Chapter 4: The Principle of Relativity

To describe the motion of an object, we need to know how far it has moved. A coordinate system is typically used as a measure to describe such motion. Once a coordinate system is established, we can determine how far an object has moved relative to that system. However, we cannot determine from this whether the object is actually moving or not. It might be the coordinate system, not the object, that is moving. Which is truly moving?

This fundamental concept of the perception of space in physics is, to a few, one of the oldest unsolved problems. Ordinary physics textbooks either avoid this problem or gloss over it, so most people are unaware that it even exists. Physicists are almost at a loss as to this problem, but their attempts to gloss over it lead to a terrible misunderstanding. The culmination of this misunderstanding is the theory of relativity.

In this chapter, we will offer one answer to this problem. We will also meticulously point out the strange logic of the theory of relativity, which is a major obstacle to scientific progress, and demonstrate that this theory is completely wrong. By the time you finish reading this chapter, no one will claim that the theory of relativity is correct.

4.1 Galileo's Principle of Relativity

Galileo asserted that the Earth was moving, but scientists at the time questioned why, if the Earth was moving, people on Earth didn't notice it.

In response to such questions, Galileo attempted to answer them by stating that if an object is dropped from a ship moving at a constant speed, the object will fall straight down from the ship's perspective. This principle, which states that an observer inside an object moving in a straight line at a constant speed cannot know whether they are moving unless they look outside, is called the principle of relativity. There are two principles called the principle of relativity: one is Galileo's (or Newton's) principle of relativity, and the other is Einstein's principle of relativity. Galileo's principle of relativity is applicable only to Newton's mechanics, such as throwing a ball,

while Einstein's principle of relativity is considered applicable to all physical phenomena, including waves, optics, and electromagnetism.

In Galileo's principle of relativity, why does an object dropped from a ship fall straight down? This is explained by the law of inertia, also discovered by Galileo, which states that an object not subjected to an external force is either at rest or in uniform linear motion. The inertia of an object dropped from a ship acts the same as the inertia of the ship, so the object falls straight down. The law of inertia seemed to have been precisely verified by Galileo's thought experiment and experiments on Earth. However, just because an object moves in a uniform linear motion on Earth does not mean that it moves in a uniform linear motion from the perspective of the sun. It was thought that "the concepts of rest or uniform linear motion can only be defined by setting some kind of standard, and unless that standard is set, it is clear that the concepts of rest or uniform linear motion are meaningless." For example, if a bomb is dropped from an airplane, from the perspective of the airplane it appears that the bomb falls straight down, but from the ground it appears that the bomb falls in a parabolic arc.

Therefore, it became necessary to define what an object is at rest or moving in a straight line at a constant velocity relative to. In modern physics, the concept of an inertial frame of reference has been devised as this standard. An inertial frame of reference is defined as "a coordinate system in which an object not subjected to external forces is at rest or moving in a straight line at a constant velocity," or more simply, "an inertial frame of reference is a coordinate system in which the law of inertia holds true," or "an inertial frame of reference is a coordinate system in which Newton's mechanics holds true with good approximations."

However, think about this carefully. The original purpose of the concept of an inertial frame of reference was to establish a standard for giving meaning to the law of inertia, so using the law of inertia to define that standard contradicts the method of definition. Of course, the expression "the laws of mechanics hold true" is even worse. This is an infinite loop of definition, and it inherently contains a logical difficulty from which one can never escape. If you were to create a program called physics and run it on a computer, it would fall into an infinite loop and crash at the very first stage.

If a physicist were to accept such a nonsensical definition, it would be tantamount to them declaring that they are abandoning logical thinking. And if they were to simply accept that physics is like that, it would be tantamount to admitting that physics is an illogical discipline.

Newton probably couldn't accept this. To solve this problem, he likely hypothesized the existence of a concept called absolute space. If we accept the existence of such an initial reference coordinate system, we can escape the infinite loop of definitions.

Newton's concept of absolute space was considered a container for all things in the universe, always constant and unchanging, regardless of external conditions. For example, if we imagine absolute space as a toy box, the stars are individual toys. No matter how we move the toys in the toy box, the toy box itself does not change shape or move. Such imagination is within the realm of human imagination and seems like something so obvious that it can be accepted without proof. In any case, Newton was able to incorporate the idea of absolute space and construct Newtonian mechanics.

Newton's famous quote, "I made no hypotheses," is well-known, but his idea of absolute space was criticized as nothing more than a hypothesis. However, there is a difference between an assumption and a hypothesis. A hypothesis is something whose results cannot be proven, while an assumption is a thought process for obtaining results that should be proven. For example, Newton's law of universal gravitation explains the movement of stars by assuming that all things attract each other. Newtonian mechanics is constructed by assuming absolute space, and Newtonian mechanics can explain the motion of objects. Yet many physicists say that the law of universal gravitation is correct, and absolute space is a hypothesis. How can we say that the law of universal gravitation is correct? Can this be proven? It cannot be proven. If it could be proven, then in physics, we don't usually say "law" or "principle." If it could be proven, it should be called a theorem.

When all knowledge is broken down, it eventually reaches the smallest possible level of subdivision. This smallest level of knowledge is not fixed; later, as deeper knowledge may reveal it consists of even smaller elements. However, at a given point in time, it represents the smallest possible level. Such knowledge can never be proven. In physics, it's called a principle; in mathematics, axioms. A strict positivist stance that rejects the very existence of such things would render the entire system of knowledge, including physics, impossible. On the other hand, neglecting positivism would reduce physics to mere fantasy, like Greek philosophy, which doesn't reflect the real world. How can we maintain this balance?

Let us state our philosophical views here.

[Principles for introducing assumptions into physics]

(1) Principles of Assumption Introduction:

In constructing a physical theory, necessary assumptions can be introduced without proof. However, utmost care should be taken when introducing these assumptions, and as much explanation as possible should be provided. It is desirable that these assumptions be introduced based on considerations of physical phenomena, and even better if they are empirically proven. Of course, these assumptions themselves must not contradict others.

When constructing a physical theory, the fewer assumptions required, the better. A theory without assumptions can be accepted without empirical verification. Here, "without assumptions" means that even if an assumption is included that has already been proven by other theories or experiments, it is not considered an assumption. However, even such assumptions are not necessarily fully proven.

(2) Principle of Empirical Research

The conclusions drawn using this method (1) must be empirically verified. Without verification, they remain mere hypotheses. Furthermore, partial verification does not necessarily mean the entire theory is correct.

Applying this idea to absolute space, the existence of absolute space itself cannot be denied, and the conclusions reached have been proven in the form of Newtonian mechanics. While not entirely satisfactory, they do not contain contradictions and are not necessarily inconsistent with our principles.

We do not believe that the idea of absolute space is the best, and we will later modify it to what we believe to be a better form, but here we will defend this idea in order to correct a misunderstanding of the concept of absolute space.

If we express Galileo's principle of relativity using absolute space,

"The results observed in a coordinate system moving at a constant velocity in absolute space are the same as the results observed in a coordinate system at rest in absolute space."

Therefore, if we define a coordinate system moving at a constant velocity in a straight line within absolute space as an absolute inertial coordinate system, then this absolute inertial coordinate system is,

"An absolute inertial coordinate system is a coordinate system that moves in a straight line at a constant velocity within absolute space."

This means that the law of inertia is,

"An object not subjected to an external force is either at rest or moving at a constant velocity in a straight line relative to an absolute inertial coordinate system."

This can be expressed as, and it shows that we have escaped the infinite loop of definitions.

It is often said that, "From the perspective of an absolute inertial coordinate system, we can observe that absolute space is moving in a straight line at a constant velocity. Considering this, we can regard the absolute inertial coordinate system as absolute space, and therefore, the absolute inertial coordinate system and absolute space are indistinguishable." A counterargument to this is that, "The assumption that absolute space is constant and unmoving is a principle. Therefore, since absolute space does not move, the appearance of absolute space moving from the perspective of an absolute inertial coordinate system is merely an illusion, not reality. Since absolute space is not moving, it is the absolute inertial coordinate system that is actually moving."

Alternatively, one might argue, "How can we perceive something like absolute space, which is absolutely motionless in the universe? We should not introduce such an unproven concept into physics." To this counterargument, one can respond, "Not all principles of physics can be proven. It is only by incorporating the concept of absolute space that we can construct Newtonian mechanics. And Newtonian mechanics has been proven in many respects, which serves as verification of the validity of the concept of absolute space."

Thus, the concept of absolute space is not entirely meaningless from a physics perspective. Most importantly, the assumption of absolute space is introduced because it is necessary in Newtonian mechanics. If this assumption were denied, one would fall into an infinite loop of definitions. Historically, Newton's absolute space came first, followed by the concept of inertial frames of reference. However, if a concept like absolute space were unnecessary, as is thought in modern physics, a thoughtful person like Newton would never have introduced such a concept.

Incredibly foolishly, physicists after Newton have rejected the concept of absolute space, which was likely Newton's agonizing choice, and have chosen to abandon logical thinking altogether. And even more terrifying, they don't even realize they've made a mistake. Nothing could be more terrifying. They are people who, despite committing a criminal act, don't think they've done anything wrong at all.

In short, physics has been ruined. This ruin is by no means insignificant. A erroneous understanding of this fundamental concept permeated the entire field of physics, and from this point onward, physics became a fictional story detached from the real world. The theory of relativity is a typical example of this, and physicists laud it as a revolution in science, but the world after the revolution is not necessarily better than before.

It's quite late, but it's not too late; mistakes must be corrected. No one has the right to reverse the course of science. We must oppose this reversal carried out by our predecessors and correct it to the right form. There is no way to return to the right path except to return to the wrong place. We are now attempting to correct the law of inertia. Of course, we don't intend to simply reverse the course and revive absolute space. We will use a different method.

The problem lies in how to define rest or uniform linear motion. The conventional view is that rest or uniform linear motion is defined relative to some reference frame located elsewhere, and without this reference frame, such concepts are meaningless. And defining this reference frame elsewhere requires using rest or uniform linear motion, leading to an infinite loop of definition.

What do stationary objects and objects in uniform linear motion have in common? As is immediately apparent, no acceleration acts on objects in these states. If we consider acceleration as relative acceleration, then that concept requires other reference points. However, in Chapter 2, we discovered that there is a concept of acceleration that does not require other reference points. We call this acceleration inertial acceleration. In other words, objects that are stationary or in uniform linear motion are in a state where no inertial acceleration is acting on them. Even such objects, when viewed from a coordinate system accelerating relative to them, appear to be experiencing relative acceleration, but inertial acceleration is not. Inertial acceleration is not determined using some reference frame located in a spatially different place. Furthermore, Newtonian mechanics is not necessary to determine whether or not inertial acceleration exists. When an object is pushed, an observer inside it can determine whether or not inertial acceleration exists by judging whether or not they are being pushed against a wall.

Using this principle, we can define a coordinate system similar to an inertial coordinate system without using absolute space or the law of inertia. That is, the redefined inertial coordinate system is:

> "An inertial coordinate system is a coordinate system based on an object that is not subject to inertial acceleration."

It can be defined as. Once this reference coordinate system is determined, the redefined law of inertia can be applied using the redefined inertial coordinate system.

> "In an inertial coordinate system, an object without external forces acting upon it will either remain at rest or move in a straight line at a constant velocity. This is known as the law of inertia."

It can be expressed as. Galileo's redefined principle of relativity uses a redefined inertial coordinate system.

> "Dynamic phenomena observed in an inertial coordinate system are the same as dynamic phenomena observed in other inertial coordinate systems."

It is defined as. The use of the term "mechanical phenomenon" in this definition is to give a limited meaning to Einstein's principle of relativity, which will be discussed later, and does not imply that Newtonian mechanics is necessary for this definition. If you do not like this expression,

> "Phenomena observed in an inertial coordinate system are the same as phenomena observed in other inertial coordinate systems. However, this does not include wave propagation phenomena such as those in optics and electromagnetism."

You can also write it like this.

These definitions do not include the phenomenon of gravity. Basically, any location with a gravitational field gradient is not an inertial coordinate system. Excluding gravity in this way is the same as the previous definition methods.

4.2 Galileo's Inertial Coordinate System

In general, inertial coordinate systems are not distinguished as Galileo's inertial coordinate system or Einstein's inertial coordinate system, but the concept of an inertial coordinate system based on Galileo's principle of relativity is a concept that holds true without including wave propagation phenomena in optics, electromagnetism, etc., so confusing it with a concept that includes wave propagation phenomena will lead to incorrect conclusions. Such incorrect conclusions refer to special relativity, but in order to avoid such confusion, we will call the inertial coordinate system based on Galileo's idea the Galileo inertial coordinate system and define it clearly.

(1) "Galileo's inertial coordinate system is a coordinate system based on an object that is not subject to inertial acceleration. However, phenomena that can be observed using this coordinate system do not include wave propagation phenomena such as those in optics and electromagnetism."

In addition to the definition above, the following two conditions hold true for Galileo's inertial coordinate system.

(2) "A coordinate system that moves at a constant velocity in a straight line relative to Galileo's inertial coordinate system is also Galileo's inertial coordinate system."

(3) "For Galileo's inertial coordinate system, a group of coordinate systems with zero relative velocity are the same Galileo inertial coordinate system."

What (2) is saying is that if you throw a ball from a car traveling in a straight line at a constant speed,

Ball speed as seen from Earth =

Speed of the car as seen from Earth

+ Speed of the ball as seen from the car

This means that the two coordinate systems of the Earth and the automobile can be linked by a relationship called the Galilean transformation.

What this (3) means is that when two people, A and B, play catch on a ship traveling in a straight line at a constant speed relative to the Earth, the situation is no different from when the ship is stationary relative to the Earth. Therefore, Galileo's inertial coordinate system taken with respect to A and Galileo's inertial coordinate system taken with respect to B can be considered the same Galileo's inertial coordinate system.

Of course, these things hold true only in the approximation that considers the Earth as Galileo's inertial coordinate system.

4.3 Michelson-Morley Experiment

Galileo's principle of relativity can be applied to mechanical phenomena, but can it also be applied to optics and electromagnetism? In the past, a hypothetical medium called ether was considered as the medium through which light waves propagated, and it was thought that light propagated through this ether at a constant speed. Maxwell's electromagnetism includes a constant called the speed of light in its equations, which meant that when electromagnetic waves were emitted from a moving object, those electromagnetic waves propagated from that object at a constant speed, the speed of light.

Physicists of the time reasoned that if the speed of light is constant, then this speed could be used as a reference to determine the relative velocity of an object with respect to the ether. Based on this idea, people like Michelson and Morley attempted to measure the relative velocity of the Earth with respect to the ether. This experiment is known as the famous Michelson-Morley experiment. The method of this experiment involves radiating light in various directions and measuring the speed of light in each direction. If light is not affected by the velocity of a moving object, then the speed of light propagation should differ depending on the direction. This is because it is unlikely that the Earth is stationary with respect to the ether.

Contrary to Michelson et al.'s predictions, the speed of light did not change with direction. The result showed that light propagates at the same speed in all directions. Michelson et al.'s experiment demonstrated that light, like mechanical objects, satisfies Galileo's principle of relativity.

4.4 Einstein's Special Theory of Relativity

Since the error of Einstein's special theory of relativity was already proven in Chapter 1, there is no need to discuss it further. However, it may not be meaningless to understand exactly where this theory is wrong. In this section (4.4), we will explain Einstein's special theory of relativity without criticism. For the sake of clarity, this explanation will not adhere strictly to Einstein's original method of explanation, but it will be a commonly used explanation of special relativity, which Einstein himself acknowledged.

Einstein made two assumptions in constructing this theory.Einstein called that assumption a principle. Einstein's definition of these two principles is:

(1) (Einstein's) principle of relativity

"The laws describing the changes in the state of a physical system are the same in form regardless of whether the changes in state are described in terms of either of two coordinate systems moving at a constant velocity relative to each other."

(2) The principle of the constancy of the speed of light states

"Light always travels at a constant speed c through a 'stationary' coordinate system. This is true whether the light originates from a stationary object or a moving object."

Therefore, the "steady" system in the principle of the constancy of the speed of light means "a coordinate system in which Newton's equations of mechanics hold true with good approximations."

(1) A train thought experiment regarding the motion of light propagating parallel to the direction of motion.

Now, let's consider a long train that can be thought of as a rigid body. This train is moving in a straight line at a constant velocity v as viewed from another "stationary" coordinate system S. There is a light source L at the center of the train, and its speed of light is c. Let the ends of the train, equidistant l from the center, be A and B. Assume the train is moving from A to B as viewed from S, and let S’ and be the "steady" coordinate system relative to the train.

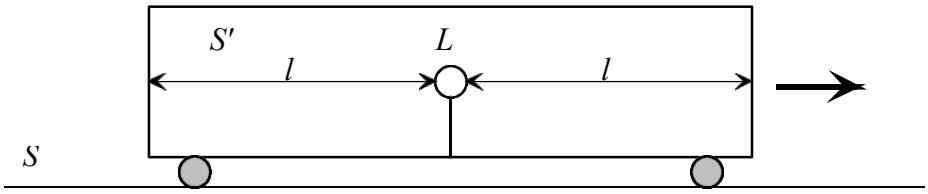


Figure 4.1 The train thought experiment

v

In this experimental setup, let's compare the view from point S and from point S', when light is emitted from a light source L in the center of the train.

From the perspective of S', the time it takes for light to reach A and B is equal. Using the time $\Delta t'$ in the coordinate

$$\Delta t' = \frac{l}{c}$$

This can be said from the interpretation of Einstein's principle of relativity, which states that light travels at the same speed relative to S whether it is directed towards A or B.

If we observe the same thing from S, then, according to the principle of the constancy of the speed of light, which states that light propagates at a constant speed c regardless of the motion of the light source, we will observe that both the light heading towards A and the light heading towards B propagate at a constant speed c as seen from S. Since the train is moving while this light is propagating, the time when the light reaches A and the time when it reaches B must be different as seen from this coordinate system S. If the time it takes for the light to reach B is Δt_B, then the path length of the light is $c\Delta t_B$, and during that time the train travels a distance of $v\Delta t_B$, so the total distance the light has traveled can be added to half the length of the train, l, and since that distance is equal to the path length of the light,

$$c\Delta t_B = l + v\Delta t_B$$
$$\Delta t_B = \frac{l}{c-v}$$

Conversely, since A is approaching the light, if we let Δt_A be the time it takes for the light to reach A,

$$c\Delta t_A = l - v\Delta t_A$$
$$\Delta t_A = \frac{l}{c+v}$$

Therefore,

$$\Delta t_A < \Delta t_B$$

Therefore, from the perspective of S, it can be seen that light does not reach both ends of the train simultaneously. This shows that the concept of simultaneous arrival is meaningless unless a coordinate system is specified.

(2) A train thought experiment regarding the motion of light propagating perpendicular to the direction of motion.

Next, let's consider the case where the train's light source L is on the floor, the distance from the floor to the ceiling is k, and the light is reflected back by a mirror M on the ceiling. We will observe this case at S' , S.

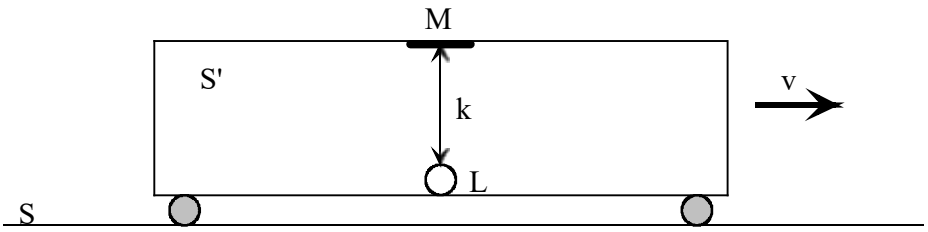


Figure 4.2 A thought experiment in which light is emitted perpendicular to the direction of the train's motion.

Assuming S', the round-trip time of light $\Delta t'$ is such that light rises straight up and descends straight down. Because it is observed to be descending,

$$\Delta t' = \frac{2k}{c}$$

Therefore, if viewed from S, the light would appear to rise and fall diagonally (Figure 4.3).

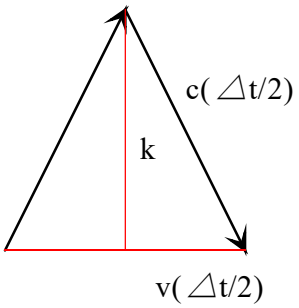


Figure 4.3 Path of light

The round-trip time of light Δt is,

$$(c\frac{\Delta t}{2})^2 = k^2 + (v\frac{\Delta t}{2})^2$$

$$(\frac{\Delta t}{2})^2 (c^2 - v^2) = k^2$$

$$\frac{\Delta t}{2} = \frac{k}{\sqrt{c^2 - v^2}}$$

$$\Delta t = \frac{2k}{c\sqrt{1 - v^2/c^2}}$$

$$\Delta t = \frac{2k/c}{\sqrt{1 - v^2/c^2}}$$

Therefore, the relationship between $\Delta t'$, and Δt is:

$$\Delta t = \frac{\Delta t'}{\sqrt{1-v^2/c^2}}$$

Therefore, time in a moving coordinate system progresses more slowly than time in a stationary coordinate system.

While there are many other things written about special relativity, this is sufficient to understand the most basic concepts, and it is also sufficient to point out its errors. Since special relativity is wrong, all subsequent theories are also wrong, so there is no need to mention anything else.

4.5 Understanding of Coordinate Systems in Special Relativity

In his paper, Einstein avoided using the terms "inertial frame of reference" or "inertial coordinate system," instead using phrases like "two coordinate systems moving at a constant velocity relative to each other" and "a coordinate system ("stationary" system) in which Newton's equations of mechanics hold with good approximation." Although the terms "inertial frame of reference" and "inertial coordinate system" likely existed at that time, he did not use them. Why did he use such vague expressions instead of using the term "inertial frame of reference"?

In the preface to his paper on special relativity (officially titled "On the Electrodynamics of Moving Bodies"), Einstein wrote:

> "It is believed that the laws of electrodynamics and optics always hold true in the same form for all coordinate systems in which the equations of mechanics hold true."

He speculated that this was the case, and called this speculation the principle of relativity. This idea had also been expressed by Lorentz. However, such an explanation would be highly inappropriate as a proposition. In this paper, Einstein describes in considerable detail how time is defined, but he gives very little description of the hypothetical principle of relativity. The vague expression "all coordinate systems in which the equations of mechanics hold" directly leads to the ambiguity of the theory. In fact, it is this vague understanding that makes the theory of relativity erroneous. Because Einstein's principle of relativity is expressed vaguely, readers of this paper must make a considerable amount of speculation. We are forced to speculate. Could "all coordinate systems in which the equations of mechanics hold" refer to Galileo's inertial coordinate system? If interpreted in this way, Einstein's principle of relativity is,

> "In Galileo's inertial coordinate system, the laws of electrodynamics and optics always hold true in the same form."

This would be the case. Einstein also adds the following second requirement in this paper.

> "Light always propagates through a vacuum at a constant speed c, and this speed is independent of the motion of the light source."

This second requirement is what is known as the principle of the constancy of the speed of light. After stating these two requirements, Einstein said the following:

"At first glance, this might seem to contradict the first requirement. However, these two requirements are sufficient to construct a simple and consistent electrodynamics of moving bodies based on Maxwell's theory of stationary bodies."

If it is said that "at first glance it may seem to contradict the first requirement," then upon closer examination it should not appear to contradict. If Einstein had been confident that the assumptions he had put forward were not contradictory, he would have stated that, and should have. The fact that he did not do so means that Einstein himself admitted that his assumptions might be contradictory.

If the assumptions used to construct a theory are mutually contradictory, then no matter how simple and consistent the subsequent conclusions may be, they are utterly meaningless.

What does it mean that "at first glance, this may seem to contradict the first requirement"? If we interpret "all coordinate systems in which the equations of mechanics hold" as Galileo's inertial coordinate system, then Galilean transformations are possible. However, the principle of the constancy of the speed of light shows that Galilean transformations are not possible. Therefore, the statement that "the laws of electrodynamics and optics always hold in the same form for Galileo's inertial coordinate system" is a contradiction. This is probably what Einstein meant by "at first glance." So what happens when we think about it carefully? To consider this, let's conduct the following thought experiment.

(1) The trolley thought experiment

Now, let's assume we have three trolleys A, M, and B that can be considered as rigid bodies. These trolleys are moving in a straight line at a constant velocity v as viewed from another "steady" coordinate system S. There is a light source L on the central trolley M, and its speed of light is c. The other trolleys A and B are equidistant l from the central trolley M, and the three trolleys are moving in the direction from A to B as viewed from S. Let $\mathrm{S_A}$, $\mathrm{S_M}$, and $\mathrm{S_B}$ be the "steady" coordinate systems based on each trolley. The distance l is assumed to be long enough to consider the phenomenon of light propagation, and the lengths of the three trolleys are negligibly short with respect to this distance, and their masses are small.

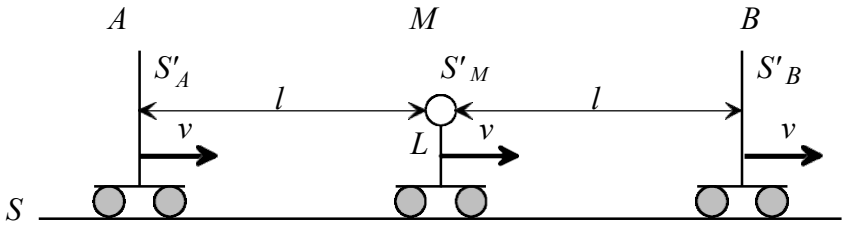


Figure 4.4 The Trolley Thought Experiment

In this experimental setup, let's compare the view from point S with the view from points $\mathrm{S_A}$, $\mathrm{S_M}$, and $\mathrm{S_B}$ when light is emitted from the light source L in the central trolley M.

When viewed from S, light propagates at a constant value c, regardless of the motion of the light source. According to the principle of the constancy of the speed of light, both the light heading towards A and the light heading towards B are observed to propagate at a constant speed c as seen from S. Since the trolley is moving while this light is propagating, the time when the light reaches A and the time when it reaches B must be different as seen from this coordinate system S. If the time when the light reaches B is Δt_B, then the path length of the light is $c\Delta t_B$ is the distance, and during that time the trolley travels a distance of $v\Delta t_B$, so the whole The distance traveled by the light can be calculated by adding the distance l between the trolleys, and since that distance is equal to the path length of the light,

$$c\Delta t_B = l + v\Delta t_B$$
$$\Delta t_B = \frac{l}{c-v}$$

Conversely, since A is approaching the light, if we let Δt_A be the time it takes for the light to reach A,

$$c\Delta t_A = l - v\Delta t_A$$
$$\Delta t_A = \frac{l}{c+v}$$

Therefore,

$$\Delta t_A < \Delta t_B$$

Therefore, from S's perspective, it can be seen that light cannot reach trolleys A and B at the same time. This is exactly the same result as in the train thought experiment.

Next, let's consider the case from S_A, S_M, and S_B. What will be the time it takes for light to reach A and B? If we consider S_A, S_M, and S_B to be Galilean inertial coordinate systems, then, as stated in 4.2(3), "a group of coordinate systems with zero relative velocity to Galilean inertial coordinate systems are the same Galilean inertial coordinate system," so S_A, S_M, and S_B can be considered as the same Galilean inertial coordinate system S. If we consider this inertial frame to be a "stationary" coordinate system, then the light will The time taken to reach A and B is equal, and using the time Δt in this coordinate system,

$$\Delta t' = \frac{l}{c}$$

This is because, in Einstein's principle of relativity for "stationary" systems, light travels at the same speed relative to S whether it is heading towards A or B. In this case, if observed from S_M, one would observe that the light reaches A and B simultaneously. However, the principle of the constancy of the speed of light states that light propagates at a constant speed c regardless of the velocity of the moving object, so the light from the trolley M is radiated in all directions at c as seen from S, and during this time the trolley A, M, and B are moving, even from S_M's perspective, the speed of light does not depend on the direction.This should result in a difference. In other words, from the perspective of the SM, the relative speed of light is observed to be faster in direction A and slower in direction B. A, M and Since the relative distance between M and B remains constant, light travels faster to A than to B.We will observe that it reaches its destination. Of course, this is the same from S's perspective as well.

If, as relativists claim, light propagates at a constant speed c from S, then light would reach A and B simultaneously. However, logically, from S's perspective, this would mean that the light traveled slowly in the direction of A and quickly in the direction of B. If light were to move in this way, it would contradict the principle of the constancy of the speed of light. Relativists argue that even in such a case, from S_M's perspective, the speed of light is c regardless of direction, and also c from S_M's perspective, but this logic can be easily refuted.

Assume that the object is traveling in a straight line with a constant velocity v relative to the coordinate system S. Let o be the position of trolley M in S at the moment when light is emitted from M, and set variables indicating the relative positions of the object to o before and after the direction of motion of the trolley M. Let a be the point after and b be the point before. According to the principle of the constancy of the speed of light, the condition for light to reach a and b simultaneously is that the distance between o and a is oa, If ob is the distance between o and b,

$$oa = ob$$

Next, In the above experimental apparatus, the same experiment is performed with the same position o as the source of light emission. At S, let oA be the distance between o and A, and oB be the distance between o and B. At the moment of light emission, the relationship between oA and oB, as observed from S, is:

$$oA = oB$$

The relationship after light is emitted is always,

$$oA < oB$$

Therefore, the motion of light emitted from trolley M cannot be affected by trolleys A and B which are located far away, so the motion of this light is the same as when M is running alone. Thus, the condition for the light to reach positions on S simultaneously from the perspective of S is oa = ob, so for the light to reach trolleys A and B simultaneously,

$$oA = oB$$

This must be the case. On the other hand, the relationship after the light is emitted is always oA < oB, so there is no point in S where the light reaches trolleys A and B simultaneously. Also, the coordinate systems S', set for trolley M and the like can be considered to exist within the coordinate system of S, so there is no point in S', where the light reaches trolleys A and B simultaneously.

Therefore, it is not the case that light travels at the same speed in directions A and B from the perspective of S_M. Special relativity arose simply from treating separate thought experiments, such as the train thought experiment and the trolley thought experiment, as the same experiment. If they are separate experiments, it is natural that the observed results will be different. There are differences in the state of the light propagation path between the train thought experiment and the trolley thought experiment, and special relativity does not take this into account.

For ordinary theories, this explanation would suffice, but those who prefer the confusing theories like special relativity would not be satisfied with this explanation. In the train thought experiment, they,

"From S's perspective, light reaches A and B simultaneously, but from S's perspective, they do not reach each other simultaneously."

Because these are the people who affirm that. I have no choice but to continue explaining. In the train thought experiment, "From S', the light is A and B are reached simultaneously, but from S perspective, they are not reached simultaneously." This can be refuted by using the common time discovered in Chapter 1. If we use the same common time, which is the same time used for S' and S, then it is impossible for the same phenomenon to be observed with different time values in S' and S. This is because, since the same time is used, it is natural that the same value will be shown. Therefore, in the train thought experiment, if light reaches A and B simultaneously from the perspective of S', then light also reaches A and B simultaneously from the perspective of S.

As a result, S_A, S_M, and S_B cannot be considered to be the same Galilean inertial coordinate system S'. Light does not travel at the same speed in all directions as viewed from S_M.

When light is emitted from a moving object, the speed of that light, as seen from the moving object, is not directionless. For example, the light from the headlights of a car traveling at 100 km/h will not be observed at a speed of 100 km/h + c from the perspective of a person on the ground. It will be c from the perspective of the ground. At this time, from the perspective of the car, the light from the car would be observed to be moving forward at a speed of c - 100 km/h. This is because the car is moving relative to the light.

The speed of light is so much faster than the speeds we experience in everyday life that anything said about light often sounds fantastical and lacks persuasiveness. This trolley thought experiment is not something that can actually be done, and logic doesn't work on relativists, which is problematic. Therefore, we have no choice but to show examples that demonstrate this understanding without using light. Galilean transformations cannot be applied to light, but light and electricity are not the only things to which Galilean transformations cannot be applied. There are also mechanical phenomena to which they cannot be applied. For example, water waves are dealt with by mechanics, not optics or electrodynamics. The statement that Galilean transformations cannot be applied to light and electricity is incorrect; what is actually incorrect is that they cannot be applied to waves.

If Einstein's principle of relativity is applicable to all physical systems, then it should naturally also be applicable to water waves and sound waves. Next, let's deepen our understanding of coordinate systems using water waves.

(2) Waves between boats traveling parallel to each other

Now, suppose there are two boats, A and B, on a lake, traveling parallel to the shore at the same speed v, separated by a constant distance l. If we set coordinate systems S_A and S_B on boards A and B respectively, and ignore the effects of Earth's gravity, then S_A and S_B can be considered Galileo's inertial coordinate systems.

4.2(3) as stated above, Galilean's definition of an inertial coordinate system states that a group of coordinate systems with zero relative velocity to a given Galilean inertial coordinate system is the same Galilean inertial coordinate system. Therefore, S_A and S_B can be considered to be the same Galilean inertial coordinate systems S' and .

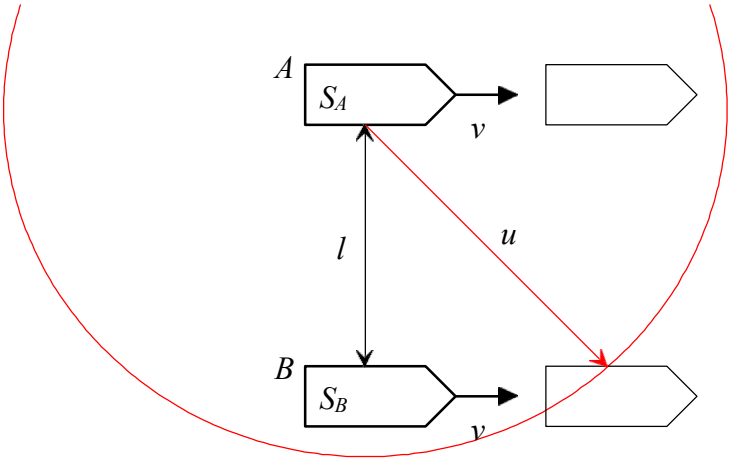


Figure 4.5 Wave propagation between parallel boats

If two people from boats A and B play catch, throwing the ball towards each other, they can do so without being aware that their boats are moving. From this phenomenon, we can consider that boats A and B are in the same Galilean inertial coordinate system S'. Of course, air resistance and other factors are ignored.

Next, the person in boat A strikes the surface of the lake, and the resulting water waves reach boat B. This phenomenon is observed from an inertial coordinate system S fixed to the shore. For simplicity, we will ignore the disturbance on the lake surface caused by the boat, and assume that the waves generated by the boat hitting the water spread out in a circular pattern, similar to the waves caused by a stone falling vertically. In this case, if we let the wave propagation speed be u and the time it takes for the wave to reach boat B be Δt,

$$u^2(\Delta t)^2 = l^2 + v^2(\Delta t)^2$$

$$\Delta t = \frac{l}{\sqrt{u^2 - v^2}}$$

$$\Delta t = \frac{l/u}{\sqrt{1 - v^2/u^2}} \qquad (3.1)$$

This is the result.

Now, let's consider the case where boats A and B have zero relative velocity to the shore, that is, they are at rest. Similarly, if the distance between boats A and B is l, and the time it takes for a wave to propagate from boat A hitting the water surface to boat B is Δt',

$$\Delta t' = \frac{l}{u} \qquad (3.2)$$

This is the result.

Assuming that the definition that a group of coordinate systems with zero relative velocity are the same Galilean inertial coordinate system holds true for wave propagation, then Δt in equation (3.1) and $\Delta t'$ in equation (3.2) must be equal,

$$\Delta t = \frac{\Delta t'}{\sqrt{1 - v^2/u^2}}$$

Therefore, the two are clearly not equal.

"The definition that a group of coordinate systems with zero relative velocity to a single Galilean inertial coordinate system are the same Galilean inertial coordinate system does not hold true in the phenomenon of wave propagation."

This leads to the conclusion that...

What has been stated here is that when observing wave propagation, the state of the propagation path influences the wave propagation phenomenon. This may seem obvious. However, in special relativity, light waves are thought to propagate at a constant speed regardless of the state of the propagation path. The idea that the interaction can be described by the relative speed between the wave source and the wave receiver, without considering the state of the wave propagation path, is certainly simple, but as has been stated here, it does not reflect the real world.

If we observe the phenomenon of waves propagating between a boat stationary relative to the shore from the sun, we see that the shore, the boat, and the lake surface are not actually stationary. However, on Earth, we can consider the shore, the boat, and the lake surface to be stationary. The concept of an inertial coordinate system became necessary because it was needed to demonstrate that when observing motion using a coordinate system that is considered to be in motion as a reference, there is no difference in observation compared to a coordinate system that can be considered virtually stationary. For the phenomenon of wave propagation to be included in such a coordinate system, it can exist without contradiction if the medium transmitting the waves has zero relative velocity with respect to other matter. Therefore, a coordinate system like the one envisioned by Einstein certainly exists.

4.6 Inertial Coordinate System Applicable to Waves

Since the understanding of a coordinate system that can handle Einstein's optics and electrodynamics is ambiguous, let's define such a coordinate system here.

As stated in 4.2(1), Galileo's inertial coordinate system is

> "Galileo's inertial coordinate system is a coordinate system based on an object that is not subject to inertial acceleration. However, phenomena that can be observed using this coordinate system do not include wave propagation phenomena such as those in optics and electromagnetism."

This was defined as. It can be considered that removing the restrictions of this definition results in an inertial coordinate system that can handle waves. If we call this coordinate system a wave-inertial coordinate system, then the wave-inertial coordinate system is:

> "A wave-inertial coordinate system is a coordinate system based on an object that is not subject to inertial acceleration."

It can be said that...

To verify such a coordinate system, one can propagate a wave (such as a light wave) and observe it from this coordinate system. If the wave propagates at the same speed in all directions, then this coordinate system can be recognized as a wave-inertial coordinate system.

Wave propagation generally depends on the state of the propagation path. Therefore, if the propagation path is moving at the same speed as the wave source (relative velocity zero), then that space can be considered a wave-inertial coordinate system. This idea was derived from considering the thought experiment (which could also be done as an actual experiment) of "waves between parallel moving boats."

The reason why waves emitted from a moving ship appear to have different speeds depending on the direction from the ship's perspective is because the wave propagation path does not have a relative velocity of zero with respect to the ship. This is also true for light waves. The reason why light emitted from a moving car appears to have different speeds depending on the direction from the car's perspective is because the relative velocity between the light propagation path and the car is not zero.

From this consideration, it seems that Galileo's inertial coordinate system can only be considered a wave-inertial coordinate system in its immediate vicinity. Therefore, wave-inertial coordinate systems, like Galileo's inertial coordinate system,

"A coordinate system that moves at a constant velocity in a straight line relative to Galileo's inertial coordinate system is also Galileo's inertial coordinate system."

"With respect to Galileo's inertial coordinate system, a group of coordinate systems with zero relative velocity are the same Galileo inertial coordinate system."

That does not apply. In other words,

"A coordinate system that moves at a constant velocity in a straight line relative to a wave-inertial coordinate system cannot be considered a wave-inertial coordinate system."

"A group of coordinate systems with zero relative velocity to a wave-inertial coordinate system are generally not the same wave-inertial coordinate system. To consider them as the same wave-inertial coordinate system, the wave propagation phenomenon must be used, and the wave propagation speed must be the same in all directions between the coordinate systems in question."

4.7 On the Adjunction of Light Propagation Paths

The idea that light moves along with the motion of its propagation path was proposed by George Stokes in 1845. At that time, the medium through which light propagated was thought to be the ether, but Stokes' idea was that "the ether moves completely with the Earth on its surface, and moves independently of the Earth far from the surface." Against this idea, Lorentz pointed out that the ether does not move with the Earth without separating at every point on its surface. As you know, no one has ever detected the ether. So how did Lorentz know the characteristics of the ether?

Because ether has never been detected, it has been excluded from modern physics, based on the idea that it is inappropriate to introduce such a concept into physics. Instead, the concept of fields, familiar from electrodynamics and other fields, has been introduced. If there is an electric charge, there is an electric field around it. If there is mass, there is a gravitational field around it.

While the ether may not be accompanied by the Earth, there is something that is: the gravitational field. The Earth's gravitational field moves in conjunction with the Earth. This can be demonstrated by the following experiment.

Suppose we have a mass-bearing object M at point A on the coordinate system. Next, suppose we move this object M to another point B on the coordinate system. If object M's gravitational field does not follow it, then object M's gravitational field should be present at point A. Experiments have shown that object M's gravitational field is not present at point A, but at point B. Therefore, the gravitational field generated by an object follows that object.

By process of elimination, if light is accompanied by an object, it can only be assumed to be accompanied by the object's gravitational field. The fact that light entering a gravitational field is bent is an experimental fact, regardless of the basis for the experiment. The bending of light entering a gravitational field means that the speed of light has changed, and it is not such a far-fetched idea to think that the path of light is affected by a moving gravitational field.

The idea that light does not follow the motion of objects in its propagation path is considered to be a defense of special relativity. However, if light does not follow the motion of objects in its propagation path, the Michelson-Morley experiment cannot be held. As is clear from the comparison between the train thought experiment and the trolley thought experiment, in the trolley thought experiment, where light does not follow the propagation path, it is impossible for light to reach trolleys A and B simultaneously. Conversely, if light reaches A and B simultaneously in the train thought experiment, then the light must have followed the propagation path.

Special relativity, in one respect, assumes that light does not accompany moving objects, while in another respect, assumes that it does. Therefore, if light does not accompany moving objects, it would contradict special relativity itself.

Ultimately, does light follow a moving object or not? The Michelson-Morley experiment showed that light followed a moving object, and therefore the speed of light did not differ depending on the direction. What the Michelson-Morley experiment demonstrated was that light follows a moving object.

4.8 The Concept of Absolute Velocity

Galileo and Newton's law of inertia states that if no acceleration acts upon an object, that object is either at rest or in uniform linear motion. However, if we consider this acceleration to be relative acceleration, then the concepts of rest or uniform linear motion become meaningless. For example, if you observe a station from an accelerating train, relative acceleration will be acting on the station, but the station is usually considered to be at rest.

If the acceleration used in the law of inertia is indeed inertial acceleration, then the concepts of rest and uniform linear motion become meaningful. Using this quantity, it is possible to clearly and quantitatively demonstrate that it is the train that is moving, not the station. Newton attempted to address such problems by assuming absolute velocity and absolute acceleration, which are velocity relative to absolute space, but with the knowledge available at the time, it was difficult to recognize the concept of absolute velocity.

The concept of inertial velocity is a quantity that indicates the change in velocity when the inertial acceleration changes from an initial state of zero inertial acceleration. Therefore, the initial velocity of an object cannot be determined using this inertial velocity. In order to give any substantial meaning to absolute velocity, there must be a way to determine the velocity of an object in this initial state. Does such a method exist?

"Imagine there is only one object in the universe. In this case, do the concepts of position and velocity of that object have any meaning? Newton thought that they are defined as position and velocity relative to absolute space. But how can we detect the existence of this absolute space? We always define position and velocity in relation to other objects. But if there is only one object in the universe, there is nothing to compare it to, so the concepts of position and velocity are meaningless. In other words, space is relative, and absolute space does not exist." This is the view of Bishop Berkeley and others, and it is also the mainstream view of modern physics.

Poincaré states: "The principle of relativity states that the laws of various physical phenomena are the same for an observer at rest and for an observer undergoing uniform parallel translation relative to that observer. Therefore, there is no way, and it is impossible, to distinguish whether or not an observer is undergoing such uniform motion." This is also Einstein's position.

To prove that Bishop Berkeley and his colleagues' ideas are wrong, all that is needed is to detect the existence of absolute space. To do this, one would need a way to detect the velocity of a single object in the universe. If that velocity can be detected, then that velocity can be called absolute velocity.

The speed of light does not depend on the speed of the light source. This property also exists for sound waves and is a general property of waves. Sound requires air or other media for propagation, but light can propagate even in a vacuum, which is considered to be empty space. Therefore, let's use light as a measurement tool.

First, let's assume that there is only one spaceship in the universe. Assume there is no external gravity, and that the accelerometer installed inside the spacecraft indicates that the inertial acceleration is zero. Therefore, the spacecraft can be considered to be at rest or in uniform, uniform linear motion. This single spacecraft consists of several parts, and some parts can be detached, like a lunar lander. The main body of the spacecraft will be simply called the spacecraft, and the detachable parts will be called the lander. The spacecraft has a light-emitting device, and both the spacecraft and the lander have clocks with the same characteristics, allowing for accurate time measurement.

From here, the lander is detached and moved to a distance so far that the spacecraft's own gravity is negligible. The lander's engines are then controlled to maintain a relative velocity of zero and a constant relative distance between the spacecraft and the lander. The question here is how to maintain a constant distance, but let's assume that it can be maintained by using something like a light, strong string. After this, light is emitted from the spacecraft and the time it takes for the light to reach the lander is measured. By repeating this operation in various directions, it is possible to determine how fast the light is traveling in each direction. This is because light does not depend on the spacecraft's velocity, and the presence or absence of the lander is not thought to affect the motion of the light. If the arrival time of light emitted in all directions is the same, then the spacecraft can be considered to be at rest.

If one were to argue that such a thought experiment is invalid, the basis for that argument would likely be the results of the Michelson-Morley experiment. The Michelson-Morley experiment was precisely an attempt to determine the absolute velocity of the Earth, and its method is fundamentally the same as that of this thought experiment. However, the difference between this thought experiment and the Michelson-Morley experiment lies in the state of the light propagation path, and it is an insufficient understanding of this difference that has led to erroneous theories such as relativity. That is, in the Michelson-Morley experiment, the propagation path is moving along with the light source, whereas in the spaceship thought experiment, it is not moving.

This movement of the propagation path is equivalent to the movement of its gravitational field, and it should be considered that the movement of the gravitational field has some effect on the motion of the light, and in fact, this difference was made clear by the Michelson-Morley experiment.

If a thought experiment like the one involving a spaceship were actually possible, it would be possible to give substantial meaning to concepts such as absolute space, absolute rest, and absolute velocity. From this perspective, the position and motion of an object are absolute, not relative. However, since it is impossible to realize a space without gravity or an empty universe, this experiment cannot actually be performed. Nevertheless, it is possible to conduct such an experiment within an arbitrary inertial coordinate system, in which case the arbitrary inertial coordinate system can be considered absolute space. In other words, it is possible to measure the velocity of an object moving at a constant linear speed within an arbitrary inertial coordinate system without comparing its relative displacement to other objects or coordinate systems. By doing so, an absolute velocity, rather than a relative one, can be obtained. This velocity is called inertial velocity.

4.9 Types of acceleration methods

When considering inertial acceleration, the values differ between acceleration due to gravity and acceleration due to non-gravity. This is because, in free fall, a well-known example of acceleration due solely to gravity, the value on an accelerometer placed inside the falling object remains completely unchanged, as empirically observed. Therefore, it can be concluded that the methods of accelerating an object can be broadly classified into acceleration due to gravity and acceleration due to non-gravity, and these must be treated separately.

Since inertial acceleration and inertial velocity differ between objects being accelerated and those not being accelerated, these values can be used to compare the states of these objects. If an accelerated object undergoes some change in accordance with its inertial velocity, then it can be assumed that there will be a difference between acceleration due to non-gravity and acceleration due to gravity. Such a difference cannot be expressed using relative velocity, because the method using relative velocity does not show a difference between acceleration due to non-gravity and acceleration due to gravity.

4.10 Regarding the maximum speed

According to relativity, no object can exceed the speed of light. While relativity is fundamentally flawed in that it deviates from the scope of relative velocity, making such a conclusion meaningless, the idea that there is some limit to the speed of an object is not entirely absurd.

For example, a yacht sailing in a wind of speed w cannot exceed w, no matter how hard it tries. Also, if the yacht's speed is small, it will accelerate linearly (the force due to the wind and the acceleration are proportional), but as the yacht's speed approaches w, it will gradually become more difficult to accelerate. The graph for such a case can be drawn as shown in Figure 4.6.

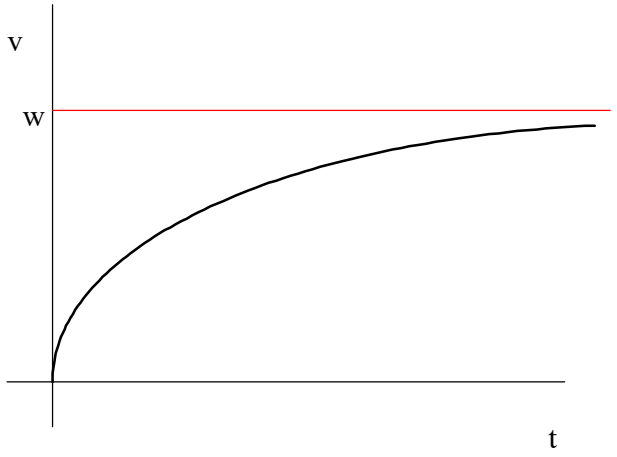


Figure 4.6 Graph of a yacht moving in a constant wind speed

In this case, the medium transmitting the force would be wind, but generally, any attempt to transmit an effect must be carried out at a finite speed. If the speed of the medium transmitting the force were infinite, the force would be transmitted instantaneously, but such an idea is occult and not very realistic. It is likely that the effect of transmitting force has a finite speed. If that speed is the speed of light, then the idea that the limiting speed is the speed of light is convincing. This is because if the speed of an object exceeds the speed of light, the effect of accelerating it will no longer be able to reach that object. However, this idea is only applicable when the object being accelerated is moving away from the source from which the accelerating force originates. Conversely, when the object being accelerated is moving towards the source from which the accelerating force originates, no matter what speed it reaches, the accelerating effect will always be able to reach the object. The former is the case of repulsion and the latter is the case of attraction.

Accelerating a heavy object requires a greater force than accelerating a light object. Therefore, accelerating an object of infinite mass requires an infinite force. Consequently, an object of infinite mass cannot be accelerated. On the other hand, when objects are dropped on Earth, heavy and light objects fall simultaneously. If we roughly extend this idea, an object of infinite mass and an object of infinitesimal mass will fall simultaneously. Consequently, according to gravity, an object of infinite mass can be accelerated in the same way as an object of infinitesimal mass. This logic is too rough, but if we assume that there is such a thing as a limiting velocity for an object's speed, and that it has some kind of functional relationship with its inertial velocity, then when an object is accelerated by gravity, the inertial velocity does not change, so we can conclude that there is no such thing as a limiting velocity.