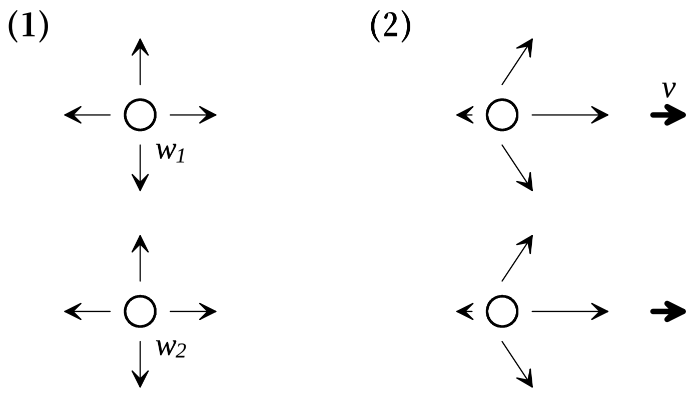

Fig. 14.8 Composition of vector which is moving

If such an idea is applied to an electric charge, it will become unnecessary to chop strange logic like a theory-of-relativity person. If the space where the electric field which is moving, and an electric field are transmitted goes together completely, as shown in Fig. 14.7 (1), it will become repulsive force, and if it does not go together completely, since an electric field is made into desertion, it will not commit what power to an electric charge, either. When magnetism exists, it is thought that it is in this interim state.