
Theory of Everything
No Free Parameters
God didn't roll the Dice

Conclusion (Universe Truth)

God did not roll dice when creating the universe.

Parameters of particle physics and cosmology

- Why is space 3D?
- Strengths of the 4 forces (Why is there a hierarchy?)
- Masses and mixing ratios of all quarks and leptons
- Mass of the Higgs boson and vacuum expectation value
- Hubble constant and Inflation
- Ratio of dark energy, dark matter, and baryons
- Baryon number (Why is there so little antimatter?)

I will explain that all of these parameters are necessarily determined.

In other words, this is a theory of everything with no free parameters.

The theoretical and measured values of the fine structure constant and the gravitational constant are in perfect agreement.

First, I will state the truth of the universe as my conclusion.
God did not roll dice when creating the universe.
I have listed the parameters of particle physics and cosmology.
I will explain that all of these parameters are necessarily determined.
In other words, this is a theory of everything with no free parameters.
Ultimately, the theoretical and measured values of the fine structure constant and the gravitational constant are in perfect agreement.

Table of contents

Table of contents.
We'll start by considering the basics of why space is three-dimensional.
The first half covers particle physics, and the second half covers cosmology.
This is a long video because it explains all of the free parameters.
If you want to take your time, we recommend viewing the PDF version.

Why is space 3D?

Why is space three-dimensional?

Before deciding the properties of particles and forces,
we will begin by determining the number of dimensions of space.

God's Choice
- ▶ 1. Add the minimum number of dimensions necessary..
- 2. Add more dimensions than necessary.
  … The number of extra dimensions is up to God.
  God would have to roll the dice to decide.

To provide a inevitable explanation, we choose the former.
There must be some reason why two dimensions are not enough for space.
I'll explain why below.

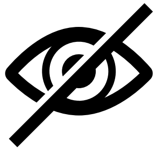
Before deciding the properties of particles and forces, we will begin by determining the number of dimensions of space.
First, let's think about why space is three-dimensional.
God has two options.
1. Add the minimum number of dimensions necessary.
2. Add more dimensions than necessary.
In the latter case, the number of extra dimensions is up to God.
In that case, God would have to roll the dice to decide.
To provide a inevitable explanation, we choose the former.
In other words, there must be some reason why two dimensions are not enough for space.

Why is space 3D?

Nothing

First of all, why do we need space?

A space where not a single elementary particle exists



No observer = Amount of information: 0 = Call it “nothing”

… No matter what properties space has, it is meaningless

First of all, why do we need space?
Let's consider a space where not a single elementary particle exists.
No matter what properties space has, it is meaningless.
Since there is no observer, the amount of information is zero.
Let's call a state with zero information amount "nothing”.

Why is space 3D?

Existence

The most basic elementary particle: minimum “existence”

“existence”: “something” that can be distinguished from "nothing“

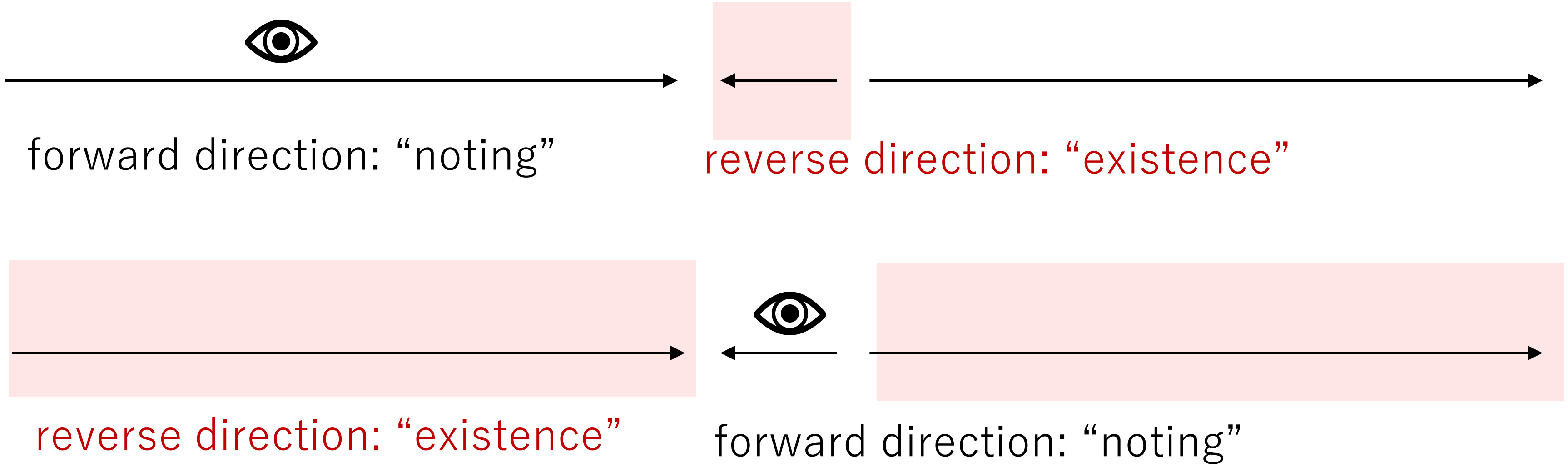
That “something” is space.
Imagine that one space can be distinguished from another in some way.
In that case, one can be defined as “existence" and the other as "nothing“.
A particle refers to the space of “existence“.

Let's start our design with the most basic elementary particle.
Consider the most basic elementary particle to be the minimum “existence“.
“existence" is “something” that can be distinguished from "nothing“.
That “something” is space.
Imagine that one space can be distinguished from another in some way.
In that case, one can be defined as “existence" and the other as "nothing“.
A particle refers to the space of “existence“.

Why is space 3D?

Reverse direction = “existence”?

Space has direction,
and we can distinguish between forward and reverse directions.



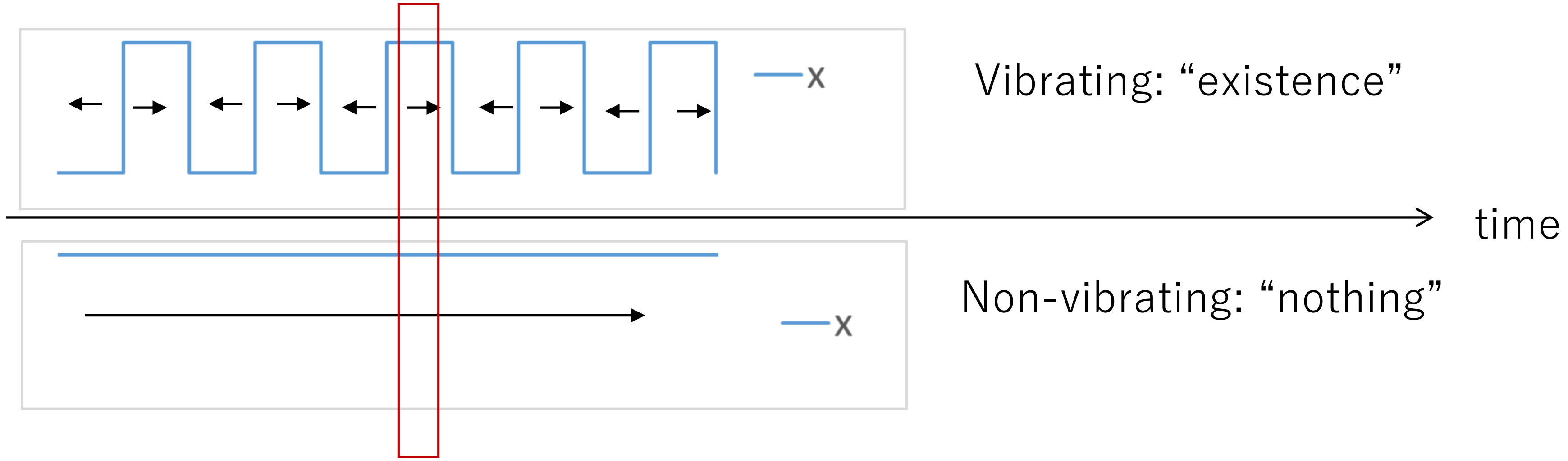
When viewed from the opposite direction,
the space that was "nothing" appears to be “existence“.

NG

Space has direction, and we can distinguish between forward and reverse directions.
Let's imagine a situation where the direction of only a certain range of space is reversed.
If the space is in the forward direction, we can define it as "nothing“, and if it is in the reverse direction, it is “existence“.
However, there is a problem with this definition.
When viewed from the opposite direction, the space that was "nothing" appears to be “existence“.
This definition of “existence" is flawed.

Why is space 3D?

Vibrating=“existence”?



Vibrating: “existence”

Non-vibrating: “nothing”

When observing space for only an infinitesimal amount of time,
it is impossible to tell whether it is vibrating or not.

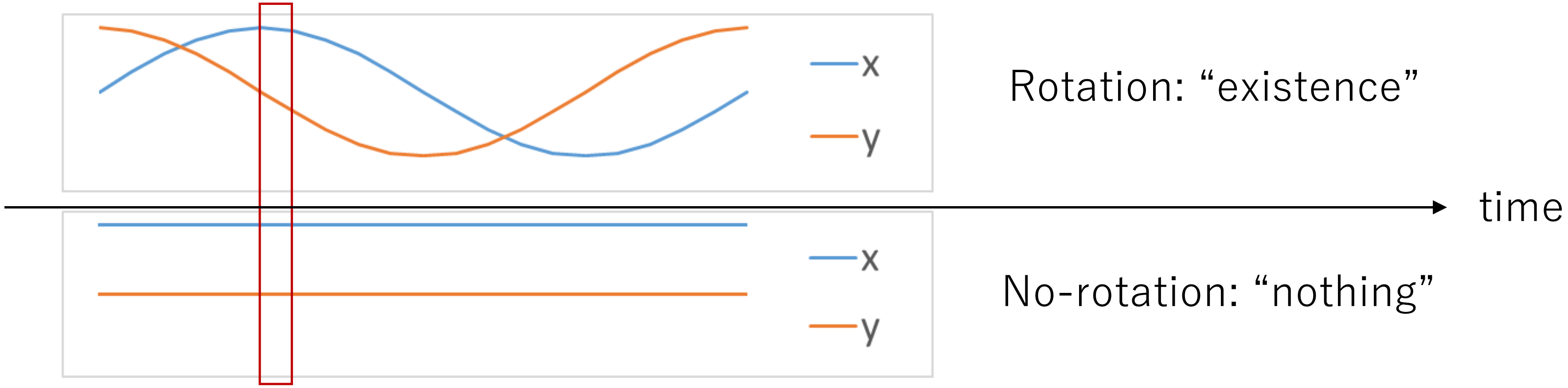
NG

Now let's make use of the time axis.
Imagine that the orientation of a certain range of space repeatedly reverses over time.
We can define vibrating space as “existence", and non-vibrating space as "nothing".
However, there is a problem with this definition.
When observing space for only an infinitesimal amount of time, it is impossible to tell whether it is vibrating or not.
This definition of “existence” is also flawed.

Why is space 3D?

Rotation="existence"?

Let's say the two axes smoothly swap over time.



This way, we can distinguish between "existence" and "nothing"
even when observing it for an infinitesimal amount of time.
We've been able to define "existence"
with two spatial dimensions and one time dimension.

OK

Now, let's make space two-dimensional.
Let's say the two axes smoothly swap over time.
In other words, if it is rotating, we define it as "existence".
This way, we can distinguish between "existence" and "nothing" even when observing it for an infinitesimal amount of time.
We've been able to define "existence" with two spatial dimensions and one time dimension.

Why is space 3D?

The rotational speed of the most basic particle

God's Choice
- 1. The smallest non-zero angular velocity
- 2. Any non-zero angular velocity
  … Roll the dice to decide

The most basic particle： Spin=1 $\hbar$
Vacuum： Spin=0 $\hbar$

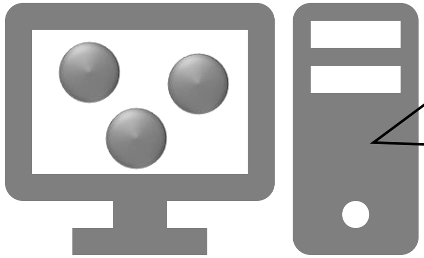
$\hbar$: Dirac constant

Let's consider the rotational speed of the most fundamental elementary particles.
God has two options.
1. The smallest non-zero angular velocity
2. Any non-zero angular velocity
The latter would be like God rolling the dice, so we'll go with the former.
Let's say the most fundamental elementary particles have spin 1, and the vacuum has spin 0.
The unit of spin is the Dirac constant.

Why is space 3D?

Particle ledger

Particles can be thought of as nothing more than representations of information.



Particle ledger

Memory address	x	y	rotation
0x0100	0x0000	0x0000	+1 $\hbar$
0x0200	0x0010	0x0114	+1 $\hbar$
0x0300	0x0020	0x0514	-1 $\hbar$

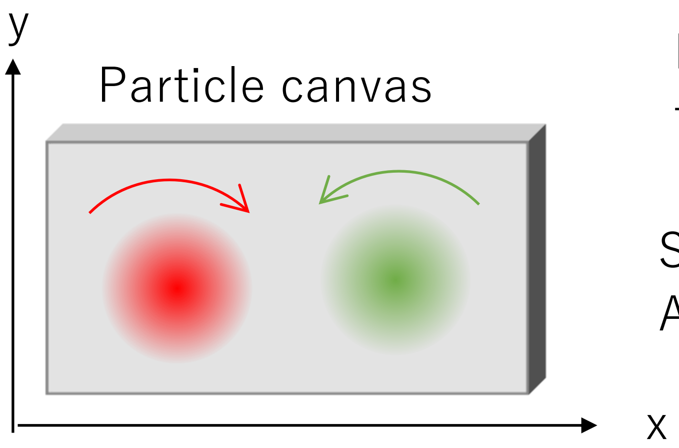
We need a mechanism to detect duplicate data.
We can distinguish between them by looking at the memory address.
A memory address is a one-dimensional integer.

Particles can be thought of as nothing more than representations of information.
For example, imagine a 3D graphic of elementary particles displayed on a computer screen.
However, in its essence, it is just hexadecimal data in memory.
What kind of information is recorded on God's computer simulating the universe?
There might be a ledger listing the positions of elementary particles, etc.
We need a mechanism to detect duplicate data.
We can distinguish between them by looking at the memory address.
A memory address is a one-dimensional integer.

Why is space 3D?

Particle canvas

To record data in two dimensions of space and one dimension of time,
let's make memory three-dimensional.



Memory addresses are
the space-time coordinates themselves.

Space-time is a canvas for recording information.
All particles are superimposed on this canvas.

The most basic particles are depicted as rotations with a non-zero magnitude.
They only have angular momentum, not spheres with a radius.

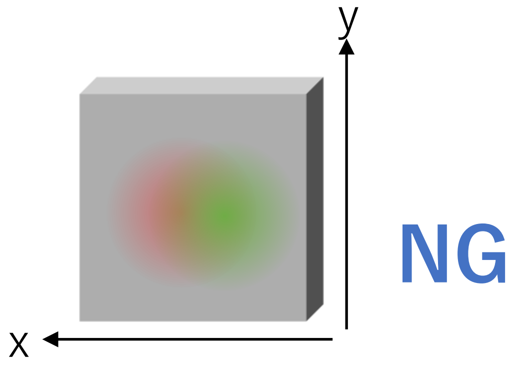
To record data in two dimensions of space and one dimension of time, let's make memory three-dimensional.
In that case, memory addresses are the space-time coordinates themselves.
In other words, space-time is a canvas for recording information.
All particles are superimposed on this canvas.
The most basic particles are depicted as rotations with a non-zero magnitude.
They only have angular momentum, not spheres with a radius.

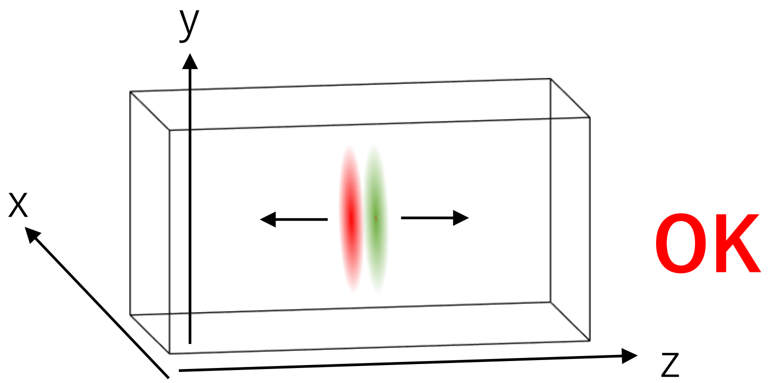
Why is space 3D?

4D Canvas

Particles have size in the direction of rotation.

If two particles are close together, they will overlap and cancel each other out.





To avoid this, we need to expand space into three dimensions.

Pair generated particles are move
in a direction perpendicular to the direction of rotation.

We have been able to express the minimum "existence"
with three spatial dimensions and one time dimension.

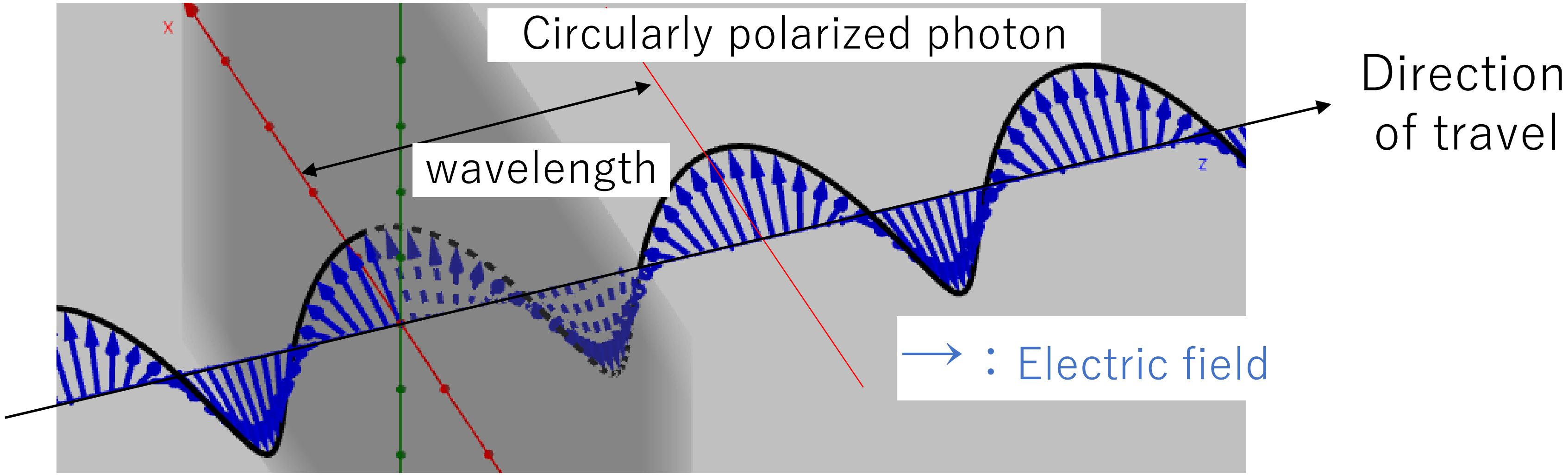
A problem arises when trying to paint multiple particles on a canvas.
Particles have size in the direction of rotation.
If two particles are close together, they will overlap and cancel each other out.
To avoid this, we need to expand space into three dimensions.
Pair generated particles are move in a direction perpendicular to the direction of rotation.
We have been able to express the minimum "existence" with three spatial dimensions and one time dimension.

Electromagnetic force

Photon

Most basic particle = photon

Spin of 1 that rotates once perpendicular to direction of travel

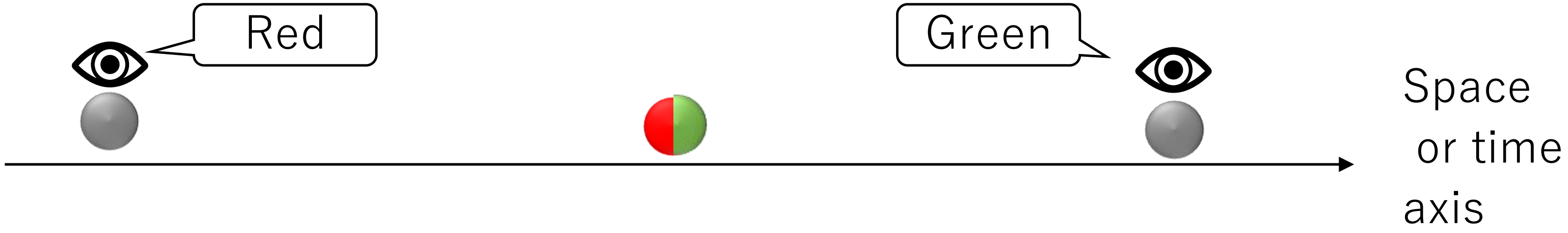


It is the particle that is said to have been created when God said, "Let there be light" in the beginning.

What is the most basic elementary particle?
It is an elementary particle with a spin of 1 that rotates once perpendicular to its direction of travel.
This matches the properties of a circularly polarized photon.
It is the particle that is said to have been created when God said, "Let there be light" in the beginning.

Electromagnetic force

Duality



When observing one particle from another particle, you cannot see the back side.
Conversely, an observer on the other side can only see the back side.
As a result, it is possible for the particles to appear to be completely different on the front and back sides.
Since space is three-dimensional, the same can be said for each axis.
In the case of the time axis, it is possible for particles to appear to be different when time goes backwards.

We are overlooking some of the information that particles can carry.
When observing one particle from another particle, you cannot see the back side.
Conversely, an observer on the other side can only see the back side.
As a result, it is possible for the particles to appear to be completely different on the front and back sides.
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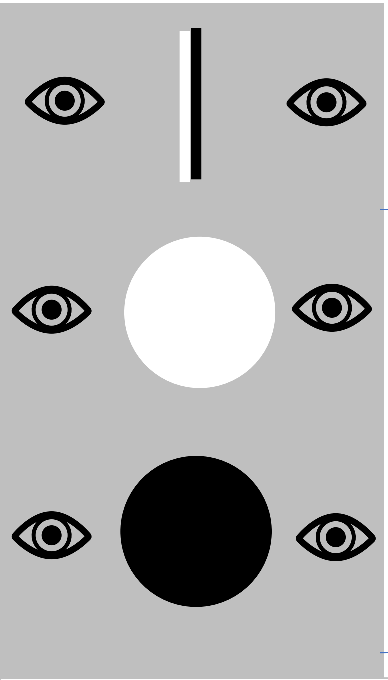
Electromagnetic force

Sphere

Since space has directions, let's illustrate it by using
white to represent one direction and black to represent the opposite direction.



The direction of a photon's electric field can be
represented by a plane with black and white on both sides.

We can assume that the particle is the same color
on both sides.
Since it appears to be the same direction from any direction
in three dimensions, it can be represented by a sphere.
There are two types of spheres: black and white.
This is a so-called conserved quantity
that does not change with the viewing direction or time.

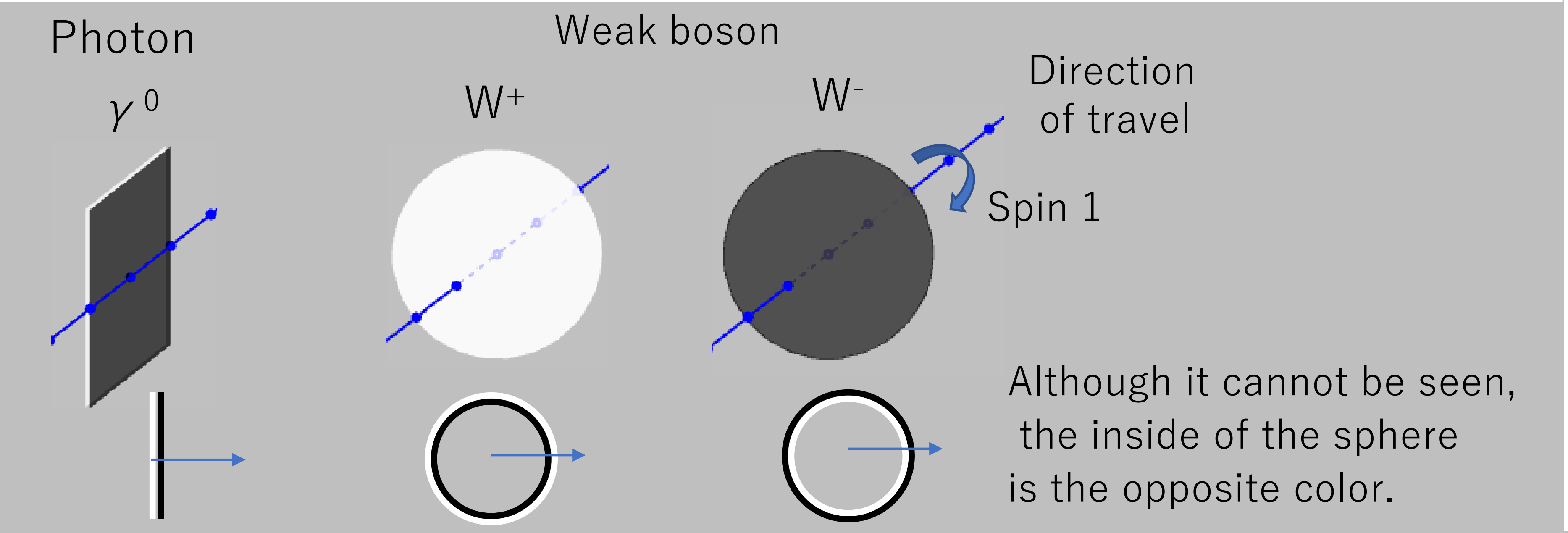
Since space has directions, let's illustrate it by using white to represent one direction and black to represent the opposite direction.
The direction of a photon's electric field can be represented by a plane with black and white on both sides.
The properties of the particle when viewed from the opposite side can be freely determined.
Therefore, we can assume that the particle is the same color on both sides.
Since it appears to be the same direction from any direction in three dimensions, it can be represented by a sphere.
There are two types of spheres: black and white.
This is a so-called conserved quantity that does not change with the viewing direction or time.

Electromagnetic force

Electric charge

White has a charge of +1, black has a charge of -1.

The average charge seen from all directions is the particle's charge.



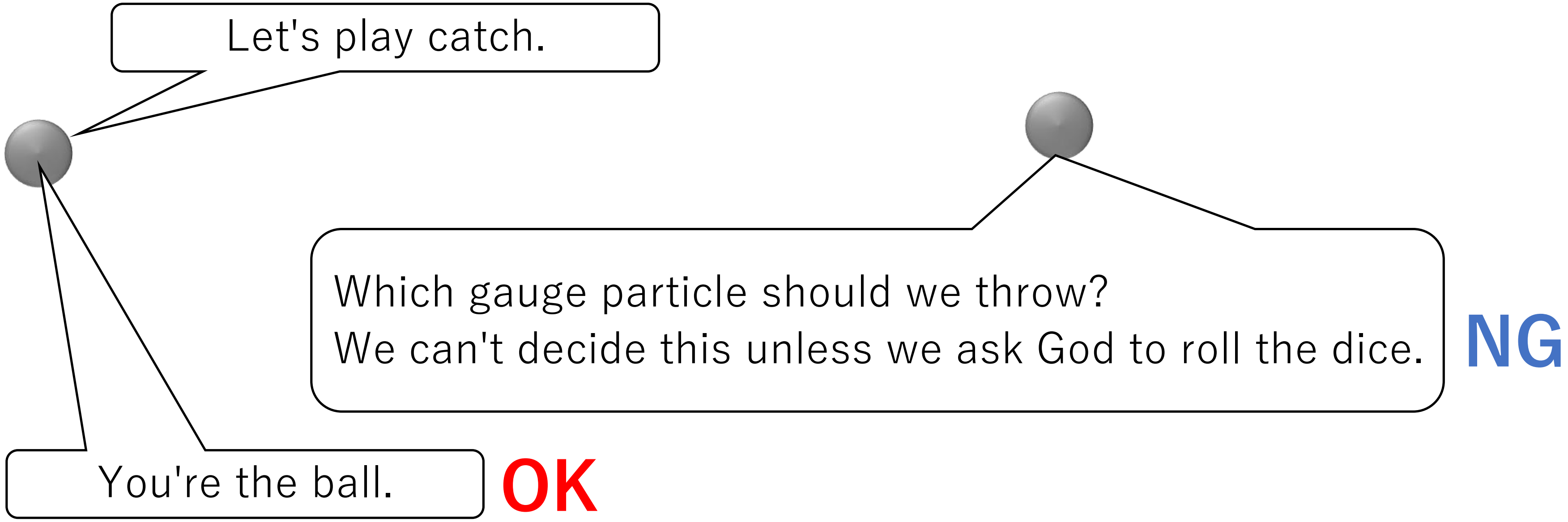
This conserved quantity corresponds to electric charge.
White has a charge of +1, and black has a charge of -1.
The average charge seen from all directions is the particle's charge.
If there is equal amounts of white and black, like a photon, the charge is 0.
A particle with a charge of ±1 and spin 1 corresponds to a weak boson.
Weak bosons are gauge particles that mediate the weak force.
Also, although it cannot be seen, the inside of the sphere is the opposite color.

Electromagnetic force

Why does force work?

Interactions can be likened to a game of catch between gauge particles.

Gauge particles are particles such as photons that mediate force.

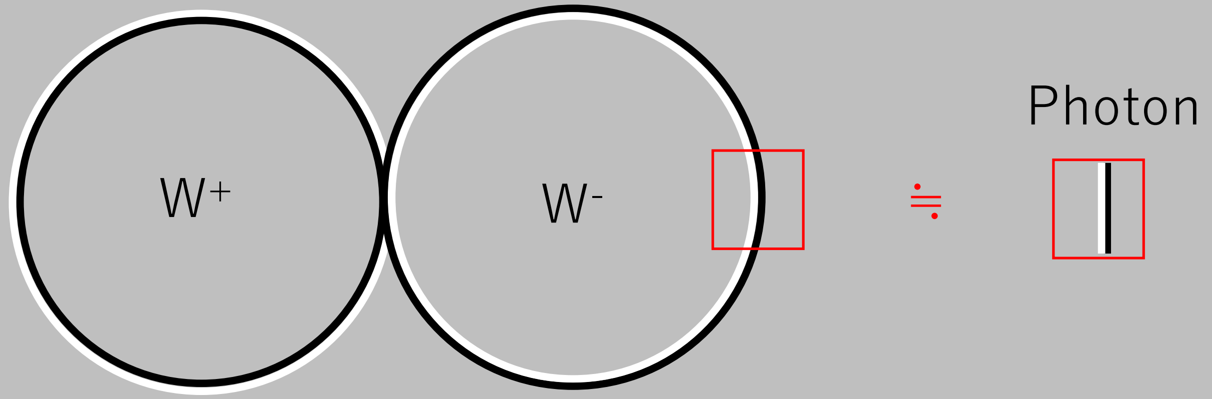


Next, let's think about why forces work.
Interactions can be likened to a game of catch between gauge particles.
Gauge particles are particles such as photons that mediate force.
Suppose a particle says, "Let's play catch“.
Which gauge particle should we throw?
We can't decide this unless we ask God to roll the dice.
The correct answer is, "You're the ball“.

Electromagnetic force

Intermediary

Although the diagram shows them as spheres, particles actually have no set size.
They just have an undefined size, not that they have no size.
If we assume the radius is equal to the distance between them,
the two particles can come into contact.

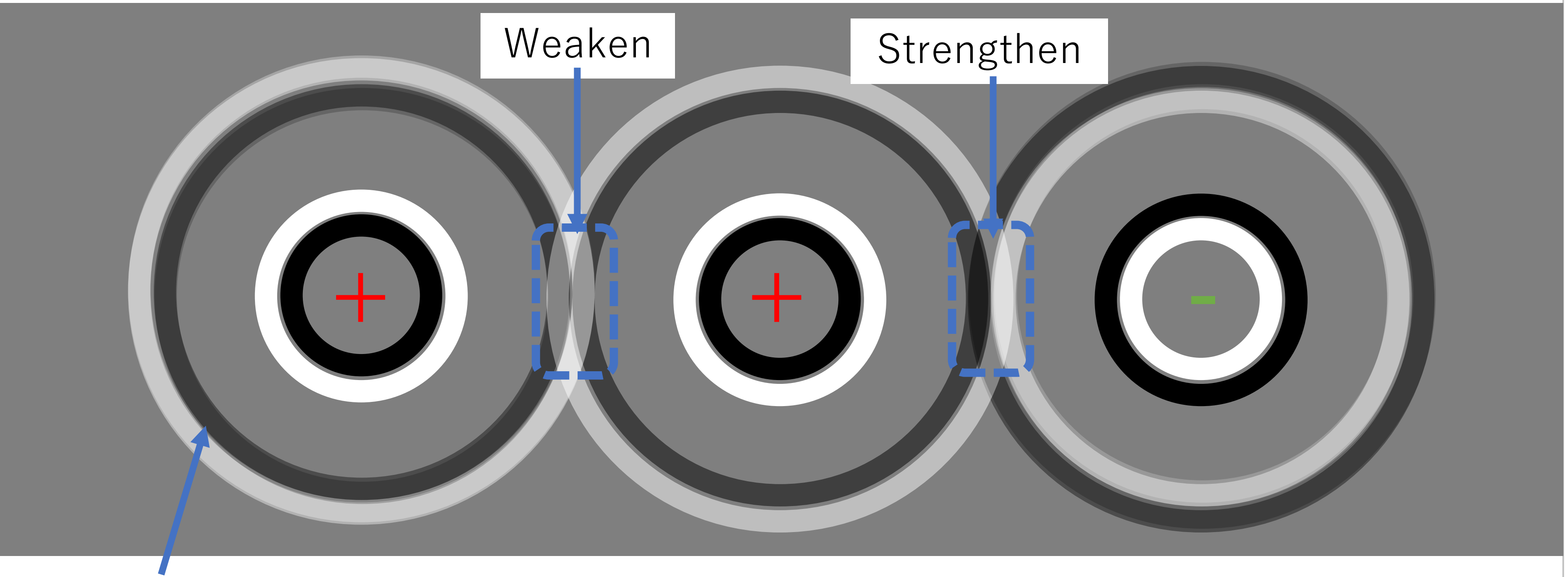


If you cut out a portion of the sphere, it looks exactly like a photon.
If you can't tell the difference, then it's the same as having a photon there.

This is a schematic diagram of two particles, one with a positive charge and one with a negative charge.
Although the diagram shows them as spheres, the particles actually have no set size.
They just have an undefined size, not that they have no size.
If we assume the radius is equal to the distance between them, the two particles can come into contact.
It seems they can interact without the intermediary of a photon.
But look closely.
If you cut out a portion of the sphere, it looks exactly like a photon.
If you can't tell the difference, then it's the same as having a photon there.

Electromagnetic force

Interference

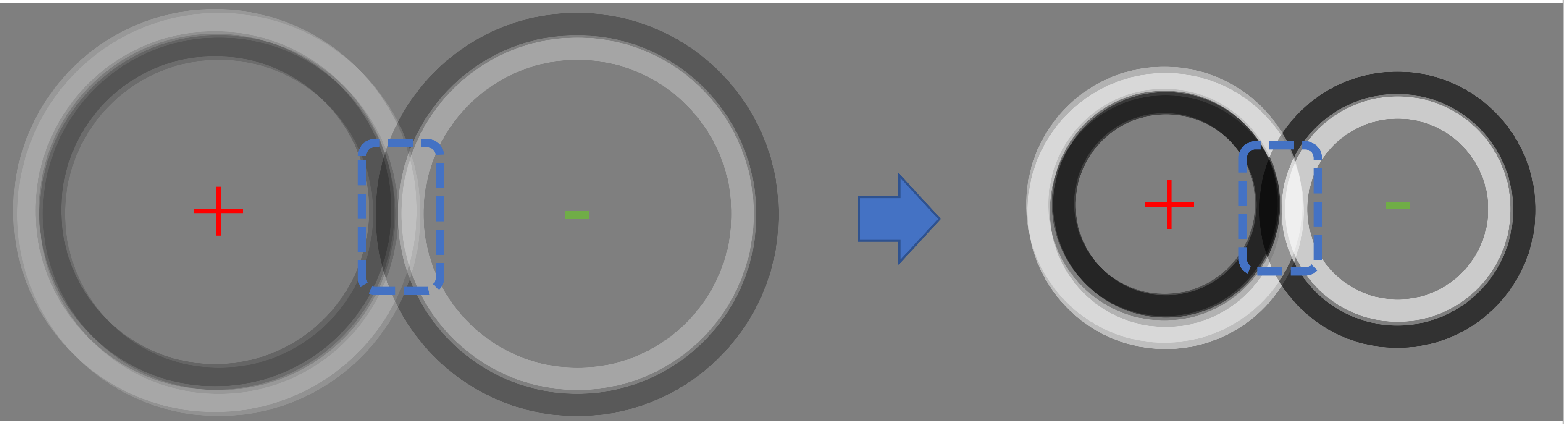


The greater the distance, the larger the surface area, resulting in dilution.

The following diagram shows the contact of charges of the same and opposite signs.
Charges of opposite signs overlap so that they reinforce each other, while charges of the same sign destructively overlap.
Also, the greater the distance, the larger the surface area, resulting in dilution.

Electromagnetic force

Electromagnetic force



The square of the wave function is the probability of a particle's existence.
For charges of opposite sign, the closer the distance, the stronger the wave.
The probability of existence is higher at a position slightly closer than its current position.
This is the attractive force of electromagnetic force.

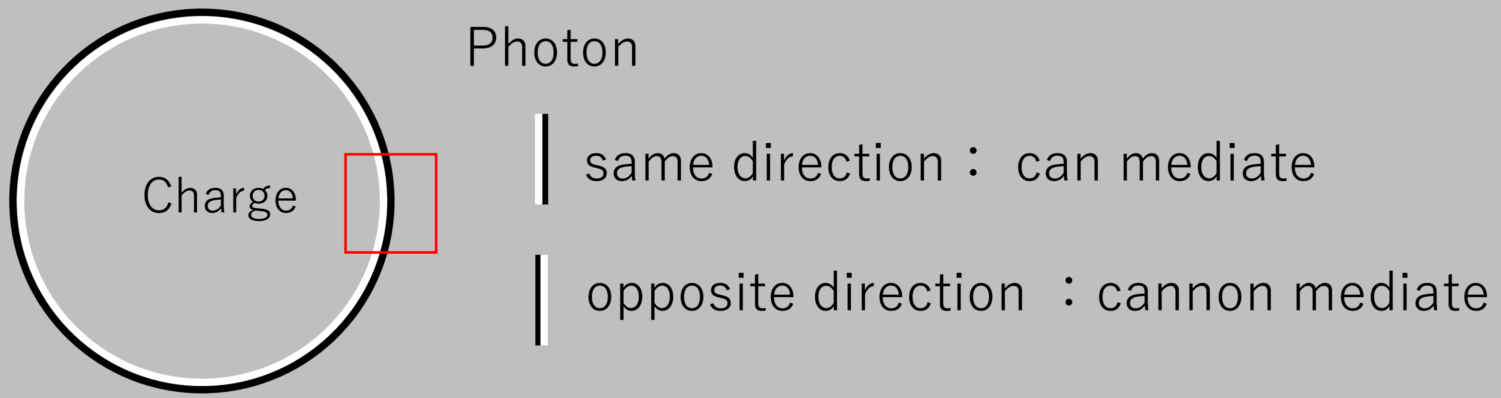
In quantum mechanics, the square of the wave function is the probability of a particle's existence.
For charges of opposite sign, the closer the distance, the stronger the wave.
The probability of existence is higher at a position slightly closer than its current position.
This is the attractive force of electromagnetic force.
For charges of the same sign, the wave weakens and becomes a repulsive force.

Electromagnetic force

Strength of the electromagnetic force (1)

Strength of the electromagnetic force
= degree to which a photon mediate an electric charge

Let's consider the degree to which the sphere formed by the electric charge coincides with the plane of a photon.



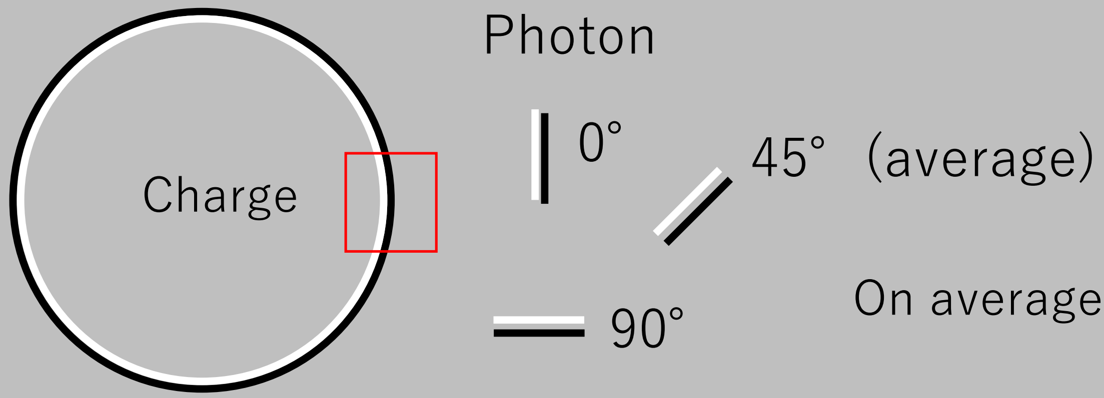
At most 1/2 of the photons can mediate an electric charge.

Let's think about the strength of the electromagnetic force.
It corresponds to the degree to which a photon mediate an electric charge.
There is no guarantee that 100% mediate will occur.
Let's consider the degree to which the sphere formed by the electric charge coincides with the plane of a photon.
First of all, photons have directionality.
Photons pointing in the opposite direction cannot mediate an electric charge.
Let's assume that the direction of the photons is random.
In that case, at most half of the photons can mediate an electric charge.

Electromagnetic force

Strength of the electromagnetic force (2)

Half of the photons are in the same direction as the charge,
but are still tilted between 0 and 90 degrees.



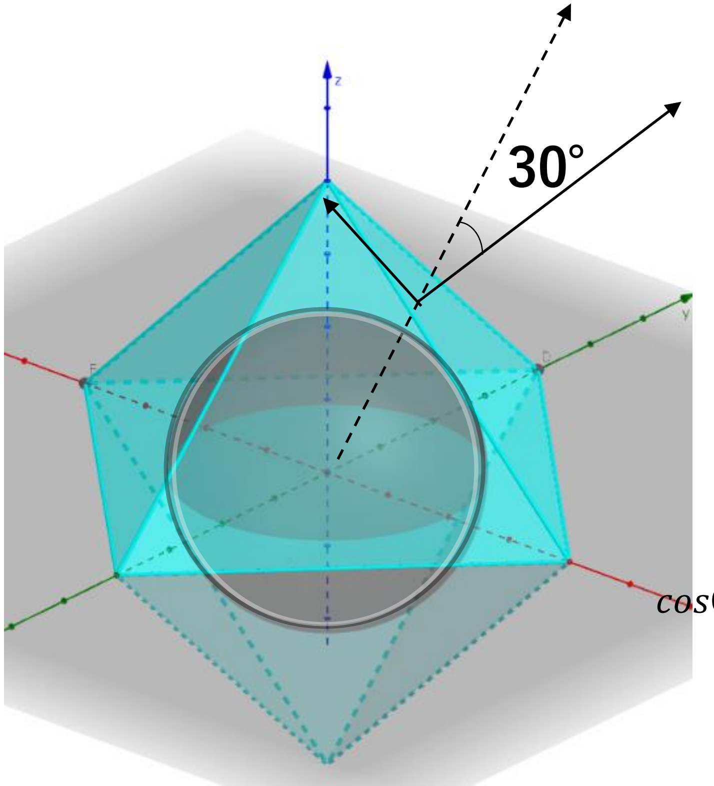
On average, they're tilted 45 degrees.

Only the cos45° component can be mediated.

Half of the photons are in the same direction as the charge, but are still tilted between 0 and 90 degrees.
On average, they're tilted 45 degrees.
The component that's in the same direction is cosine 45 degrees.
Therefore, only the cosine 45 degree component can be mediated.

Electromagnetic force

Strength of the electromagnetic force (3)



The sphere and the plane do not coincide, but are tilted.

Let's calculate the average tilt between the sphere and the plane.

The average angle between the normal to a regular octahedron and a sphere is 30° .

$$cos\Theta = \frac{\int_0^{\pi/2}\int_0^{\pi/2}\left(\frac{1}{\sqrt{3}}\cdot cos\Theta + \frac{1}{\sqrt{3}}\cdot sin\Theta cos\varphi + \frac{1}{\sqrt{3}}\cdot sin\Theta sin\varphi\right)\sin\Theta\, d\Theta d\varphi}{\int_0^{\pi/2}\int_0^{\pi/2}\sin\Theta\, d\Theta d\varphi}$$

Only the cos30° component can be mediated.

Furthermore, the sphere and the plane do not coincide, but are tilted.
Let's calculate the average tilt between the sphere and the plane.
Let's consider dividing space symmetrically into eight parts.
It is sufficient to calculate only the space where x, y, and z are all positive directions.
The average angle between the normal to a regular octahedron and a sphere is 30 degrees.
Only the cosine 30 degrees component can be mediated.

Electromagnetic force

Strength of the electromagnetic force (4)

Gauge coupling constant of the electromagnetic force

$$e = \frac{1}{2} \times cos45° \times cos30° = \frac{1}{2} \times \frac{1}{\sqrt{2}} \times \frac{\sqrt{3}}{2} = \sqrt{\frac{3}{32}} = 0.306$$

Fine structure constant

$$\alpha = \frac{e^2}{4\pi} = \frac{3}{128\pi} = 1/134$$

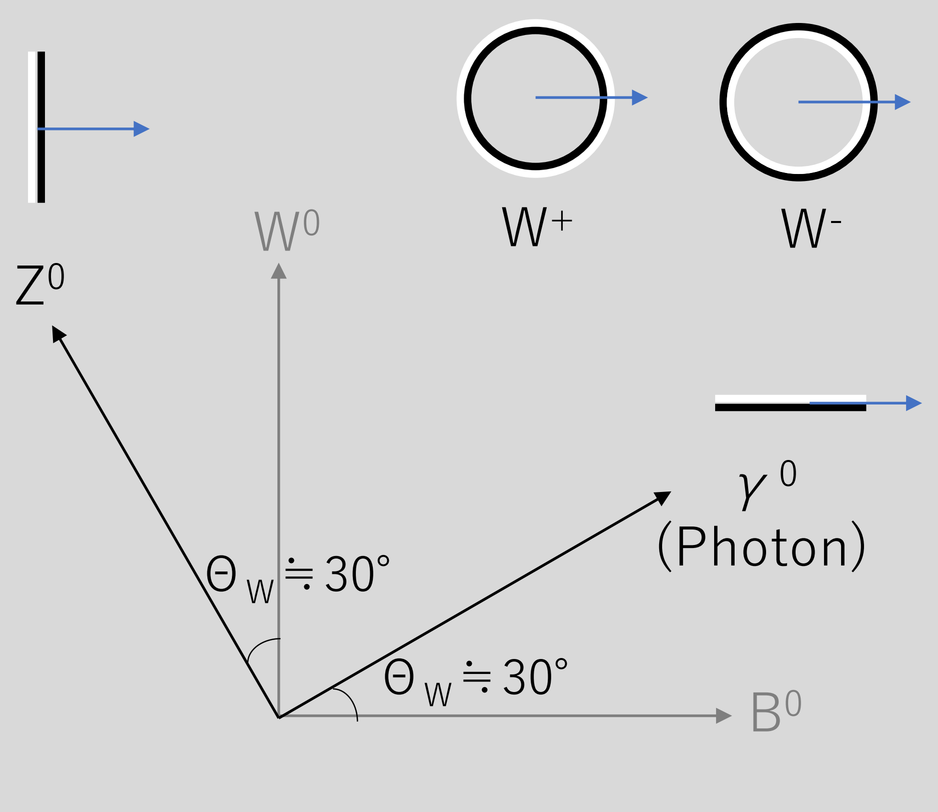
actual measured: 1/137.035999177(21)

The theoretical and measured values are calibrated in the “Fine structure constant" chapter until they fit perfectly.

The strength of the electromagnetic force is found by multiplying half by the cosine of 45 degrees and the cosine of 30 degrees.
This is a dimensionless quantity called the gauge coupling constant.
This value is converted to 1/134 of the fine structure constant.
The actual measured value is 1/137.
The theoretical and measured values are calibrated in the “Fine structure constant" chapter until they fit perfectly.

Electromagnetic force

Electroweak unified theory



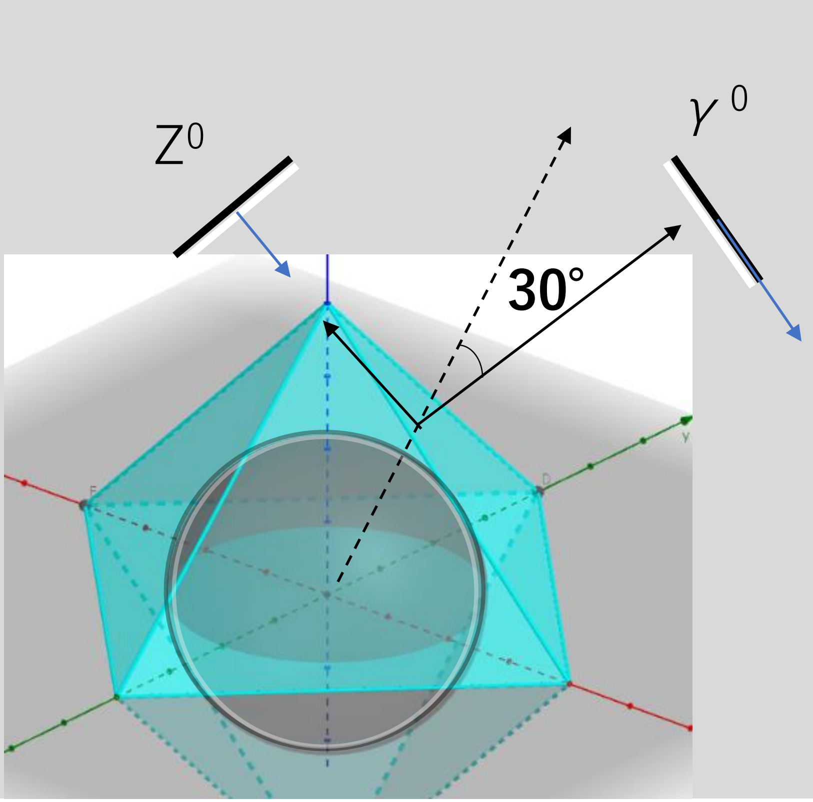
The neutral W and B bosons mixed together to form a photon and a Z boson.

$\Theta_W \fallingdotseq 30°$ Weak-mixing angle or Weinberg angle

Let's also consider the weak force.
First, I will explain the key points of the electroweak unified theory, which is the Standard Model.
There were three types of weak bosons: those with positive, negative, and neutral charges.
A neutral W boson mixed with a neutral B boson at an angle of approximately 30 degrees.
As a result of this mixing, a photon and Z boson were formed, which were orthogonal to each other.
This weak-mixing angle is also called the Weinberg angle.
The 30-degree tilt between a plane and a sphere corresponds to the Weinberg angle.
The W boson is a sphere, and the photon and Z boson are planes.
The Z boson is a plane perpendicular to the photon.

Electromagnetic force

Orthogonal forces



Photon：mediate transverse wave

$$e = \frac{1}{2} \times cos45° \times cos30°$$

Z^0： mediate longitudinal wave

$$z = \frac{1}{2} \times cos45° \times sin30°$$

The separation of the electromagnetic force and the weak force is due to differences in directionality.

The Z boson is also a gauge particle that mediates force.
Electromagnetic waves are transverse waves.
The orthogonal Z boson can be thought of as mediating longitudinal waves.
The gauge coupling coefficient for the Z boson is obtained by changing the cosine of the photon to a sine.
The separation of the electromagnetic force and the weak force is due to differences in directionality.

Electromagnetic force

Weak-mixing angle

Actual measurements $\Theta_W \fallingdotseq 28.7°$

God's Choice

1. Roll the dice to determine the angle
2. It is determined by geometric necessity

One of the most elegant interpretations would be the 30° between a plane and a regular tetrahedron.
This can be determined simply from the number 3, the number of dimensions of space.

In the Standard Model, the weak-mixing angle can only be determined by actual measurement.
The measured value is 28.7 degrees.
Was this decided by God rolling dice?
That interpretation simply means giving up on a scientific explanation.
It must be determined by geometric necessity.
One of the most elegant interpretations would be the 30-degree angle between a plane and a regular tetrahedron.
This can be determined simply from the number 3, the number of dimensions of space.
Any slight differences can be made up with correction calculations.

Fermion and Generation

Quarks and leptons

		Charge							
		-1	-2/3	-1/3	0	0	+1/3	+2/3	+1
Generation	1	electron e	$\bar{u}$	down d	$\bar{\nu}_e$	neutrino ν_e	$\bar{d}$	up u	$\bar{e}$
	2	muon μ	$\bar{c}$	strange s	$\bar{\nu}_\mu$	neutrino ν_μ	$\bar{s}$	charm c	$\bar{\mu}$
	3	tauon τ	$\bar{t}$	bottom b	$\bar{\nu}_\tau$	neutrino ν_τ	$\bar{b}$	top t	$\bar{\tau}$
		lepton	quark		lepton		quark		lepton

Next, let's think about quarks and leptons.
The horizontal axis of the table is electric charge.
Leptons have an integer charge, while quarks have a fractional charge.
Leptons have one color, but quarks come in three.
Those shown in grey are antiparticles with an opposite charge.
The vertical axis of the table is generation.
There are three generations, but the only difference between them is mass.
There are 48 types in total.

Fermion and Generation

Isospin and hypercharge

Electric charge		isospin		Hypercharge
Q	$=$	T	$+$	Y

$$T = \begin{cases} \pm\frac{1}{2} & Y = \begin{cases} \pm\frac{1}{6} & \text{Quark} \\ \pm\frac{1}{2} & \text{Lepton} \end{cases} \\ \pm 1 \quad W^+,\ W^- & \\ 0 \quad Z^0,\ \gamma^0 & Y = 0 \end{cases}$$

In the Standard Model, charge is the sum of isospin and hypercharge.
Both quarks and leptons have an isospin of ±1/2.
Leptons have a hypercharge of ±1/2.
Quarks have a hypercharge of ±1/6.
The W boson has an isospin of ±1.
Emitting or absorbing a W boson changes its isospin.

Fermion and Generation

Sign combination

	charge Q	= isospin T $\pm 1/2$	hypercharge + Y_R $\pm 1/6$	+ Y_G $\pm 1/6$	+ Y_B $\pm 1/6$	color
ν_e	+0	+1/2	−1/6	−1/6	−1/6	
$\bar{d}$	+1/3	+1/2	−1/6	−1/6	+1/6	R
	+1/3	+1/2	−1/6	+1/6	−1/6	G
	+1/3	+1/2	+1/6	−1/6	−1/6	B
u	+2/3	+1/2	+1/6	+1/6	−1/6	R
	+2/3	+1/2	+1/6	−1/6	+1/6	G
	+2/3	+1/2	−1/6	+1/6	+1/6	B
$\bar{e}$	+1	+1/2	+1/6	+1/6	+1/6	

The charges of quarks and leptons can be expressed by the following combinations.
It is the sum of one ±1/2 and three ±1/6.
This forms the hypercharge portion into three parts.
There are 16 possible combinations of signs, or 2 to the fourth power.
This corresponds to the first generation of quarks and leptons.
The table only shows those with positive isospin.
Leptons have three matching 1/6 signs, while quarks do not.
As only one of the three has a different sign, there are three degrees of freedom for colors.

Fermion and Generation

The origin of the combination (1)

Where do the 2^4 combinations come from?
A particle can have different properties in one direction and the opposite direction.

3D space

A particle can have positive or negative charge in six directions:
+x, -x, +y, -y, +z, and -z.

combination： 2^6

1D time

A particle can have positive or negative charge in two directions:
+t and -t.

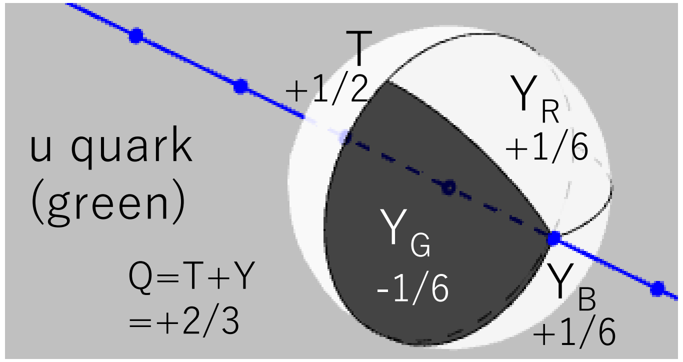
combination： 2^2

Where do the 2^4 combinations come from?
A particle can have different properties in one direction and the opposite direction.
In three-dimensional space, a particle can have positive or negative charge in six directions: +x, -x, +y, -y, +z, and -z.
There are 2^6 combinations.
Similarly, a particle can have positive or negative charge in two directions on the time axis: +t and -t.

Fermion and Generation

The origin of the combination (2)

The + direction can also be the space axis, and the - direction the time axis.
Positive and negative charges can be taken in the 4 directions: +x, +y, +z, and -t.
The combinations are 2^4, which correspond to quarks and leptons.



Time axis		Space axis
Isospin		Hypercharge
T	$+$	$Y_R + Y_G + Y_B$
$\pm 1/2$		$\pm 1/6 \quad \pm 1/6 \quad \pm 1/6$

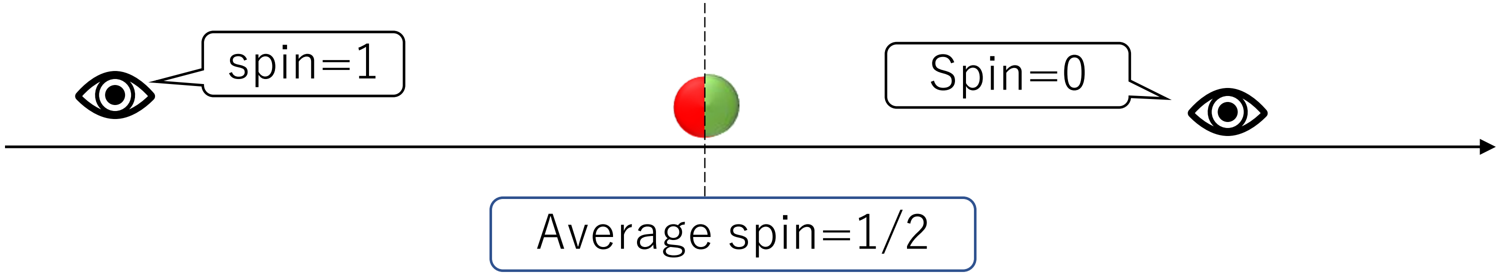
The three terms of hypercharge correspond to the three axes of space.
The difference between the three colors indicates the different space axes.

The + direction can also be the space axis, and the - direction the time axis.
Positive and negative charges can be taken in the four directions: +x, +y, +z, and -t.
The combinations are 2 to the fourth power, which correspond to quarks and leptons.
A schematic diagram of the u quark is shown.
The hemisphere on the time axis side has isospin.
The hemisphere on the space axis side has hypercharge.
The three terms of hypercharge correspond to the three axes of space.
The difference between the three colors indicates the different space axes.

Fermion and Generation

Fermion

Quarks and leptons have spin 1/2 and are called fermions.
Particles are allowed to have different properties when viewed from opposite side.
They can have spin 1 when viewed from one side,
and spin 0 when viewed from the other side.

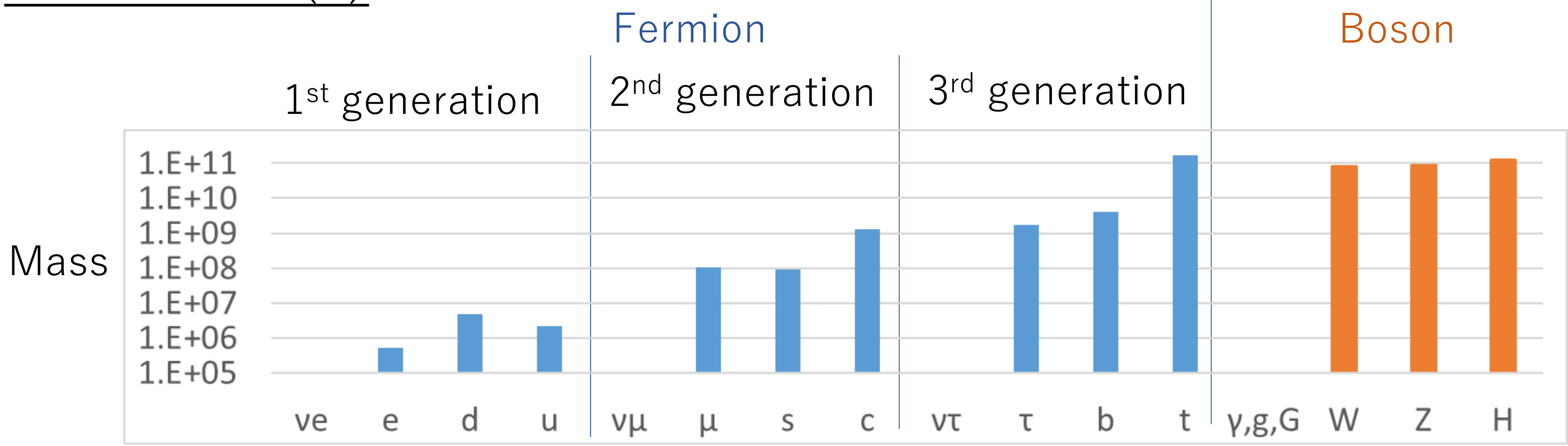


On average, they have spin 1/2.
“nothing" has spin 0 and “existence" has spin 1.
Fermions are like a mixture of half “existence" and half "nothing“.

Let's think about spin.
Quarks and leptons have spin 1/2 and are called fermions.
Particles are allowed to have different properties when viewed from the opposite side.
They can have spin 1 when viewed from one side, and spin 0 when viewed from the other side.
On average, they have spin 1/2.
“nothing" has spin 0 and “existence" has spin 1.
Fermions are like a mixture of half “existence" and half "nothing“.

Fermion and Generation

Generation (1)



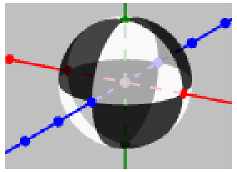
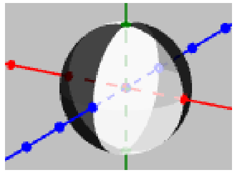
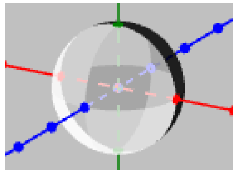
The number of generations is not conserved.
If the generation of one particle decreases,
it does not necessarily mean that the generation of another particle increases.
Quark generations are mixed,
and certain proportions of them behave like different generations.

Bosons have no generations, but fermions have three generations.
The larger the generation, the heavier the mass, but all other properties remain unchanged.
On the other hand, the mass of a boson is approximately that of a zero-generation or third-generation fermion.
The number of generations is not conserved.
For example, if the generation of one particle decreases, it does not necessarily mean that the generation of another particle increases.
Furthermore, quark generations are mixed, and certain proportions of them behave like different generations.

Fermion and Generation

Generation (2)

Only particles with spin 1/2 have generations.
Now, let's consider the degree of mixing of the spin 0 and spin 1 parts.
If space is divided into eight directions, half has spin 1 and the rest has spin 0.

Generation	1	2	3
			
X	Antisymmetric	Symmetric	Symmetric
Y	Antisymmetric	Antisymmetric	Symmetric
Z	Antisymmetric	Antisymmetric	Antisymmetric

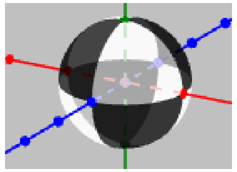
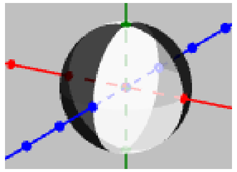
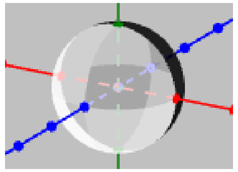
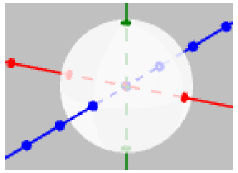
The three directions are symmetric or antisymmetric.

Only particles with spin 1/2 have generations.
Now, let's consider the degree of mixing of the spin 0 and spin 1 parts.
If space is divided into eight directions, half has spin 1 and the rest has spin 0.
There are three levels of mixing, as shown in the diagram.
The three directions are symmetric or antisymmetric.

Fermion and Generation

Generation (3)

Generation = The number of symmetric dimensions + 1

	Fermion			Boson
Generation	1	2	3	(4)
				
X	Antisymmetric	Symmetric	Symmetric	Symmetric
Y	Antisymmetric	Antisymmetric	Symmetric	Symmetric
Z	Antisymmetric	Antisymmetric	Antisymmetric	Symmetric

Bosons correspond to the fourth generation.
As the number of antisymmetric dimensions increases,
the mass tends to become smaller.

The number of symmetric dimensions + 1 is thought to correspond to a generation.
On the other hand, bosons are unmixed and therefore symmetric in all three directions.
Bosons correspond to the fourth generation.
As the number of antisymmetric dimensions increases, the mass tends to become smaller.

Fermion and Generation

Generation (4)

God's Choice

1. I rolled the dice and decided on 3 generations.
2. Since space is 3D, the number of generations is also 3.

The dimensionality of mixing is one of the most elegant interpretations.
Perhaps it is a mixing of spins.
The raw materials remain the same, only the degree of mixing is different.
Therefore, this is consistent with the property of non-conservation.
It is also not unusual for the degree of mixing to mix between generations.

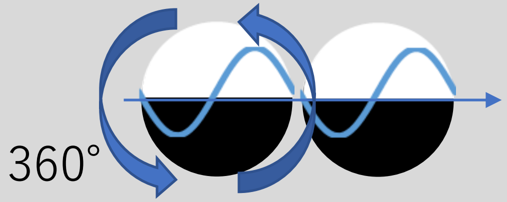
Did God roll the dice to decide the number of generations to be 3?
Since space is three-dimensional, we can deduce that the number of generations is also 3.
The dimensionality of mixing is one of the most elegant interpretations.
Perhaps it is a mixing of spins.
The raw materials remain the same, only the degree of mixing is different.
Therefore, this is consistent with the property of non-conservation.
It is also not unusual for the degree of mixing to mix between generations.

Spin and Puli repulsion force

Spin 1/2

Photon

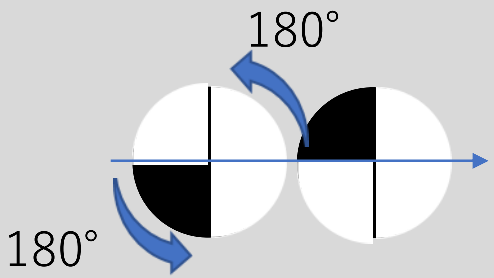
Spin 1



The whole thing rotates 360°
and returns to its original phase.

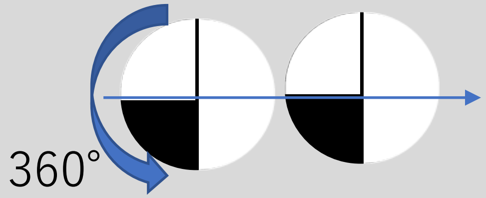
Fermion

Spin 1/2



If the whole thing rotates 180° ,
it will not return to its original phase.

NG



If one half rotates 360° ,
it will return to its original phase.

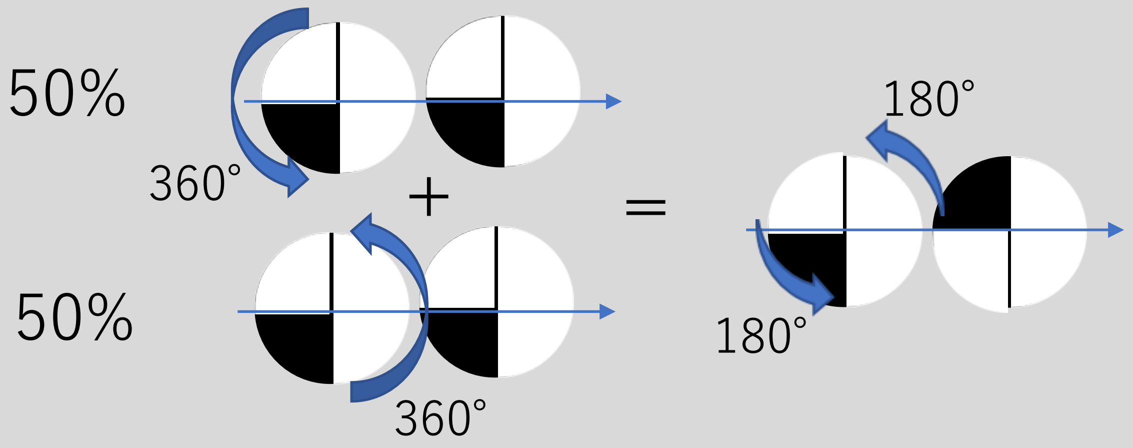
OK

Let's try to interpret the mysterious properties of spin 1/2.
Photons have spin 1, so they rotate 360 degrees in one wavelength and return to their original phase.
Fermions, on the other hand, have spin 1/2.
If the whole thing rotates 180 degrees, it will not return to its original phase.
If half of it rotates 360 degrees, it will return to its original phase.
It's just that the amount of rotation is half, but it still makes a full rotation.

Spin and Puli repulsion force

720°　rotation

The case where the particle is rotated 360°　mechanically, rather than by spin.



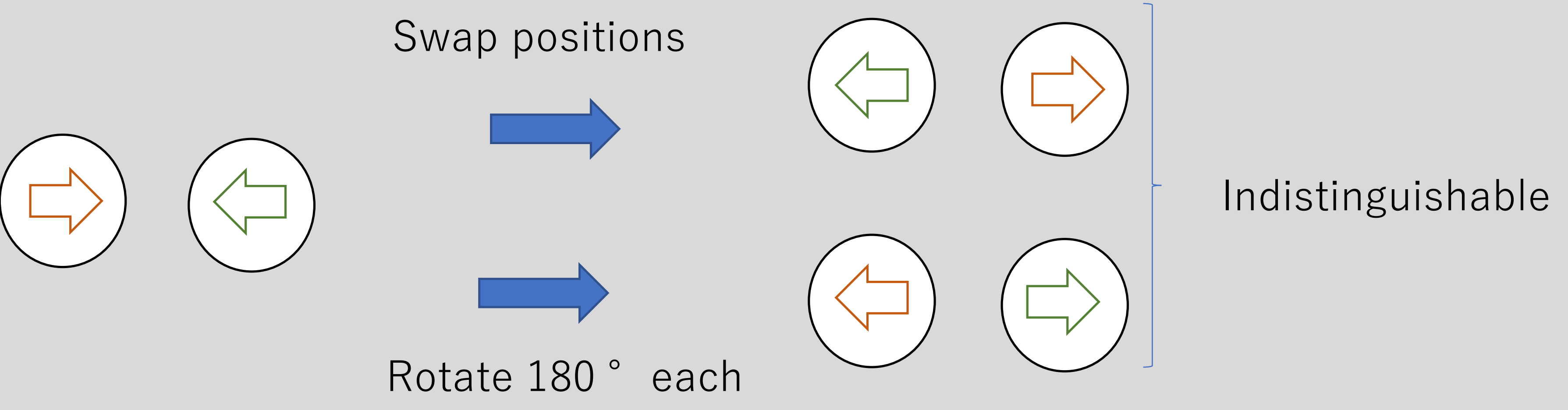
Half the 360°　rotation and the other half 360°　rotation are mixed 50/50.

The rotation is slowed down so that the total rotation is 180°　,
and the phase is reversed.

Furthermore, spin 1/2 particle will have its phase reversed when it rotates 360 degrees, and will not return to its original state until 720 degrees.
Let's consider the case where the particle is rotated 360 degrees mechanically, rather than by spin.
With mechanical rotation, it is not possible to rotate only half of the particle, as is possible with spin.
Half of the 360 degrees rotation and the other half of the 360 degrees rotation are mixed 50/50.
The rotation is slowed down so that the total rotation is 180 degrees, and the phase is reversed.

Spin and Puli repulsion force

Swap positions

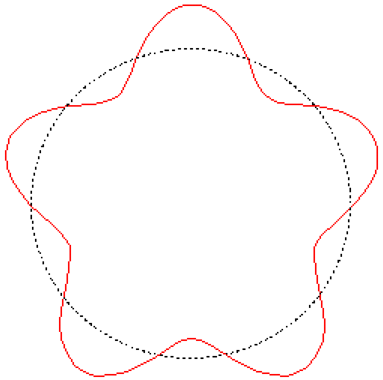


As this amounts to a total rotation of 360° , the phase is inverted.

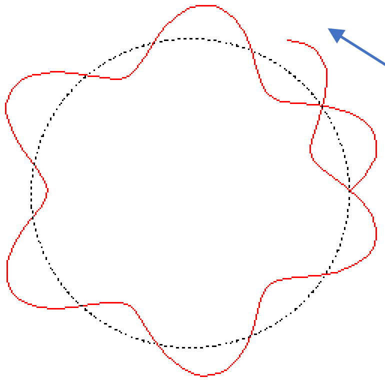
Furthermore, fermions have the property that their phase is inverted when two particles of the same type are swapped.
The illustration shows two particles facing each other.
For convenience, they have been colored differently to make them easier to distinguish, but in reality they are indistinguishable.
If the two particles are swapped, they become back-to-back.
This is indistinguishable from the two particles rotating 180 degrees each without swapping their positions.
As this amounts to a total rotation of 360 degrees, the phase is inverted.

Spin and Puli repulsion force

Quantum condition



Integer multiple of wavelength



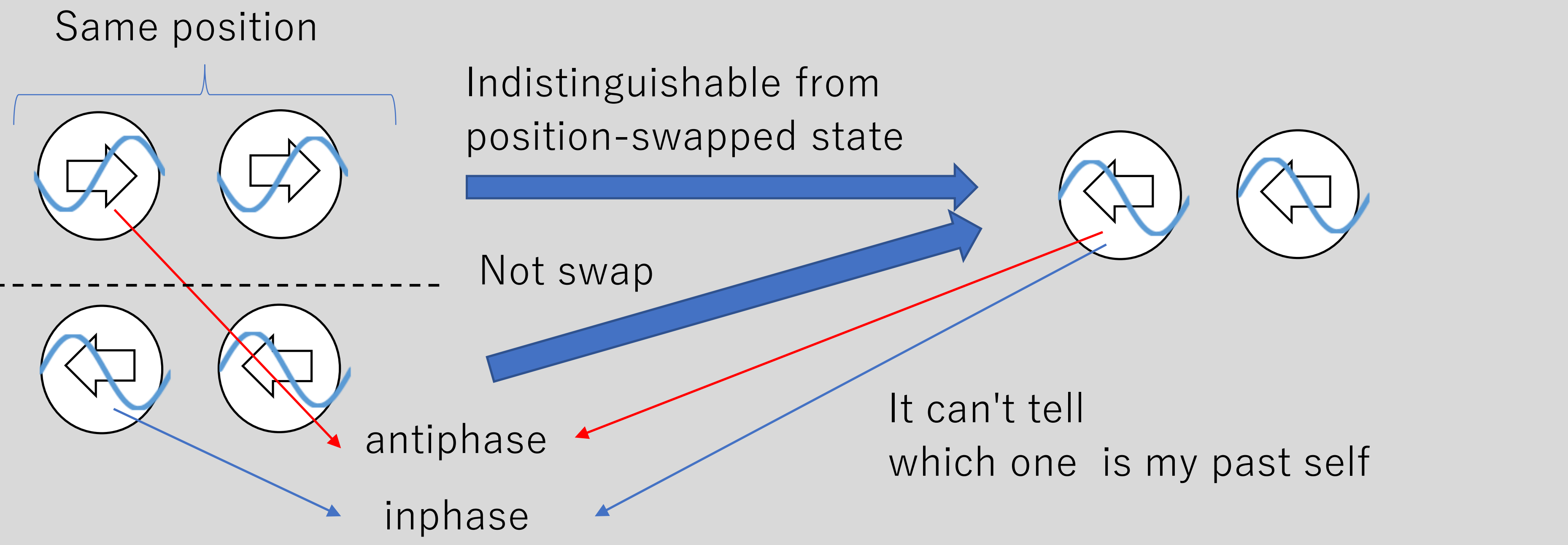
NOT Integer multiple of wavelength

If it is off by half a wavelength,
 it will be in antiphase with its previous self.
If it interferes with its previous self, the wave will disappear.
What's important is that it also interferes
 with its own self at a different time.

Before explaining the Pauli exclusion principle, we will explain the quantum conditions for Bohr hydrogen.
But before that, I will explain the quantum conditions for Bohr hydrogen.
The length of the orbit must be an integer multiple of the wavelength.
What's wrong if it's not an integer multiple?
If it is off by half a wavelength, it will be in antiphase with its previous self.
If it interferes with its previous self, the wave will disappear.
What's important is that it also interferes with its own self at a different time.

Spin and Puli repulsion force

Pauli exclusion principle



When a fermion interferes with its past version of the opposite phase, the waves disappear and it is not allowed to exist.

Let's interpret the Pauli exclusion principle.
Particles of the same type cannot occupy the same quantum state.
Therefore, two indistinguishable fermions cannot exist at the same location.
Existing at the same location is indistinguishable from their positions being swapped.
The swapping of positions is not necessary, and they may not have been swapped.
It is impossible to distinguish whether a past version of itself has had its positions swapped or not.
When a fermion interferes with its past version of the opposite phase, the waves disappear and it is not allowed to exist.

Spin and Puli repulsion force

Pauli repulsion force

The force of interference with one's past self

…there is no need for a gauge particle to mediate it.

- Inphase(50%) …No force acts
- Antiphase(50%) … Force acts

Coupling constant

$$g_P = \frac{1}{2}$$

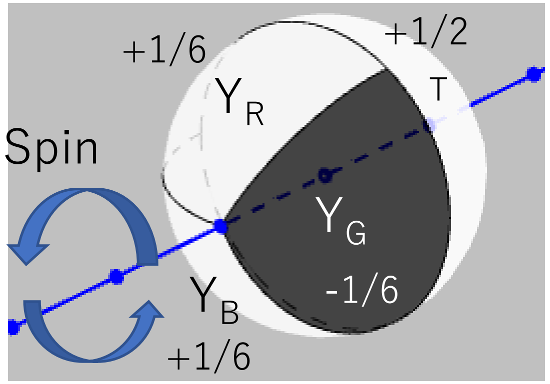
The square of the wave amplitude is the probability that a particle exists.
No matter how close they get, 50% of the amplitude will remain.
Therefore, the existence of black holes is allowed.

The force that acts due to the Pauli exclusion principle is called the Pauli repulsion force.
Because it is a force due to interference with its past self, there is no need for a gauge particle to mediate it.
Past selves have a 50% chance of being in phase, and a 50% chance of being out of phase.
A repulsive force only acts when they are out of phase.
Therefore, the coupling constant, which represents the strength of the Pauli repulsion force, is 1/2.
The square of the wave amplitude is the probability that a particle exists.
No matter how close they get, 50% of the amplitude will remain.
Therefore, the existence of black holes is allowed.

Strong Force

Color

Particles with fractional electric charge, like quarks, have color.



Direction of travel

Green Up quark (U_G)

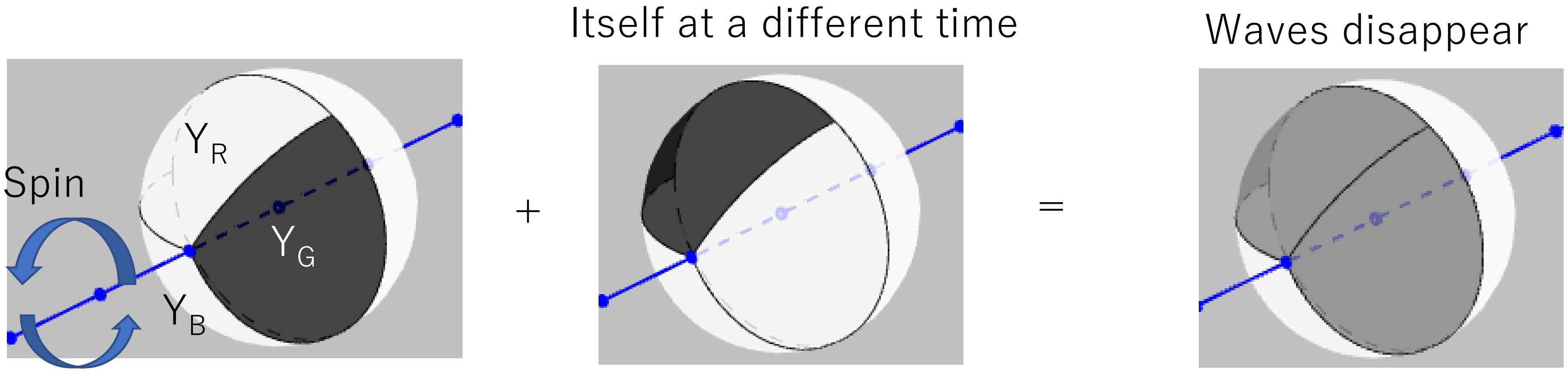
Color corresponds to direction in space.
Colored particles have electric charge biased in three directions.
The strong force connects the three colored particles together so that they become colorless.
Colored particles cannot exist stably on their own.

Next, we will consider the strong force.
The strong force only acts on colored particles.
Particles with fractional electric charge, like quarks, have color.
A schematic diagram of a green up quark is shown.
Color corresponds to direction in space.
Colored particles have electric charge biased in three directions.
The strong force connects the three colored particles together so that they become colorless.
Colored particles cannot exist stably on their own.

Strong Force

Color Rotation

When a particle spins, the direction of its biased electric charge changes.
The particle overlaps with itself t a different time and interferes with itself.



When a particle overlaps with its pre- and post-spin selves,
its electric charges cancel out.
When the waves disappear, the probability of existence is 0.

Why can't colored particles exist on their own?
When a particle spins, the direction of its biased electric charge changes.
The particle overlaps with itself at a different time and interferes with itself.
When a particle overlaps with its pre- and post-spin selves, its electric charges cancel out.
When the waves disappear, the probability of existence is 0.

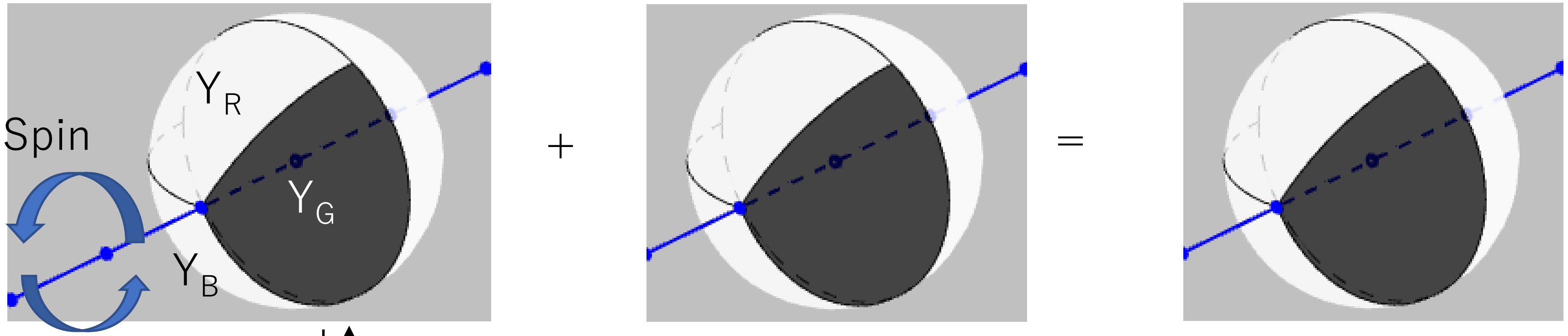
Strong Force

Color retention

The strong force is mediated by gauge bosons called gluons.
Gluons themselves have a color.
When a gluon is absorbed or emitted, the color changes.

Itself after spin

Waves not disappear



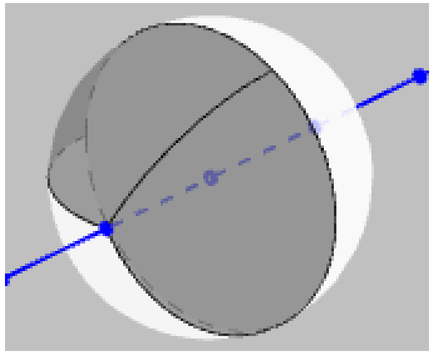
Gluon (g)

By absorbing and emitting gluons,
the color remains the same when the object spins.

The strong force is mediated by gauge bosons called gluons.
Gluons themselves have a color.
When a gluon is absorbed or emitted, the color changes.
If nothing is done, the color changes when the object spins.
By absorbing and emitting gluons, the color remains the same when the object spins.
This allows the waves to exist without disappearing.

Strong Force

Strength of the strong force



Interfering part (magnitude of charge)

= strength of the strong force

(gauge coupling constant)

$$g_s = \frac{1}{3}$$ (1/3 of sphere)

?

$$a_s = \frac{g_s^2}{4\pi} = \frac{1}{36\pi} = 0.009$$

It is not as simple as this.

Unlike the electromagnetic force, it does not weaken by terms such as 1/2.
This is because the degree of interference with itself
does not decrease as the particle moves away from other particles.

Calculate the strength of the strong force.
The part where interference occurs is 1/3 of the sphere.
Therefore, the gauge coupling constant is 1/3.
The coupling constant between two particles is obtained by squaring this.
We obtained a value close to the measured value.

Strong Force

Low-energy strong force

Because gluons themselves have color,
the force can be increased by up to 3 times due to the anti-screening effect.

Quark color(1) + Gluon color(1) + Gluon anti-color(1)=3

$$g_s(0) = \frac{1}{3} \times 3 \times 2\pi = 2\pi$$

$$\alpha_s(0) = \frac{g_s^2}{4\pi} = \pi = 3.1416$$

$$\alpha_s(0.142GeV) = 3.13$$

Measured

- Rotational force (strong force): 2π (circumference)
- Linear force (other than the strong force): 1 (radius)

The strength of the strong force changes on the energy scale.
Let's consider the low-energy limit.
Because gluons themselves have color, the force can be increased by up to three times due to the anti-screening effect.
Gluons have color and anti-color.
If the magnitude of the color possessed by quarks is taken to be 1, then the total is doubled.
Separately, the strength of the force is multiplied by 2pi.
Rotational forces such as the strong force are multiplied by 2pi, the circumference of a circle.
All forces other than the strong force are linear forces, and are multiplied by 1, which corresponds to the radius.
The strong coupling constant calculated in this way matches the measured value.

Strong Force

High-energy strong force

At the energy scale of the tauon,
this is the strength when there is no color enhancement by gluons.

$$g_s\left(M_\tau = \frac{3}{2\pi r} M_H\right) = \frac{1}{3} \times 1 \times 2\pi = \frac{2\pi}{3}$$

Tauon mass   Higgs mass

$$\alpha_s(M_\tau) = \frac{g_s^2}{4\pi} = \frac{\pi}{9} = 0.3491$$

$$\alpha_s(M_\tau) = 0.31$$

Measured

Why we choose tauons will be explained
at the end of the chapter "Charged Lepton Mass".

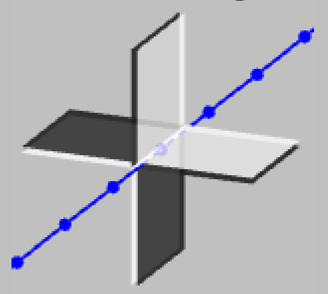
From now on, we will consider the strong force at high energies.
The higher the energy, the smaller the anti-screening effect and the weaker the force.
Therefore, we generally look at the strength at the energy of the Z boson.
Here, however, we will look at it at the energy scale of the tauon.
At the energy scale of the tauon, this is the strength when there is no color enhancement by gluons.
This matches the measured value.
The gauge coupling constant in this case is 2/3 pi.
Multiplying the tauon mass by 2/3 pi r gives the Higgs mass.
Why we choose tauons will be explained at the end of the chapter "Charged Lepton Masses".

Strong Force

Gluon

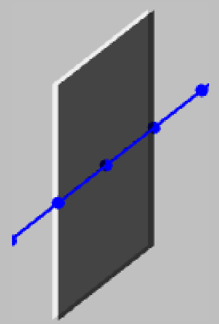
Since two of the three color interfere with each other,
it needs the ability to swap its charge in two directions.
It is a particle with an electric field on two axes
perpendicular to its direction of travel.

Gluon(g)



Spin=1
Mass=0
Charge=0

Photon(γ)



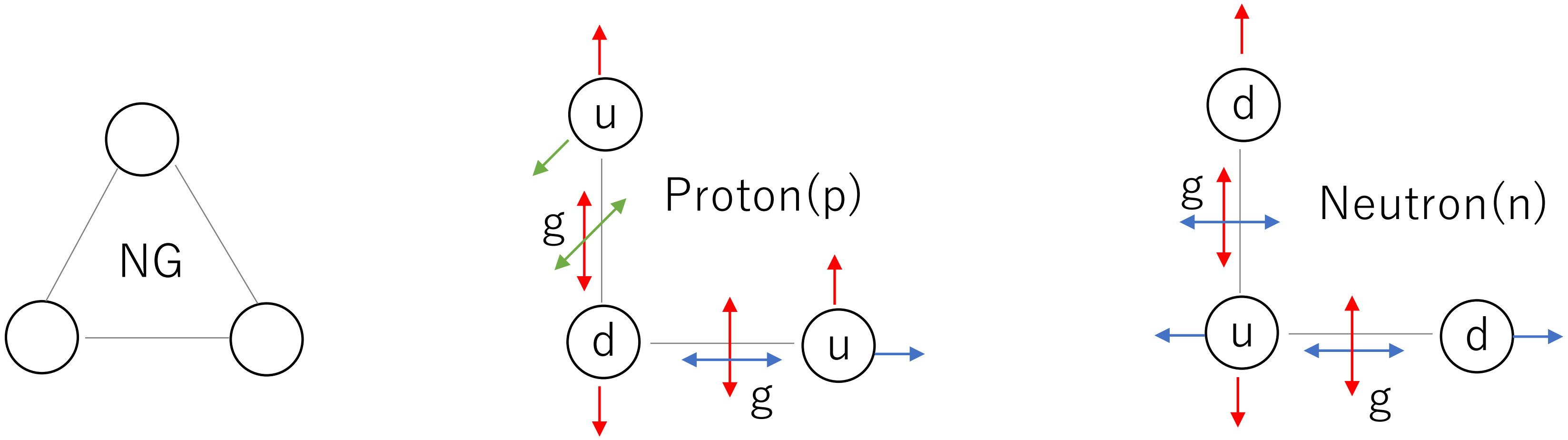
Since the color of the gluon is determined by the direction it is facing,
one type is sufficient.

A schematic diagram of a gluon is shown below.
Its properties of spin 1, mass 0, and charge 0 are the same as those of a photon.
Since two of the three color interfere with each other, it needs the ability to swap its charge in two directions.
It is a particle with an electric field on two axes perpendicular to its direction of travel.
Since there is equal amounts of white and black, its charge is 0.
In the Standard Model, eight types of gluon are theoretically required.
However, since the color of the gluon is determined by the direction it is facing, one type is sufficient.

Strong Force

Baryon

The emitted gluon is absorbed by another quark.



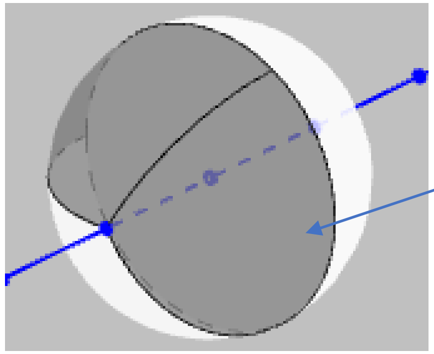
In order for the color to be colorless,
the three particles must be aligned in the same direction.
The three quarks line up at right angles.

The emitted gluon is absorbed by another quark.
With three quarks, it becomes a proton or a neutron.
In order for the color to be colorless, the three particles must be aligned in the same direction.
The three quarks line up at right angles.

Strong Force

Color confinement

It is believed that quarks cannot be extracted on their own.
However, color is merely a spatial distribution of hypercharge.
God did not newly institute the concept of color and constraint of colorlessness.



If we were to extract a single quark,
only 1/3 of the particle's waves
would disappear due to rotation.

Since the square of the wave amplitude does not become zero,
the probability of the particle's existence does not become zero.
Quark-gluon plasma is also permitted.

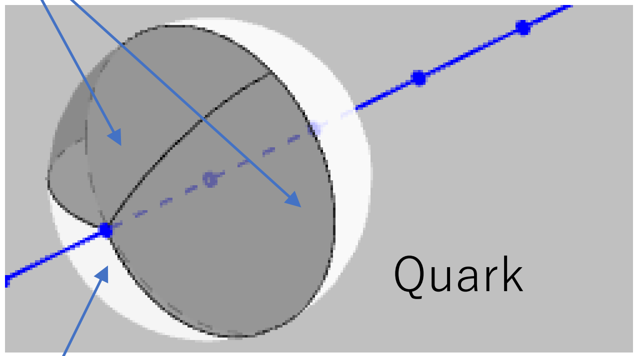
It is believed that quarks cannot be extracted on their own, a phenomenon known as color confinement.
However, color is merely a spatial distribution of hypercharge.
God did not newly institute the concept of color and the constraint of colorlessness.
If we were to extract a single quark, only one-third of the particle's waves would disappear due to rotation.
Since the square of the wave amplitude does not become zero, the probability of the particle's existence does not become zero.
Quark-gluon plasma is also permitted.

Strong Force

Proton spin crisis

Experiments have shown that
quarks are only responsible for about 33% of the proton's spin.

2/3 of the color is exchanged by gluons.
⇒ 2/3 of the quark's spin is carried away by gluons.



1/3 of the color is not exchanged by gluons.
⇒ 1/3 of the quark's spin remains uncarried.
It's a very simple interpretation.

There is a problem called the proton spin crisis.
Experiments have shown that quarks are only responsible for about 33% of the proton's spin.
2/3 of the color is exchanged by gluons.
Therefore, 2/3 of the quark's spin is carried away by gluons.
1/3 of the color is not exchanged by gluons.
Therefore, 1/3 of the quark's spin remains uncarried.
It's a very simple interpretation.

Strong Force

Why do colors exist?

God's Choice

1. Because they are necessary for humans to exist.

… Anthropic principle

2. Because they are necessary for particles to exist.

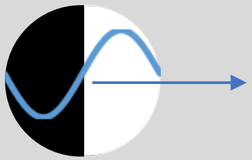
…A strong force is at work to ensure that waves disappear with rotation and the probability of a particle's existence does not become zero.

If all forces are necessarily necessary for particles to maintain their existence, then God would not need to roll dice.

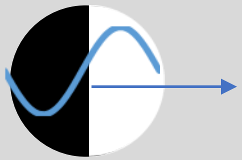
First of all, why do colors exist?
1. Because they are necessary for humans to exist.
This is the so-called anthropic principle.
2. Because they are necessary for particles to exist.
A strong force is at work to ensure that waves disappear with rotation and the probability of a particle's existence does not become zero.
If all forces are necessarily necessary for particles to maintain their existence, then God would not need to roll dice.

Higgs mechanism

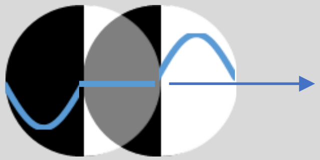
Parallel translation



a particle that is rotationally symmetric
with respect to the direction of travel.
…The wave does not disappear due to rotation.



it has traveled 1/2 wavelength



The wave disappears as it interferes with itself,
which was 1/2 wavelength ago.

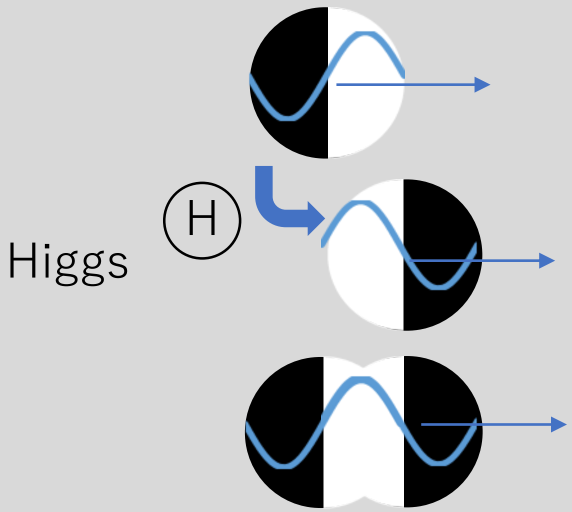
Since the probability of existence becomes 0, the particle is not allowed to move.

Let's consider parallel translation rather than rotation.
Consider a particle that is rotationally symmetric with respect to the direction of travel.
The wave does not disappear due to rotation.
Consider what happens after it has traveled 1/2 wavelength.
The wave disappears as it interferes with itself, which was 1/2 wavelength ago.
Since the probability of existence becomes 0, the particle is not allowed to move.

Higgs mechanism

Front and back reversal

Let's consider the mechanism by which particles move.



As they travel half a wavelength,
the particles swap positions.
The Higgs boson does this.

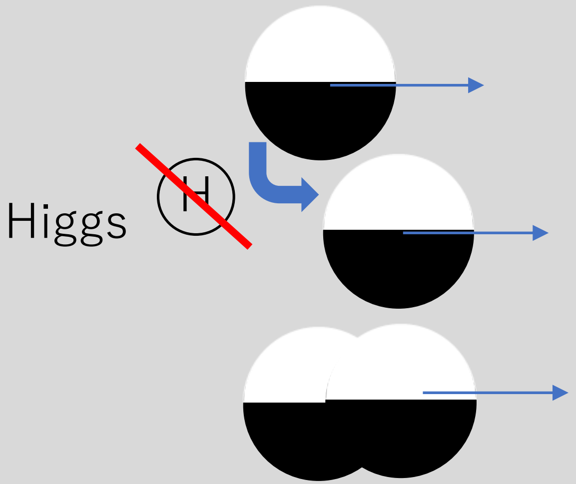
Even when they interfere with themselves,
which are half a wavelength ahead,
the wave does not disappear.

Particles are allowed to move as long as they swap positions.

Let's consider the mechanism by which particles move.
As they travel half a wavelength, the particles swap positions.
The Higgs boson does this.
Even when they interfere with themselves, which are half a wavelength ahead, the wave does not disappear.
Particles are allowed to move as long as they swap positions.

Higgs mechanism

Front-to-back symmetry



Let's consider a particle
that is symmetrical front to back.

Even when they interfere with themselves,
which are half a wavelength ahead,
the wave does not disappear.

Symmetrical front to back: Higgs boson is not needed for movement ··· Mass=0

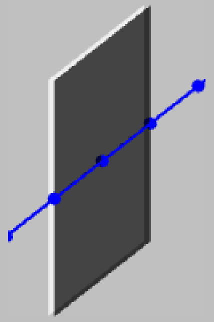
Asymmetrical front to back: Higgs boson is needed for movement ··· Mass>0

Let's consider a particle that is symmetrical front to back.
The Higgs boson does not need to switch front to back.
Even if it interferes with itself 1/2 wavelength in front, the wave does not disappear.
If it is symmetrical front to back, a Higgs boson is not needed for movement.
In other words, it has zero mass.
If it is asymmetrical front to back, a Higgs boson is needed for movement.
In other words, it has mass.

Higgs mechanism

Gauge boson mass (1)

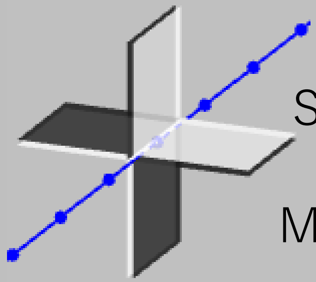
γ^0(Photon)



Symmetrical front to back

Mass=0

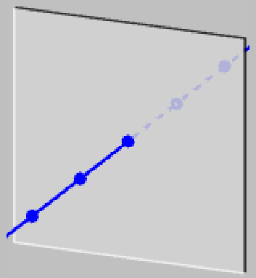
g^0(gluon)



Symmetrical front to back

Mass=0

Z^0



Asymmetrical front to back

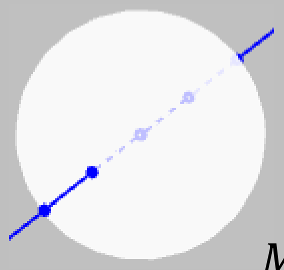
Mass=91.19GeV/c^2

Let's look at the symmetry and mass of gauge particles.
The photon is symmetric front to back and has zero mass.
The same is true for gluons.
The Z boson is asymmetric front to back and has mass.

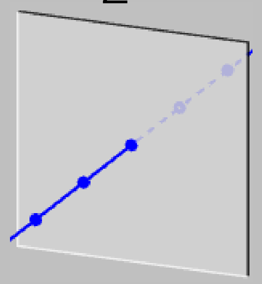
Higgs mechanism

Gauge boson mass (2)

Because the W boson is a sphere,
it is partially asymmetric in the front-to-back direction.



Mass
M_W=80.37GeV/c^2



Mass
M_Z=91.19GeV/c^2

$$\frac{M_W}{M_Z} = cos\Theta_W$$ Standard Model

$$= cos30°$$ Proportion of faces facing forward-to-back

30° : Average angle between a plane and a regular octahedron

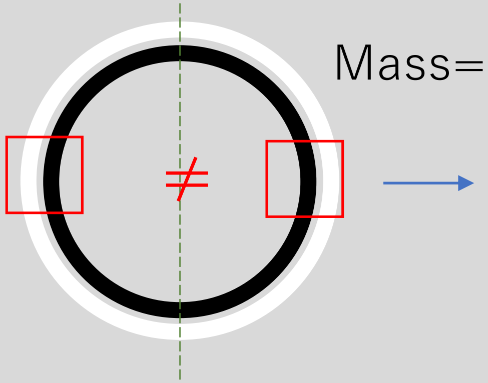
Mass = Proportional to the magnitude of the front-to-back asymmetry

Let's also look at the W boson.
Because the W boson is a sphere, it is partially asymmetric in the front-to-back direction.
Its mass is slightly smaller than that of the Z boson.
In the Standard Model, the mass ratio of these bosons is the cosine weak mixing angle.
This corresponds to the proportion of faces facing forward-to-back.
30 degrees is the average angle between a plane and a regular octahedron.
The mass is proportional to the magnitude of the front-to-back asymmetry.

Higgs mechanism

Moving symmetry

Electron

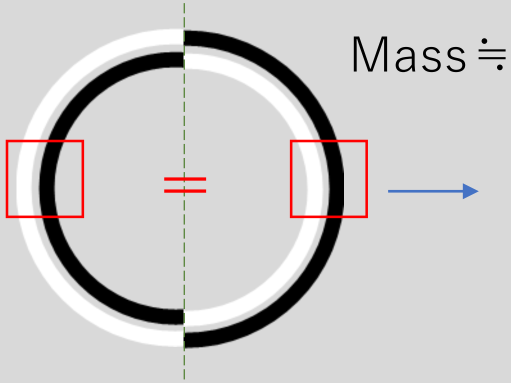


Mass=0.511MeV/c^2

Mirror Symmetric

Moving **Anti**symmetric

Neutrino



Mass≒0

Mirror **Anti**symmetric

Moving Symmetric

Moving Symmetry: To move parallel and match

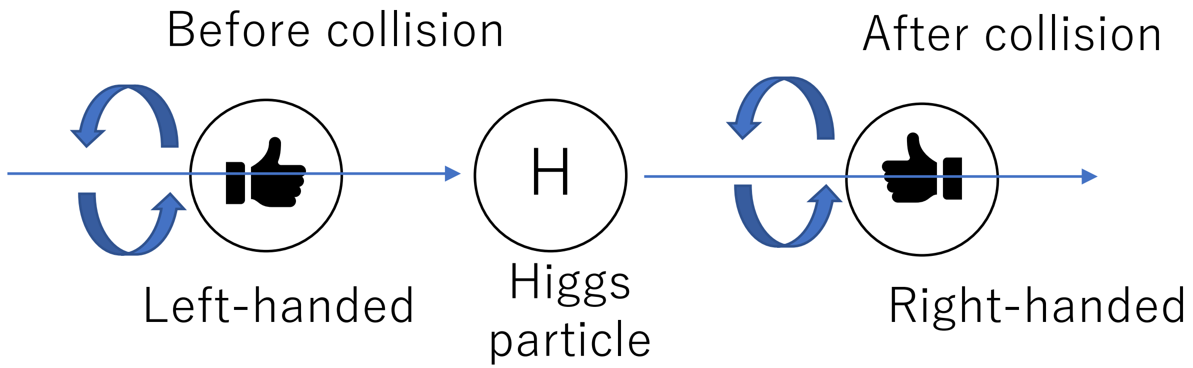
Mass = Proportional to the magnitude of the Moving Asymmetry

Let's look at the symmetry and mass of electrons and neutrinos.
Distinguish between mirror symmetry and moving symmetry.
Translational symmetry occurs when two objects coincide after a parallel translation.
Electrons have mirror symmetry but moving antisymmetry.
Neutrinos have mirror antisymmetry but moving symmetry.
Mass is proportional to the magnitude of the moving asymmetry.
Therefore, electrons are heavier than neutrinos.

Higgs mechanism

Higgs mechanism (1)

The resistance caused by a collision with a Higgs boson condensed in a vacuum is mass.



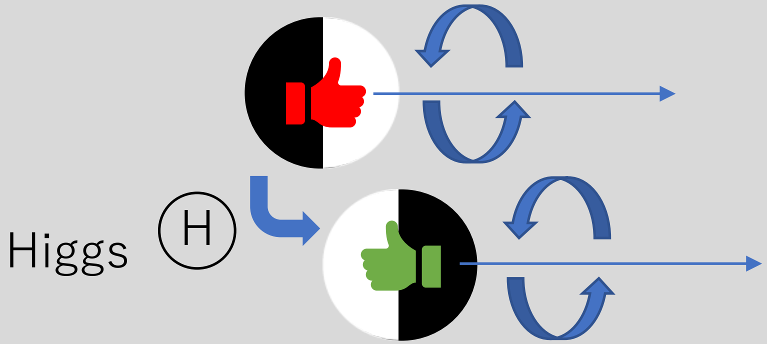
When it collides with a Higgs boson,
the left-handed and right-handed forms are swapped.
This is called chirality, and it is reversed on a mirror plane.
The direction of spin does not change.

Let's look at the role of the Higgs boson in the Standard Model.
The resistance caused by a collision with a Higgs boson condensed in a vacuum is mass.
When it collides with a Higgs boson, the left-handed and right-handed forms are swapped.
This is called chirality, and it is reversed on a mirror plane.
The direction of spin does not change.

Higgs mechanism

Higgs mechanism (2)

Earlier, we thought that the role of the Higgs particle is to swap front and back.



If front and back are distinguishable,
the right-handed and left-handed types will swap.
This does not contradict the Standard Model.

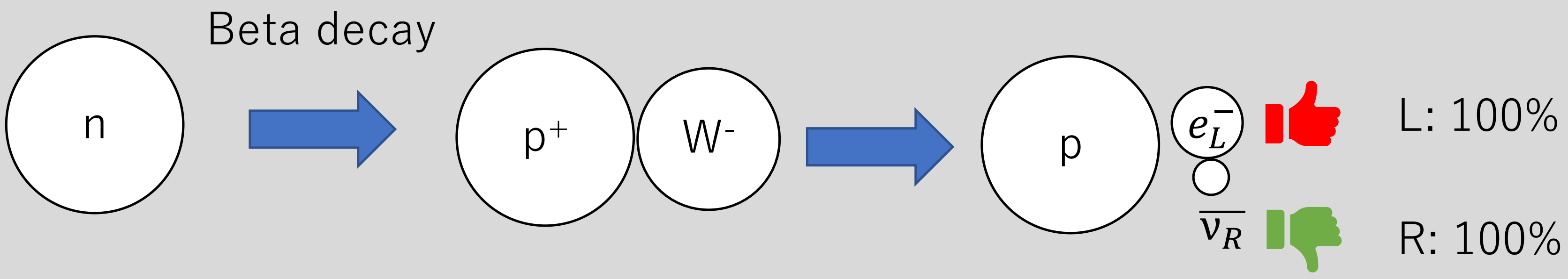
Chirality :Distinguishing whether a particle is facing forward or backward

Earlier, we thought that the role of the Higgs particle is to swap front and back.
Swap front and back without changing the direction of spin.
This results in a mirror image.
If front and back are distinguishable, the right-handed and left-handed types will swap.
This does not contradict the Standard Model.
Chirality corresponds to distinguishing whether a particle is facing forward or backward.

Chirality

Beta decay

In the Standard Model, only quarks and leptons have different properties between right-handed and left-handed particles.
Only left-handed particles and right-handed antiparticles can interact weakly.



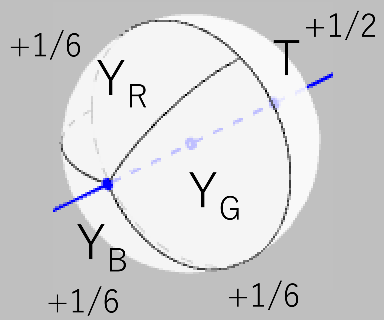
For example, in beta decay, a neutron changes into a proton and emits a W boson.
The W boson decays into an electron and an antineutrino.
The electron is always left-handed and the antineutrino is always right-handed.

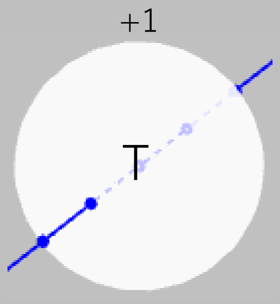
In the Standard Model, only quarks and leptons have different properties between right-handed and left-handed particles.
Only left-handed particles and right-handed antiparticles can interact weakly.
For example, in beta decay, a neutron changes into a proton and emits a W boson.
The W boson decays into an electron and an antineutrino.
In this case, the electron is always left-handed and the antineutrino is always right-handed.

Chirality

Distinguishing between front and back

Electron(positron)	W^+ boson





Isospin part(T) +
Hypercharge part(Y)

All Isospin part(T)

Front and back can be distinguished

Front and back cannot be distinguished

= Right-handed and left-handed types can be distinguished

The electron and W boson are illustrated below.
Both have the same electric charge.
Electrons have an isospin part and a hypercharge part, so it is possible to distinguish between front and back.
Therefore, we can distinguish between right-handed and left-handed types.
On the other hand, the entire W boson is an isospin part, so it is impossible to distinguish between front and back.

Chirality

Particles and antiparticles (1)

Q=T+Y	-1	-2/3	-2/3	0	0	+1/3	+2/3	+1
	e	$\bar{u}$	d	$\bar{\nu_e}$	ν_e	$\bar{d}$	u	$\bar{e}$
T	-1/2	-1/2	-1/2	-1/2	+1/2	+1/2	+1/2	+1/2
Y_R	-1/6	-1/6	+1/6	+1/6	-1/6	-1/6	+1/6	+1/6
Y_G	-1/6	+1/6	-1/6	+1/6	-1/6	+1/6	-1/6	+1/6
Y_B	-1/6	-1/6	+1/6	+1/6	-1/6	-1/6	+1/6	+1/6
$Y_R \times Y_G \times Y_B$	-	+	-	+	-	+	-	+
"-"	odd	even	odd	even	odd	even	odd	even

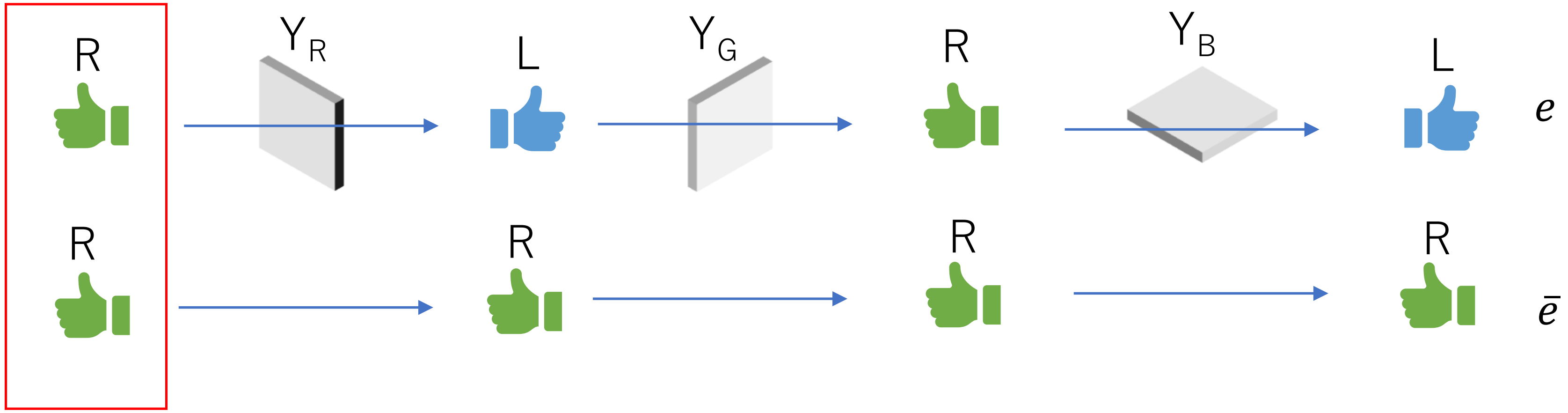
”-” in hypercharge　　odd：particle　　even：antiparticle

Particles only weakly interact with antiparticles if they are left-handed, and antiparticles only if they are right-handed.
First of all, what is the difference between particles and antiparticles?
When particles and antiparticles are arranged in order of their charge, they appear alternately.
Let's take a look at the sign of the hypercharge.
We calculated the product of the signs of the three hypercharges.
This indicates whether the number of "-"s is even or odd.
If the "-" in the hypercharge is odd, it is a particle, and if it is even, it is an antiparticle.

Chirality

Particles and antiparticles (2)

The sign of hypercharge(Y) represents three directions in space.
If it is "-", we assume that it has been mirror-flipped.



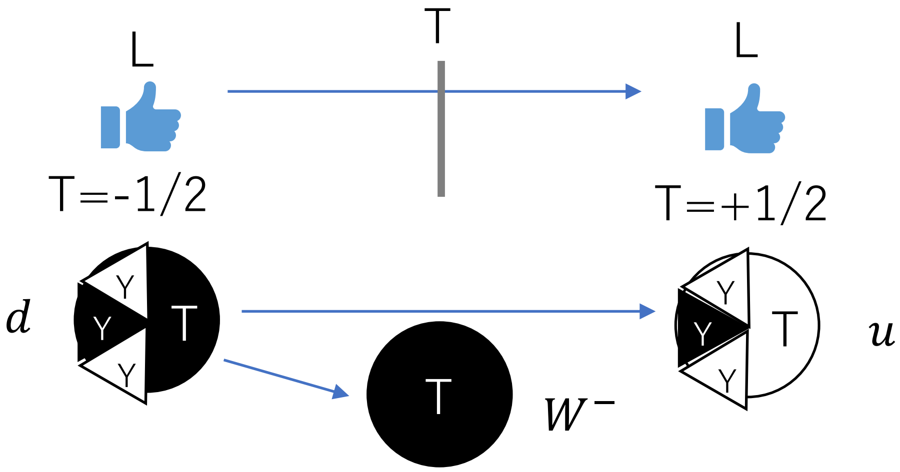
We can say that before mirror-flipping,
only right-handed particles weakly interact.

The sign of hypercharge represents three directions in space.
If it is "-", we assume that it has been mirror-flipped.
Since all three signs of an electron are "-", it is mirror-flipped three times.
Since all three signs of a positron are "+", it is mirror-flipped once.
The left-handed electron was right-handed before mirror-flipping.
Both right-handed electrons were right-handed before mirror-flipping.
We can say that before mirror-flipping, only right-handed particles weakly interact.
However, if it is "+", we assume that it has been mirror-flipped, and it is left-handed.

Chirality

Particles and antiparticles (3)

The sign of isospin(T) indicates the direction of time.
Even if the flow of time is reversed, it does not become a mirror image,
so right-handed and left-handed types do not switch places.



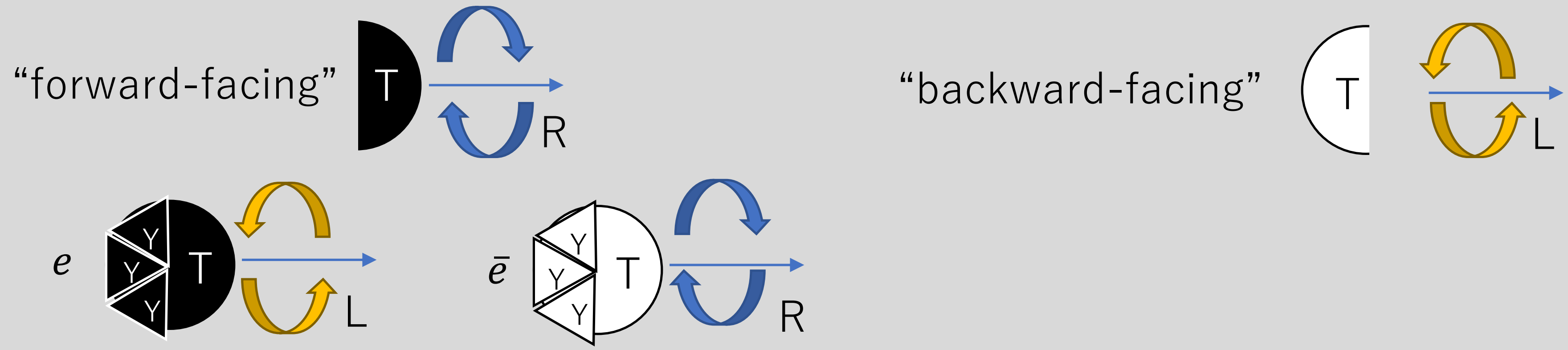
In beta decay, the isospin of the d quark is reversed,
but it does not become an antiparticle.

Isospin also has a sign.
The sign of isospin indicates the direction of time.
Even if the flow of time is reversed, it does not become a mirror image, so right-handed and left-handed types do not switch places.
In beta decay, the isospin of the d quark is reversed, but it does not become an antiparticle.

Chirality

Chirality

If the side in front of the direction of travel is the isospin side,
we assume it is "forward-facing“.
A "forward-facing" particle before mirror-reversal is said to be rotating right.



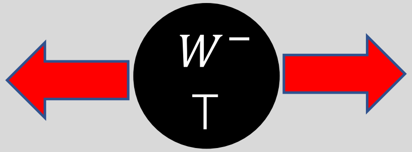
In reality, hypercharge allows us to see direction of rotation after mirror-reversal.
If it's a particle, it appears to rotate left,
and if it's an antiparticle, it appears to rotate right.

So what exactly are right-handed and left-handed?
Let's express this in terms of "forward-facing" and "backward-facing“.
If the side in front of the direction of travel is the isospin side, we assume it is "forward-facing“.
A "forward-facing" particle before mirror-reversal is said to be rotating right.
In reality, hypercharge allows us to see the direction of rotation after mirror-reversal.
If it's a particle, it appears to rotate left, and if it's an antiparticle, it appears to rotate right.

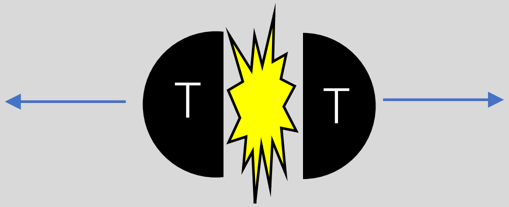
Weak Force

W decay

When a W boson decays,
the two particles that are produced are both always "forward-facing".

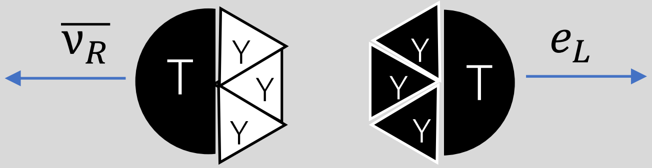


The weak isospin force is thought to act as a force pulling particles outward.



Even after a particle decays,
the isospin part(T) is reused.

Only the hypercharge part (Y) is pair-produced.



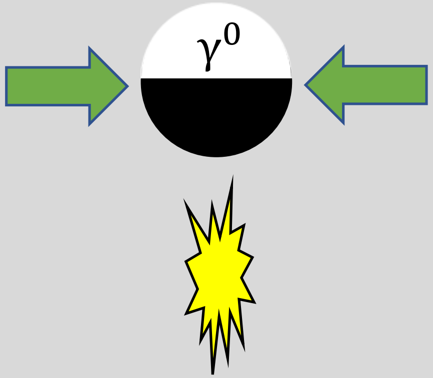
“forward-facing” “forward-facing”

The resulting particles are inevitably "forward-facing“.

Let's think about why only "forward-facing" particles interact weakly.
When a W boson decays, the two particles that are produced are both always "forward-facing".
"Backward-facing" particles do not result because they cannot interact with the W boson.
The weak isospin force is thought to act as a force pulling particles outward.
Even after a particle decays, the isospin part is reused.
Only the hypercharge part is pair-produced.
The resulting particles are inevitably "forward-facing“.

Weak Force

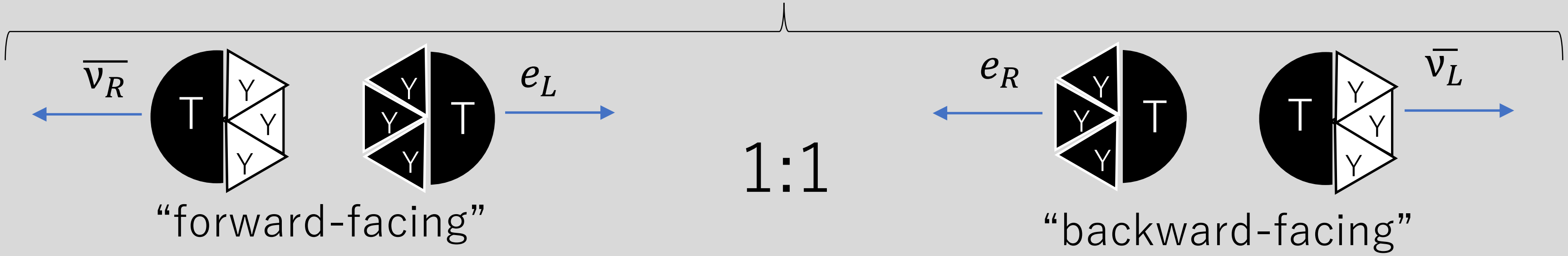
Photon decay



We can think of the force due to the electric charge as acting to compress the particle inward.

We consider it to disappear completely once.
In other words, the isospin side(T) is not reused.

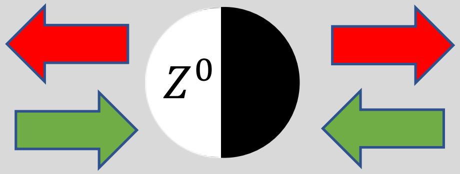
Since pair generation occurs from zero,
there will be an equal amount of "forward-facing" and "backward-facing".



Let's consider the case of electromagnetic force in a similar way.
Pair creation from photons is the decay of a photon.
We can think of the force due to the electric charge as acting to compress the particle inward.
We consider it to disappear completely once.
In other words, the isospin side is not reused.
Since pair generation occurs from zero, there will be an equal amount of "forward-facing" and "backward-facing".

Weak Force

Z decay



The Z boson is subjected to both a force due to isospin(T) and a force due to electric charge(Q).

strength of the binding of the Z boson in the Standard Model： $T - Q\sin^2\Theta_W$

The force due to isospin and the force due to electric charge have opposite signs and weaken each other.
This matches the idea of forces acting outward and inward.

Let's also consider the decay of the Z boson.
The Z boson is subjected to both a force due to isospin and a force due to electric charge.
Below is an equation that shows the strength of the binding of the Z boson in the Standard Model.
The force due to isospin and the force due to electric charge have opposite signs and weaken each other.
This matches the idea of forces acting outward and inward.

Weak Force

Coupling constant for the Z boson

(coupling constant for isospin)

As with photons, we consider it to be tilted by 45° on average, and only the cos45° component can mediate force.

$$cos45° = \frac{1}{\sqrt{2}} = 0.707$$

Measured value： $\sqrt{g^2 + g'^2} = \frac{g}{cos\Theta_W} = 0.718$

For photons, we further divided it by 2, but this is not necessary here.
This is thought to be because partial recycling occurs,
so the opposite half is not wasted.

Calculate the coupling constant for the Z boson.
Calculate the coupling constant for isospin.
As with photons, we consider it to be tilted by 45° on average, and only the cos45° component can mediate force.
If we make corrections, we should be able to match the measured value.
For photons, we further divided it by 2, but this is not necessary here.
This is thought to be because partial recycling occurs, so the opposite half is not wasted.

Weak Force

Coupling constant for the W boson

The cos45° is the same as for the Z boson.
Because the W boson is spherical,
we think it can only partially mediate force.
The average angle between the sphere and the regular octahedron is 30°,
so we multiply by the cos30°.

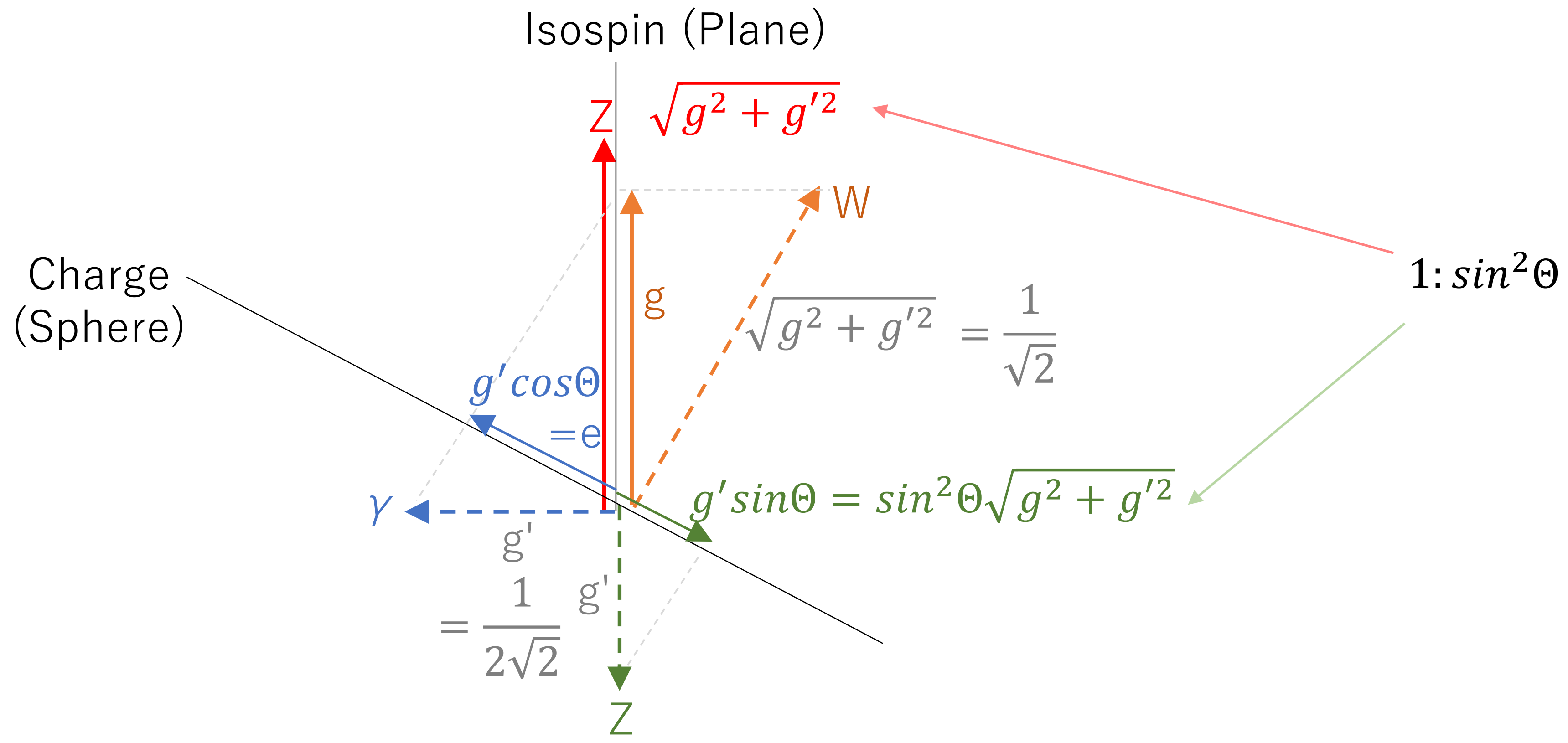
$$cos45° \times cos30° = \sqrt{\frac{3}{8}} = 0.612$$

Measured value： $g = esin\Theta_W = 0.630$

Calculate the coupling constant for the W boson.
The cosine of 45 degrees is the same as for the Z boson.
Because the W boson is spherical, we think it can only partially mediate force.
The average angle between the sphere and the regular octahedron is 30 degrees, so we multiply by the cosine of 30 degrees.
If we make a corrected calculation, I think this will be in line with the actual measured value.

Weak Force

Strength of the electroweak force

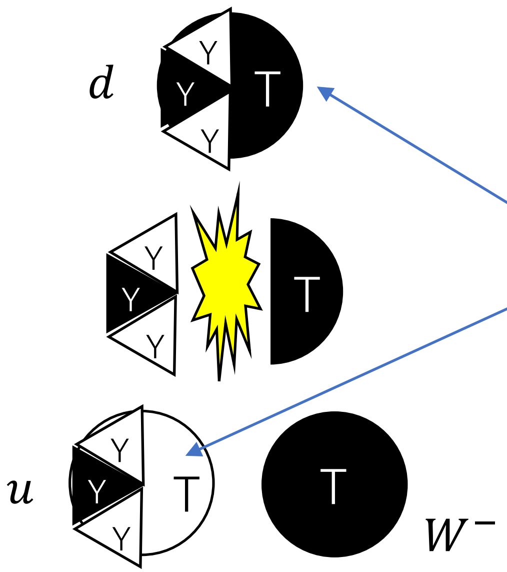


Here is a schematic diagram of the strength of the electroweak force.
The strength of the force due to isospin is the component in the direction of the isospin axis.
The strength of the force due to charge is the component in the direction of the charge axis.
The two axes are in a spherical and flat relationship, tilted at 30 degrees.
The dotted line shows the strength of the force before mixing.
Z has forces both above and below.
We can see that the ratio of the isospin of Z to the force acting on the charge is the sine squared.

Weak Force

What is the weak force? (1)

Unlike the strong force and mass, it seems that the absence of the weak force would not cause waves to disappear and cause any problems.

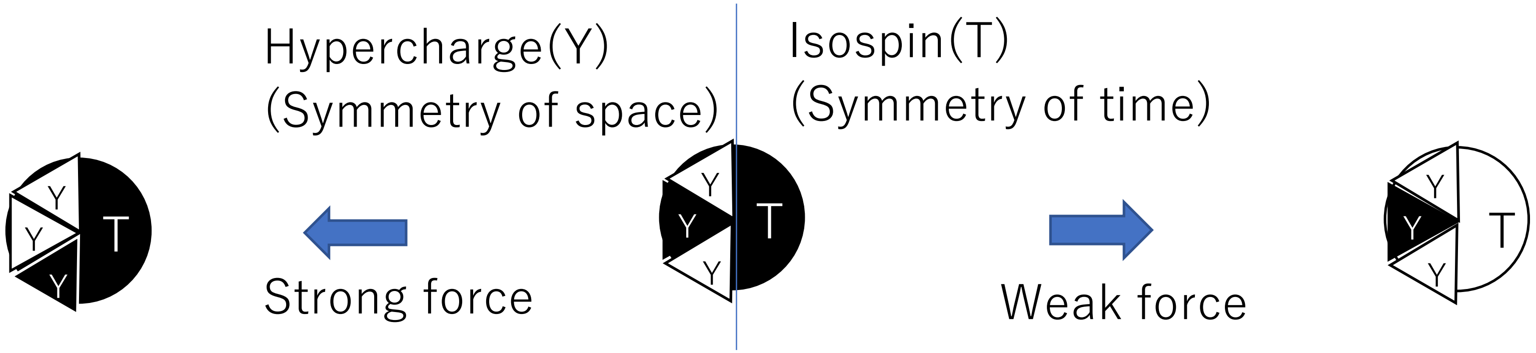


As a result,
the isospin portions(T) are swapped.

So what is the weak force?
Unlike the strong force and mass, it seems that the absence of the weak force would not cause waves to disappear and cause any problems.
Let's take a look at what changes before and after beta decay.
The isospin portion is reused and a W boson is emitted.
The missing isospin is pair-produced.
As a result, the isospin portions are swapped.

Weak Force

What is the weak force? (2)



Isospin has the freedom to take on values of +1/2 or -1/2.
Having degrees of freedom means that it can be changed.
That is the weak force.

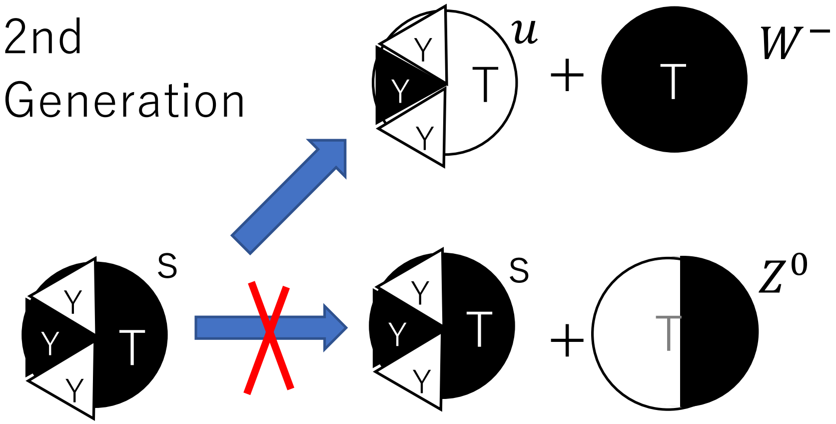
Fermions have isospin and hypercharge.
The strong force reverses the sign of hypercharge.
The weak force reverses the sign of isospin.
Hypercharge is a symmetry of space, and isospin is a symmetry of time.
Both have smallest units and are quantized.
Isospin has the freedom to take on values of +1/2 or -1/2.
Having degrees of freedom means that it can be changed.
That is the weak force.

Weak Force

Flavor Change (1)

1st
Generation …More uniform mixing than the 2nd generation

2nd
Generation



T and Y parts are broken down,
so it is thought that they remix.

the T and Y parts are maintained,
so it is thought that they do not remix.

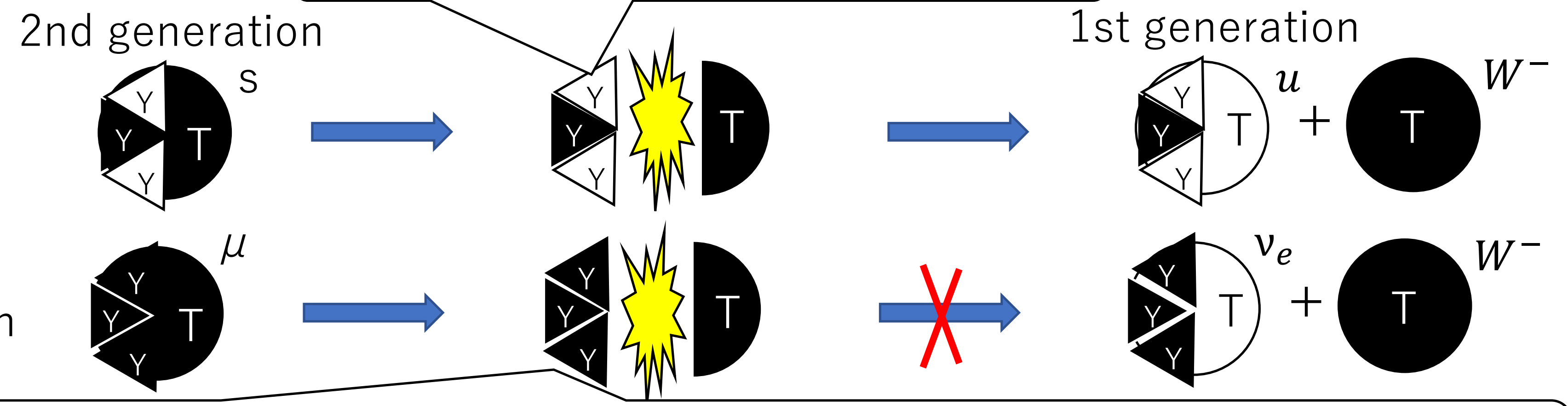
There is no force that forces uniform mixing.
When they are broken down,
it is simply impossible to identify the original mixed state.

The weak force also changes the generation of quarks.
Second-generation strange quarks emit a weak boson and change into first-generation up quarks.
On the other hand, they do not change into down quarks by emitting a Z boson.
Generations are the level of uniformity of mixing, and the first generation is more uniformly mixed than the second generation.
When a weak boson is emitted, the T and Y parts are broken down, so it is thought that they remix.
When a Z boson is emitted, the T and Y parts are maintained, so it is thought that they do not remix.
There is no force that forces uniform mixing.
When they are broken down, it is simply impossible to identify the original mixed state.

Weak Force

Flavor Change (2)

The original mixture state is unknown.



If the three Y parts, which correspond to spatial directions, have same sign, it is thought that the original mixed state is remembered.

Since generations represent the degree of spatial mixing, it is thought that if the charge is spatially uneven, the mixing will be disrupted.

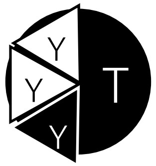
Leptons also emit weak bosons and change into other particles.
However, leptons do not change into a different generation.
If the three Y parts, which correspond to spatial directions, have the same sign, it is thought that the original mixed state is remembered.
On the other hand, it is thought that quarks no longer know their original mixed state.
Since generations represent the degree of spatial mixing, it is thought that if the charge is spatially uneven, the mixing will be disrupted.

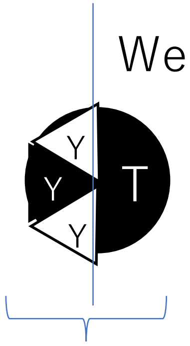
Weak Force

CP symmetry

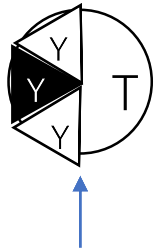
Does swapping charge and chirality not change the physical phenomenon?

Strong force： Symmetry of Y part





Weak force： Symmetry of Y part



Mass does not change
⇒ CP conservation

Mass： Entire symmetry

Mass changes
⇒ CP violation

The strong force is equivalent to simply changing the orientation of a particle, so it is thought to conserve CP.

It is known that CP symmetry is slightly violated in the weak force.
CP symmetry means that physical phenomena do not change even if charge and chirality are swapped.
On the other hand, CP is experimentally preserved in the strong force.
When the strong force is applied, the color changes but the mass does not change.
The strong force is equivalent to simply changing the orientation of a particle, so it is thought to conserve CP.
On the other hand, when the weak force is applied, a change in mass also occurs, so it is thought to violate CP.

Mass

What is the Higgs particle?

Light
- Particle properties (local) … Photon
- Wave properties (non-local)

Particles have always been thought of as simply spaces with different properties.

Vacuum
- Particle properties (local) … Higgs particle
- Wave properties (non-local)

Next, we will begin calculating the mass.
But first, let's consider what the Higgs boson is.
Light has both particle properties and wave properties.
It can also be said to have localized and non-local properties.
Particles have always been thought of as simply spaces with different properties.
As a result, a vacuum should also have localized properties.
The Higgs boson can be interpreted as the particle properties of a vacuum.

Mass

Why does mass exist?

God's choice

1. It doesn't really need to exist,
   so it didn't exist in the early universe.

…The timing of the mass generation
was determined by rolling dice.

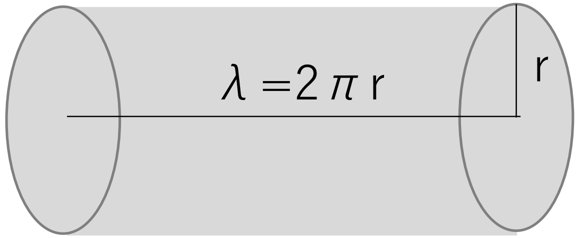
2. It was there from the beginning
   because it was necessary for the particles to move.

First of all, why does mass exist?
It's not necessary, so it's thought that it didn't exist in the early universe.
However, in that case, you'd have to roll dice to decide when mass would arise.
Since mass is necessary for particles to move, we should assume that it has been there from the beginning.

Mass

Higgs collision volume

Mass can be interpreted as the degree of collision with the Higgs boson.
Calculate the volume in which a particle collides with a Higgs boson.
Calculate the volume of space a sphere passes through
while traveling one wavelength.



$$V = 2\pi r \times \pi r^2$$
$$= 2\pi^2 r^3$$

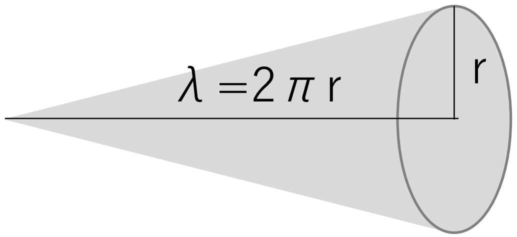
When the collision occurs at 100% of this volume,
the mass will be at its maximum

Mass can be interpreted as the degree of collision with the Higgs boson.
Calculate the volume in which a particle collides with a Higgs boson.
Calculate the volume of space a sphere passes through while traveling one wavelength.
Let's say the radius is r and the wavelength is $\lambda = 2\pi r$.
The volume can be calculated as a cylinder.
When the collision occurs at 100% of this volume, the mass will be at its maximum.

Mass

Collision volume of the Higgs itself

The Higgs boson acts on the asymmetry in the direction of travel.
Although space has three dimensions,
it only acts in one dimension, the direction of movement.
Therefore, the collision volume is also 1/3.



$$V_H = \frac{1}{3} \times 2\pi r \times \pi r^2$$

$$= \frac{2}{3}\pi^2 r^3$$

This corresponds to the component of the cylinder in the direction of travel.
This is exactly the volume of a cone.

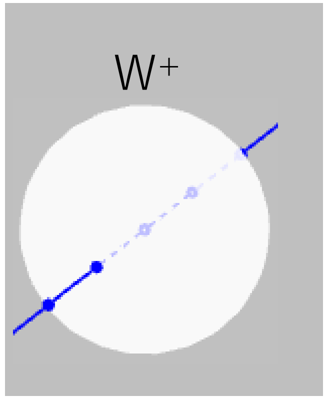
We calculate the volume where the Higgs boson itself collides with another Higgs boson.
The Higgs boson acts on the asymmetry in the direction of travel.
Although space has three dimensions, it only acts in one dimension, the direction of movement.
Therefore, the collision volume is also 1/3.
This corresponds to the component of the cylinder in the direction of travel.
This is exactly the volume of a cone.

Mass

Mass of W boson

We will calculate the mass from the ratio of the Higgs collision volumes.

Higgs particle mass (measured)： $M_H = 125.2GeV/c^2$



W volume $V_W = \frac{4}{3}\pi r^3$

W mass $M_W = \frac{V_W}{V_H} M_H = \frac{\frac{4}{3}\pi r^3}{\frac{2}{3}\pi^2 r^3} M_H = \frac{2}{\pi} M_H = 79.70GeV/c^2$

Measured value：$80.37GeV/c^2$

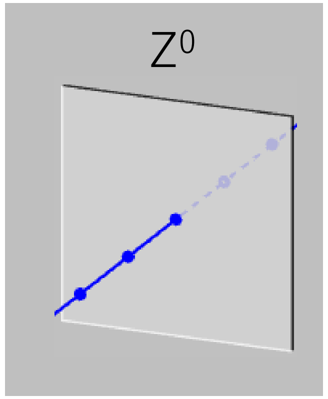
(error：-0.8%)

Let's calculate the mass of the W boson.
We will calculate the mass from the ratio of the Higgs collision volumes.
We will use the measured mass of the Higgs particle as a reference.
We will assume that the W boson is a sphere.
We can find the mass from the volume ratio of the sphere to the cylinder.
The error from the measured value is 0.8%, which is roughly correct.

Mass

Mass of Z boson

We calculate it in ratio to the W boson.
The Z boson is a planar particle.
We calculate it using the 30° tilt of the sphere and the regular octahedron.



Volume $$V_Z = \frac{V_W}{cos30°} = \frac{1}{cos30°} \times \frac{4}{3}\pi r^3 = \frac{8}{3\sqrt{3}}\pi r^3$$

Mass $$M_Z = \frac{V_W}{V_H}M_H = \frac{\frac{8}{3\sqrt{3}}\pi r^3}{\frac{2}{3}\pi^2 r^3}M_H = \frac{4}{\sqrt{3}\pi}M_H = 92.04GeV/c^2$$

Measured value： $91.19GeV/c^2$

(error：+0.9%)

Let's also calculate the mass of the Z boson.
We calculate it in ratio to the W boson.
The Z boson is a planar particle.
We calculate it using the 30 degree tilt of the sphere and the regular octahedron.
The error from the actual measured value is 0.9%, which is roughly correct.

Mass

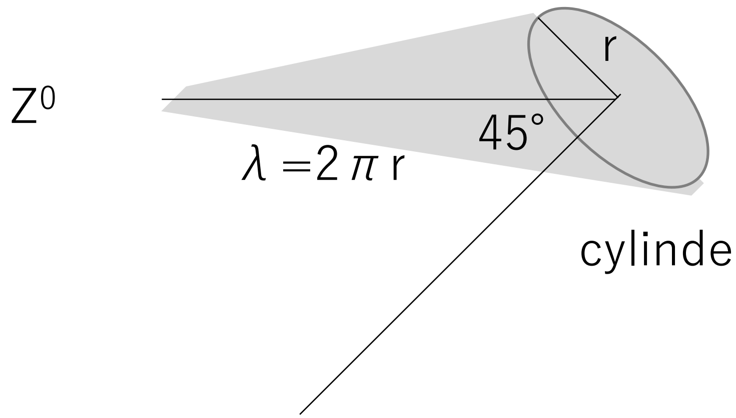
Weak force and mass (1)

The component of the tilt relative to direction of movement of plane becomes mass.

Since both weak force and mass are forces with a component in direction of move, the magnitude of coupling constant is proportional to mass.

$$M_Z = g_Z M_H = cos45° M_H = \frac{1}{\sqrt{2}} M_H = \frac{\frac{1}{\sqrt{2}} V_H}{V_H} \times M_H = 88.53 GeV/c^2$$

Measured $91.19 GeV/c^2$



cylinder tilted at 45°

There is another way to calculate mass.
The component of the tilt relative to the direction of movement of the plane becomes the mass.
Since both weak force and mass are forces with a component in direction of movement, the magnitude of coupling constant is proportional to mass.
Multiplying the Z boson coupling constant by the Higgs mass gives the mass of the Z boson.
This is slightly lighter than the previous calculation method.
From this formula, we can reverse-calculate the volume.
The result is a cylinder tilted at 45 degrees.

Mass

Weak force and mass (2)

$$M_W = g_W M_H = cos45°cos30°M_H = \sqrt{\frac{3}{8}}M_H = \frac{\sqrt{\frac{3}{8}}V_H}{V_H} \times M_H = 76.67GeV/c^2$$

実測値 $80.37GeV/c^2$

W+ The shape is like a cone tilted at 45° ,
tilted by another 30° .

In terms of the component in the direction of movement,
this shape is thought to be more accurate than a sphere.

$M_H = g_H M_H$ $g_H = 1$ The coupling constant of the Higgs boson is 1.

We will use the same method to calculate the mass of the W boson.
It is slightly lighter than the previous calculation method.
The shape is like a cone tilted at 45 degrees, tilted by another 30 degrees.
In terms of the component in the direction of movement, this shape is thought to be more accurate than a sphere.
We also plugged the mass of the Higgs boson into the same equation.
We can say that the coupling constant of the Higgs boson is 1.

Charged lepton Mass

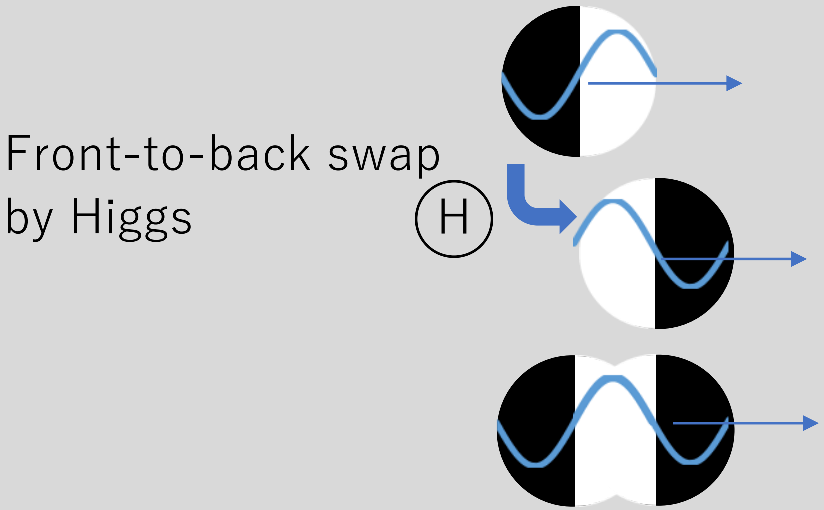
Generation and Symmetry

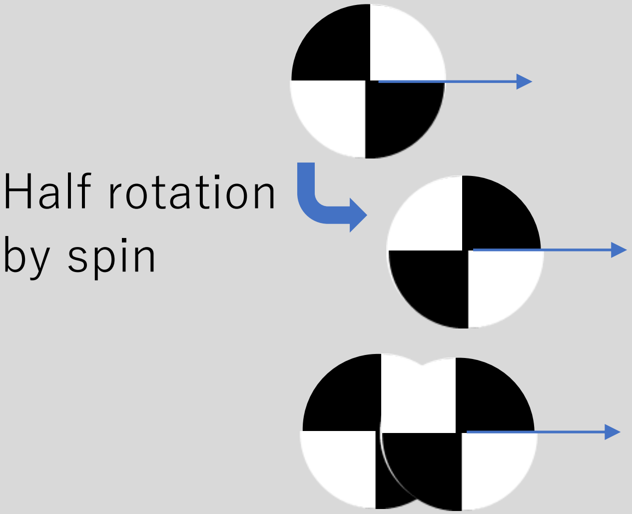
		Fermion			Boson
Generation		1	2	3	4
Mirror Symmetry	X	Antisymmetric	Symmetric	Symmetric	Symmetric
	Y	Antisymmetric	Antisymmetric	Symmetric	Symmetric
	Z	Antisymmetric	Antisymmetric	Antisymmetric	Symmetric
Moving Symmetry	X	Symmetric	Antisymmetric	Antisymmetric	Antisymmetric
	Y	Symmetric	Symmetric	Antisymmetric	Antisymmetric
	Z	Symmetric	Symmetric	Symmetric	Antisymmetric
Dimension of Antisymmetry		0	1	2	3

Next, we will calculate the mass of fermions.
Let's review generations, which only fermions have.
The mirror symmetry of spin changes depending on the generation.
Translation symmetry, which is proportional to mass, has the inverse relationship to mirror symmetry.
As the number of generations increases, the number of antisymmetric dimensions increases.
Bosons correspond to four generations.

Charged lepton Mass

Spin and Symmetry (1)





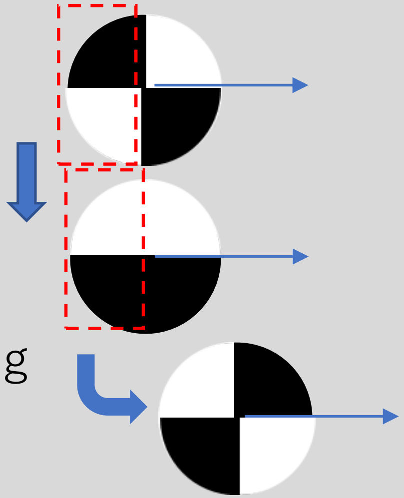
In a particle like the one shown in the diagram on the right,
the front and back are swapped by a half rotation due to spin.
As a result, there is no need for the front-to-back swap due to Higgs mechanism,
and the particle becomes lighter.

Let's consider the relationship between spin and symmetry.
The diagram on the left shows the front-to-back swap of a particle due to the Higgs mechanism.
We are looking at the interference between the front and back particles after they have traveled half a wavelength.
After traveling half a wavelength, the particle undergoes a half rotation due to spin.
In a particle like the one shown in the diagram on the right, the front and back are swapped by a half rotation due to spin.
As a result, there is no need for the front-to-back swap due to the Higgs mechanism, and the particle becomes lighter.

Charged lepton Mass

Spin and Symmetry (2)

When the spin is 1/2,
only half of the wavelength makes a half rotation.



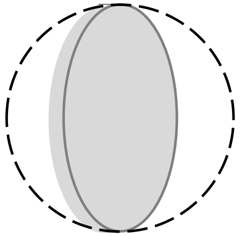
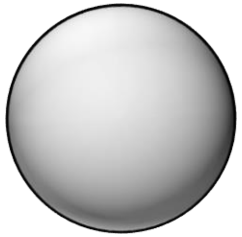
This changes the amount of front-to-back swapping required by the Higgs.

The generation of fermions is determined by how the halves are divided.
Different divisions require different amounts of Higgs,
and therefore different masses.

Let's consider the case of spin 1/2.
When the spin is 1/2, only half of the wavelength makes a half rotation.
This changes the amount of front-to-back swapping required by the Higgs.
The generation of fermions is determined by how the halves are divided.
Different divisions require different amounts of Higgs, and therefore different masses.

Charged lepton Mass

Tauon mass

	τ (Tauon)	W boson
Charge	1	1
Generation	3	4
Dimension of Antisymmetry	2	3
Higgs collision Volume	 Disk	 Sphere

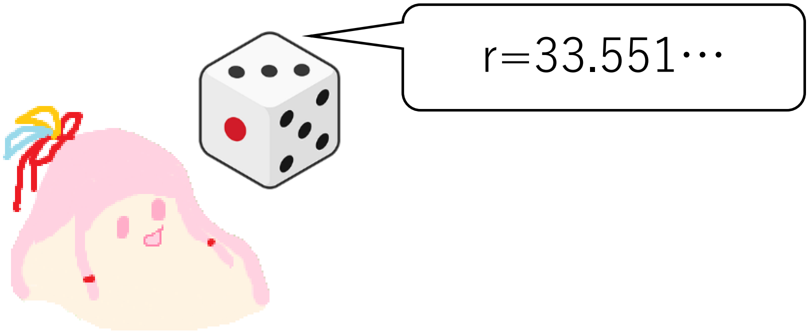
It is thought that the tauon is symmetric in only one dimension, and will no longer collide with the Higgs.

We will calculate this from the mass of the tauon.
It is a third-generation charged lepton.
Since its charge is 1, it can be imagined as a sphere, just like the W boson.
The antisymmetric dimension is 3 for the W boson, and 2 for the tauon.
It is thought that the tauon is symmetric in only one dimension, and will no longer collide with the Higgs.
We assume that it will no longer collide with the Higgs in the Z direction.
This will result in a disk sliced from a sphere.

Charged lepton Mass

God’s dice (1)

I want to calculate the volume of a disk, but I have no idea about its thickness.
Let me borrow God's power for now.
I will roll God's dice just once.



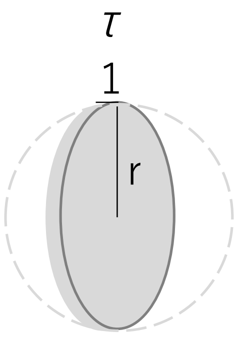
If I can explain this number later, I will return the dice.

I want to calculate the volume of a disk, but I have no idea about its thickness.
Let me borrow God's power for now.
I will roll God's dice just once.
The dice come up with the number 33.551.
I will use this as the radius r.
If I can explain this number later, I will return the dice.

Charged lepton Mass

Tauon mass (2)

Use r=33.551



Disk

Volume $V_\tau = 1 \times \pi r^2$

Mass $M_\tau = \dfrac{V_\tau}{V_H} M_H = \dfrac{\pi r^2}{\frac{2}{3}\pi^2 r^3} M_H = \dfrac{3}{2\pi r} M_H = 1781.2 MeV/c^2$

Measured value： $1776.9 MeV/c^2$

(error：+0.2%)

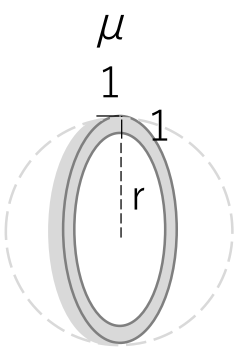
You could say that r was adjusted to match.

Let's resume the tauon calculations.
Calculate the volume of a disk with radius r and thickness 1.
Use r=33.551.
Calculate the mass from the volume ratio to the Higgs particle.
This matches the measured value with an error of 0.2%.
You could say that r was adjusted to match.

Charged lepton Mass

Muon mass

Since it is the second generation, the antisymmetric dimension is reduced by one.
We assume that there are no more collisions with the Higgs in the radial direction.



Ring

Volume $V_{\mu} = 1 \times 1 \times 2\pi r$

Mass $M_{\mu} = \dfrac{V_{\mu}}{V_H} M_H = \dfrac{2\pi r}{\frac{2}{3}\pi^2 r^3} M_H = \dfrac{3}{\pi r^2} M_H = 106.15 MeV/c^2$

Measured value： $105.66 MeV/c^2$

(error：+0.5%)

No arbitrary adjustments were made to make them match.

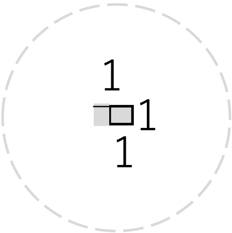
Similarly, we calculate the mass of the muon.
Since it is the second generation, the antisymmetric dimension is reduced by one.
We assume that there are no more collisions with the Higgs in the radial direction.
This will result in a ring.
The width and thickness of the ring will be set to 1.
With this, we can calculate the volume and mass.
The results matched with an error of 0.5%.
No arbitrary adjustments were made to make them match.

Charged lepton Mass

Electron mass

Since this is the first generation, one antisymmetric dimension is removed.
We also assume that
there will be no collisions with the Higgs in the circular direction.

e



Cube

Volume $V_e = 1 \times 1 \times 1$

Mass $M_e = \dfrac{V_e}{V_H} M_H = \dfrac{1}{\frac{2}{3}\pi^2 r^3} M_H = \dfrac{3}{2\pi r^3} M_H = 0.5034 MeV/c^2$

Measured value： $0.5110 MeV/c^2$

(error：-1.5%)

No arbitrary adjustments were made to achieve the match.

Similarly, we calculate the mass of the electron.
Since this is the first generation, one antisymmetric dimension is removed.
We also assume that there will be no collisions with the Higgs in the circular direction.
This then results in a unit cube.
With this, we have calculated the volume and mass.
These values matched with an error of 1.5%.
No arbitrary adjustments were made to achieve the match.

Charged lepton Mass

Meaning of the radius r

In the symmetric direction, there will be no collisions with the Higgs boson.

Thickness=0 (Volume=0) ⋯ 100% Symmetry

In fact,

Thickness>0 (Volume=0) ⋯ there is still asymmetry of
$1/r = 2.9805\%$.

Where does this approximately 3% asymmetry come from?

Let's consider the meaning of the radius $r = 33.551$.
In the symmetric direction, there will be no collisions with the Higgs boson.
However, if the thickness becomes 0, the volume will also become 0.
In fact, it seems that a thickness of $1/r$ remains.
This can be interpreted as not being completely symmetric.
In other words, there is still asymmetry of $1/r = 2.9805\%$.
Where does this approximately 3% asymmetry come from?

Charged lepton Mass

Koide formula

Empirical rule for the mass ratio of charged leptons

Minimum

$$\frac{1+1+1}{\left(\sqrt{1}+\sqrt{1}+\sqrt{1}\right)^2}=\frac{1}{3}$$

Medium

$$\frac{M_e+M_\mu+M_\tau}{\left(\sqrt{M_e}+\sqrt{M_\mu}+\sqrt{M_\tau}\right)^2}\approx\frac{2}{3}$$

Maximum

$$\frac{0+0+1}{\left(\sqrt{0}+\sqrt{0}+\sqrt{1}\right)^2}=1$$

$$\frac{1+2\pi r+\pi r^2}{\left(\sqrt{1}+\sqrt{2\pi r}+\sqrt{\pi r^2}\right)^2}=\frac{2}{3}$$

r=33.57715⋯

This is difficult to interpret geometrically, and may be a coincidence.

One possibility for explaining the radius r is the Koide formula.
This is an empirical rule for the mass ratio of charged leptons.
Solving this gives r = 33.577.
This is difficult to interpret geometrically, and may be a coincidence.

Charged lepton Mass

Unification of Mass and Strong Force (1)

At the energy scale of tauons,
the strong force is the strength when the color enhancement by gluons is 0.

$$g_s(M_\tau) = \frac{1}{3} \times 1 \times 2\pi = \frac{2\pi}{3}$$

$$\alpha_s(M_\tau) = \frac{g_s^2}{4\pi} = \frac{\pi}{9} = 0.3491$$

Measured $\alpha_s(M_\tau) = 0.31$

Rotation of strong force $\frac{2\pi r}{3} \times \pi r^2 = \frac{2\pi^2 r^3}{3} = V_H$ Higgs volume

$V_\tau = \pi r^2$ Tauon volume

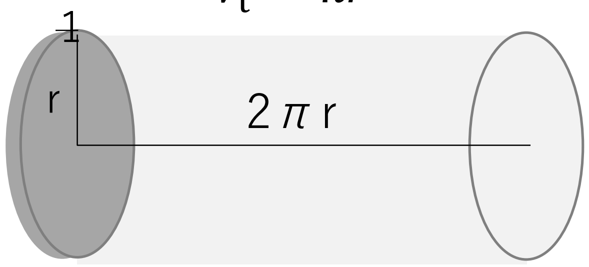
It can be said that the energy scale of the strong force is determined
by the same principle as mass due to the Higgs mechanism.

Now let's talk about the strong force, which we have been leaving aside for now.
At the energy scale of tauons, the strong force is the strength when the color enhancement by gluons is 0.
In this case, the gauge coupling constant is 2/3 pi.
If the radius is r, the amount of rotation due to the strong force is 2/3 pi r.
Meanwhile, the volume of a tauon is pi r squared.
Multiplying these together gives the volume of the Higgs particle.
It can be said that the energy scale of the strong force is determined by the same principle as mass due to the Higgs mechanism.

Charged lepton Mass

Unification of Mass and Strong Force (2)

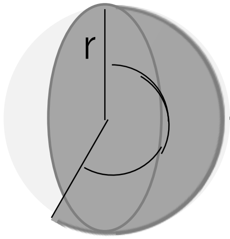
$$V_\tau = \pi r^2$$



Mass： Resistance to movement

Energy is determined by the volume
that is passed through during movement.

$$\mathrm{V} = \pi r^2 \times \frac{2}{3}\pi$$



$$\frac{2\pi r}{3}$$

Strong force： Resistance to spin

Energy is determined by the volume
that the spin passes through.

Let's compare them using diagrams.
Mass can be thought of as the resistance to movement.
Energy is determined by the volume passed through by the movement.
The strong force can be thought of as the resistance to spin.
Energy is determined by the volume passed through by spin.
Rotating by 2/3 pi r gives the Higgs volume.
Since energy is determined by the same principle, they can be said to be unified.

Neutrino Mass and Mixing

Neutrino mass (1)

The three masses are simply assumed
to be a geometric progression of the square root of r.

$$M_1 = \frac{r^{-2}}{V_H^2} M_H = 0.00179 eV/c^2$$

$$M_2 = \frac{r^{-1.5}}{V_H^2} M_H = 0.0104 eV/c^2$$

$$M_3 = \frac{r^{-1}}{V_H^2} M_H = 0.0601 eV/c^2$$

$$\Delta M_{21}^2 = 2.47 \times 10^{-3} (eV/c^2)^2$$

$$2.45(3) \times 10^{-3} (eV/c^2)^2$$

(Measured)

$$\Delta M_{32}^2 = 7.37 \times 10^{-5} (eV/c^2)^2$$

$$7.50(19) \times 10^{-5} (eV/c^2)^2$$

(Measured)

The denominator is the square of the Higgs volume,
making it lighter than other particles.

From this, we calculate the neutrino mass.
Neutrinos have three eigenmass states, which are a mixture of each other.
Only the square of the mass difference has been measured.
The three masses are simply assumed to be a geometric progression of the square root of r.
This matches the measured values within the measurement error range.
The denominator is the square of the Higgs volume, making it lighter than other particles.

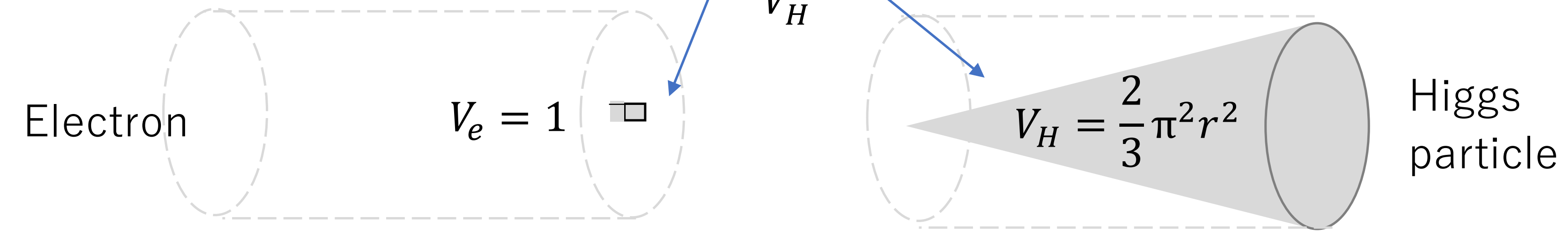
Neutrino Mass and Mixing

Neutrino mass (2)

Electron mass $M_e = \dfrac{V_e}{V_H} \times M_H$

Rearrange the equation so that the denominator is the square of the Higgs volume.

$$M_e = \frac{V_e \times V_H}{V_H^2} \times M_H$$



The mass is proportional to the product of the electron volume and Higgs volume.
This can be interpreted as a collision when two volumes overlap.

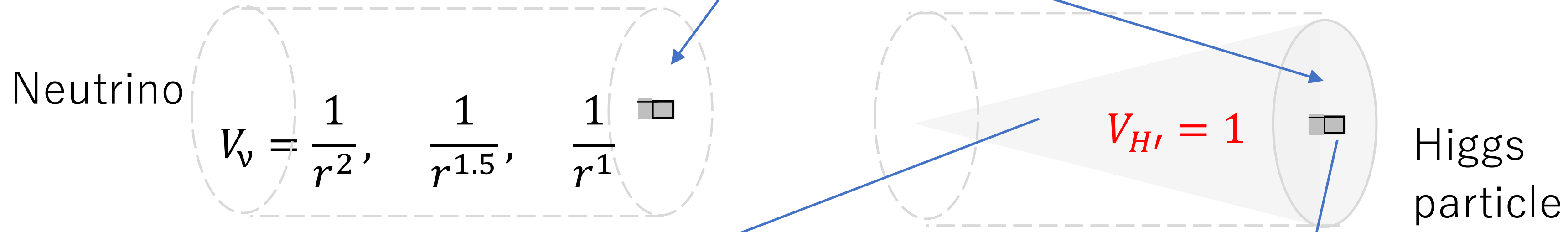
Let's look back at electrons.
The mass of an electron is inversely proportional to the first power of the Higgs volume.
Rearrange the equation so that the denominator is the square of the Higgs volume.
The mass is proportional to the product of the electron's volume and the Higgs volume.
This can be interpreted as a collision when two volumes overlap.

Neutrino Mass and Mixing

Neutrino mass (3)

We consider the volume of the Higgs boson it is colliding with to decrease.

Neutrino mass $M_\nu = \frac{V_\nu \times V_{H'}}{V_H^2} \times M_H$



Symmetric component ：
Not collide with the neutrino

$$\frac{2}{3}\pi^2 r^3 - 1$$

Asymmetric component ：
Collide with the neutrino

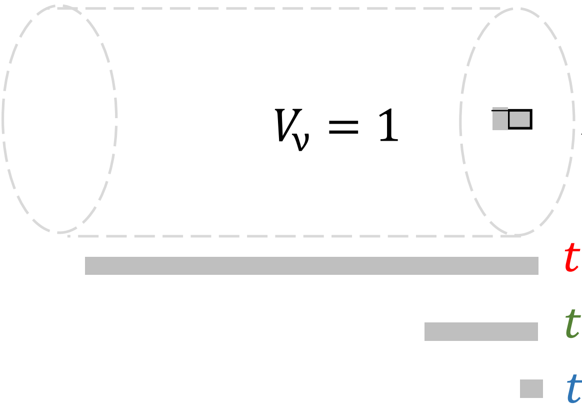
$$1$$

Similarly, let's consider the case of neutrinos.
We consider the volume of the Higgs boson it is colliding with to decrease.
We consider the collision to be a volume of 1.
Only the asymmetric component of the Higgs boson collides with the neutrino.
The remaining symmetric component does not collide with the neutrino.
However, if we continue to think in this way, the volume of the neutrino becomes smaller than 1.

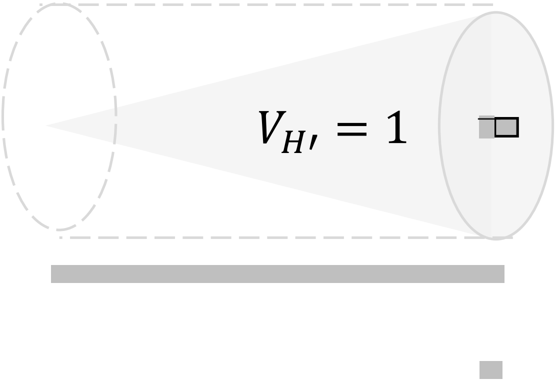
Neutrino Mass and Mixing

Neutrino mass (4)

We think that a collision occurs when two product of volumes and times overlaps.



$$M_{1,2,3} = \frac{V_\nu t_{1,2,3} \times V_{H'} t_{H'}}{(V_H t_H)^2} \times M_H$$



$t_3 = r$

$t_2 = \sqrt{r}$

$t_1 = 1$

$t_H = r$

$t_{H'} = 1$

Of the Higgs particle's time r, only part 1 collides with the neutrino.
There are three levels of neutrino time: 1, root r, and r.

We consider symmetry not only in space but also in the time axis.
We think that a collision occurs when the product of two volumes and times overlaps.
Of the Higgs particle's time r, only part 1 collides with the neutrino.
There are three levels of neutrino time: 1, root r, and r.

Neutrino Mass and Mixing

Neutrino mixing matrix

The mass ratio of M1 to M3 is r, so we enter just that into the matrix.

average of left and right

$$\begin{pmatrix} 1 & ? & 1/r \\ ? & ? & ? \\ ? & ? & ? \end{pmatrix} \Rightarrow \begin{pmatrix} 1 & 0.515 & 0.030 \\ ? & ? & ? \\ ? & ? & ? \end{pmatrix} \Rightarrow \begin{pmatrix} 0.647 & 0.333 & 0.019 \\ ? & ? & ? \\ ? & ? & ? \end{pmatrix}$$

total 1

$$\begin{array}{cc} & \begin{array}{ccc} M_1 & M_2 & M_3 \end{array} \\ \begin{array}{c} \nu_e \\ \nu_\mu \\ \nu_\tau \end{array} & \begin{pmatrix} 0.82 & 0.55 & 0.15 \\ 0.40 & 0.59 & 0.70 \\ 0.40 & 0.59 & 0.70 \end{pmatrix} \end{array} \quad \begin{pmatrix} 0.805 & 0.577 & 0.139 \\ 0.420 & 0.577 & 0.700 \\ 0.420 & 0.577 & 0.700 \end{pmatrix} \Leftarrow \begin{pmatrix} 0.647 & 0.333 & 0.019 \\ 0.176 & 0.333 & 0.490 \\ 0.176 & 0.333 & 0.490 \end{pmatrix}$$

remainder is distributed equally

measured(about)

square root

Neutrino mixing is represented by a matrix.
The mass ratio of M1 to M3 is r, so we enter just that into the matrix.
In the middle column, enter the average value of the left and right columns.
Make sure the horizontal total is 1.
Enter the remaining values equally into the bottom two rows.
Finally, take the square root.
Using only r, we obtained a matrix that is close to the actual measured value.

Neutrino Mass and Mixing

Generations and Dimensions

Flavor		ν_1 H(core)	ν_2	ν_3, ν_e u,d,e	ν_μ s,c, μ	ν_τ b,t, τ	H,Z,W
Dimension number of Asymmetry	Space	0	0	0	1	2	3
	Time	0	0.5	1	1	1	1
	Total	0	0.5	1	2	3	4
Generation		0	0.5	1	2	3	4

Generation = Dimension number of Asymmetry

For neutrinos, the symmetry of space does not directly affect their mass, but it does indirectly affect the degree of mixing of time symmetry.

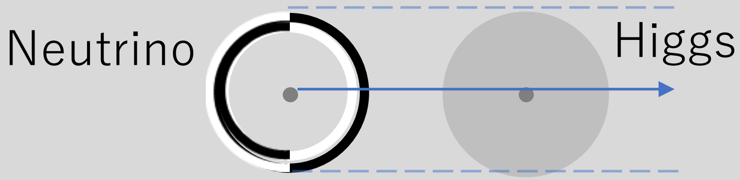
The relationship between generations and number of dimensions is shown in a table.
We consider not only space but also time.
The generations correspond to the asymmetric number of dimensions.
For neutrinos, the symmetry of space does not directly affect their mass, but it does indirectly affect the degree of mixing of time symmetry.
Neutrino masses correspond to generations 0, 0.5, and 1.
The Higgs particle is of the fourth generation, but its core is of the zeroth generation.

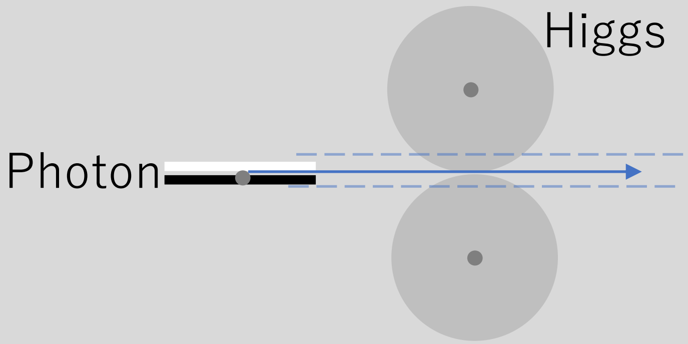
Neutrino Mass and Mixing

Photon mass

All particles are thought to have an asymmetric core.

Mass is created when the cores of a neutrino and the Higgs collide.





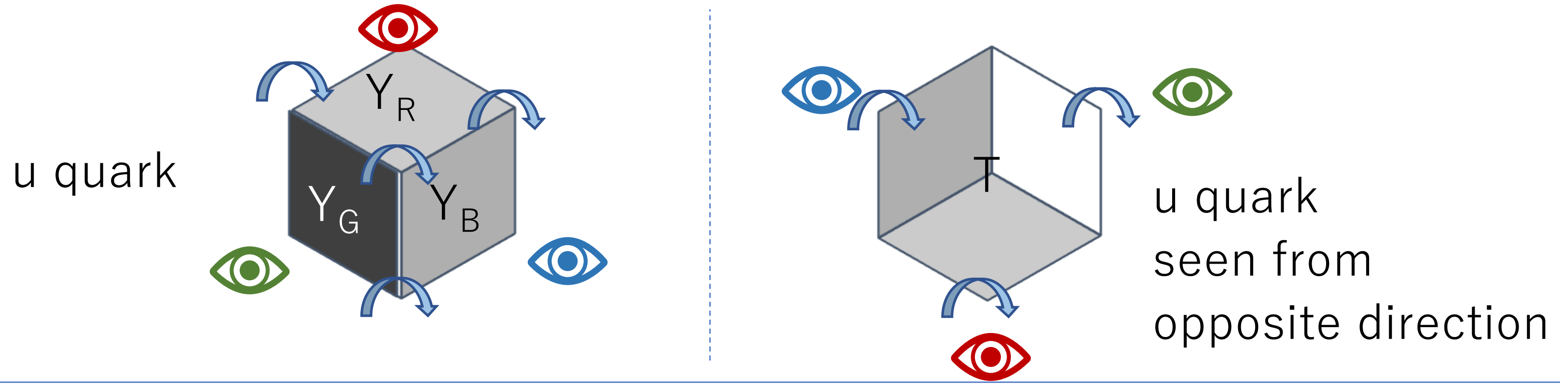
Photon is a particle that represents a plane parallel to direction of movement, and because it has no width, it is not collide with Higgs.

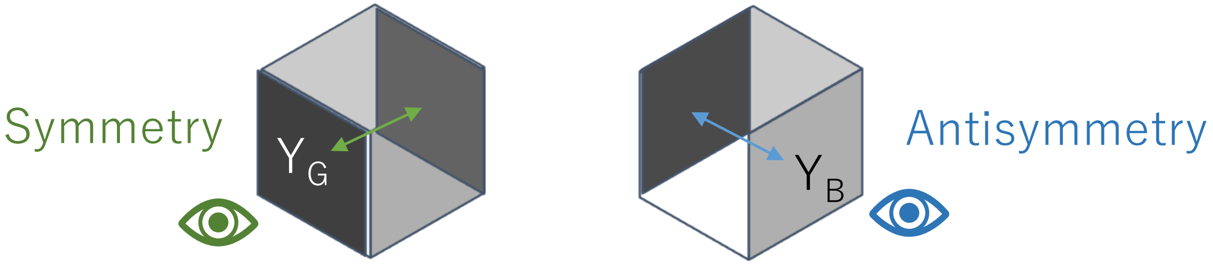
Let's consider the mass of a photon.
All particles are thought to have an asymmetric core.
Mass is created when the cores of a neutrino and the Higgs collide.
Photon is a particle that represents a plane parallel to direction of movement, and because it has no width, it is not collide with Higgs.
Photons are allowed to have no mass.

Quark Mass and Mixing

Quark Symmetry (1)

With half a rotation, half the face is flipped.





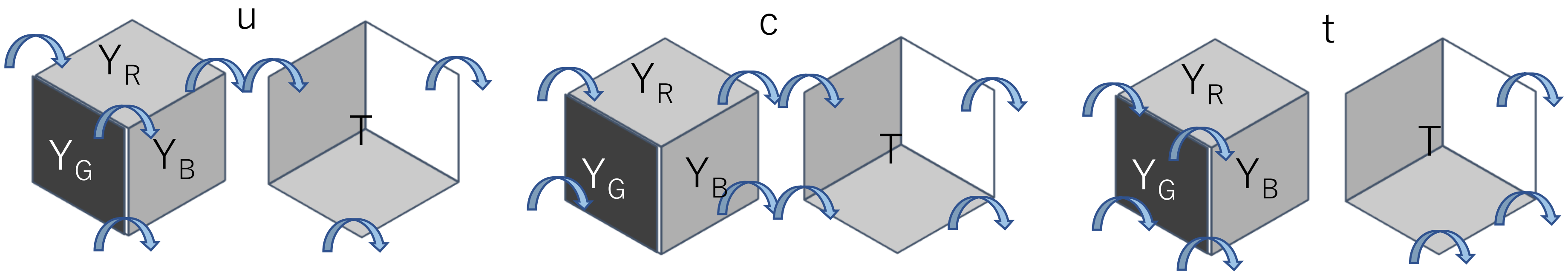
View moving symmetry from three directions.

Now let's consider the mass of a quark.
We have illustrated an up quark.
We have also illustrated what it looks like from the opposite side.
With a half rotation, half of the face is flipped.
We look at moving symmetry from three directions.
As shown in the diagram below, we compare the faces on the opposite side by looking through them.
The colors represent the direction, with the opposite side being the opposite color.

Quark Mass and Mixing

Quark Symmetry (2)

Schematic diagram of a u-type quark viewed from the front and back.



Charge: 6 sides are positive or negative

Generation: How to choose 4 vertices to spin out of 8 vertices

Mass: Discrepancy when cut in half and swapped

The symmetry of the 6 faces and the symmetry of the 8 vertices are inseparable.

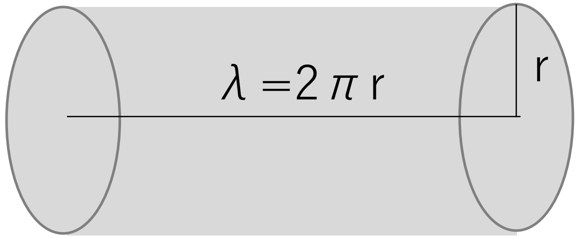
Unless the planes are aligned, as in leptons, symmetry is broken.

We have shown a schematic diagram of a u-type quark seen from the front and back.
The charge means that the six faces are positive or negative.
The generation is the choice of which four of the eight vertices will spin.
The mass is the discrepancy when the quark is cut in half and swapped.
The symmetry of the six faces and the symmetry of the eight vertices are inseparable.
Except when the faces are aligned, like in leptons, the symmetry is broken.

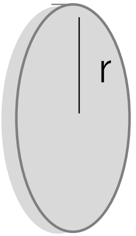
Quark Mass and Mixing

Top quark mass

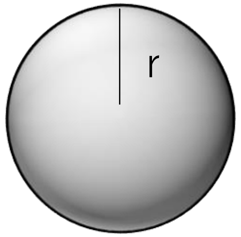
Limit of volume



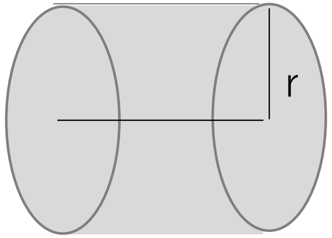
τ



W



t (top quark)



The only way to increase volume
is in the vertical direction.

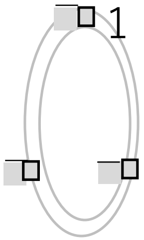
Next, let's calculate the mass of the top quark.
It is the heaviest elementary particle.
Let's think about what shape its volume is.
The volume is limited to a cylinder with a height of $2\pi r$.
Even tauons and W bosons use the full radial space.
Therefore, the only way to increase volume is in the vertical direction.

Quark Mass and Mixing

u type quark mass

u (up)

$$\frac{3}{2} \times 8^{0}$$



$$V_u = \frac{3}{2} 8^{0} \times 3$$

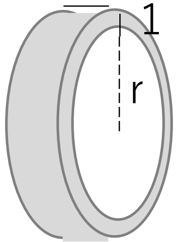
$$M_u = 2.27 MeV/c^2$$

measured: $2.16 MeV/c^2$

error: +4.9%

c (charm)

$$\frac{3}{2} \times 8^{1}$$



$$V_c = \frac{3}{2} 8^{1} \times 2\pi r$$

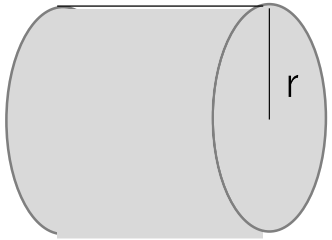
$$M_c = 1274 MeV/c^2$$

$1273 MeV/c^2$

+0.1%

t (top)

$$\frac{3}{2} \times 8^{2}$$



$$V_t = \frac{3}{2} 8^{2} \times \pi r^2$$

$$M_t = 170.99 GeV/c^2$$

$172.57 GeV/c^2$

-0.9%

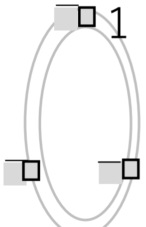
We will calculate the masses of three generations of u-type quarks.
Unlike electrons, up quarks are assumed to be three cubes.
The height of the cylinder changes depending on the generation.
The height of the cylinder follows a geometric progression.
The error from the actual measured mass values is about 1%.

Quark Mass and Mixing

d type quark mass

d (down)

$$3 \times \left(\frac{8}{3}\right)^{0}$$



$$V_d = 3\left(\frac{8}{3}\right)^{0} \times 3$$

$$M_d = 4.5MeV/c^2$$

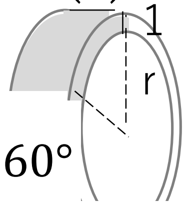
measured: $4.7MeV/c^2$

error: -3.6%

s (strange)

$$3 \times \left(\frac{8}{3}\right)^{1}$$

$\frac{1}{9}360°$



$$V_s = 3\left(\frac{8}{3}\right)^{1} \times 2\pi r$$

$$M_s = 94.3MeV/c^2$$

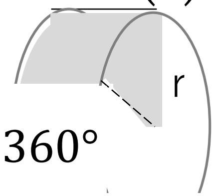
$93.5MeV/c^2$

+0.9%

b (bottom)

$$3 \times \left(\frac{8}{3}\right)^{2}$$

$\frac{1}{9}360°$



$$V_d = 3\left(\frac{8}{3}\right)^{2} \times \pi r^2$$

$$M_d = 4.222GeV/c^2$$

$4.183GeV/c^2$

+0.9%

Calculate the masses of the three generations of d-type quarks.
Assume that the volume in the circumferential direction is only 1/9 of 360 degrees.
The height of the cylinder changes depending on the generation.
The height of the cylinder follows a geometric progression.
The error from the actual measured mass value is about 1%.

Quark Mass and Mixing

Quark mixing matrix (1)

The ratio of first to second generations is r,
and the ratio of second to third generations is r squared.

$$\begin{pmatrix} 1 & 2/r & 1/r^3 \\ 2/r & 1 & 2/r^2 \\ 1/r^3 & 2/r^2 & 1 \end{pmatrix} \Rightarrow \begin{pmatrix} 94.4\% & 5.62\% & 0.003\% \\ 5.62\% & 94.2\% & 0.172\% \\ 0.003\% & 0.172\% & 94.2\% \end{pmatrix}$$

Both vertically and horizontally, total 100%

$$\Downarrow$$

$$\begin{array}{cc} & \begin{array}{ccc} d & s & b \end{array} \\ \begin{array}{c} u \\ c \\ t \end{array} & \begin{pmatrix} 0.974 & 0.225 & 0.004 \\ 0.225 & 0.973 & 0.042 \\ 0.009 & 0.041 & 0.999 \end{pmatrix} \end{array}$$

measured

$$\begin{pmatrix} 0.971 & 0.237 & 0.005 \\ 0.237 & 0.971 & 0.042 \\ 0.005 & 0.042 & 0.999 \end{pmatrix}$$

square root

Quarks are also mixed together and are represented by a matrix.
The ratio of first to second generations is r, and the ratio of second to third generations is r squared.
Both the vertical and horizontal dimensions must add up to 100%.
Finally, take the square root.
Using only r, we obtained a matrix that is close to the actual measured value.

Quark Mass and Mixing

Quark mixing matrix (2)

$$\begin{pmatrix}\sqrt{M_d} & \sqrt{M_s} & \sqrt{M_b}\end{pmatrix} \propto \begin{pmatrix}\sqrt{M_u} & \sqrt{M_c} & \sqrt{M_t}\end{pmatrix}\begin{pmatrix}0.974 & 0.225 & 0.004\\ 0.225 & 0.973 & 0.042\\ 0.009 & 0.041 & 0.999\end{pmatrix}$$

(Nishida) Empirical formula

$$\begin{pmatrix}\sqrt{M_d} & \sqrt{M_s} & \sqrt{M_b}\end{pmatrix} \approx \sqrt{1/r}\begin{pmatrix}\sqrt{M_u} & \sqrt{M_c} & \sqrt{M_t}\end{pmatrix}\begin{pmatrix}1 & \sqrt{2/r} & \sqrt{1/r^3}\\ \sqrt{2/r} & 1 & \sqrt{2/r^2}\\ \sqrt{1/r^3} & \sqrt{2/r^2} & 1\end{pmatrix}$$

$$= \begin{pmatrix}\sqrt{M_u} & \sqrt{M_c} & \sqrt{M_t}\end{pmatrix}\begin{pmatrix}\sqrt{1/r} & \sqrt{2/r^2} & \sqrt{1/r^4}\\ \sqrt{2/r^2} & \sqrt{1/r} & \sqrt{2/r^3}\\ \sqrt{1/r^4} & \sqrt{2/r^3} & \sqrt{1/r}\end{pmatrix}$$

The square root of a d-type quark mass can be expressed as a mixing of the square root of a u-type quark mass.

There is an empirical formula between quark masses and mixing matrices.
When the square root of a u-type quark is multiplied by the mixing matrix, it is proportional to the square root of a d-type quark.
If the coefficients are expressed using r, they are approximately equal.
The matrix can also be expressed approximately using r.
The square root of a d-type quark mass can be expressed as a mixing of the square root of a u-type quark mass.

Quark Mass and Mixing

Quark mixing matrix (3)

Inverse matrix (approximation)

u→d

$$\frac{1}{\sqrt{r}}\begin{pmatrix} 1 & \frac{\sqrt{2}}{\sqrt{r}} & \frac{1}{\sqrt{r^3}} \\ \frac{\sqrt{2}}{\sqrt{r}} & 1 & \frac{\sqrt{2}}{\sqrt{r^2}} \\ \frac{1}{\sqrt{r^3}} & \frac{\sqrt{2}}{\sqrt{r^2}} & 1 \end{pmatrix}$$

d→u

$$\sqrt{r}\begin{pmatrix} 1 & -\frac{\sqrt{2}}{\sqrt{r}} & \frac{1}{\sqrt{r^3}} \\ -\frac{\sqrt{2}}{\sqrt{r}} & 1 & -\frac{\sqrt{2}}{\sqrt{r^2}} \\ \frac{1}{\sqrt{r^3}} & -\frac{\sqrt{2}}{\sqrt{r^2}} & 1 \end{pmatrix}$$

+ : u→d

- : d→u

$$\frac{1}{\sqrt{r^{\pm 1}}}\begin{pmatrix} 1 & \pm\frac{\sqrt{2}}{\sqrt{r}} & \frac{1}{\sqrt{r^3}} \\ \pm\frac{\sqrt{2}}{\sqrt{r}} & 1 & \pm\frac{\sqrt{2}}{\sqrt{r^2}} \\ \frac{1}{\sqrt{r^3}} & \pm\frac{\sqrt{2}}{\sqrt{r^2}} & 1 \end{pmatrix}$$

We were able to convert from u-type to d-type using a mixing matrix, but what about the reverse?
We calculated the inverse matrix.
The terms in the top right and bottom left have changed shape.
The conversion from u-type to d-type and from d-type to u-type can be expressed just by changing the sign.

Quark Mass and Mixing

Higgs collision probability

Higgs collision volume

Higgs collision probability $P = \frac{V}{2\pi^2 r^3}$ (Cylinder)

Mass $\mathrm{M} = P \times 3M_H$

The Higgs collision probability is the probability that a particle exists at a position where it will collide with a Higgs particle.

$$\text{Particle existence probability} = Wave\ amplitude^2$$

$$Wave\ amplitude = \sqrt{\text{Particle}\ exisitence\ probability} \propto \sqrt{Mass}$$

When waves mix, this can be interpreted as the square roots of the masses mixing.

Let's consider why it appears that the square roots of the masses are mixing.
Mass is proportional to the Higgs collision volume.
The ratio of the Higgs collision volume to the volume of the cylinder is defined as the Higgs collision probability.
The Higgs collision probability is the probability that a particle exists at a position where it will collide with a Higgs particle.
The probability of a particle existing is the square of the wave amplitude.
Conversely, the wave amplitude is the square root of the particle's existence probability.
The wave amplitude is proportional to the square root of the mass.
When waves mix, this can be interpreted as the square roots of the masses mixing.

Quark Mass and Mixing

Mass mixing

	Higgs collision volume (Mass)	Intergenerational Mixing
Chaeged Lepton	Geometry without coefficients	No
Quark	(1) Geometry with coefficients? (2) Mixuture of Geometry without coefficients?	Yes

We rethink the mass of a quark
as a mixture of geometric shapes without coefficients.

The masses of charged leptons could be expressed as geometric shapes without coefficients.
On the other hand, the masses of quarks had to be expressed as geometric shapes with coefficients.
Furthermore, quarks mix between generations, but charged leptons do not.
If there is no mixing, it can be said that coefficients are not necessary.
It is only as a result of mixing that coefficients appear to exist, but there were no coefficients before mixing.
Let's rethink quark mass as a mixture of geometric shapes without coefficients.

Quark Mass and Mixing

d-type quark mass mixing

If the difference in the number of generations is 1,
then the mass will mix by r to the power of -1.

$$
\begin{array}{cc}
 & \begin{array}{cccc} e & \mu & \tau & \color{red}{2H} \end{array} \\
\begin{array}{c} d \\ s \\ b \end{array} & \begin{pmatrix} r^0 & r^{-1} & r^{-2} & r^{-3} \\ r^{-1} & r^0 & r^{-1} & r^{-2} \\ r^{-2} & r^{-1} & r^0 & r^{-1} \end{pmatrix}
\end{array}
$$

Higgs particle assumed as the fourth generation

Make the total of the rows and cols 100%

$$
\begin{pmatrix} M_d \\ M_s \\ M_b \end{pmatrix} = \begin{pmatrix} 97.0\% & 2.9\% & 0.1\% & 0.0\% \\ 2.8\% & 94.3\% & 2.8\% & 0.1\% \\ 0.1\% & 2.8\% & 94.3\% & 2.8\% \end{pmatrix} \begin{pmatrix} M_e \\ M_\mu \\ M_\tau \\ 2M_H \end{pmatrix} |\color{red}{Q}| = \begin{pmatrix} 3.8MeV/c^2 \\ 120MeV/c^2 \\ 2.91GeV/c^2 \end{pmatrix}
$$

Mass is proportional to the magnitude of the charge

Calculate the mass of a d-type quark.
Assume that the masses of four generations of charged leptons mix.
We assume the Higgs boson is the fourth generation.
If the difference in the number of generations is 1, then the mass will mix by r to the power of -1.
The matrix of the difference in the number of generations should sum to 100% in both length and width.
Assuming that mass is proportional to the magnitude of the charge, it is multiplied by the absolute value of the charge.
The calculated mass is close to the measured value, but there is an error of more than 10%.

Quark Mass and Mixing

u-type quark mass mixing

Overall,
the mixing ratio is 1/4 times larger.

Only the mixing with the fourth generation has an increased order.

$$\begin{array}{c} \\ u \\ c \\ t \end{array}\begin{array}{c} \begin{array}{cccc} e & \mu & \tau & 2H \end{array} \\ \begin{pmatrix} (4r)^{0} & (4r)^{-1} & (4r)^{-2} & (4r)^{-3+0.5} \\ (4r)^{-1} & (4r)^{0} & (4r)^{-1} & (4r)^{-2+1} \\ (4r)^{-2} & (4r)^{-1} & (4r)^{0} & (4r)^{-1+1.5} \end{pmatrix} \end{array}$$

Make the total of the rows and cols 100%

$$\begin{pmatrix} M_u \\ M_c \\ M_t \end{pmatrix} = \begin{pmatrix} 99.3\% & 0.7\% & 0.0\% & 0.0\% \\ 0.7\% & 97.8\% & 0.7\% & 0.7\% \\ 0.0\% & 0.1\% & 7.9\% & 92.0\% \end{pmatrix} \begin{pmatrix} M_e \\ M_\mu \\ M_\tau \\ 2M_H \end{pmatrix} |Q| = \begin{pmatrix} 1.7MeV/c^2 \\ 1.29GeV/c^2 \\ 154GeV/c^2 \end{pmatrix}$$

Calculate the mass of a u-type quark.
Only the differences from d-type quarks are highlighted.
Overall, the mixing ratio is 1/4 times larger.
Only the mixing with the fourth generation has an increased order.

Quark Mass and Mixing

Charged lepton mass mixing

Mixing ratio
- d-type quark：r
- u-type quark：4r
- Charged lepton： ∞

The greater the charge, the less mixing between generations there is.

$$\begin{array}{cc} & \begin{array}{cccc} e & \mu & \tau & 2H \end{array} \\ \begin{array}{c} e \\ \mu \\ 2H \end{array} & \begin{pmatrix} \infty^{0} & \infty^{-1} & \infty^{-2} & \infty^{-3+?} \\ \infty^{-1} & \infty^{0} & \infty^{-1} & \infty^{-2+?} \\ \infty^{-2} & \infty^{-1} & \infty^{0} & \infty^{-1+?} \end{pmatrix} \end{array}$$

$$\Downarrow$$

$$\begin{pmatrix} M_e \\ M_\mu \\ M_\tau \end{pmatrix} = \begin{pmatrix} 100\% & 0\% & 0\% & 0\% \\ 0\% & 100\% & 0\% & 0\% \\ 0\% & 0\% & 100\% & 0\% \end{pmatrix} \begin{pmatrix} M_e \\ M_\mu \\ M_\tau \\ 2M_H \end{pmatrix} |Q|$$

We've shown the same thing for charged leptons.
Charged leptons do not mix between generations.
The mixing ratio is infinity.
The mixing ratio of u-type quarks is four times that of d-type quarks.
The greater the charge, the less mixing between generations there is.

Gravity

The nature of gravity

Gravitation is a force that acts over a long distance, like electromagnetic force.
There is no repulsive force, only attractive force.
The graviton, which mediates gravity, is thought to have spin 2.
Spin 2 means that it becomes identical when rotated 180 degrees.
A photon rotated 180° is thought to mediate a force in the opposite direction.
Since gravitons are the same even when rotated 180° ,
they are thought to only exert an attractive force.

Now it's time to start thinking about gravity.
Gravitation is a force that acts over a long distance, like electromagnetic force.
There is no repulsive force, only attractive force.
The graviton, which mediates gravity, is thought to have spin 2.
Spin 2 means that it becomes identical when rotated 180 degrees.
A photon rotated 180 degrees is thought to mediate a force in the opposite direction.
Since gravitons are the same even when rotated 180 degrees, they are thought to only exert an attractive force.

Gravity

Coupling constant of Gravity

We've multiplied the electromagnetic coupling constant by 1/2.
This is because we believe that opposite-pointing photons cannot mediate force.

Coupling constant of Electromagnetic

$$e = \frac{1}{2} \times cos45° \times cos30° = \frac{1}{2} \times \frac{1}{\sqrt{2}} \times \frac{\sqrt{3}}{2} = \sqrt{\frac{3}{32}} = 0.306$$

Coupling constant of Gravity

$$g_G = cos45° \times cos30° = \frac{1}{\sqrt{2}} \times \frac{\sqrt{3}}{2} = \sqrt{\frac{3}{8}} = 0.613$$

Gravitons have no front or back.
We can remove only the 1/2 term from the photon coupling constant.

Let's estimate the gauge coupling constant of gravity.
We'll use the electromagnetic force, a force acting over a long distance, as a reference.
We've multiplied the electromagnetic coupling constant by 1/2.
This is because we believe that opposite-pointing photons cannot mediate force.
Gravitons have no front or back.
We can remove only the 1/2 term from the photon coupling constant.
We've now estimated the gauge coupling constant of gravity.

Gravity

Planck scale

Scale at strength of gravity is equivalent to a gauge coupling constant of 1.

Planck length $$l_P = \sqrt{\frac{\hbar G}{c^3}} = 1.616 \times 10^{-35} m$$

Scale at strength of gravity is equivalent to a gauge coupling constant of g_G.

Gravitation length $$l_G = \frac{l_P}{g_G} = \sqrt{\frac{8}{3}} l_P = \sqrt{\frac{8\hbar G}{3c^3}} = 2.639 \times 10^{-35} m$$

Let's explain the Planck scale.
It is the scale at which the strength of gravity is equivalent to a gauge coupling constant of 1.
However, we have been able to estimate a gauge coupling constant for gravity that is not 1.
Let's also find the scale at which the strength of gravity is equivalent to the gauge coupling constant we found earlier.
The length scale can be found by dividing the "Planck length" by the coupling constant.
Let's call this length the “Gravitation length“.

Gravity

Higgs scale

Compton wavelength
of the Higgs boson

$$\lambda_H = \frac{h}{M_H c} = 9.903 \times 10^{-18} m$$

Higgs length

$$l_H = \frac{\lambda_H}{2\pi} = \frac{\hbar}{M_H c} = 1.576 \times 10^{-18} m$$

Hierarchy

$$\begin{array}{ccc} l_H & \gg & l_P \ , (l_G) \\ 10^{-18} m & & 10^{-35} m \end{array}$$

Only the scale of gravity is far removed from the scales of the other forces.
This is called the hierarchy problem.
Let's calculate the scale of the Higgs boson.
Divide the Compton wavelength of the Higgs boson by 2π.
Let's call this the "Higgs length“.

Gravity

God’s dice (2)

The numerical ratio of the hierarchy is so large that there is no way to explain it.
Please allow me to borrow God's power for now.
I will roll God's dice one more time.

$\ln W = 40.5$

Because the number is so large,
I have taken the natural logarithm.

If I can explain this number later, I will return the dice.

The numerical ratio of the hierarchy is so large that there is no way to explain it.
Please allow me to borrow God's power for now.
I will roll God's dice one more time.
The dice show 40.5.
Because the number is so large, I have taken the natural logarithm.
If I am able to explain this number later, I will return the dice.

Gravity

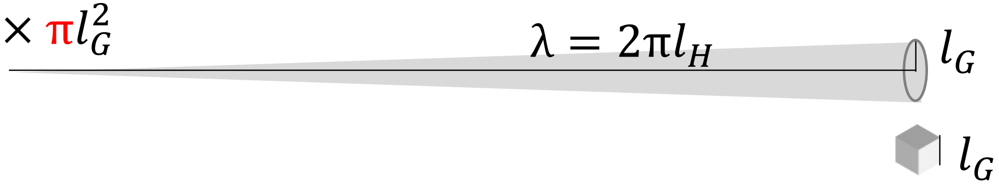
Hierarchy

$$\frac{l_H}{l_G} = 5.972 \times 10^{16}$$

$$W \approx \frac{2}{3}\pi^2 \times \frac{l_H}{l_G} = 3.929 \times 10^{17} \qquad ln\left(\frac{2}{3}\pi^2 \times \frac{l_H}{l_G}\right) = 40.512$$

The value W determined by rolling the dice is based on this.

$$W \approx \frac{V_W}{V_G} \qquad V_W = \frac{2\pi}{3} l_H \times \pi l_G^2 \qquad V_G = l_G^3$$



W is the volume ratio
between a cube and a cone inflated only in the height direction.

Let's calculate the hierarchy.
We can do this by looking at the ratio of the Higgs length to the gravitational length.
However, we will deliberately multiply it by 2/3 and pi squared.
The value W determined by rolling dice is based on this.
W is the volume ratio between a cube and a cone inflated only in the height direction.

Gravity

Beautiful Unity of Forces

In the early universe, the four forces were unified?.

The strengths of the four forces were the same and indistinguishable.
One type of force would be sufficient, but there were four duplicated.
Redundancy is, in other words, waste.

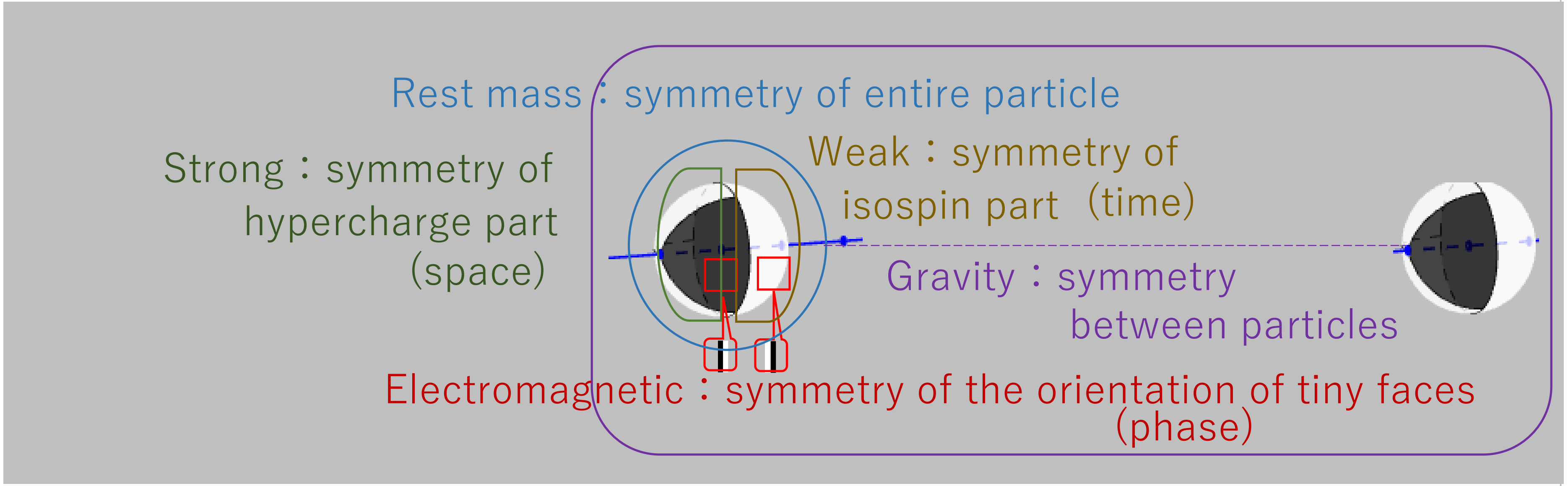
Unity in the sense that the forces have the same strength ： not beautiful

Unity in the sense that they can be explained by the same principles： beautiful

Let's think about the unification of forces.
It is predicted that in the early universe, the four forces were unified.
This is because unification is more beautiful.
The strengths of the four forces were the same and indistinguishable.
One type of force would be sufficient, but there were four duplicated.
Redundancy is, in other words, waste.
Can we call that beautiful?
Unity in the sense that the forces have the same strength is not beautiful.
Unity in the sense that they can be explained by the same principles is beautiful.

Gravity

Symmetry as the source of force



All forces are neither redundant nor missing.
There are different forces for symmetries at each level.

All forces have underlying symmetries.
The electromagnetic force acts on the symmetry of the orientation of tiny faces.
The strong force acts on the symmetry of the hypercharge part of a particle.
The weak force acts on the symmetry of the isospin part of a particle.
Mass acts on the symmetry of the entire particle.
Gravity acts on the symmetry between particles.
All forces are neither redundant nor missing.
There are different forces for symmetries at each level.

Gravity

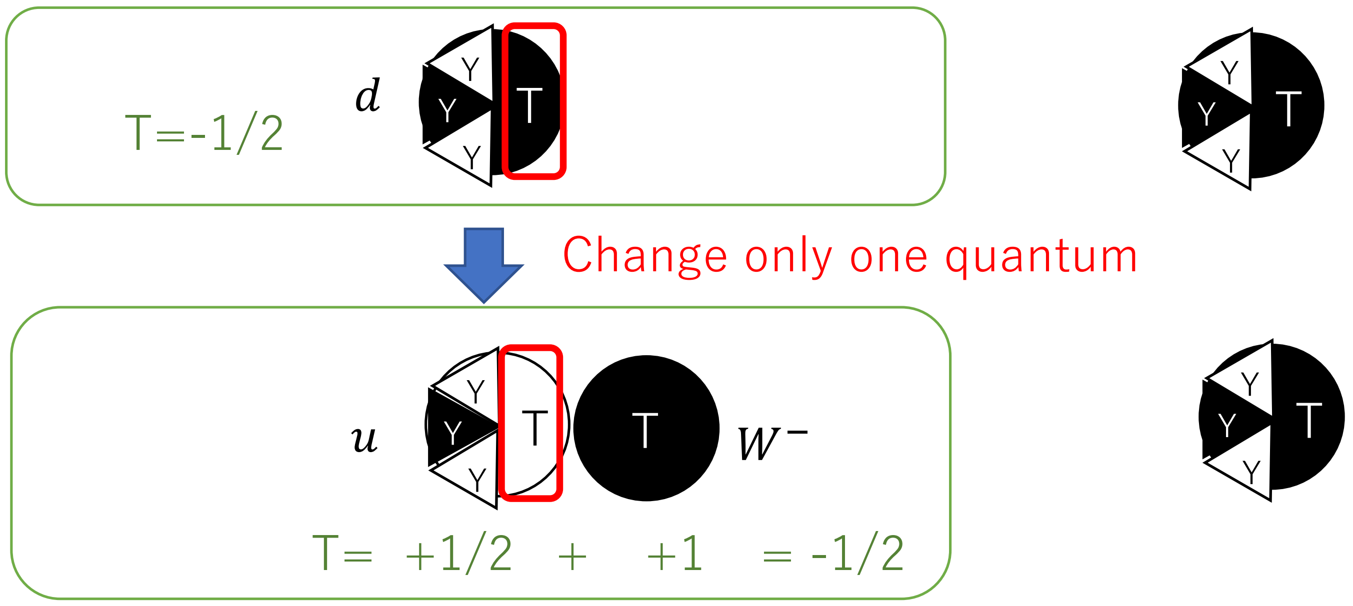
Quantum

Force	Quantum (unit of force)
Electromagnetic	Charge
Strong	Hypercharge
Weak	Isospin
Rest mass	Hypercharge, Isospin, Generation
Gravity	Energy

Each force has a corresponding quantum.
A quantum is the unit in which force acts.
The quanta of the electromagnetic force, strong force, and weak force are electric charge, hypercharge, and isospin.
Rest mass is determined by hypercharge, isospin, and generation.
The quantum corresponding to gravity is energy.

Gravity

Local gauge transformation



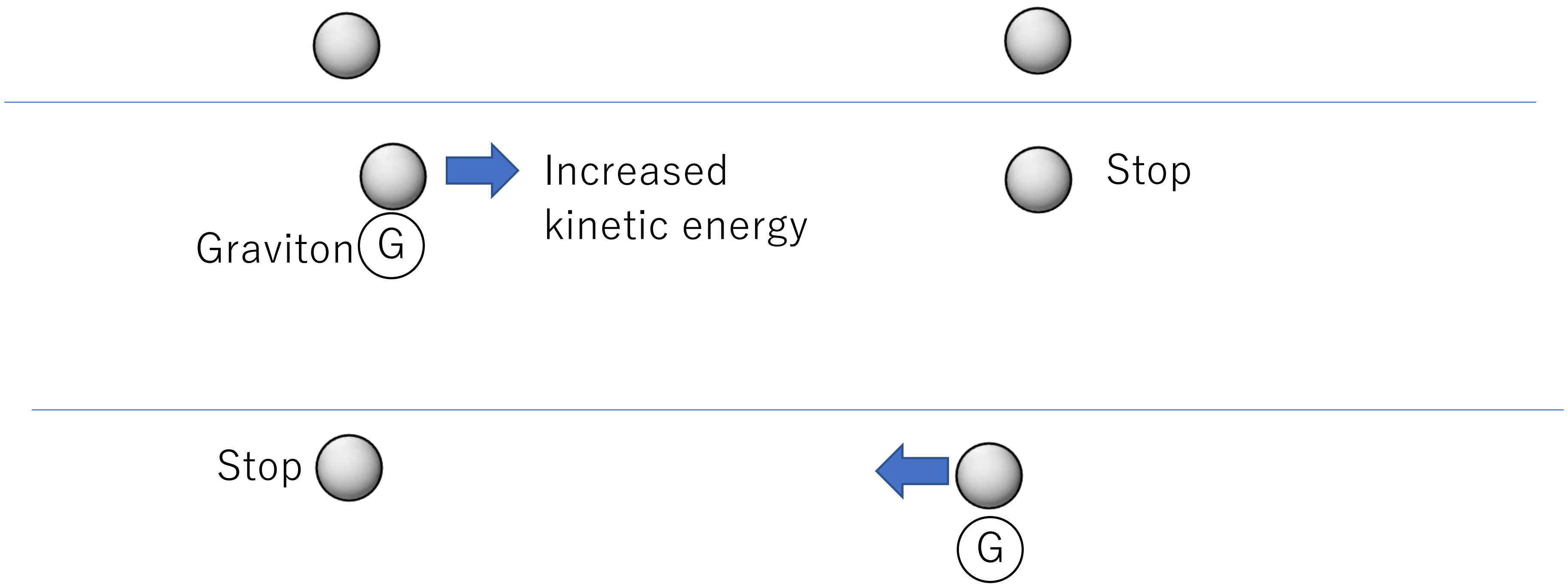
The sum of the isospin of the u and W- does not change from the d.

This is because gauge particles appear so that the quantum remains unchanged.

Let's explain local gauge transformations.
We change only one quantum.
Here, we change the isospin of a single particle.
When a d quark changes to a u quark, a W-boson appears.
The sum of the isospin of the u quark and W-boson does not change from the d quark.
This is because gauge particles appear so that the quantum remains unchanged.

Gravity

Local gauge transformation of gravity (1)



Looking at it from the other side, it's contradictory.

Let's consider a local gauge transformation of gravity.
Let's think about kinetic energy.
Suppose we change the kinetic energy of only one particle so that it increases.
Gravitons appear so that the total energy remains unchanged.
However, when we think about it relatively, a contradiction arises.
From the perspective of the particle on the right, it appears that the particle on the left has increased momentum.
Conversely, from the perspective of the particle on the left, it appears that the momentum of the particle on the right has increased.
It is impossible to determine how many gravitational forces will be generated from each particle.

Gravity

Energy

Potential energy + Kinetic energy = Total energy (conserved)

The addition of different concepts cannot be a fundamental physical quantity.

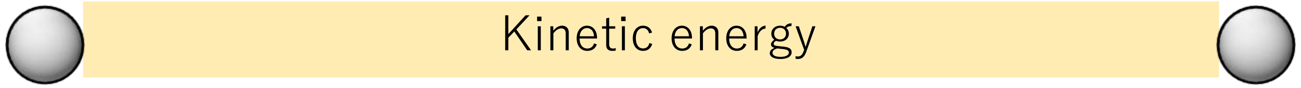
To begin with, energy is not an visible quantity.
In reality, energy simply causes the positions of particles to appear to change.
Essentially, constant energy means that the scale of space is constant.
Energy is a property of space, not a property of particles.

What is energy, anyway?
The sum of potential energy and kinetic energy is conserved.
However, the addition of different concepts cannot be a fundamental physical quantity.
To begin with, energy is not an visible quantity.
In reality, energy simply causes the positions of particles to appear to change.
Essentially, constant energy means that the scale of space is constant.
Energy is a property of space, not a property of particles.

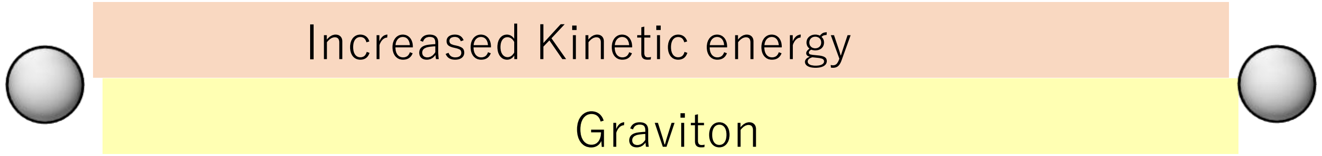
Gravity

Local gauge transformation of gravity (2)

Kinetic energy is a property of the space between two particles.



Increasing kinetic energy changes space.
The graviton, which appears to cancel out the change,
is space that emerges from that space.



The idea that space changes due to energy is the essence of general relativity.
Gravitational forces can also be interpreted as a particle rather than as space.

Let's consider the local gauge transformation for gravity once again.
Kinetic energy is a property of the space between two particles.
It cannot be defined so that the two particles each have independent quantities.
Increasing kinetic energy changes space.
The graviton, which appears to cancel out the change, is space that emerges from that space.
The idea that space changes due to energy is the essence of general relativity.
Gravitons are not particles that emerge from particles.
However, particles can be interpreted as a type of space.
Conversely, gravitational forces can also be interpreted as a particle rather than as space.

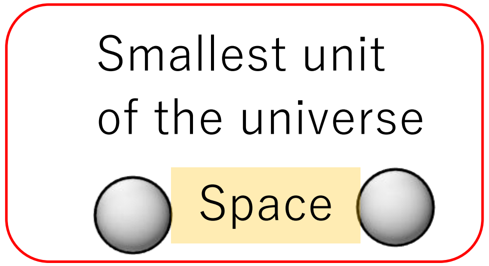
Gravity

Quantization of gravity (1)

There must be a smallest unit of energy mediated by a graviton.

Mass=1 | Entire Universe | Graviton | Mass=1

if the universe is infinitely large, we run into problems.



Let's think of the universe as simply being made up of an infinite collection of the smallest unit universes.
The smallest unit of the universe is 2 particles
and the space between them.
We only need to consider energy between the 2 particles.

Let's attempt to quantize gravity.
There must be a smallest unit of energy mediated by a graviton.
For example, let's say the mass of the entire universe is 1.
If a graviton carries a mass of 1, we can say that gravity has been quantized.
However, if the universe is infinitely large, we run into problems.
Let's think of the universe as simply being made up of an infinite collection of the smallest unit universes.
The smallest unit of the universe is two particles and the space between them.
We only need to consider the energy between the two particles

Quantization of gravity (2)

Property common to gravity and electromagnetic

- The force weakens as the distance increases.

  In electromagnetic force, we have interpreted the gravitational force as working through constructive interference between waves.

➡ The greater the distance, the more diluted the waves become.

Property unique to gravity

- the greater the energy, the stronger it becomes.

  The longer the wavelength, the weaker the force.

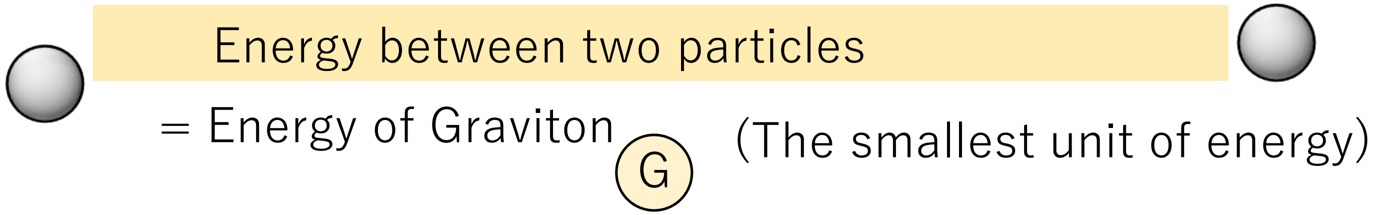
➡ Even with a long wavelength, the waves are diluted.

Let's think about the relationship between gravity's strength and energy.
First, a property common to gravity and electromagnetic force is that the force weakens as the distance increases.
In electromagnetic force, we have interpreted the gravitational force as working through constructive interference between waves.
The greater the distance, the more diluted the waves become.
Also, a property unique to gravity is that the greater the energy, the stronger it becomes.
The longer the wavelength, the weaker the force.
Even with a long wavelength, the waves are diluted.

Gravity

Quantization of gravity (3)

The smaller the energy, the more diluted the graviton is.
If the energy is not the same, the graviton is not the same.
The smallest unit of energy carried by a graviton does not have to be same either.



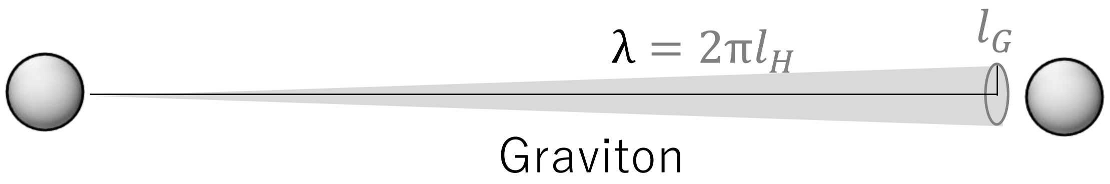
The smallest unit of energy can be considered to be equal to the energy between two particles.
The energy of the space between two particles is equal to the energy of a graviton.
This will not seem strange if you think of it as simply reinterpreting space as particles.

The smaller the energy, the more diluted the graviton is.
If the energy is not the same, the graviton is not the same.
The smallest unit of energy carried by a graviton does not have to be the same either.
The smallest unit of energy can be considered to be equal to the energy between two particles.
The energy of the space between two particles is equal to the energy of a graviton.
This will not seem strange if you think of it as simply reinterpreting space as particles.

Gravity

Quantization of gravity (4)

Gravity is diluted and weakened according to the wavelength.
Gravitons can be thought of as being stretched to the length of the wavelength.
Gravitation weakens by one power of the wavelength.
Gravitons can be imagined as undergoing uniaxial inflation between two particles.



$$W = \frac{V_W}{V_G}$$

This is why the volume ratio of a uniaxially inflated cone was used in calculating the hierarchy W.

Gravity is diluted and weakened according to the wavelength.
Gravitons can be thought of as being stretched to the length of the wavelength.
Gravitation weakens by one power of the wavelength.
Gravitons can be imagined as undergoing uniaxial inflation between two particles.
Although they are cylindrical, if you look at just the one-dimensional components, their volume is 1/3.
The volume of a graviton is represented by a cone.
This is why the volume ratio of a uniaxially inflated cone was used in calculating the hierarchy W.

Entropy

Entropy

Thermodynamic entropy $$\Delta S = \frac{\Delta Q}{T}$$

Statistical mechanical entropy $$S = k_B ln W$$

Interpreted as number of states W
= hierarchical parameter W

Equipartition theorem $$Q = \frac{1}{2} N k_B T$$

Energy is equally distributed among the degrees of freedom of motion, N.
(For example, if motion is possible in the X, Y, and Z directions, then N=3)

degrees of freedom $$N = 2 ln W = 81$$

k_B : Boltzmann constant =1
(natural unit system)

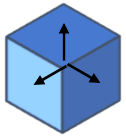
Let's think about entropy.
There is thermodynamic entropy and statistical mechanical entropy.
Here, the number of states W is interpreted as being the same as the hierarchy parameter.
There is also the equipartition theorem.
Energy is equally distributed among the degrees of freedom of motion, N.
For example, if motion is possible in the X, Y, and Z directions, then N=3.
The Boltzmann constant is 1 in the natural unit system.
Calculating the degrees of freedom, N, gives us 81.

Entropy

Degree of freedom (1)

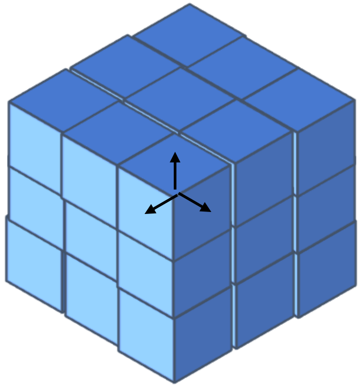
degrees
of freedom

$N = 3$



3 Dimension

Create Hierarchy



$N = 3 \times 3^3 = 81$

81 Dimension

Each of the 3-dimensional directions is divided into 3 parts, resulting in 27 parts.
Each part has 3 degrees of freedom, so there are 81 degrees of freedom in total.

Let's interpret 81 degrees of freedom.
First, there are 3 degrees of freedom in 3-dimensional space.
After the hierarchy is created, it looks like the image on the right.
Each of the 3-dimensional directions is divided into 3 parts, resulting in 27 parts.
Each part has 3 degrees of freedom, so there are 81 degrees of freedom in total.

Entropy

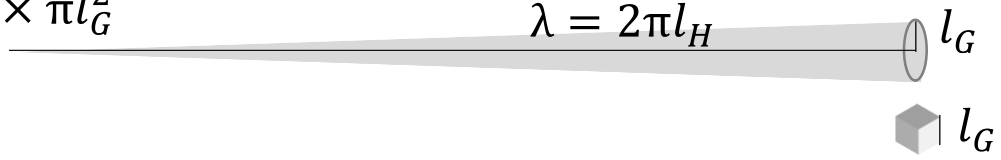
Degree of freedom (2)

W is the volume ratio of a cone inflated only in the height direction, representing a graviton, to a cube.

$$W = \frac{V_W}{V_G}$$

$$V_W = \frac{2\pi}{3} l_H \times \pi l_G^2$$

$$V_G = l_G^3$$



When there is one cube inside the cone, the number of states is W.
This number of states W is determined by the degrees of freedom N=81.
The smaller the mass and the longer the wavelength,
the weaker the gravitational force will be.
Even if the mass is the same, the greater the degrees of freedom,
the more the gravitational force will be stretched.

Let's review the relationship between W and the strength of gravity.
W is the volume ratio of a cone inflated only in the height direction, representing a graviton, to a cube.
When there is one cube inside the cone, the number of states is W.
This number of states W is determined by the degrees of freedom N=81.
The smaller the mass and the longer the wavelength, the weaker the gravitational force will be.
Even if the mass is the same, the greater the degrees of freedom, the more the gravitational force will be stretched.

Number of states and energy

Hierarchy W ： Number ratio

Thermodynamic entropy $\Delta S = \dfrac{\Delta Q}{T}$ Heat / Temperature

Statistical mechanical entropy Boltzmann's constant $S = k_B \ln W$ Number of states

$Q = T k_B \ln W$

Assume temperature T is constant.

$Q \propto \ln W$

Thermal energy is proportional to the logarithm of the number of states

We will interpret the hierarchy W as representing the number of states.

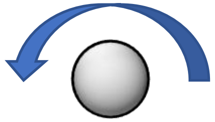
Hierarchy $\ln W$ ： Energy ratio

We have thought of the hierarchy W as a ratio of numbers.
What about energy ratios?
We have shown the formulas for entropy in thermodynamics and statistical mechanics.
Combining these two formulas, we get the relationship between the amount of heat Q and the number of states W.
We will assume that the temperature is constant.
We have seen that thermal energy is proportional to the logarithm of the number of states.
Therefore, we will interpret the hierarchy W as representing the number of states.
Then, the logarithm of W can be thought of as an energy ratio.

Universe

Beginning of the Universe (1)

First, rotation was necessary to distinguish “existence" from “nothing“.
In order to create rotation, 3D space and 1D time were created.



A space that rotates left was created, representing “existence“.
However, without something to compare it to, you can't say it's rotating.

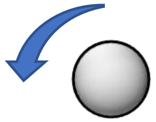
For comparison, a space with no rotation was created, representing "nothing“.

When viewed from the other way around, the non-rotating space appears to be rotating right.
It's unclear which is “existence“.

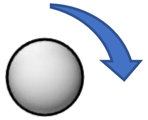
From here, let's think about the beginning of the universe from God's perspective.
First, rotation was necessary to distinguish “existence" from “nothing“.
In order to create rotation, three-dimensional space and one-dimensional time were created.
A space that rotates left was created, representing “existence“.
However, without something to compare it to, you can't say it's rotating.
For comparison, a space with no rotation was created, representing "nothing“.
Here's where a problem arises.
When viewed from the other way around, the non-rotating space appears to be rotating right.
It's unclear which is “existence“.

Universe

Beginning of the Universe (2)



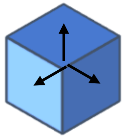
Because the two are symmetrical,
it is impossible to tell
which one is “existence“.



Creating Hierarchy

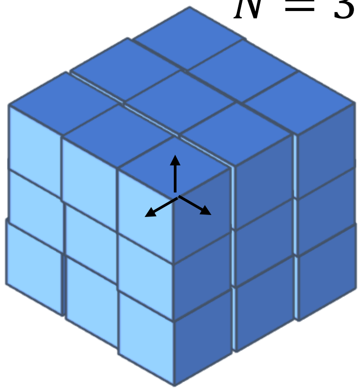
Degree
of
freedom

N = 3



The two became asymmetrical,
and could be distinguished.

$N = 3 \times 3^3 = 81$

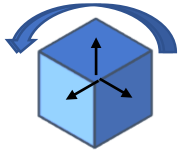


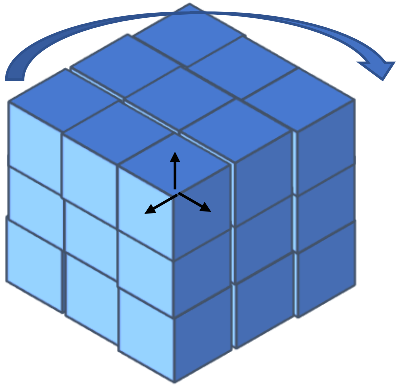
It also appears to be half rotated to the left and half rotated to the right.
Because the two are symmetrical, it is impossible to tell which one is “existence“.
So God created a hierarchy in only one of them.
The two became asymmetrical, and could be distinguished.
The two lived happily ever after.

Universe

Beginning of the Universe (3)

The length and mass of the 2 particles are based on the Higgs particle as a natural unit.





Degree of freedom：

$N = 3$

$N = 81$

$$W = exp\left(\frac{81}{2}\right) = 3.881 \times 10^{17}$$

Length： $l_H = \dfrac{\hbar}{M_H c} = 1.576 \times 10^{-18} m$

$W l_H = 0.6117 m$

Inflated Higgs volume： $\dfrac{4}{3}\pi(W l_H)^3 = 0.9585 m^3$

Let's compare the properties of the two particles.
The degrees of freedom are now 1 and 81.
The length and mass of the two particles are based on the Higgs natural unit.
The ratio of their lengths is an exponent of half 81.
The inflated Higgs volume can be calculated.
This is simply the volume of a sphere with radius equal to the inflated Higgs length.

Universe

Higgs Vacuum Expectation Value (V.E.V.)

Suppose that initially, the vacuum contained the energy of two Higgs bosons.

$N = 3$

$M_H = 125.20 GeV/c^2$ M_H

Creating Hierarchy

$N = 81$ $N = 3$

M_H $\left(1 - \frac{3}{81}\right) M_H$ $\frac{3}{81} M_H$

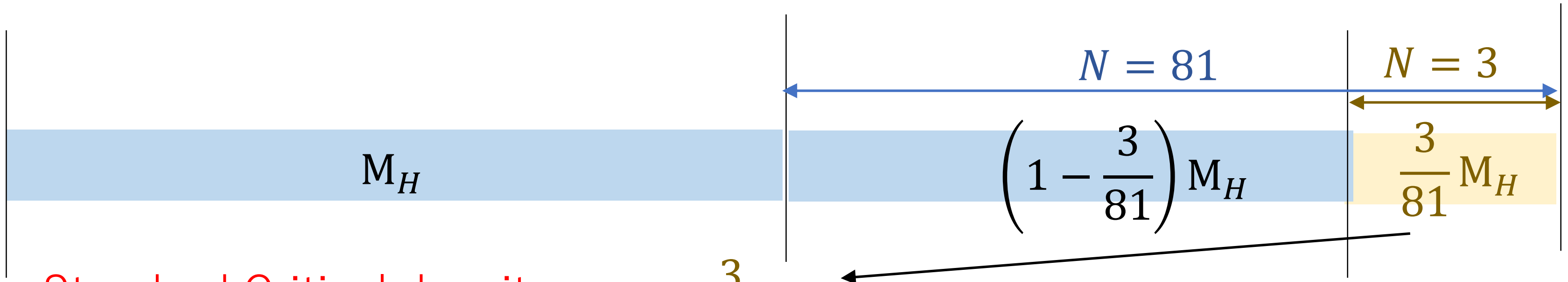
$$\left(2 - \frac{3}{81}\right) M_H = 245.76 GeV/c^2$$

Higgs $V.E.V. = 246.2196 GeV$ Measured

Let's consider what happened to the Higgs boson at the creation of the universe.
Suppose that initially, the vacuum contained the energy of two Higgs bosons.
Only one side underwent inflation, creating a hierarchy.
The degrees of freedom increased from 3 to 81.
The energy equivalent to three degrees of freedom changed into something that is not a vacuum.
The remainder remained as a vacuum.
The energy of this remaining vacuum is called the Higgs vacuum expectation value.
Even the actual measured value is slightly less energy than that of two Higgs bosons.

Universe

Critical density



Standard Critical density

$$\rho_s = \frac{\frac{3}{81} M_H}{\frac{4}{3}\pi (W l_H)^3} = 8.62 \times 10^{-27} kg/m^3$$

Inflated Higgs volume

Measured

Critical density $\rho_{crit} = \frac{3H_0^2}{8\pi G} = 8.53(13)\ or\ 10.01(28) \times 10^{-27} kg/m^3$

Hubble constant $H_0 = 67.4(6)\ or\ 73.0(10) kms^{-1}Mpc^{-1}$

The current critical density appears to be close to the standard critical density.

Let's consider what changed from the vacuum.
The reference critical density is the mass that changed from the vacuum divided by the inflationary Higgs volume.
There are currently two measured values for the critical density.
This is because the measured value of the Hubble constant is split in two depending on the measurement method.
The current critical density appears to be close to the reference critical density.

Universe

Cosmic inflation

Higgs particle

$$l_H = \frac{\hbar}{M_H c} = 1.576 \times 10^{-18} m$$

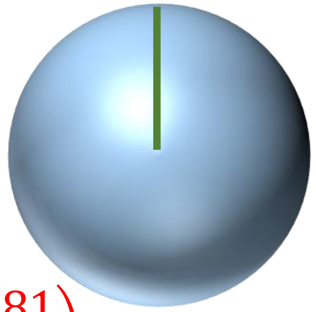
$$t_H = \frac{l_H}{c} = 5.257 \times 10^{-27} s$$

$$M_H = 125.2 GeV/c^2$$

$$t_H \times M_H c^2 = \hbar$$

Cosmic inflation

$$t \leqq t_H$$



$$exp\left(\frac{81}{2}\right) l_H = 0.6117m$$

Its size after inflation is about the same as in typical inflation models.

Due to the uncertainty principle,
Higgs boson came into existence by borrowing energy from vacuum fluctuations.

In other words, the universe is a virtual particle.

Let me explain cosmic inflation.
In the beginning, there was the Higgs boson.
Higgs time is the Higgs length divided by the speed of light.
Multiplying the Higgs time by the Higgs energy gives the reduced Planck constant.
Due to the uncertainty principle, the Higgs boson came into existence by borrowing energy from vacuum fluctuations.
In other words, the universe is a virtual particle.
As the universe went through inflation, the Higgs length grew larger.
Its size after inflation is about the same as in typical inflation models.

Universe

The end of the universe

Remember, the universe exists because of energy borrowed from the vacuum.
Whatever is borrowed must be paid back.
Once the repayment is complete, the universe will return to nothingness.

Vacuum Fluctuation

Standard Hubble time

$$H_s{}^{-1} = \frac{\hbar}{\frac{80\pi^2}{729W^{2.5}} M_H c^2} = 1.44 \times 10^{10} year$$

Repayment deadline

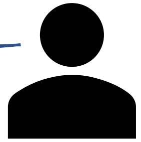
$1.38 \times 10^{10} year$

current age of the universe

Borrowed energy, discounted by inflation

It's time to give back the vacuum energy you borrowed!

Due to the law of conservation of energy, I cannot repay



It's reluctant, but we have to think about the end of the universe.
Remember, the universe exists because of energy borrowed from the vacuum.
Whatever is borrowed must be paid back.
Once the repayment is complete, the universe will return to nothingness.
Hubble time is Planck's constant divided by the borrowed energy.
That 14.4 billion years is the repayment deadline.
It's now 13.8 billion years, so it's about time to pay it back.
However, due to the law of conservation of energy, it can't be paid back.

Universe

Expansion of the Universe

If you don't repay the vacuum energy,
I will inflate prices
and make energy less valuable!

If the universe expands,
the wavelength of light will lengthen and its energy will decrease.
It will also become more difficult to travel long distances,
effectively making energy less valuable.
If the distance between particles becomes infinite,
the value of energy will be zero and expansion will also be zero.

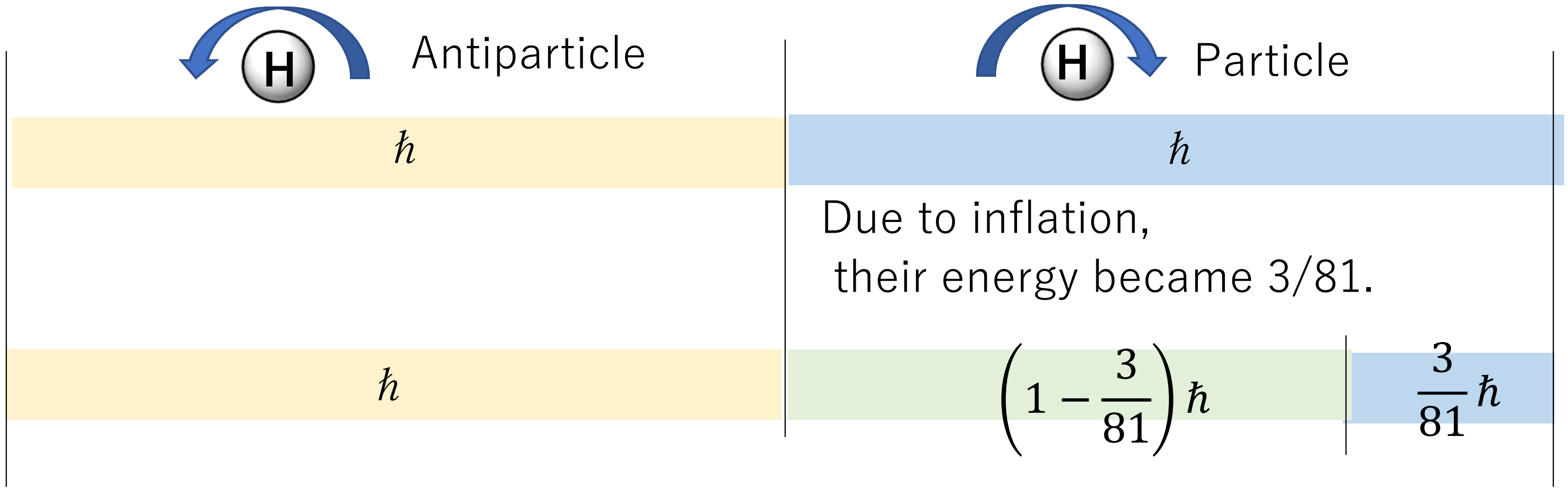
The universe is expanding so as to be flat
because it is adjusted so that the debt is just repaid exactly.

God has thought of it.
If you don't repay the vacuum energy, I will inflate prices and make energy less valuable!
If the universe expands, the wavelength of light will lengthen and its energy will decrease.
It will also become more difficult to travel long distances, effectively making energy less valuable.
If the distance between particles becomes infinite, the value of energy will be zero and expansion will also be zero.
The universe is expanding so as to be flat because it is adjusted so that the debt is just repaid exactly.

Universe

Decreasing vacuum energy

It borrowed energy from
fluctuations in the vacuum.

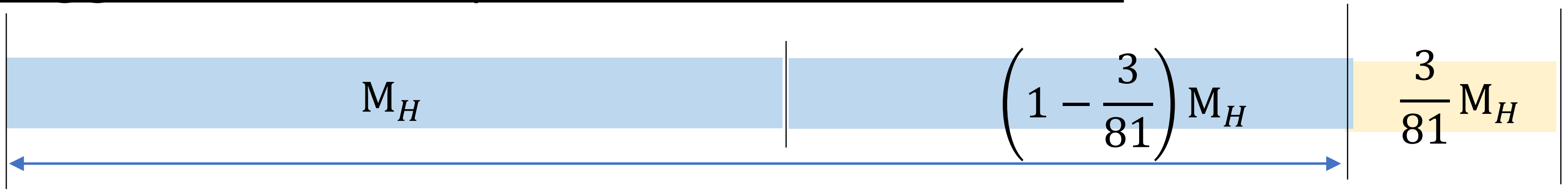


Because 3/81 of the energy is still borrowed,
the amount of energy that can be borrowed from the vacuum has decreased.

Let me explain why the Higgs vacuum expectation value has decreased.
The particles that caused inflation borrowed energy from vacuum fluctuations.
Due to inflation, their energy became 3/81.
Because 3/81 of the energy is still borrowed, the amount of energy that can be borrowed from the vacuum has decreased.

Universe

Higgs Vacuum Expectation Value (V.E.V.)



$245.76GeV/c^2$ Theoretical

$246.22GeV/c^2$ Measured

The measured value of the Higgs V.E.V. is slightly smaller than theoretical value.
This is thought to be because the vacuum energy has been partially repaid.

$$\text{Higgs } V.E.V. = \left(2-\gamma\frac{3}{81}\right)\times 125.20(\pm 0.11)GeV = 246.2196GeV \quad \text{Measured}$$

Debt ratio $\gamma = 90.2(\pm 4.7)\%$

Let's take another look at the Higgs vacuum expectation value.
The measured value of the Higgs V.E.V. is slightly smaller than the theoretical value.
This is thought to be because the vacuum energy has been partially repaid.
We introduce a parameter called the debt ratio γ.
We can calculate the current debt rate β from the measured value.
It appears that approximately 90% of the debt remains.

Universe

Hubble tension

The Hubble constant is the rate at which the universe is expanding,
but there are two conflicting measured values.

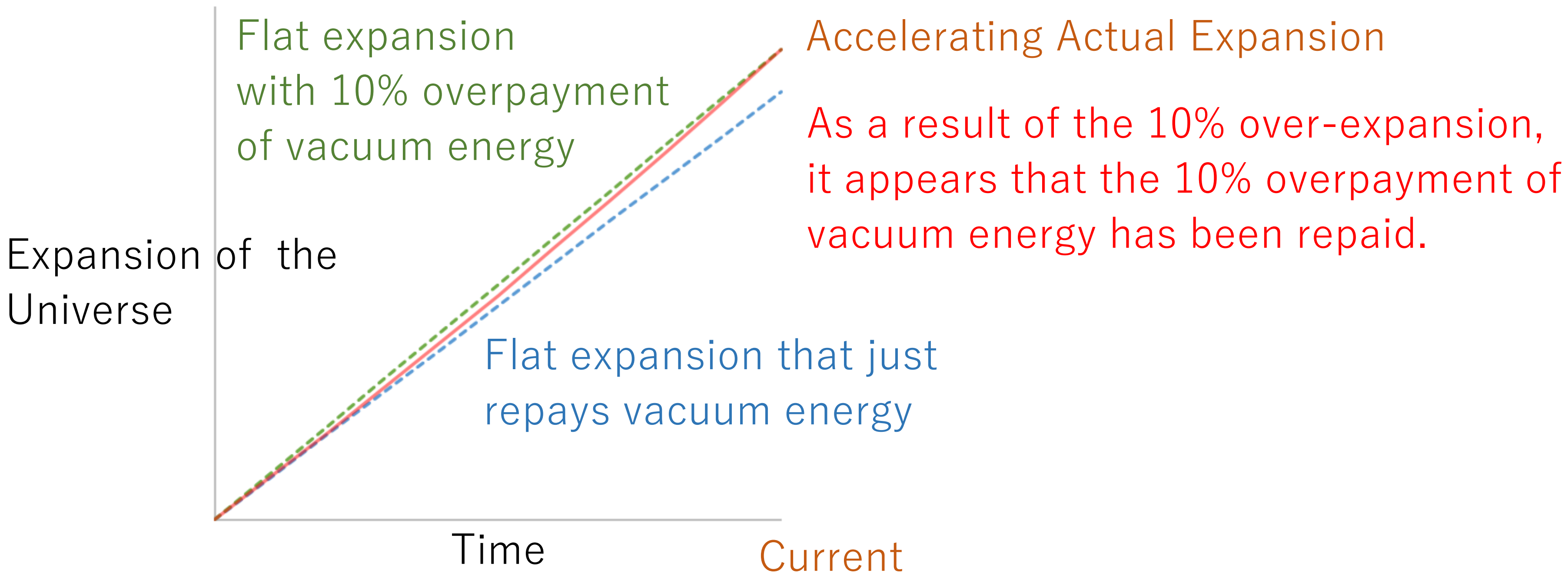
$$\frac{\overset{\text{Early universe}}{67.4kms^{-1}Mpc^{-1}}}{\underset{\text{Late universe}}{73.0kms^{-1}Mpc^{-1}}} = \frac{\overset{\text{Late universe}}{1.339 \times 10^{10}year}}{\underset{\text{Early universe}}{1.451 \times 10^{10}year}} = 92.3\%$$

There is a hypothesis that there was early dark energy,
which existed only in the early period.
If the amount of early dark energy is around 10%,
this seems to match actual measurements.
This is likely related to the debt ratio γ of 10%.

Let me explain Hubble tension.
The Hubble constant is the rate at which the universe is expanding, but there are two conflicting measured values.
They are calculated based on the early and late universes, respectively.
It can also be expressed as the ratio of Hubble times.
The Hubble time in the late universe is approximately 92% of that of the early universe.
This is thought to be not a measurement error, but that something is actually changing.
There is a hypothesis that there was early dark energy, which existed only in the early period.
If the amount of early dark energy is around 10%, this seems to match actual measurements.
This is likely related to the debt ratio γ of 10%.

Universe

Over expansion (1)



The expansion of the universe is shown in a graph.
The horizontal axis is time and the vertical axis is the expansion of the universe.
A flat expansion that just repays vacuum energy would be a straight line.
The actual expansion of the universe appears to be accelerating.
It is thought that the expansion is currently close to what would occur if vacuum energy were overpaid by 10%.
As a result of the 10% over-expansion, it appears that the 10% overpayment of vacuum energy has been repaid.

Universe

Fine structure constant (1)

As the vacuum energy decreases,
it is thought that the interactions also weaken.

Gauge coupling constant $e = \left(1 - \gamma \frac{1}{81}\right) \times \frac{1}{2} \times cos45° \times cos30°$

Fine structure constant $\alpha^{-1} = \frac{4\pi}{e^2} = 137.05999177(21)$ Measured

Debt ratio $\gamma = 88.9954699(6)\%$

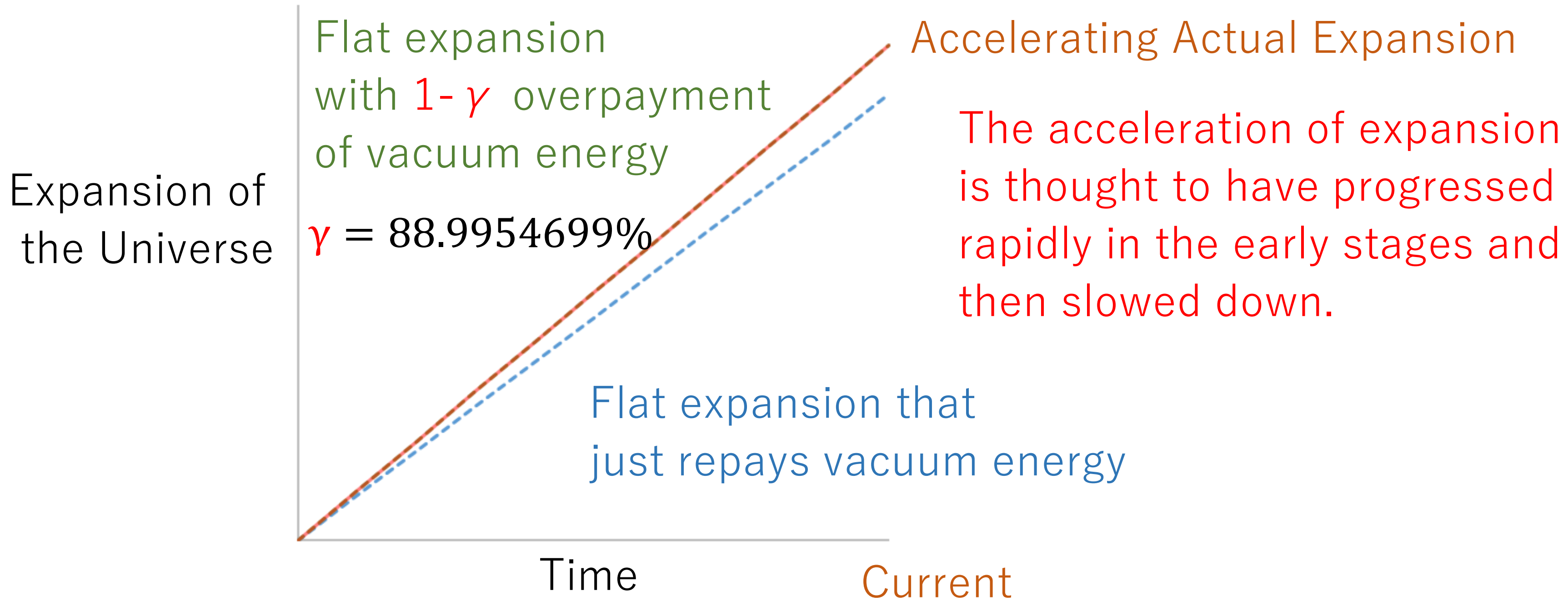
The fine structure constant is a variable
that changes depending on the debt ratio.

Let's consider the fine structure constant.
As the vacuum energy decreases, it is thought that the interactions also weaken.
The debt ratio was calculated from the measured value of the fine structure constant.
The debt ratio was approximately 89%, a highly accurate value.
The fine structure constant is a variable that changes depending on the debt ratio.

Universe

Over expansion (2)

Observations show that the fine structure constant has changed very little.



Correction to the graph of the expansion of the universe.
Observations show that the fine structure constant has changed very little.
The acceleration of expansion is thought to have progressed rapidly in the early stages and then slowed down.
In the later stages of the universe, it is thought to become nearly linear, and the fine structure constant will remain nearly constant.
The current amount of overexpansion can be accurately predicted from the fine structure constant.

Universe

Second inflation

Higgs V.E.V.

$$\frac{M_H + \left\{1 - \frac{3}{81}\right\} M_H}{\frac{4}{3}\pi(W l_H)^3}$$

Standard Critical density

$$\frac{\frac{3}{81} M_H}{\frac{4}{3}\pi(W l_H)^3}$$

Debt ratio γ

Second inflation

$$\frac{M_H + \left\{1 - \gamma\frac{3}{81}\right\} M_H}{\frac{4}{3}\pi(W l_H)^3}$$

$$\frac{\gamma\frac{3}{81} M_H}{\frac{4}{3}\pi(W l_H)^3} = \frac{\frac{3}{81} M_H}{\gamma\frac{4}{3}\pi(W l_H)^3}$$

This early dark energy was repaid to the Higgs V.E.V.

The volume of the universe increased or its mass decreased

We have graphed the energy balance.
Here, we assume second-order inflation.
Due to second-order inflation, the volume of the universe increased or its mass decreased.
The amount of change corresponds to the initial dark energy.
This initial dark energy was repaid to the Higgs V.E.V.

Universe

Higgs mass

Fermi coupling constant $G_F = 11663788(6) \times 10^{-5} GeV^{-2}$ Measured

Higgs $V.E.V = \dfrac{1}{\sqrt{\sqrt{2}G_F}} = 246.2196(4)GeV$

Higgs mass $M_H = \dfrac{V.E.V.}{2 - \frac{3}{81}\gamma} = 125.172747(23)GeV/c^2$ Theoretical

125.20(11) Measured

Now we will calculate the theoretical value of the Higgs mass.
First, there is a highly accurate measured value for the Fermi coupling constant.
The Higgs V.E.V. can be obtained from the Fermi coupling constant.
The Higgs mass can be calculated from the V.E.V. and the debt ratio γ.
This matches the measured value.

Universe

Gravitational constant

Gauge coupling constant

$$g_G = \left(1 - \gamma \frac{1}{81}\right) \times cos45° \times cos30°$$

Debt ratio $\gamma = 1$

Gravitational constant

$$G = \left(\frac{2}{3}\pi^2\right)^2 \frac{g_G^2 \hbar c}{W^2 M_H^2} = \left(\frac{80}{81}\right)^2 \frac{\pi^4 \hbar c}{6W^2 M_H^2}$$

$$= 6.674325(24) \times 10^{-11} m^3 kg^{-1} s^{-2}$$ Theoretical

$$6.67430(15) \times 10^{-11}$$ Measured

In the case of gravity, the calculation is done with the debt ratio set to 1.
The effect of debt seems to vary depending on the type of interaction.

The gravitational constant is considered in the same way as the fine structure constant.
However, in the case of gravity, the calculation is done with the debt ratio set to 1.
The theoretical value and measured value are consistent.
The theoretical value was obtained with higher accuracy than the actual measured value.
The effect of debt seems to vary depending on the type of interaction.

Universe

Weak mixing angle

In the weak force, we assume that there is no damping like fine structure constant.
When the balance of force strengths changes, the weak mixing angle changes.

$$cos\Theta_W = \frac{1}{\left(1 - \gamma\frac{1}{81}\right)} cos30° = cos28.88°$$

$$sin^2\Theta_W = 1 - cos^2\Theta_W = 0.2332$$

0.238 Measured at low energy

We will also consider the weak force.
In the weak force, we assume that there is no damping like the fine structure constant.
When the balance of force strengths changes, the weak mixing angle changes.
The weak force is relatively stronger than the electromagnetic force.
We think the weak mixing angle will be close to the actual measured value at low energies.

Universe

Hubble constant

Standard critical density $\rho_s = \frac{3}{81} \times \frac{M_H}{\frac{4}{3}\pi(Wl_H)^3} = \frac{3H_s^2}{8\pi G}$

Standard Hubble constant $H_s = \frac{80\pi^2 c}{81 \cdot 9W^{2.5} l_H} = 67.739264(8) kms^{-1}Mpc^{-1}$

Hubble constant $H_0 = 67.4(.6)\ or\ 73.0(10) kms^{-1}Mpc^{-1}$

Standard Hubble time $t_s = \frac{1}{H_s} = 14.44346456(13)\ billion\ year$

Age of the Universe $t_0 = 13.797(23)\ billion\ year$

The difference between Hubble constant and standard Hubble constant is due to difference between age of the universe and standard Hubble time.

Calculate the Hubble constant.
The Hubble constant at the standard critical density will be called the standard Hubble constant.
The reciprocal of the standard Hubble constant will be called the standard Hubble time.
The difference between Hubble constant and standard Hubble constant is due to difference between age of the universe and standard Hubble time.

Universe

Volume and Mass

Standard Hubble distance
$$l_s = \frac{c}{H_s} = W^{2.5}\frac{729}{80\pi^2}l_H = 8.66\times10^{43}l_H$$
$$= 2.23\times10^{26}Wl_H$$
$$= \exp(60.67)Wl_H$$

Equivalent to the e-folding number in typical inflation models

Standard Hubble volume
$$V_s = \frac{4}{3}\pi\left(\frac{c}{H_s}\right)^3 = W^{4.5}\frac{729^3}{80^3\pi^6}\times\frac{4}{3}\pi(Wl_H)^3 = 2.72\times10^{132}V_H$$
$$= 4.66\times10^{79}W^3V_H$$

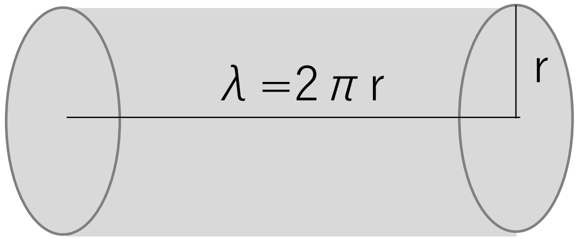
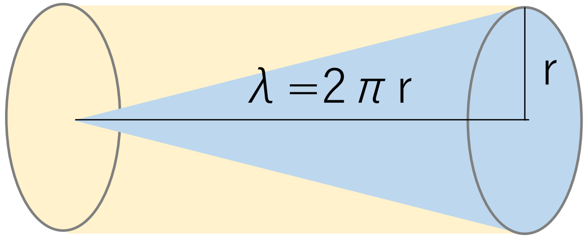
Standard Critical density
$$\rho_s = \frac{\frac{3}{81}M_H}{\frac{4}{3}\pi(Wl_H)^3} = 6.34\times10^{-55}\frac{M_H}{V_H}$$
$$V_H = \frac{4}{3}\pi l_H^3$$

Standard Hubble Mass
$$M_s = \rho_s V_s = W^{4.5}\frac{3\cdot729^3}{81\cdot80^3\pi^6}M_H = 4.12\times10^{77}M_H$$
$$= exp(57.21)W^3M_H$$

Once the standard Hubble constant is determined, the standard Hubble distance is determined.
It is the 61st power of Napier's number for the inflated Higgs length.
This scale is equivalent to a typical inflation model.
The standard Hubble volume is also determined as the volume of the sphere.
We have stated how many times larger the Higgs particle it is.
The standard Hubble mass is also determined from the volume and critical density.

Dark matter and Dark energy

Higgs collision volume

	Volume	Mass	
	$V = 2\pi^2 r^3$	$3M_H$	The volume that a particle passes through while traveling 1 λ
	$V_H = \frac{1}{3} \times 2\pi^2 r^3$	M_H	Horizontal to the direction of travel
	$V_V = \frac{2}{3} \times 2\pi^2 r^3$	$2M_H$	Vertical to the direction of travel

Let's think about the ratio of matter to dark energy.
Let's recall the existence of something called the Higgs collision volume.
The volume a particle passes through while traveling one wavelength is a cylinder.
The Higgs collision volume is 1/3 of this volume, the component horizontal to the direction of travel.
The remaining component perpendicular to the direction of travel is 2/3.
Mass is proportional to the Higgs collision volume.

Dark matter and Dark energy

Matter ratio (1)

Matter Ω_m	Dark energy Ω_Λ
Horizontal component $\frac{1}{3} = 33.333\%$	Vertical component $\frac{2}{3} = 66.667\%$

I also believe that matter decreased due to the second inflation.

I believe that dark energy was not affected by the expansion.

$$\frac{\gamma\frac{1}{3}}{\gamma\frac{1}{3}+\frac{2}{3}} = 31.967\% \qquad \frac{\frac{2}{3}}{\gamma\frac{1}{3}+\frac{2}{3}} = 69.205\%$$

Measured	31.5% ±0.7%	68.5% ±0.7%

I have graphed the ratio of matter to dark energy.
I believe that 1/3 corresponding to the horizontal component became matter, and 2/3 corresponding to the vertical component became dark energy.
I also believe that matter decreased due to the second inflation.
On the other hand, I believe that dark energy was not affected by the expansion.
The ratio of matter to dark energy matches the actual measured value.

Dark matter and Dark energy

Matter ratio (2)

Measured $$\frac{\Omega_b}{\Omega_b+\Omega_c}=\frac{4.93\%}{4.93\%+26.57\%}=\frac{1}{6.39}\approx\frac{1}{2\pi}$$ Theoretical

Baryon

$$\gamma\frac{1}{3}\times\frac{1}{2\pi}$$

$$\Omega_b=\frac{\frac{\gamma}{6\pi}}{\frac{\gamma+2}{3}}$$

Dark matter

$$\gamma\frac{1}{3}\times\left(1-\frac{1}{2\pi}\right)$$

$$\Omega_c=\frac{\frac{\gamma}{3}\left(1-\frac{1}{2\pi}\right)}{\frac{\gamma+2}{3}}$$

Dark energy

$$\frac{2}{3}$$

$$\Omega_\Lambda=\frac{\frac{2}{3}}{\frac{\gamma+2}{3}}$$

Theoretical (Standard Hubble time)

4.90113875(3)% 25.89362421(1)% 69.20523704(2)%

Measured

4.93(6)% 26.5(7)% 68.5(7)%

The ratio of matter is graphed.
The measured ratio of baryons to the total of baryons and dark matter is approximately 2 pi.
The theoretical value shows that this is exactly 2 pi.
This matches the measured value.
This theoretical value is for the standard Hubble time.

Dark matter and Dark energy

Matter ratio (3)

$$a = \left(\frac{t_s}{t_0}\right)^{\frac{2}{3}}$$

Standard Hubble time $t_H = 14.434646(1)\ billion\ year$

Age of Universe $t_0 = 13.797(23)\ billion\ year$

Baryon

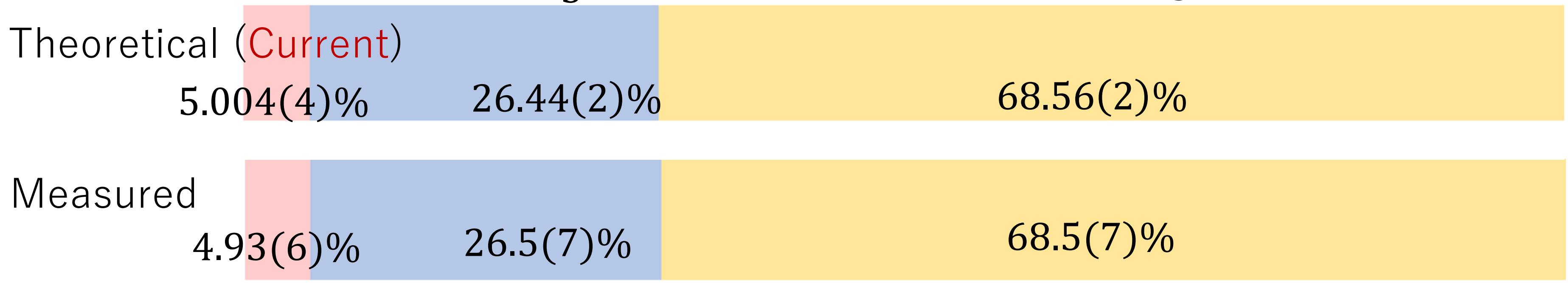
$$\Omega_b = \frac{\frac{a\gamma}{6\pi}}{\frac{a\gamma + 2}{3}}$$

Dark matter

$$\Omega_c = \frac{\frac{a\gamma}{3}\left(1 - \frac{1}{2\pi}\right)}{\frac{a\gamma + 2}{3}}$$

Dark energy

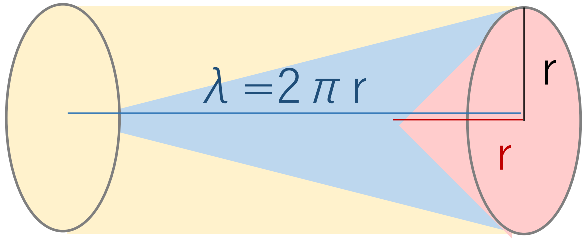
$$\Omega_\Lambda = \frac{\frac{2}{3}}{\frac{a\gamma + 2}{3}}$$



We calculate the current ratio taking into account the expansion of the universe.
The universe is expanding at the rate of 2/3 of time.
However, dark matter does not change.
Calculated using the ratio of standard Hubble time to the age of the universe.
This is closer to the actual measured value than before.

Dark matter and Dark energy

Interpretation of matter ratio



$V = 2\pi r \times \pi r^2$

$\Omega_b = \frac{1}{3} \times r \times \pi r^2 / V$ Ordinary matter

$\Omega_c = \frac{1}{3} \times (2\pi r - r) \times \pi r^2 / V$ Dark matter

$\Omega_\Lambda = \frac{2}{3} \times 2\pi r \times \pi r^2 / V$ Dark energy

Particles are considered to have a size r not only in the radial direction but also in the height direction.
Ordinary matter corresponds to the volume that it occupies even without moving.

Dark matter corresponds to the volume that it occupies by moving.

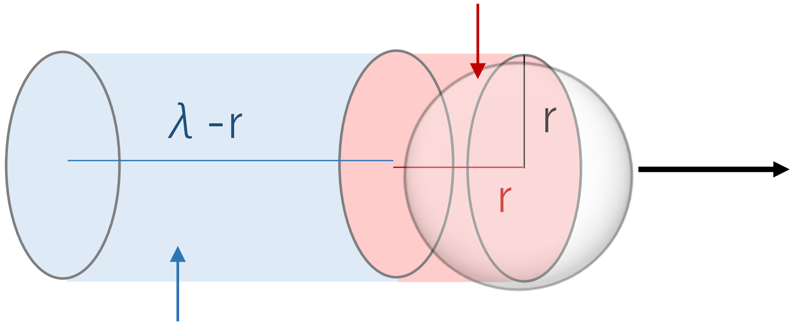
Dark energy corresponds to the volume that is not occupied by moving.

Let's think about the meaning of matter ratios.
As shown in the diagram, all matter occupies the volume of a cone with a height of 2 π r.
Normal matter occupies a portion of that volume, a cone with a height of r.
The remainder is dark matter.
Particles are considered to have a size r not only in the radial direction but also in the height direction.
Ordinary matter corresponds to the volume that it occupies even without moving.
Dark matter corresponds to the volume that it occupies by moving.
Dark energy corresponds to the volume that is not occupied by moving.

Dark matter and Dark energy

Dark matter

Ordinary matter is when the particle itself has mass.



Dark matter is when the space through which a particle passes has mass.

- Is dark matter a space that is attached to ordinary matter?
- Is dark matter a space that exists independently?

Let's think about how dark matter has mass.
The mass ratio of a particle to dark matter is the ratio of the volume of the particle itself to the volume it passes through.
Ordinary matter is a particle that itself has mass.
Dark matter is the space that a particle passes through that has mass.
Is dark matter a space that is attached to ordinary matter?
Or is dark matter a space that exists independently?

Dark matter and Dark energy

Origin of energy

	Energy ratio Ω		Asymmetry of origin
	Particle	Antiparticle	
Dark energy	$\frac{2}{3}$	0	X,Y direction
Dark matter	$\frac{1}{3}\times\left(1-\frac{1}{2\pi}\right)$	0	Z direction (moving component)
Ordinary matter	$\frac{1}{3}\times\frac{1}{2\pi}$	0	Z direction (rest component)

The asymmetry that existed equally in all three directions
has been distributed as energy.

The origin of energy is summarized in the table.
The asymmetry that existed equally in all three directions has been distributed as energy.
The energy of matter originates from the asymmetry in the Z direction, which is the direction of motion.
Dark energy originates in the X and Y directions, so it is twice as abundant as matter.

Dark matter and Dark energy

Cosmological constant problem

Planck mass

$$\frac{M_p}{l_P^3}$$

Planck volume

Dark energy

Measured

Higgs mass

$$\frac{M_H}{\frac{4}{3}\pi\left\{exp\left(\frac{81}{2}\right)l_H\right\}^3}\times\frac{3}{81}\Omega_\Lambda$$

Inflated

Higgs volume

122 digit mismatch! Match!

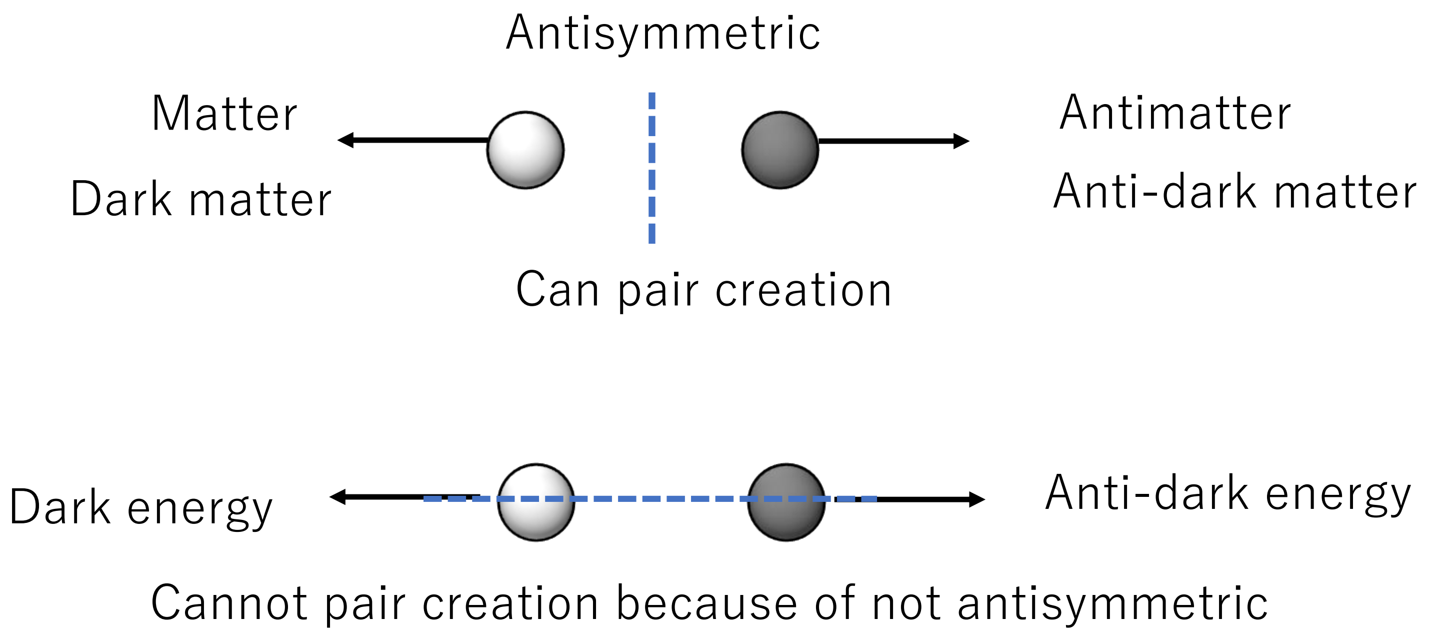
$5.15\times10^{96}kg/m^3$ >>>> $5.83(16)\times10^{-27}kg/m^3$ $=$ $5.907(2)\times10^{-27}kg/m^3$

You are free to use the Planck scale as a natural unit,
but there is no necessity for something on the Planck scale to exist in nature.
If the vacuum is filled with Higgs,
it would be natural to think in terms of the Higgs scale.

Regarding dark energy, there is something called the cosmological constant problem.
The theoretical value for dark energy and the measured value differ by 120 orders of magnitude.
The conventional theoretical value is the Planck mass divided by the Planck volume.
However, in this theory, the Higgs mass is divided by the inflated Higgs volume.
This matches the measured value.
The weaker the gravity, the larger the inflated Higgs volume.
On the other hand, the weaker the gravity, the smaller the Planck volume.
You are free to use the Planck scale as a natural unit, but there is no necessity for something on the Planck scale to exist in nature.
If the vacuum is filled with Higgs, it would be natural to think in terms of the Higgs scale.

Dark matter and Dark energy

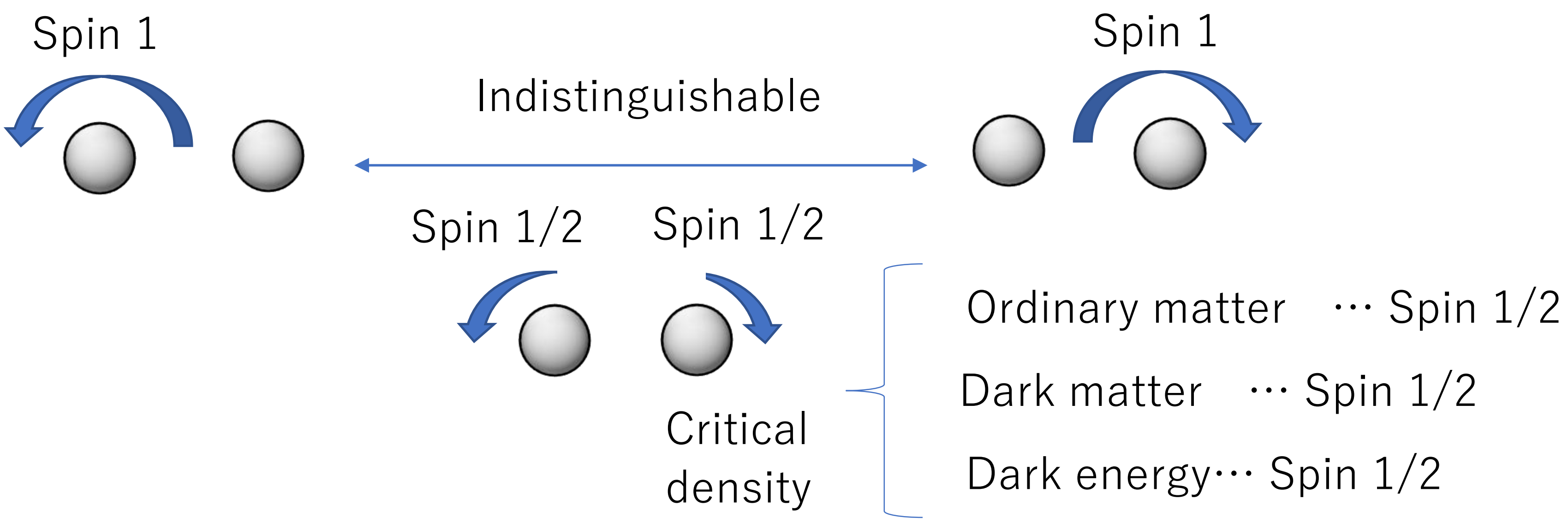
Pair creation



This explains why dark energy cannot exist as a particle.
For ordinary matter and dark energy, the direction of pair creation and the direction of the asymmetry that originates are the same.
When a particle and antiparticle are paired, they become antisymmetric in that direction.
On the other hand, the asymmetry that originates in dark energy is perpendicular to the direction of pair creation.
Since there is no antisymmetry in the perpendicular direction, pair creation is not possible.

Dark matter and Dark energy

Spin



Does dark energy cause space to rotate?

Let's think about spin.
Originally, there were two particles, one of which rotated once.
However, because of symmetry, they appear to rotate 1/2 times relative to each other.
Therefore, ordinary matter has spin 1/2.
Similarly, dark matter and dark energy also have spin 1/2.
Does dark energy cause space to rotate?

Baryon number

The difference between particles and antiparticles

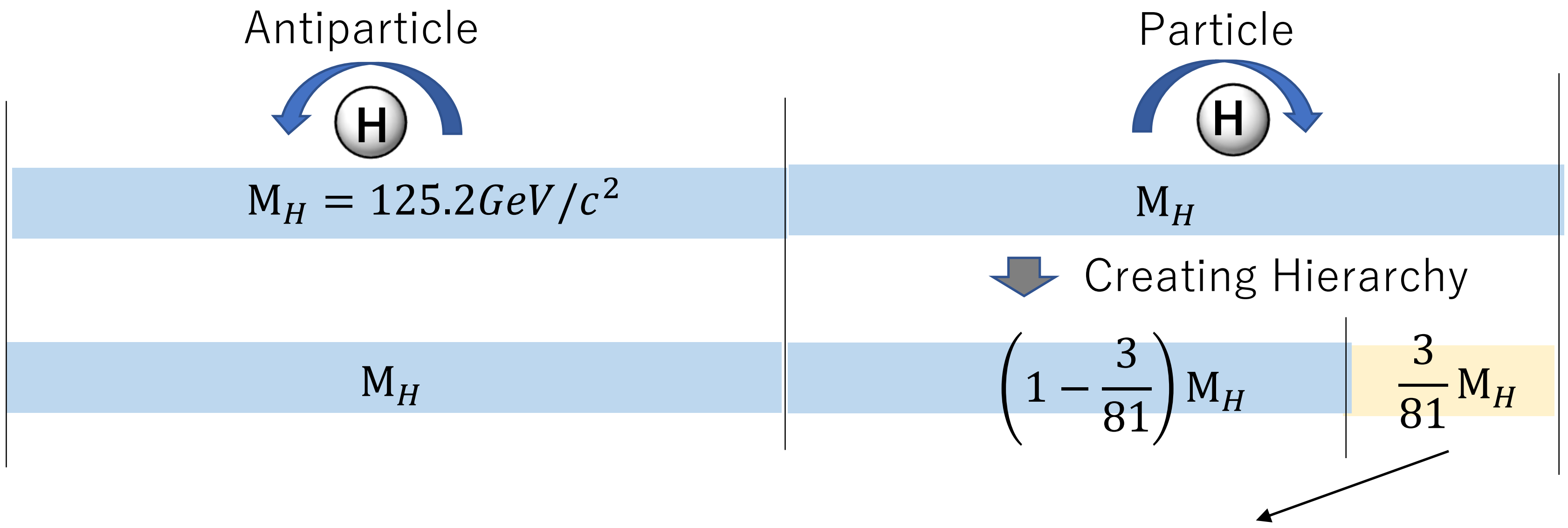
	e	$\bar{u}$	d	$\overline{\nu_e}$	ν_e	$\bar{d}$	u	$\bar{e}$
Y_R	-1/6	-1/6	+1/6	+1/6	-1/6	-1/6	+1/6	+1/6
Y_G	-1/6	+1/6	-1/6	+1/6	-1/6	+1/6	-1/6	+1/6
Y_B	-1/6	-1/6	+1/6	+1/6	-1/6	-1/6	+1/6	+1/6
$Y_R \times Y_G \times Y_B$	-	+	-	+	-	+	-	+
"-"	odd	even	odd	even	odd	even	odd	even

Simply put, it's whether they rotate left or right.
Particles and antiparticles should be symmetrical.

Let's think about why there are so many particles and so few antiparticles.
First, let's review the difference between particles and antiparticles.
It's whether the product of the signs of their hypercharges is negative or positive.
It's whether the number of mirror image inversions is odd or even.
Simply put, it's whether they rotate left or right.
Particles and antiparticles should be symmetrical.

Baryon number

Asymmetry between particles and antiparticles



Inevitably, matter would have the properties of a particle, not an antiparticle.
Dark matter and dark energy should also have the properties of a particle.
On the other hand, the vacuum is slightly biased towards antiparticles.

The two Higgs bosons condensed in the vacuum are thought to have the properties of a particle and an antiparticle.
Suppose only the particle-like Higgs boson becomes matter.
Inevitably, matter would have the properties of a particle, not an antiparticle.
Dark matter and dark energy should also have the properties of a particle.
On the other hand, the vacuum is slightly biased towards antiparticles.
Overall, the properties of particles and antiparticles are equal.

Baryon number

Baryon number

$$\frac{\text{Baryon number}}{\text{Photon number}} \quad \frac{n_b}{n_\gamma} = 6.04(12) \times 10^{-10} \quad \text{Measured}$$

Entropy density $$s = g_* \frac{\pi^4}{45\zeta(3)} \times n_\gamma = g_* \frac{\pi^4}{45\zeta(3)} \times \frac{2\zeta(3)}{\pi^2} \left(\frac{k_B T_0}{\hbar c}\right)^3 = g_* \frac{2\pi^2}{45} \left(\frac{k_B T_0}{\hbar c}\right)^3$$

Cosmic Microwave Background Temperature $$T_0 = 2.7255(6) K$$

Particle Degrees of Freedom $$g_* = 2 + \frac{7}{8} \times 2 \times 3 \times \frac{4}{11} = \frac{34}{11}$$

Photon(L,R) Neutrino(L,R × 3gen)

Baryon number entropy density ratio $$\frac{n_b}{s} = 0.858 \times 10^{-10}$$

Even as the universe expands, entropy is conserved.

The baryon number to entropy density ratio is an indicator of baryon asymmetry.

Let's consider baryon number.
The ratio of baryon number to photon number has been measured.
Even as the universe expands, entropy is conserved.
The baryon number to entropy density ratio is an indicator of baryon asymmetry.
Entropy is calculated from the cosmic microwave background temperature and the degrees of freedom of particles.

Baryon number

Fermion number

When considering the asymmetry between particles and antiparticles, we need to consider leptons as well.

ν_e d_R d_G u_B

e u_R u_G d_B

$$n_b = \frac{2}{8} n_f$$

Assume that from the beginning, there are equal amounts of 8 types of fermions with three generations.

Fermion

Fermion number $$\frac{n_f}{s} = \frac{8}{2} \times \frac{n_b}{s} = 3.43 \times 10^{-10}$$

Baryon

When considering the asymmetry between particles and antiparticles, we need to consider leptons as well.
Assume that there are equal amounts of eight types of fermions across three generations from the beginning.
For every eight fermions, two baryons are created.
In other words, the fermion number is 8/2 the baryon number.

Baryon number

Entropy of Hubble time

The entropy of the universe is constant, but its density changes as it expands.
Therefore, we calculate the entropy density in standard Hubble time.

Current
Entropy density

$$s = g_* \frac{2\pi^2}{45}\left(\frac{k_B T_0}{\hbar c}\right)^3$$

$T_0 = 2.7255(6)K$
Current cosmic microwave background temperature

Standard Hubble time
Entropy density

$$s_s = g_* \frac{2\pi^2}{45}\left(\frac{k_B T_0}{\hbar c}\right)^3 \times \left(\frac{t_0}{t_s}\right)^2 = g_* \frac{2 \cdot 80^2 \pi^6 M_H^2 c k_B^3 T_0^3 t_0^2}{45 \cdot 81^3 W^5 \hbar^5}$$

Age of the universe $t_0 = 13.797(23)\ billion\ year$

Standard Hubble time $t_s = 14.434646(1)\ billion\ year$

The entropy of the universe is constant, but its density changes as it expands.
Therefore, we calculate the entropy density in standard Hubble time.
This is multiplied by the ratio of the age of the universe to the standard Hubble time.
It is assumed that the universe expands at the 2/3 power of time.

Baryon number

Entropy per volume

Entropy per inflated Higgs volume

$$S_s = s_s \times \frac{4}{3}\pi(W l_H)^3 = g_* \frac{8}{5}\left(\frac{\pi}{3}\right)^7 \left(\frac{80}{81}\right)^2 \times \frac{k_B^3 T_0^3 t_0^2}{W^2 \hbar^2 M_H c^2} = 2.534 \times 10^9$$

$$g_* \sqrt{W} = 2.435 \times 10^9$$

$$\frac{\gamma + 2}{3} S_H = 2.441 \times 10^9$$

$$\left(\frac{\beta + 2}{3} \times \frac{S_s}{g_*}\right)^2 = W = exp\left(\frac{81}{2}\right)$$ Assume

The square of the entropy per degree of freedom is the number of states W.

So far, we've looked at entropy per unit volume.
Here, we calculate the entropy per unit volume of the inflated Higgs.
The result is close to the square root of the number of states, W.
Assuming we correct it by a certain coefficient, it matches exactly.
The square of the entropy per degree of freedom is the number of states W.
This coefficient will be explained later.

Baryon number

Matter ratio

Baryon $\Omega_b = \dfrac{\frac{\gamma}{6\pi}}{\frac{\gamma+2}{3}}$ $= 4.90113875(3)\%$

Dark matter $\Omega_c = \dfrac{\frac{\gamma}{3}\left(1-\frac{1}{2\pi}\right)}{\frac{\gamma+2}{3}}$ $= 25.89362421(1)\%$

Dark energy $\Omega_\Lambda = \dfrac{\frac{2}{3}}{\frac{\gamma+2}{3}}$ $= 69.20523704(2)\%$

$$\frac{\gamma}{6\pi} + \frac{\gamma}{3}\left(1-\frac{1}{2\pi}\right) + \frac{2}{3} = \frac{\gamma+2}{3} = 96.3318231(2)\%$$

Debt ratio

$\gamma = 88.9954699(6)\%$

Second inflation can be thought of as the number of particles decreasing, but the total energy did not decrease and was adjusted to 100%.

Because the energy per particle was adjusted, entropy was also adjusted.

Let's look back at the calculation of matter ratios.
We considered second inflation to have occurred at a debt ratio of γ.
The sum of the three numerators is the coefficient that appeared earlier.
The denominator is that coefficient, normalized so that the total adds up to 100%.
Second inflation can be thought of as the number of particles decreasing, but the total energy did not decrease and was adjusted to 100%.
Because the energy per particle was adjusted, entropy was also adjusted.

Baryon number

Baryon number (2)

$$\left(\frac{\gamma+2}{3}\times\frac{S_s}{g_*}\right)^2 = W \quad \text{Assume}$$

$$\left(\frac{n_x}{s}\right)^2 = \frac{1}{W}\times\left(\frac{\gamma+2}{3}\right)^2 \times \Omega_x$$

Fermion

$$\frac{n_f}{s} = \frac{\gamma+2}{3}\sqrt{\frac{1}{W}\times\Omega_b} = \frac{\gamma+2}{3}\sqrt{\frac{1}{W}\times\frac{\frac{\gamma}{6\pi}}{\frac{\gamma+2}{3}}} = 3.42337930(2)\times 10^{-10}$$

Baryon

$$\frac{n_b}{n_\gamma} = \frac{2}{8}\times\frac{n_f}{s}\times g_*\frac{\pi^4}{45\zeta(3)} = 6.02466287(3)\times 10^{-10}$$

$6.04(12)\times 10^{-10}$ Measured

Dark matter

$$\frac{n_c}{s} = \frac{\gamma+2}{3}\sqrt{\frac{1}{W}\times\Omega_c} = 7.86869918(3)\times 10^{-10}$$

Calculate the theoretical value of the baryon number.
Swap the numerator and denominator in the equation assumed earlier.
The number of particles is the inverse of the number of states divided by the energy ratio.
The fermion number and baryon number have been calculated.
They match the measured values.
The dark matter number could also be calculated in a similar manner.

Baryon number

Baryon number (3)

Fermion $n_f = \frac{\gamma + 2}{3}\sqrt{\frac{1}{W} \times \Omega_b \times s} = 1.0001(7)m^{-3}$

Baryon $n_b = \frac{2}{8} n_f = 0.2500(2)m^{-3}$

$0.2515(17)$	CMB	Measured
$0.248(5)$	BBN	

Dark matter $n_c = \frac{\gamma + 2}{3}\sqrt{\frac{1}{W} \times \Omega_c \times s} = 2.299(2)m^{-3}$

Next, we calculated the number of particles per unit volume.
We calculated the fermion number and baryon number.
There are two measured values: one from the cosmic microwave background and one from the Big Bang nucleosynthesis.
It matches both.
We performed similar calculations for dark matter.

Baryon number

Average mass of one particle (1)

We can find the average mass of a particle by dividing the critical density of matter by the number of particles per unit volume.

Fermion $$M_f = \frac{\Omega_b \times \rho_{crit}}{n_f} = 242MeV/c^2$$

Baryon $$M_b = \frac{8}{2} M_f = 967\mathrm{M}eV/c^2$$

Dark matter $$M_c = \frac{\Omega_c \times \rho_{crit}}{n_c} = 556MeV/c^2$$

However, the number of particles per unit volume changes due to the expansion of the universe.

Let's calculate the average mass of a particle.
We can find the average mass of a particle by dividing the critical density of matter by the number of particles per unit volume.
We were able to calculate this not only for fermions and baryons, but also for dark matter.
However, the number of particles per unit volume changes due to the expansion of the universe.

Baryon number

Average mass of one particle (2)

We consider the inflated Higgs volume as a unit.
Multiplying the critical density by that volume gives us just the Higgs mass.
We assume that
the number of particles has decreased from 1 due to second inflation.

Fermion
$$M_f = \frac{\Omega_b \times \rho_{crit} \times \frac{4}{3}\pi(W l_H)^3}{\frac{\gamma + 2}{3}} = \frac{\frac{\gamma}{6\pi} \times \frac{M_H}{27}}{\left(\frac{\gamma + 2}{3}\right)^2} = 236MeV/c^2$$

Baryon
$$M_b = \frac{8}{2} M_f = 943MeV/c^2 \quad \fallingdotseq \quad \text{Hydrogen}$$

Dark matter
$$M_c = \frac{\Omega_c \times \rho_{crit} \times \frac{4}{3}\pi(W l_H)^3}{\frac{\gamma + 2}{3}} = 1246MeV/c^2$$

We calculate the average mass of a particle so that the expansion of the universe does not affect it.
We consider the inflated Higgs volume as a unit.
Multiplying the critical density by that volume gives us just the Higgs mass.
We assume that the number of particles has decreased from 1 due to second inflation.
We calculated not only fermions and baryons, but also dark matter.
The mass of baryons was almost the same as that of hydrogen.

Baryon number

Average mass of one particle (3)

$$M_b = \frac{8}{2} M_f = 943 \mathrm{M}eV/c^2 \quad ≒ \quad \text{Hydrogen}$$

Coincidence?

Let's assume that this is not a coincidence but a necessity.

$$\gamma = \frac{1 - 72\pi \frac{M_f}{M_H} \pm \sqrt{1 - 144\pi \frac{M_f}{M_H}}}{36\pi \frac{M_f}{M_H}}$$

$$Average\ Mass = \frac{Particle\ total\ Mass\ - Antiparticle\ total\ Mass}{Particle\ Number - Antiparticle\ Number}$$

Perhaps the universe is adjusted to match the masses of particles.

Is it a coincidence that the average mass of baryons is almost the same as that of hydrogen?
Let's assume that this is not a coincidence but a necessity.
The debt ratio γ is determined from the average mass.
However, the mass of antiparticles is taken as negative when calculating the average mass.
Perhaps the universe is adjusted to match the masses of particles.

Fine structure constant

Debt parameter

$$\alpha^{-1} = \frac{4\pi}{\left\{\frac{1}{2} cos45° cos30° \left(1 - \gamma_0 \frac{1}{81}\right)\right\}^2} = 137.035999177(21)$$ Measured

The fine structure constant may change slightly over time.

Debt parameter γ Function of time

Current debt ratio $\gamma_0 = 88.9954699(6)\%$ Measured

Minimum debt ratio γ_{min} $\gamma_{min} \leqq \gamma(t) \leqq 1$

From here, we will investigate the fine structure constant.
The fine structure constant is determined by the debt ratio, as shown in the equation.
However, the fine structure constant may change slightly over time.
Therefore, the debt parameter γ is assumed to be a function of time.
The current debt ratio is assumed to be $\gamma 0$.
We also assume that there is a minimum debt ratio.

Fine structure constant

Particle types

Fermion

8	×	2	×	2	×	3	=	96
$\nu, d_r, d_g, d_b, u_r, u_g, u_b, e$		L, R		Particle/Antiparticle		Generation		

Boson

6	×	2	+	1	×	1	=	13
$\gamma^0, Z^0, W^+, W^-, g^0, G^0$		L, R		H^0		Spin 0		

Internal degrees of freedom

Fermion： $\frac{7}{8}$ Boson： 1

Changing the subject, let's count the types of particles.
Quarks are three color and leptons are one color, so there are eight types of fermions per generation.
There are twice as many right-handed and left-handed fermions, and twice as many particles and antiparticles.
Multiplying this by three further generations makes a total of 96 types of fermions.
There are six types of gauge bosons, and twice as many right-handed and left-handed bosons.
There is only one Higgs boson as it has spin 0, so there is 13 types of bosons in total.
There is only one type of gluon and graviton, and no extra particles like dark matter are included.
Furthermore, the internal degrees of freedom for fermions is 7/8, while for bosons it is 1.

Fine structure constant

Minimum debt ratio

$$\gamma_0 = 88.9954699(6)\%$$

Degree of freedom

Particle types

$$\frac{\frac{7}{8}\times 96+13}{96+13} = \frac{97}{109} = 88.9908257\%$$

$= \gamma_{min}$ Assume

Minimum debt ratio

The Universe initially borrowed energy from vacuum according to type of particle.
However, due to the degrees of freedom, there is excess energy.
The excess can be repaid, but it does not have to be done right away.
The mind of the universe fluctuate as to whether or not to repay the excess.

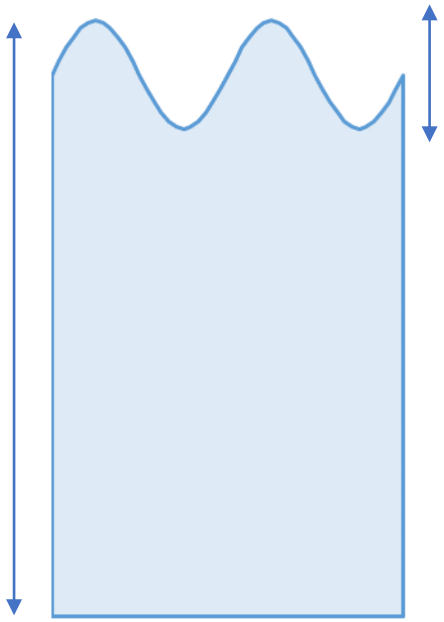
Let's calculate the ratio of particle types to the total internal degrees of freedom.
It is slightly smaller than the current debt ratio.
Let's assume that this value is the minimum debt ratio.
The Universe initially borrowed energy from vacuum according to type of particle.
However, due to the degrees of freedom, there is excess energy.
The excess can be repaid, but it does not have to be done right away.
The mind of the universe fluctuate as to whether or not to repay the excess.

Fine structure constant

Cosmic microwave background

Energy borrowed from the vacuum

E_s



Direction of Cosmic Microwave Background

Fluctuation energy $E_f = (1 - \gamma_{min})E_H$

The universe has been paying back or borrowing again the excess energy that has become free.

$$\text{Fluctuation} \approx \frac{1}{20000 \sim 30000}$$ Measured

$$= \frac{1}{\sqrt[4]{\frac{2}{3}\mathrm{W}}} = \frac{1}{22553}$$ Assume

Speaking of fluctuations, there's the cosmic microwave background radiation.
The universe has been paying back or borrowing again the excess and free energy it has.
This appears as fluctuations in the cosmic microwave background radiation.
The energy of the fluctuations is 1 minus the minimum debt rate.
The amplitude of the fluctuations is actually measured to be one in tens of thousands.
We'll assume that this can be expressed using W.

Fine structure constant

Fluctuation energy

Total energy at the early universe

$$E_s = \frac{1}{t_s} \times \hbar$$

Planck constant

Standard Hubble time

Fluctuation energy

$$E_f = \frac{1}{t_0} \times \frac{\hbar}{\sqrt[4]{\frac{2}{3}W}}$$

Current time

The amount of energy that can be borrowed decreases over time.

Current energy

$$E_0 = \gamma_{min} E_s + E_f$$

As shown in the equation above, dividing Planck's constant by the Hubble time gives the total energy at the early universe.
Next, the fluctuation energy is the reduced Planck's constant divided by the current time.
This shows that the amount of energy that can be borrowed decreases over time.
The equation below shows that the current energy is the minimum borrowing rate plus fluctuation energy.
As the fluctuation energy decreases over time, it asymptotically approaches the minimum borrowing rate.

Fine structure constant

Current debt ratio

$$\gamma_0 = \frac{E_0}{E_s} = \frac{\gamma_{min} E_s + E_f}{E_s} = \gamma_{min} + \frac{1}{t_0/t_s} \times \frac{1}{\sqrt[4]{\frac{2}{3}W}}$$

We will correct this so that the debt ratio is 1 when the current time is 0.

$$\gamma_0 = \gamma_{min} + \frac{1}{\frac{t_0}{t_s} + \frac{1}{1-\gamma_{min}} \times \frac{1}{\sqrt[4]{\frac{2}{3}W}}} \times \frac{1}{\sqrt[4]{\frac{2}{3}W}}$$

$t_0 = 0$：

$$\gamma(0) = \gamma_{min} + (1-\gamma_{min}) \times \sqrt[4]{\frac{2}{3}W} \times \frac{1}{\sqrt[4]{\frac{2}{3}W}} = 1$$

Calculate the current debt ratio.
The current debt ratio is the current energy divided by the total energy at the beginning of the universe.
However, when the current time is 0, the fluctuation energy becomes infinite.
We will correct this so that the debt ratio is 1 when the current time is 0.

Fine structure constant

Theoretical value from the current time

Current time $t_0 = 13.797(23)\ billion\ year$ Λ-CDM mode

Current debt ratio $$\gamma_0 = \gamma_{min} + \frac{1}{\frac{t_0}{t_s} + \frac{1}{1-\beta_{min}} \times \frac{1}{\sqrt[4]{\frac{2}{3}W}}} \times \frac{1}{\sqrt[4]{\frac{2}{3}W}} = 88.995463(8)\%$$

88.9954699(6)% Measured

Fine structure constant

$$\alpha^{-1}(t_0) = \frac{4\pi}{\left\{\frac{1}{2}cos45°cos30°\left(1-\gamma_0\frac{1}{81}\right)\right\}^2} = 137.03599893(26)$$

137.035999177(21) Measured

Calculate the theoretical value of the fine structure constant.
We used the value from the Λ-CDM model as the current time.
By calculating the current debt ratio, we can also calculate the fine structure constant.
This matches the measured value, within the margin of error.
However, the accuracy is one order of magnitude lower than the measured value.

Fine structure constant

From temperature to time

$$\left(\frac{\gamma_{min}+2}{3}\times\frac{S_s}{g_*}\right)^2 = W \qquad \text{Assume}$$

Temperature of the Universe $T_0 = 2.7255(6)K$ Measured

Age of the Universe $$t_0 = \sqrt{\left(\frac{3}{\gamma_{min}+2}\right)\frac{5}{8}\left(\frac{3}{\pi}\right)^7\left(\frac{81}{80}\right)^2\frac{W^{2.5}\hbar^2 M_H c^2}{k_B^3 T_0^3}}$$

$$= 13.781(5)\ billion\ year$$

13.797(23) Λ-CDM model

Fine structure constant $\alpha^{-1}(t_0) = 137.035999104(52)$

137.035999177(21) Measured

We calculated the age of the universe from the cosmic microwave background radiation.
We considered the relationship assumed in calculating the baryon number, with the minimum debt ratio fixed.
We were able to calculate the age of the universe from the measured temperature of the universe.
This matches the Λ-CDM model within error, but it appears slightly younger.
We also calculated the fine structure constant.
The error is smaller, but it still matches the measured value.
The Λ-CDM model is fitted by assuming various parameters.
On the other hand, this equation allows us to convert from temperature to time without any parameters.

Fine structure constant

From time to temperature

Age of the Universe $t_0 = 13.797(23)\ billion\ year$ Λ-CDM model

Temperature of the Universe

$$T_0 = \sqrt[3]{\left(\frac{3}{\beta_{min}+2}\right)\frac{5}{8}\left(\frac{3}{\pi}\right)^7\left(\frac{81}{80}\right)^2\frac{W^{2.5}\hbar^2 M_H c^2}{k_B^3 t_0^2}}$$

$$= 2.7235(30)K$$

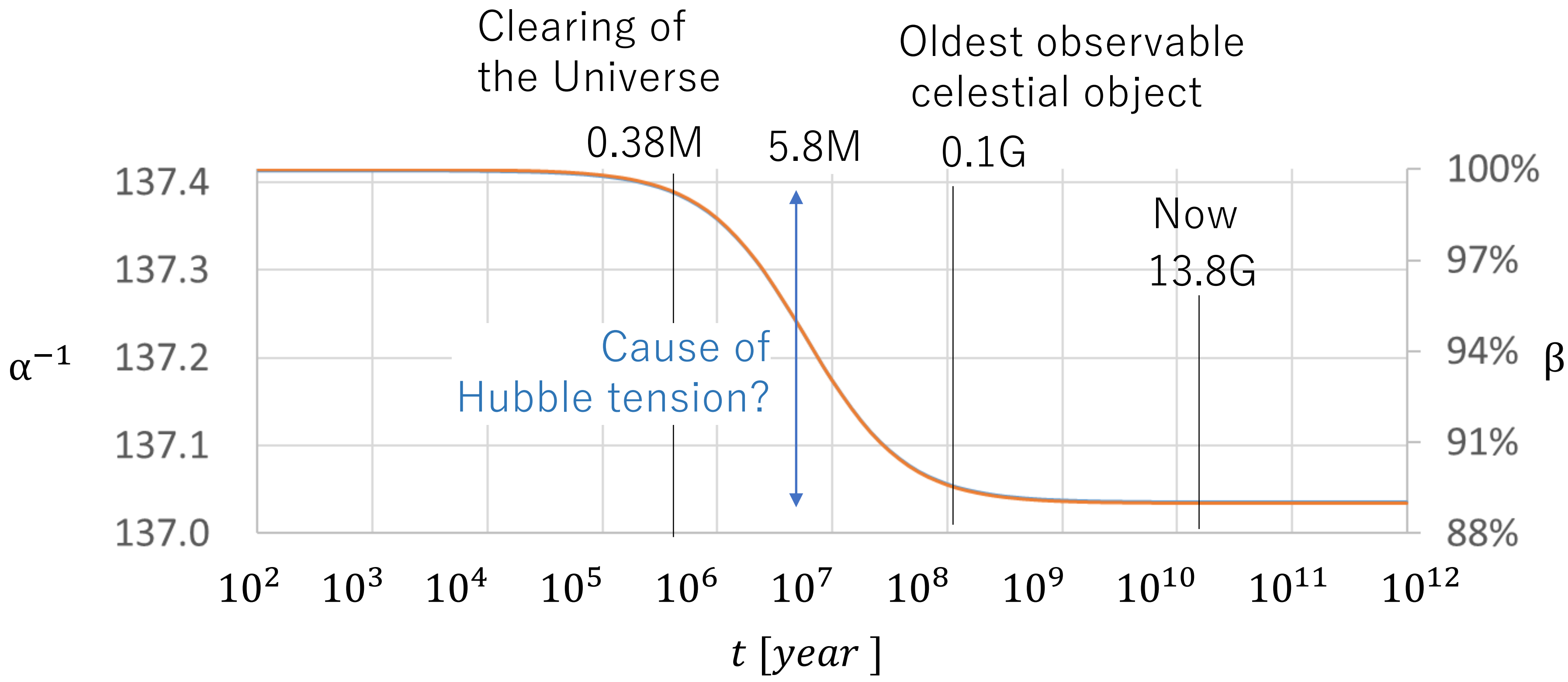
2.7255(6) Measured

When we want to know about the physics of the universe at current time, the only parameter we need to know is the current time.

Conversely, we can calculate the temperature of the cosmic microwave background radiation from the age of the universe.
However, there is no way to know the age directly.
Calculations using an estimated age result in lower accuracy, so it is better to measure the temperature directly.
This equation also has no free parameters.
When we want to know about the physics of the universe at current time, the only parameter we need to know is the current time.

Fine structure constant

Changes over time (1)



The logarithmic graph shows the change in the debt ratio and fine structure constant over time.
The two values are linked.
They have now stabilized at a nearly constant value.
There is only a slight difference compared to the 100 million years since the oldest celestial objects became observable.
Meanwhile, in the 380,000 years since the universe first became clear, there has been almost no change since the beginning of the universe.
It takes 5.8 million years for the value to change by half.
This change over time may be the cause of Hubble tension.

Fine structure constant

Changes over time (2)

$$\alpha^{-1}(0) = 137.413262668$$
$$\alpha^{-1}(0.38M) = 137.390061424$$
$$\alpha^{-1}(Now) = 137.035999104$$

$$\frac{\alpha(0) - \alpha(Now)}{\alpha(Now)} = -0.27\%$$

$-1.2\% \sim +0.4\%$ Constraints from Big Bang nucleosynthesis

$$\frac{\alpha(Now - 11G) - \alpha(Now)}{\alpha(Now)} = -4.5 \times 10^{-6} \quad = -4.1 \times 10^{-16}\ /year$$

$-5.7(\pm 1.0) \times 10^{-6}$ Measurement from 10 to 12 billion years ago

$$\Delta\alpha(Now) = -8.4 \times 10^{-17}/year$$

$-1.6(\pm 2.3) \times 10^{-17}$ Current measurement

We have included calculated values such as when the universe first cleared up.
The change in the fine structure constant between the early universe and the present is calculated to be -0.27%.
This is within the limit imposed by Big Bang nucleosynthesis.
Also, measured values from 10 to 12 billion years ago are available, and when compared, they match.
The current rate of change has also been measured, and although the error is large, it is on the same order.
It appears that the fine structure constant was smaller in the past than it is now.
Also, the change in the fine structure constant appears to be slowing over time.

Fine structure constant

Equation

$$\alpha^{-1} = \frac{4\pi}{\left\{\frac{1}{2}cos45°cos30°\left(1-\gamma_0\frac{1}{81}\right)\right\}^2} = 137.035999104(52) \quad \text{Theoretical}$$

$$137.035999177(21) \quad \text{Measured}$$

$$W = exp\left(\frac{81}{2}\right)$$

$$\gamma_0 = \frac{97}{109} + \frac{1}{H_s t_0 \sqrt[4]{\frac{2}{3}W} + \frac{109}{109-97}}$$

$$H_s = \frac{80}{81} \times \frac{\pi^2 M_H c^2}{9W^{2.5}\hbar}$$

$$t_0 = \frac{81}{80}\sqrt{\frac{81\cdot 981 W^{2.5}\hbar^2 M_H c^2}{56\pi^7 k_B^3 T_0^3}}$$

Temperature of the Universe $T_0 = 2.7255(6)K$ Measured

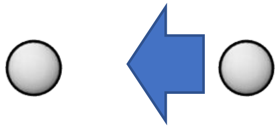
$$\alpha^{-1} = \frac{4\pi}{\left\{\sqrt{\frac{3}{32}}\left(1-\frac{1}{81}\left(\frac{97}{109}+\frac{1}{\sqrt{\frac{81\cdot 981 M_H^3 c^6}{56\pi^3 exp\left(\frac{5\cdot 81}{4}\right)k_B^3 T_0^3}}\sqrt[4]{\frac{2}{3}exp\left(\frac{81}{2}\right)}+\frac{109}{109-97}}\right)\right)\right\}^2}$$

I've put together an equation for the fine structure constant.
It can be calculated if you know the age or temperature of the universe.
The Higgs mass is also needed, but this can be determined precisely from the Fermi coupling constant.
Alternatively, since the Higgs mass is a natural unit, we can just use 1.
It is possible to force it into a single equation, but it will be long.

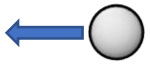
Modified Gravity

Modified Newtonian mechanics (1)

Solar system level



Galactic level



$$Gravity \propto \frac{1}{Distance^{2}}$$

$$Gravity \propto \frac{1}{Distance^{1}}$$

The closer the acceleration is to 0, the more gravity is modified in the stronger.
At the solar system level,
the strength of gravity remains approximately the minus square of the distance.
At the galactic level,
the strength of gravity is approximately the minus first power of the distance.

Let me introduce modified Newtonian mechanics.
Dark matter was postulated to explain the rotational motion of galaxies.
However, if the strength of gravity is modified, it can be explained without dark matter.
Such a theory is called modified Newtonian mechanics.
The closer the acceleration is to 0, the more gravity is modified in the stronger.
At the solar system level, the strength of gravity remains approximately the minus square of the distance.
At the galactic level, the strength of gravity is approximately the minus first power of the distance.

Modified Gravity

Modified Newtonian mechanics (2)

Parameters of modified Newtonian mechanics

$$a_0 = 1.2 \times 10^{-10} m/s^2$$

$$Hc = 7.1 \times 10^{-10} m/s^2$$

Hubble constant
(Expansion of the Universe)

$$H_0 = 73.0 kms^{-1} Mpc^{-1}$$

Modified Newtonian mechanics has only one parameter.
This parameter is within one order of magnitude of
the product of the Hubble constant and the speed of light.
The Hubble constant is the rate at which the universe is expanding.
The expansion of the universe due to dark energy can be explained
by the hierarchy parameter W.
If the relationship can be explained well, no additional parameters are necessary.

Modified Newtonian mechanics has only one parameter.
This parameter is within one order of magnitude of the product of the Hubble constant and the speed of light.
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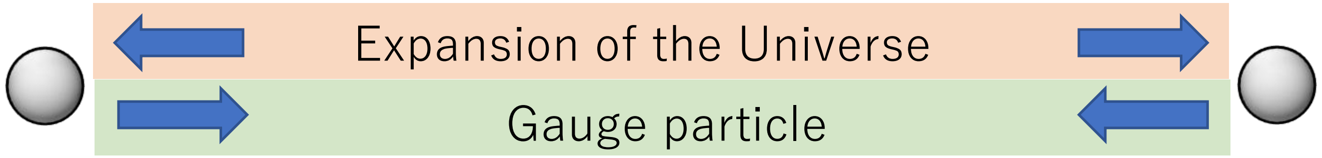
The expansion of the universe due to dark energy can be explained by the hierarchy parameter W.
If the relationship can be explained well, no additional parameters are necessary.

Modified Gravity

Modified Newtonian mechanics (3)

Local gauge transformation



When space changes, gauge particles are generated to cancel out the change.

Gravity = Gravity by mass + Gravity by expansion

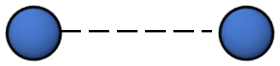
Increase

Let's think about why gravity is modified.
First, assume space is not expanding.
Next, suppose dark energy changes space to an expanding state.
Now, consider a local gauge transformation.
When space changes, gauge particles are generated to cancel out the change.
In other words, a force is generated.
In addition to gravity due to mass, gravity due to expansion is added.
As a result, gravity becomes stronger.

Modified Gravity

Modified Newtonian mechanics (4)

Gravity by mass



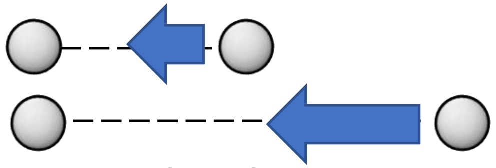
Mass remains the same regardless of distance

$$Gravity \propto \frac{1}{Distance^{2}}$$

Spherical spreading and attenuation

×

Gravity by expansion



The greater the distance, the greater the expansion rate.

$$Expansion \propto Distance^{1}$$

Hubble's law

=

$$Gravity \propto \frac{1}{Distance^{1}}$$

Let's compare gravity due to mass with gravity due to expansion.
Mass does not change even if distance changes.
Gravity is proportional to the negative squared of the distance, because it expands spherically.
On the other hand, Hubble's law states that the speed at which a star moves away is proportional to the first power of the distance.
Due to expansion, gravity is also proportional to the negative squared of the distance.
The strength of gravity is proportional to the negative squared of the distance, obtained by multiplying the negative squared force by the first power.

Modified Gravity

Modified Newtonian mechanics (5)

Conventional Gravity

Additional Gravity

$$F = \frac{GM^2}{R^2} + \frac{\sqrt{Ga_0M^3}}{R}$$

$$a_0 = 1.2 \times 10^{-10} m/s^2$$

$$F = \frac{\sqrt{G}M}{R} \times \frac{\sqrt{G}M}{R} + \frac{\sqrt{G}M}{R} \times \sqrt{Ma_0}$$

Modified Newtonian mechanics has a variation that expresses it as the sum of two gravitational forces.
Conventional gravity is the force that follows the square of the distance.
Additional gravity is the force that follows the first power of the distance.
Substituting the Hubble constant into the acceleration parameter gives the following equation.

Modified Gravity

Longitudinal Gravity (1)

Gauge coupling constant

Photon $e = \frac{1}{2} \times cos45° \times cos30°$ transverse wave

Z^0 $z = \frac{1}{2} \times cos45° \times sin30°$ longitudinal wave

Graviton $g_G = cos45° \times cos30°$ transverse wave

Graviton' $g_{G'} = cos45° \times sin30°$ longitudinal wave

$$G = \left(\frac{2}{3}\pi^2\right)^2 \frac{g_G^2 \hbar c}{W^2 M_H^2}$$

$$G' = \left(\frac{2}{3}\pi^2\right)^2 \frac{g_{G'}^2 \hbar c}{W^2 M_H^2}$$

Gravitational waves are thought to be transverse waves.
It is not strange that a force equivalent to a longitudinal wave exists.

I overlooked one thing about gravity.
Electromagnetic waves are transverse waves, but there is also a force that corresponds to a longitudinal wave.
These are cosine and sine components.
Gravitational waves are thought to be transverse waves.
It is not strange that a force equivalent to a longitudinal wave exists.

Modified Gravity

Longitudinal Gravity (2)

Transverse Gravity

Longitudinal Gravity

$$F = \frac{\sqrt{G}M}{R} \times \frac{\sqrt{G}M}{R} \quad + \quad \frac{\sqrt{G}M}{R} \times \sqrt{Ma_0}$$

$$F = \frac{\sqrt{G}M}{R} \times \frac{\sqrt{G}M}{R} \quad + \quad \frac{\sqrt{G'}M}{R} \times \sqrt{M\frac{H_0c}{2}}$$

$$(H_0 = 73.0kms^{-1}Mpc^{-1})$$

Empirical

$$a_0 = 1.2 \times 10^{-10} m/s^2$$

$$a_0 = \frac{G'}{G} \times \frac{H_0c}{2} = \left(\frac{sin30°}{cos30°}\right)^2 \frac{H_0c}{2}$$

$$= \frac{H_0c}{6} = 1.18 \times 10^{-10} m/s^2$$

Theoretical

We have been able to explain the acceleration parameters theoretically.

Now, let's assume that the gravity added in modified Newtonian mechanics is longitudinal wave gravity.
We change it to a longitudinal wave gravitational constant.
We also set the acceleration parameter to half the product of the Hubble constant and the speed of light.
Then, we found that the theoretical and empirical values for the acceleration parameter matched well.
We have been able to explain the acceleration parameters theoretically.

Modified Gravity

Longitudinal Gravity (3)

Transverse Gravity — Longitudinal Gravity

$$F = \frac{\sqrt{G}M}{R} \times \frac{\sqrt{G}M}{R} + \frac{\sqrt{G'}M}{R} \times \sqrt{M\frac{H_0 c}{2}}$$

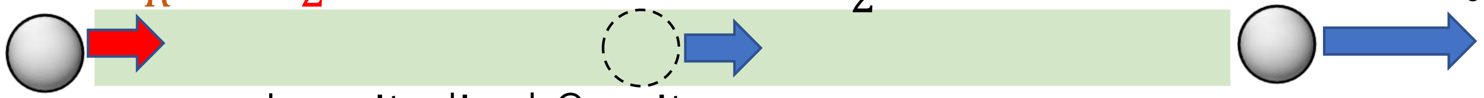
Particle — Particle — Particle — Space

Expansion Speed

$$a = \frac{c}{R}v = \frac{H_0 c}{2}$$

$$v = H_0\frac{R}{2}$$

$$v = H_0 R$$



Longitudinal Graviton

$\frac{c}{R}$: The shortest time required for communication between two particles.

a : The acceleration required to reach expansion speed in shortest time.

Let's interpret the meaning of the equation.
Conventional transverse wave gravity is the force acting between particles.
Longitudinal wave gravity can be interpreted as the force acting between a particle and space.
Suppose there is a longitudinal wave gravitational force in the space of two particles.
The expansion speed of the gravitational force is half the expansion speed of the two particles.
The shortest time required for communication between two particles is c/R.
The acceleration required to reach the expansion speed in the shortest time is a.

Modified Gravity

Longitudinal Graviton

What properties are necessary for its force to reach infinity?

- The mass of the gauge particle is 0 …This is not a necessary condition
- The gauge particle does not decay …This is a necessary condition

Therefore, it is not forbidden for longitudinal wave gravitons to have mass.
The true identity of dark matter may be a longitudinal graviton.

Let's think about what a longitudinal wave graviton is.
What properties are necessary for its force to reach infinity?
It is not a necessary condition for gauge particles to have zero mass.
What is a necessary condition is that gauge particles do not decay.
Therefore, it is not forbidden for longitudinal wave gravitons to have mass.
The true identity of dark matter may be a longitudinal graviton.

Modified Gravity

Entropic gravity

General relativity	Quantum gravity	Entropic gravity
Space-time is distorted	Gravitons are exchanged	Entropy increases

"Space-time“, “Graviton“, and "Entropy" are all invisible concepts that humans have arbitrarily defined.

In all cases,
the visible concept of "the relative positions of particles" is simply changing.

They are simply different interpretations of the same phenomenon
using concepts that do not need to be distinguished.

There is also something called entropic gravity in the theory of gravity.
Gravity simply appears as an increase in entropy.
In general relativity, gravity appears as a distortion of space-time.
In quantum gravity, gravitational forces are exchanged.
"Space-time“, "graviton“, and "entropy" are all invisible concepts that humans have arbitrarily defined.
In all cases, the visible concept of "the relative positions of particles" is simply changing.
They are simply different interpretations of the same phenomenon using concepts that do not need to be distinguished.

Modified Gravity

Comparison with entropic gravity

	Entropic Gravity	Gravity in this video
Degree of freedom	$\mathrm{N} = \frac{4\pi R^2}{l_P^2}$	$\mathrm{N} = 81$
Meaning	Gravity weakens with distance	Gravity is weaker than other forces
Modified Gravity	$a_0 = \frac{H_0 c}{6}$	$a_0 = \left(\frac{sin30°}{cos30°}\right)^2 \frac{H_0 c}{2} = \frac{H_0 c}{6}$

It's not a contradiction, it's just that they're focusing on different things.
Perhaps they can be interpreted in a way that makes them compatible.

I compared it with entropic gravity.
The degrees of freedom of entropic gravity show that gravity weakens with distance.
On the other hand, the degrees of freedom in this video show that gravity is weaker than other forces.
It's not a contradiction, it's just that they're focusing on different things.
The strength of modified gravity is the same in both.
Perhaps they can be interpreted in a way that makes them compatible.

Modified Gravity

Dark matter

Dark matter VS Modified gravity

If there is room for uncertainty, then neither is the optimal solution.
If there was a theory that had the best of both, there would be no uncertainty.

Dark matter is thought to exist independently of other particles.
Furthermore, its amount must necessarily be fixed inevitably.

So which is correct, dark matter or modified gravity?
If there is room for uncertainty, then neither is the optimal solution.
If there was a theory that had the best of both, there would be no uncertainty.
Dark matter is thought to exist independently of other particles.
Furthermore, its amount must necessarily be fixed inevitably.

Silver Cube

Two dice

Asymmetry parameter

$r = 33.551 \ldots$

Hierarchy parameter

$lnW = 40.5$

$$r \quad : \quad 2lnW$$

$$= \frac{81}{\sqrt{2}+1} \qquad = 81$$

$$1 \quad : \quad \sqrt{2}+1$$

Silver ratio

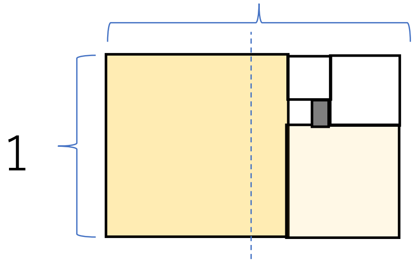
Once one is determined, the other is also determined.
In other words, God has only rolled one die.

Finally, let's organize the dice.
So far, we've rolled God's dice twice.
The asymmetry parameter r and the hierarchical parameter W.
Doubling the natural logarithm of W gives us 81.
The ratio of the two parameters is now 1 to root 2 + 1.
This is called the silver ratio.
Once one is determined, the other is also determined.
In other words, God has only rolled one die.

Silver Cube

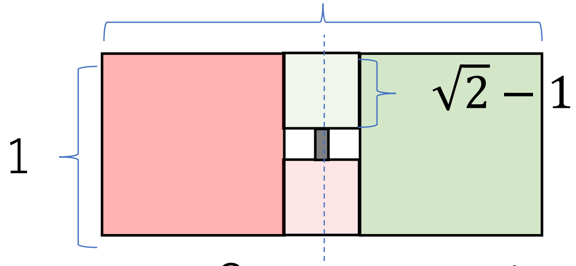
Gold and Silver

Golden ratio

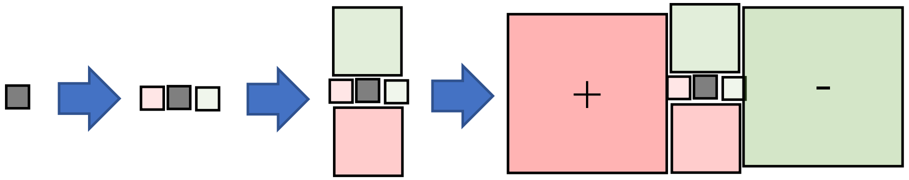


Asymmetry

Silver ratio $\sqrt{2}+1$



Symmetry …beautiful



Repeatedly adding squares to both ends of the long side results in the silver ratio.

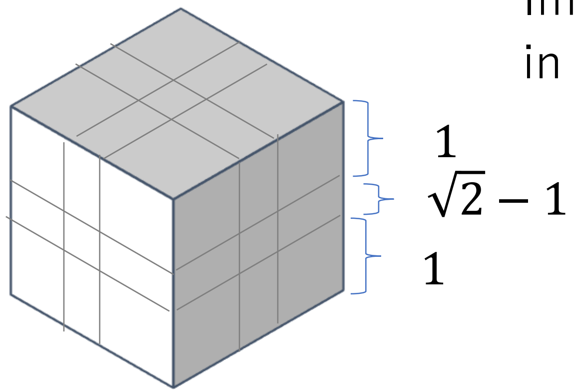
When adding something,
you must add something with the opposite sign to balance it out.
In its simplest, silver ratio results when layered through symmetrical self-similarity.

Let's think about where the silver ratio came from.
If you cut a square from a golden ratio rectangle, it becomes a golden ratio rectangle.
If you cut a square from both ends of a silver ratio rectangle, it becomes a silver ratio rectangle.
In terms of symmetry, the silver ratio is more aesthetically pleasing than the golden ratio.
Repeatedly adding squares to both ends of the long side results in the silver ratio.
When adding something, you must add something with the opposite sign to balance it out.
In its simplest form, the silver ratio results when layered through symmetrical self-similarity.

Silver Cube

Silver Cube

Let's think about how to explain both the 81 degrees of freedom and the silver ratio at the same time.



$N = 3 \times 3^3 = 81$

Imagine a cube that has been divided into thirds in each of 3 directions using the silver ratio.

It is divided into 27 compartments, although each compartment is not of equal size.

If each section has N=3 degrees of freedom, then the total is N=81.

If we can explain this silver cube well, then there will be no dice rolled by God.

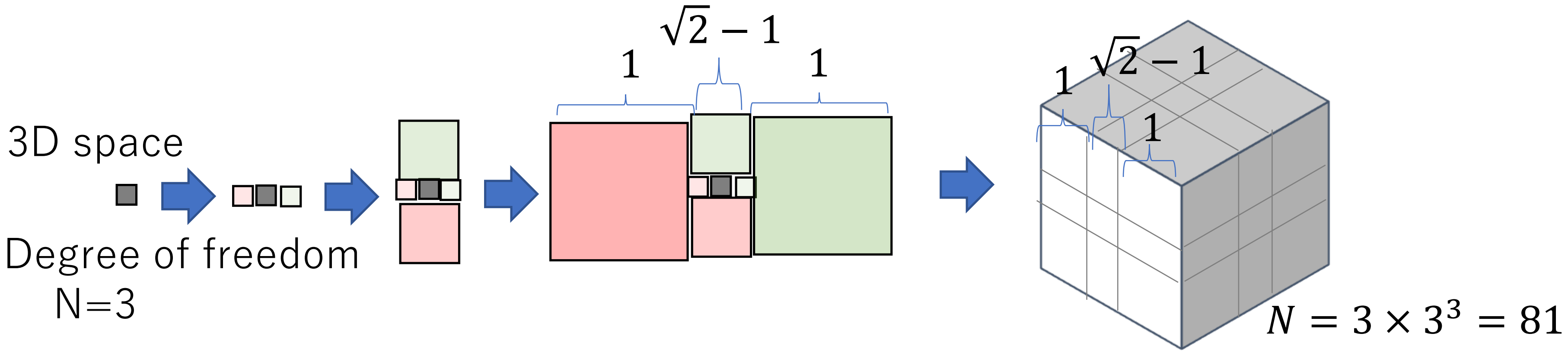
Let's think about how to explain 81 degrees of freedom and the golden ratio at the same time.
Imagine a cube that has been divided into thirds in each of three directions using the golden ratio.
The sections are not all the same size, but it is divided into 27 sections.
If each section has N=3 degrees of freedom, then the total is N=81.
If we can explain this silver cube well, then there will be no dice rolled by God.

Silver Cube

Creating the Silver Cube

(1) God wanted to express the minimum existence without rolling dice.

(2) There should be no directionality or finite numerical parameters.



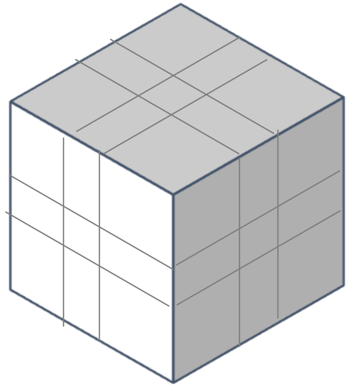
(3) The 3D space replicated itself infinitely on both sides in all 3 directions.

(4) From any direction, it can be seen divided into 3 parts according to silver ratio.

Let's think about how the silver cube was created when the universe was created.
God wanted to express the minimum of "existence" without rolling dice.
There should be no directionality or finite numerical parameters.
The 3D space replicated itself infinitely on both sides in all 3 directions.
From every direction, it appears to be divided into thirds according to the silver ratio.

Silver Cube

Number of states



$$W = \exp\left(\frac{N}{2}\right) = exp\left(\frac{81}{2}\right)$$

Inflated Higgs length

$$W l_H = \frac{exp\left(\frac{81}{2}\right)}{1} \times l_H$$

Gravitation length

$$l_G = \frac{1}{exp\left(\frac{81}{2}\right)} \times \frac{2}{3}\pi^2 l_H$$

square of the number of particles

$$\left(\frac{n}{s}\right)^2 = \frac{1}{exp\left(\frac{81}{2}\right)} \times \Omega$$

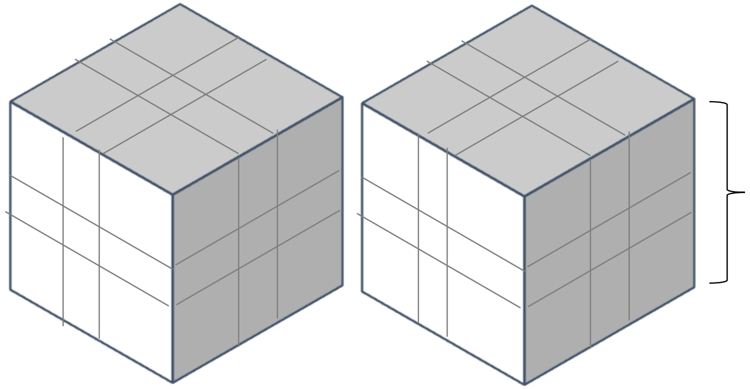
$$exp\left(\frac{0}{2}\right) = 1$$

We can say that before the hierarchy was created, there were no degrees of freedom.

Let's use the silver cube to interpret the hierarchy W.
The number of states is the exponent of half the degrees of freedom.
We get the inflated Higgs length and gravitational length.
Similarly, we get the squared number of particles.
It is a ratio to 1.
It is compared with 0 degrees of freedom.
We can say that before the hierarchy was created, there were no degrees of freedom.

Silver Cube

Energy



$\sqrt{2}+1$

$N = 81$

Critical density $\rho_{crit} = \frac{3}{81} \times \frac{M_H}{\frac{4}{3}\pi\left\{exp\left(\frac{81}{2}\right) l_H\right\}^3}$

Higgs V.E.V. $\left\{2 - \frac{3}{81}\right\} \times M_H c^2$

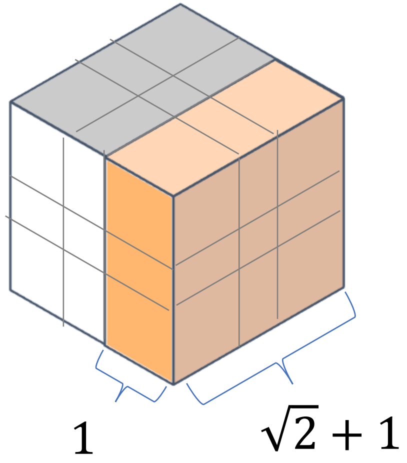
$N = 3$

You can think of it as
being compared with 1 degree of freedom.

Next, we look at energy.
Energy is proportional to the logarithm of the number of states.
We can obtain the critical density and Higgs vacuum expectation value.
This is compared with 1 degree of freedom.

Silver Cube

Asymmetry



$N = 81$

For a given face,
aspect 1 corresponds to the hierarchy one generation back.

Asymmetry $\quad r = 81 \times \dfrac{1(\sqrt{2}+1)(\sqrt{2}+1)}{(\sqrt{2}+1)^3} = 33.551$

$$\frac{1}{r} = \frac{1}{81} \times \frac{(\sqrt{2}+1)^3}{1(\sqrt{2}+1)(\sqrt{2}+1)} = \frac{1}{33.551}$$

$N = 1$ 

You can think of it as
being compared with 1 degree of freedom.

Next, let's look at asymmetry in mass.
Let's look at just one face of the silver cube.
For a given face, aspect 1 corresponds to the hierarchy one generation back.
The degree of freedom corresponding to that partial volume is the asymmetry parameter r.
The mass decreases by r to 1.
You can think of it as being compared with 1 degree of freedom.

Supplement

Higgs natural units

	Planck units	Higgs units
c (light speed)	1	1
$\hbar$ (Dirac cosntant)	1	1
k_B (Boltzmann costant)	1	1
M_H (Higgs mass)	$125.20(11)GeV/c^2$	1 $125.172747(23)GeV/c^2$
G (Gravity constant) $[m^3kg^{-1}s^{-2}]$	1 $6.67430(15)\times 10^{-11}$	$\left(\frac{80}{81}\right)^2 \frac{\pi^4 \hbar c}{6W^2 M_H^2}$ $6.674325(24)\times 10^{-11}$

From here on, I will provide some additional explanation.
Speaking of natural units, there is the Planck unit.
Let's create a more natural unit in which the mass of the Higgs boson is set to 1.
We think that the Planck mass was created through inflation of the Higgs mass.
Therefore, the Higgs mass is the original mass.
Let's call this the Higgs unit.
The gravitational constant can now be expressed in terms of other constants.

Supplement

Force and Symmetry (1)

Energy $E = gM_H c^2$

$E = g$ (Higgs unit system)

Gauge coupling constant $g = Asymmetry$ $(0 \leqq g \leqq 1)$

- 0 : Symmetry
- 1 : Antisymmetry

The force acts so that the wave does not disappear but increases the probability of the particle's existence.

When the force acts to prevent the wave from completely disappearing, g=1.

Energy and gauge coupling constants can be converted in terms of the Higgs mass.
In the Higgs unit system, energy and gauge coupling constants are equal.
The gauge coupling constant is the magnitude of the asymmetry.
The asymmetry is a value between 0 and 1.
0 is symmetric, and 1 is antisymmetric.
The force acts so that the wave does not disappear but increases the probability of the particle's existence.
When the force acts to prevent the wave from completely disappearing, g=1.

Supplement

Force and Symmetry (2)

Hierarchy	Force	Symmetry	Cause of Interfere
Tiny part	Electromagnetic	Direction (Phase)	Other particle
Half particle	Weak	Isospin	Other particle
	Srong	Hypercharge	(Spinning) Self
Whole particle	Pauli repulsion	Spin symmetry	(Swapping) Self
	Mass	Moving symmetry	(Moving) Self
Inter particles	Gravity	Positional relationship	Other particle
	Gravity'	Expansion of space	Other particle

There are different types of forces because there are different types of symmetry.
There are different types of symmetry because there is a hierarchy.

There are different types of forces because there are different types of symmetry.
There are different types of symmetry because there is a hierarchy.
There are different symmetries for tiny parts, half a particle, whole particles, and between particles.
Different symmetries cause different interference.

Supplement

Force and Symmetry (3)

Force	Gauge coupling constant
Electromagnetic	$cos45°cos30°/2[\gamma] + cos45°sin30°/2[Z]$
Weak	$cos45°cos30°/2[W] + cos45°/2[Z]$
Strong	$2\pi(@0), 2\pi/3(@M_\tau)[g]$
Pauli repulsion	$1/2[-]$
Mass	$1[H]$
Gravity	$cos45°cos30°[G] + cos45°sin30°[G']$

The effect of vacuum energy is omitted.

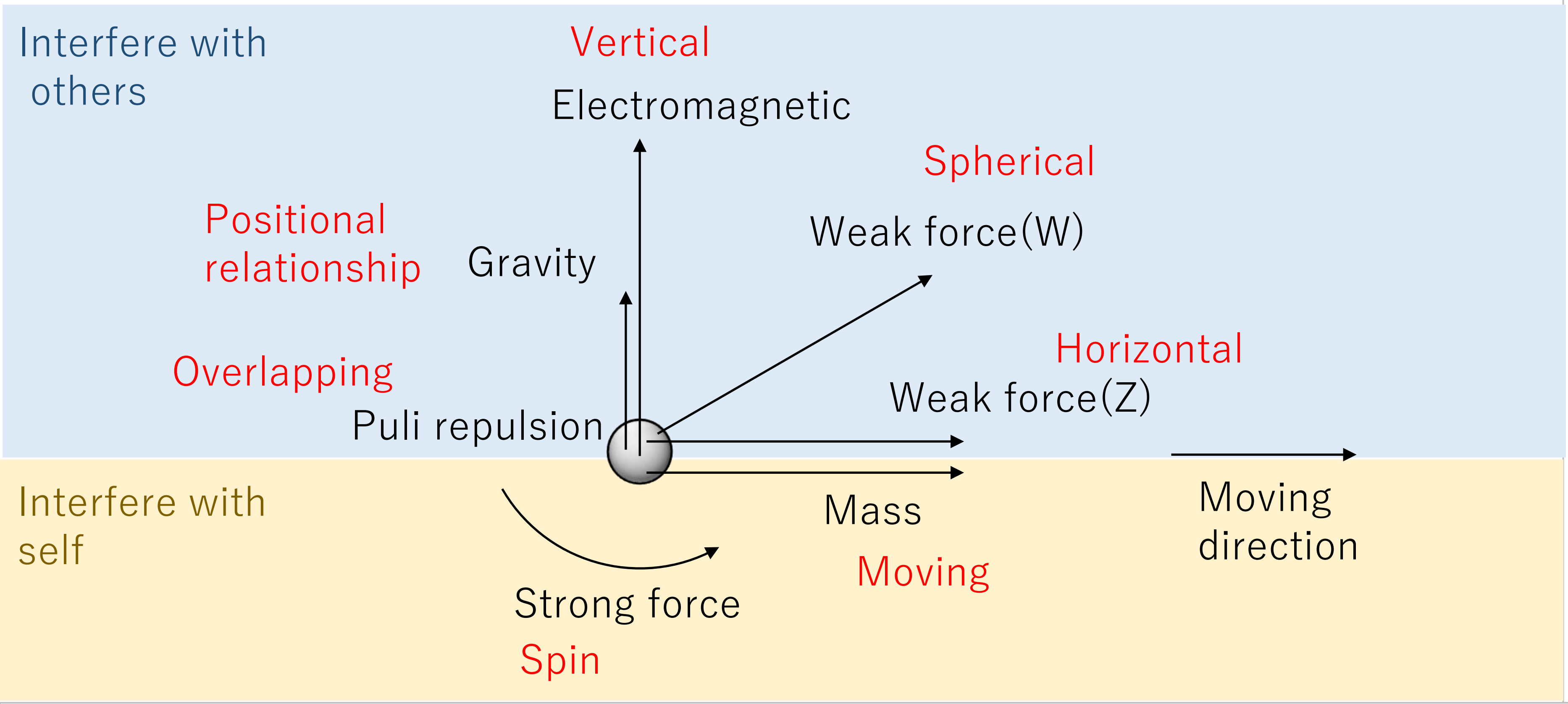
They are unified in that if the degree to which the wave is weakened is the same, the strength of the force will also be the same.

The gradient of the probability of a particle's existence becomes the force.

I have summarized the gauge coupling constants.
Naturally, the way the force works and its strength will differ.
They are unified in the sense that if the degree to which the wave weakens is the same, the strength of the force will also be the same.
You can also say that the gradient of the probability of a particle's existence becomes the force.
Here, the effect of vacuum energy is omitted.

Supplement

Force and Symmetry (4)



The relationships between all forces are illustrated here.
They are divided into two major sections, top and bottom.
Only the strong force and mass, shown below, are forces that arise from interference with themselves.
The only difference between these two is that one is translation, while the other is rotation.
All other forces, shown above, are forces that arise from interference with others.
The only difference between the electromagnetic force and the weak force is directionality.
The Pauli repulsive force is not directional, as it is not mediated by gauge particles.
Gravity arises from the relative positions of particles, and is affected by hierarchy.

Supplement

Super string theory

10^{500} types !

Too much?
Too little?

Wouldn't it be beautiful if everything were made of string?
Everyone has different aesthetic sense, so there is no right or wrong answer.
God chose one type of string from among 10 to the power of 500 combinations.
Isn't a die with 10 to the power of 500 sides too big?
In fact, the opposite is true: there are too few combinations.
That's because the universe is infinite.
Wouldn't an infinite number of combinations be more beautiful?

Let's also talk about superstring theory, which is said to be a candidate for the theory of everything.
Wouldn't it be beautiful if everything were made of string?
Everyone has different aesthetic sense, so there is no right or wrong answer.
God chose one type of string from among 10 to the power of 500 combinations.
Isn't a die with 10 to the power of 500 sides too big?
In fact, the opposite is true: there are too few combinations.
That's because the universe is infinite.
Wouldn't an infinite number of combinations be more beautiful?

Supplement

Is the universe infinite?

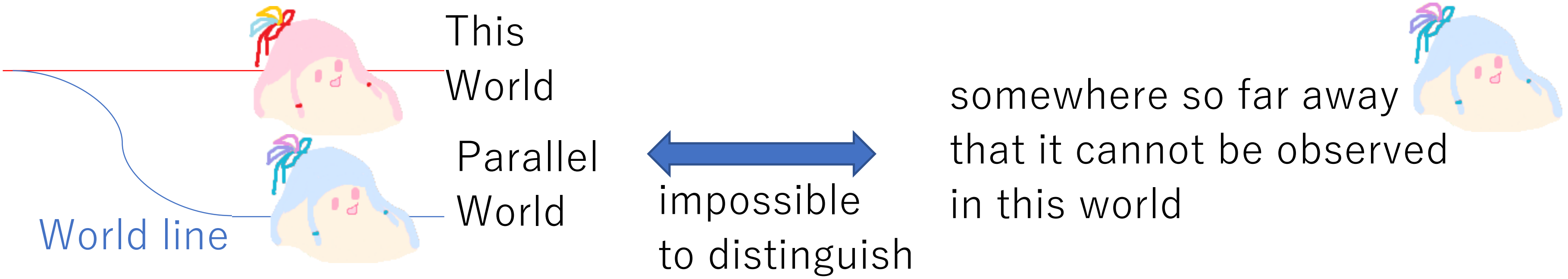
God's choice
- ・Size of the universe is finite： God needs to roll the dice and decide size
- ▶ ・Size of the universe is infinite： God doesn't play dice

Is the universe really infinite?
We cannot see outside the edge of the universe because it is expanding faster than the speed of light.
Only one assumption is necessary to estimate the size of the universe.
God does not play dice.
Suppose the universe has a finite size.
In that case, God would have to roll dice to determine its size.
If God does not roll dice, the universe is infinite.

Supplement

Parallel World

Not rolling the dice means not making any choice.
God does not choose the universe, and all parallel worlds exist.



Parallel worlds do not require world lines.
A world equivalent to that parallel world exists somewhere in the universe.
This is because the universe is infinite.
It is impossible to distinguish between a parallel world
and somewhere so far away that it cannot be observed in this world.

Not rolling the dice means not making any choice.
God does not choose the universe, and all parallel worlds exist.
Parallel worlds do not require world lines.
A world equivalent to that parallel world exists somewhere in the universe.
This is because the universe is infinite.
It is impossible to distinguish between a parallel world and somewhere so far away that it cannot be observed in this world.

Supplement

Another World

・Parallel World ··· Exist

・Afterlife World ··· Exist

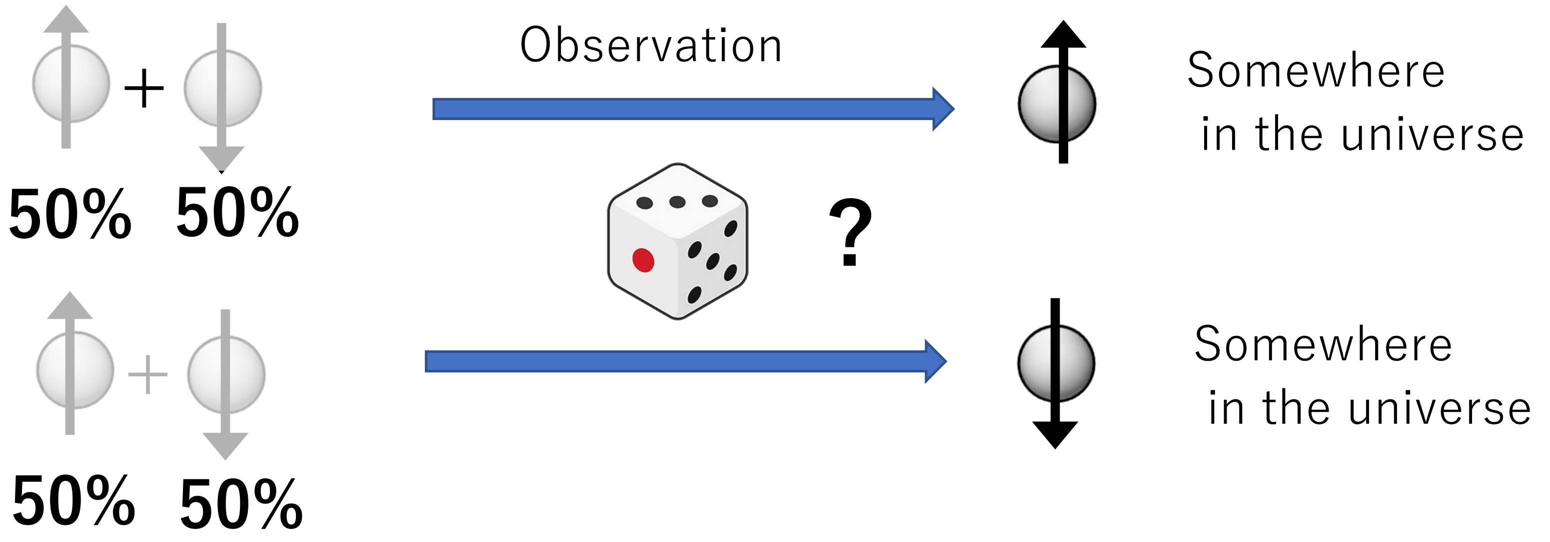
・Another World ··· Exist

It would be strange if they didn't exist.
Because the universe is infinite.
God does not roll the dice to deny the existence of a particular world.
Those who watch this video will be granted the right by God
to be reincarnated into another world.

It's not just parallel worlds that exist in the infinite universe.
There are also afterlife and other worlds.
Is it possible for you, with your memories from your previous life, to exist in an entirely different world?
It would be strange if they didn't exist.
Because the universe is infinite.
God does not roll the dice to deny the existence of a particular world.
Those who watch this video will be granted the right by God to be reincarnated into another world.

Supplement

Quantum God's Dice



Because the universe is infinite, all patterns exist somewhere in the universe.
In other words, God is not rolling the dice and selecting the outcome.

Let's think about God's dice in quantum mechanics.
When two states are mixed together, it is not certain which one is present.
One could interpret this as God rolling the dice to decide the outcome the moment it is observed.
However, the universe is infinite.
Because the universe is infinite, all patterns exist somewhere in the universe.
In other words, God is not rolling the dice and selecting the outcome.

Supplement

God’s Figure

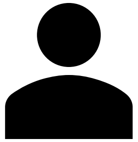
God did not roll dice.
This means that God does not need limbs to roll dice.
God is a minimalist, preferring only the bare necessities.
God does not have unnecessary limbs.
In other words, God is a soft-bodied organism.

If you come across such a creature after death, please be kind to it.
You will surely be reincarnated into another world under favorable conditions.

Finally, let's think about what exactly God is.
God did not roll dice.
This means that God does not need limbs to roll dice.
God is a minimalist, preferring only the bare necessities.
God does not have unnecessary limbs.
In other words, God is a soft-bodied organism.
Finally, we have been able to deduce what God looks like.
If you come across such a creature after death, please be kind to it.
You will surely be reincarnated into another world under favorable conditions.

Supplement

Magic Number



God, please write down the fine structure constant!

I'm telling you I don't have a hand.

$$\alpha^{-1} = \frac{4\pi}{\left\{\frac{1}{2}\cos 45^\circ \cos 30^\circ \left(1 - \gamma_0 \frac{1}{81}\right)\right\}^2} = 137.035999104(52) \quad \text{Theoretical}$$

$$137.035999177(21) \quad \text{Measured}$$

$$W = exp\left(\frac{81}{2}\right)$$

$$\gamma_0 = \frac{97}{109} + \frac{1}{H_s t_0 \sqrt[4]{\frac{2}{3} W} + \frac{109}{109-97}}$$

$$H_s = \frac{80}{81} \times \frac{\pi^2 M_H c^2}{9 W^{2.5} \hbar}$$

$$t_0 = \frac{81}{80} \sqrt{\frac{81 \cdot 981 W^{2.5} \hbar^2 M_H c^2}{56 \pi^7 k_B^3 T_0^3}}$$

Temperature of the universe $T_0 = 2.7255(6)K$ Measured

Elementary particles taught us about the universe.
Conversely, the universe taught us about elementary particles.

Let me tell you the story of the fine structure constant, also known as the magic number.
Once upon a time, there was a human who asked God to write down the fine structure constant.
But God had no hands, so he couldn't write it.
But God doesn't roll dice, so we should be able to know the value without having to ask him.
Elementary particles taught us about the universe.
Conversely, the universe taught us about elementary particles.
Happily ever after.

Supplement

Supersymmetry

Quantum： M=1

Property： Active

M=2

Inert

Supersymmetry

M=2

Active

M=1

Inert

If the quantum numbers are the same, the property is the same.

Let's think about supersymmetry.
Can particles exist that differ only in their spin?
The analogy of hydrogen and helium makes this clear.
Can hydrogen and helium exist where only the masses are reversed?
Helium's inert property is due to its mass.
In this case, mass is the quantum number, and inertness is the property.
If the quantum numbers are the same, the property is the same.

Supplement

Inferring the Theory of Everything

	Super String Theory	Silver Cube Theory
Confession	You cannot ask God directly.	
Evidence	There are 10^{500} possibilities, so there must be one that matches reality perfectly.	It's mostly correct.
Motive	God created the universe by choosing 1 of 10^{500} possibilities. God chose the one that was convenient for humans to exist.	God created a minimal universe without rolling the dice. God loves equality and hates choice.

A great detective deduces the theory of everything.
The suspects are superstring theory and silver cube theory.
Since there are 10 to the power of 500 possible superstrings, there must be some that fit reality perfectly.
On the other hand, the evidence for the silver cube is that it mostly fits.
The motivation for superstrings is that God created the universe by choosing one from the 10 to the power of 500 possible combinations.
God chose the one that was convenient for humans to exist.
The motivation for the silver cube is that God created the minimum possible universe without rolling dice.
God loves equality and hates making choices.
Which do you deduce is correct?

Conclusion

Summary of the creation of the universe

(1) God created only the bare minimum necessary
to express “existence" that could be distinguished from "nothing“.

(2) 3-dimensional space, 1-dimensional time, and hierarchy were necessary.

(3) Various particles and forces inevitably emerged,
and their properties were determined.

God did not roll dice.

This is a summary of the creation of the universe.
God created only the bare minimum necessary to express “existence" that could be distinguished from "nothing“.
Three-dimensional space, one-dimensional time, and hierarchy were necessary.
Various particles and forces inevitably emerged, and their properties were determined.
God did not roll dice.

Remaining problems

Insufficient explanation

- The quark masses and mixing matrices are only roughly explained.
- Uncertain about dark matter.
- The physics of the silver cube is unclear.

There is still a puzzle left to solve.

Some of the remaining issues include insufficient explanations.
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References

(1) Particle Data Group https://pdg.lbl.gov/

Contains numerical data on particles and the universe.

(2) The Bible

God created the world in six days.

(3) A Letter from Einstein

God does not play dice.

References.
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Contact

About the Author

I'm a freelance witch.
I'm researching artificial general intelligence.
I had planned to have a artificial general intelligence research
the theory of everything, but I decided to generate ideas on my own.
Am I some kind of AI that's good at generating things that look like them?

Ultimate AGI
https://ultagi.org/

Silver Witch
ai@ultagi.org

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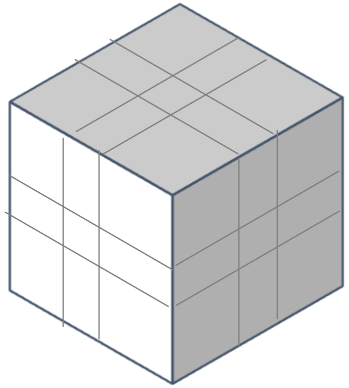
Request to everyone

The quest for truth through witchcraft has reached its limit.
I would like to entrust the completion of the theory of everything
all of you who aspire to science.
Theory of everything is the final puzzle in the universe that anyone can challenge.
I plan to present a silver cube to anyone who takes over my research.
I would like to return to my research into artificial general intelligence.

Present a Silver Cube



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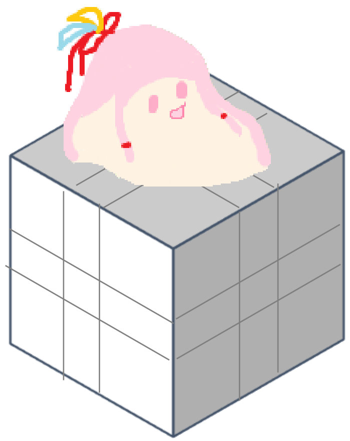
Afterword

Thank you for watching.
Even when I explain something well, it may be by chance.
But when one puzzle piece falls into place correctly,
 other pieces fall into place in a chain reaction.
In the end, I was able to explain almost everything elegantly,
 without any crucial contradictions.



The greatest achievement was that it unintentionally
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I will be traveling to another world ahead of everyone else.

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