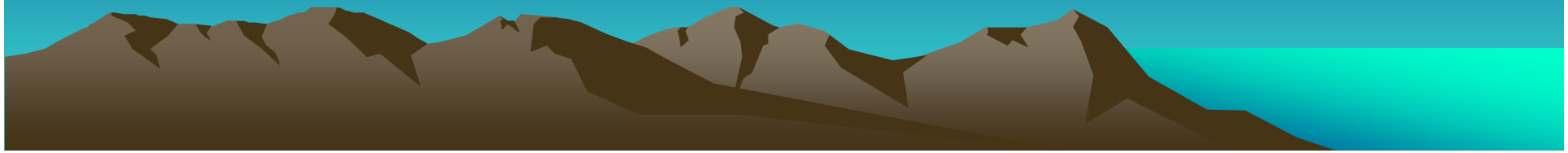
“A Workshop on Using Space for Teaching”

（SEEC）

JAXA
宇宙航空研究開発機構
Japan Aerospace Exploration Agency

Let’s think in terms of making a top

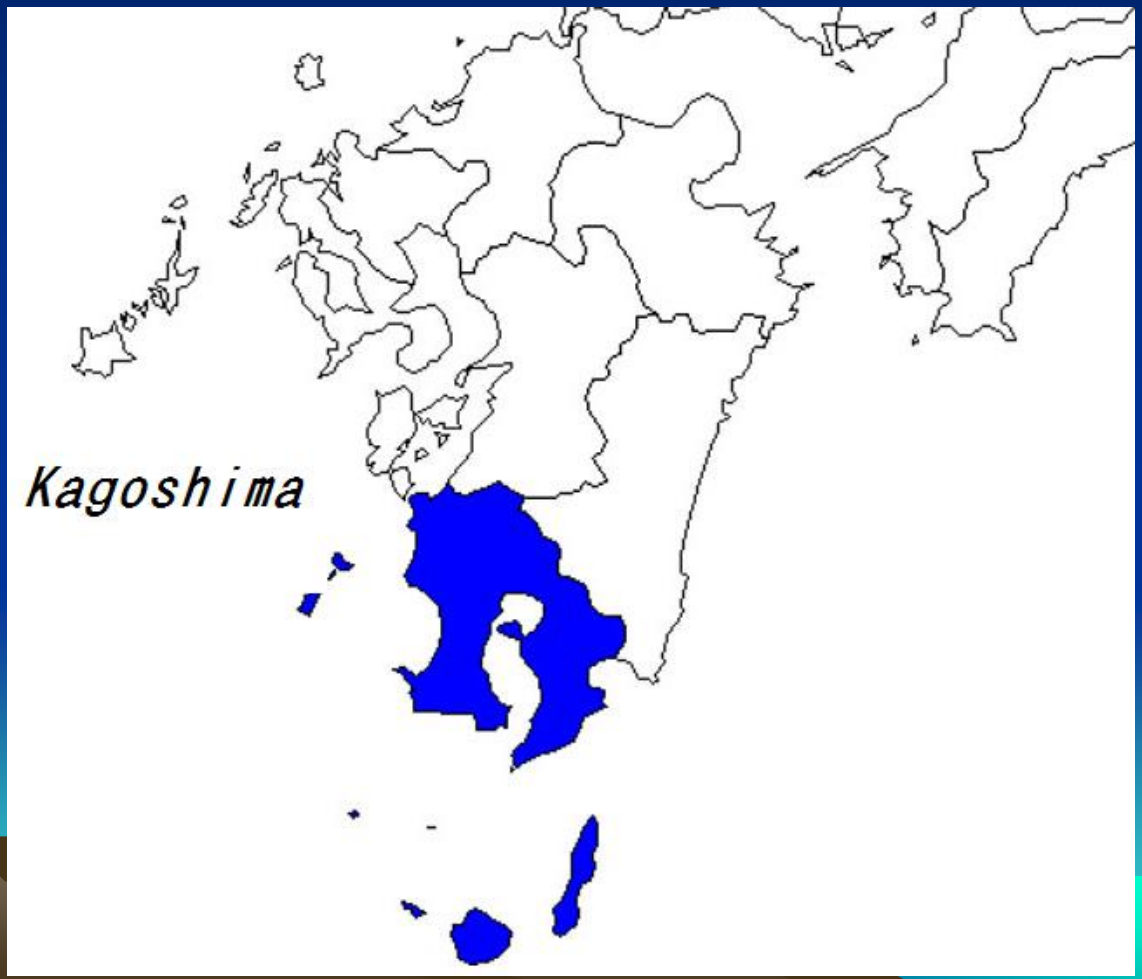


Self introduction

I am from Kagoshima in Japan.

Self introduction

Kagoshima is a very attractive place.




おみくじ
おみくじ

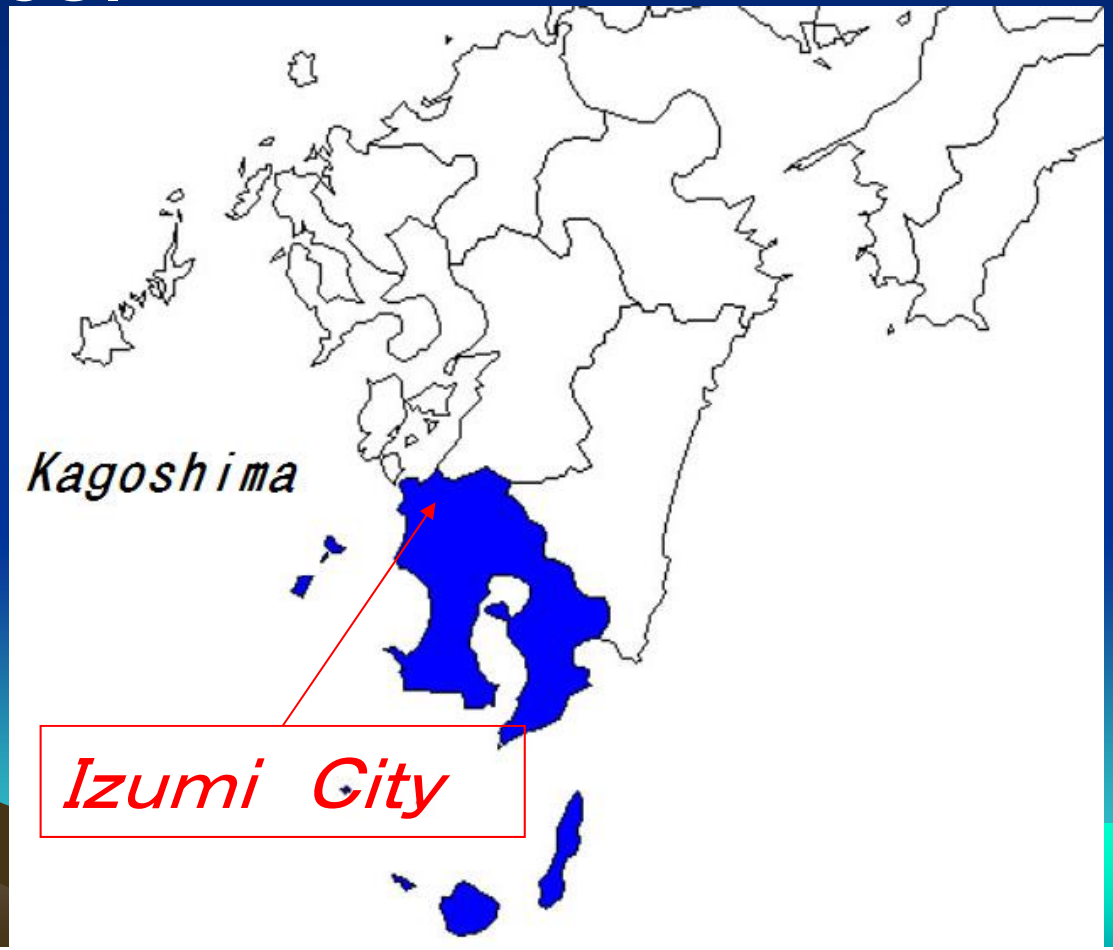
One of them is Sakurajima.

Sakurajima

Sakurajima is a mountain that symbolizes the Kagoshima city, and it is an active volcano that still continues to erupt.
It is only 2 km. from Kagoshima!

Self introduction

There are two rocket launching sites in Kagoshima, and it's the closest location to space.



A video of Noguchi-san, and an illustration movie on figure skating will be attached.

Self introduction

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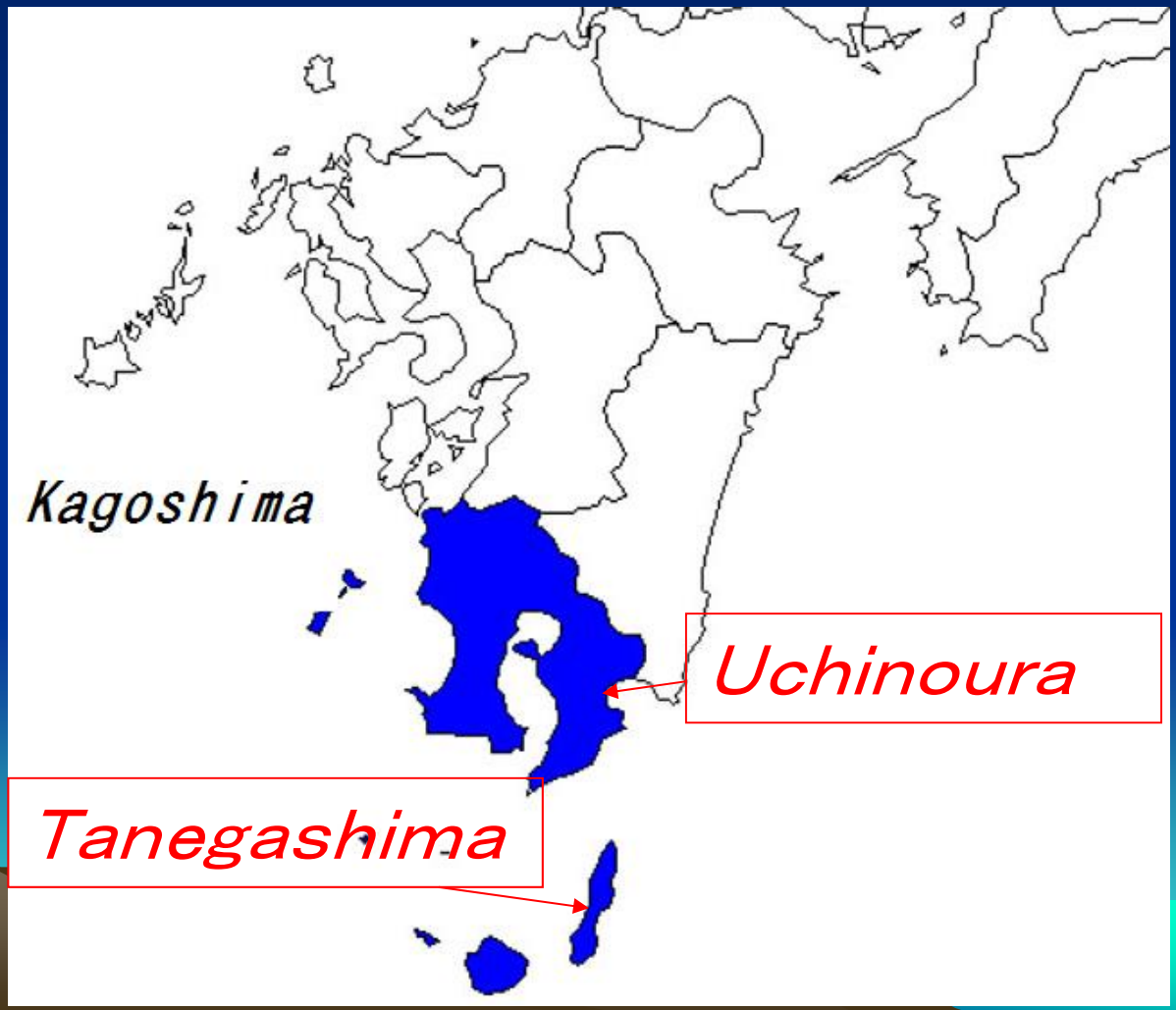
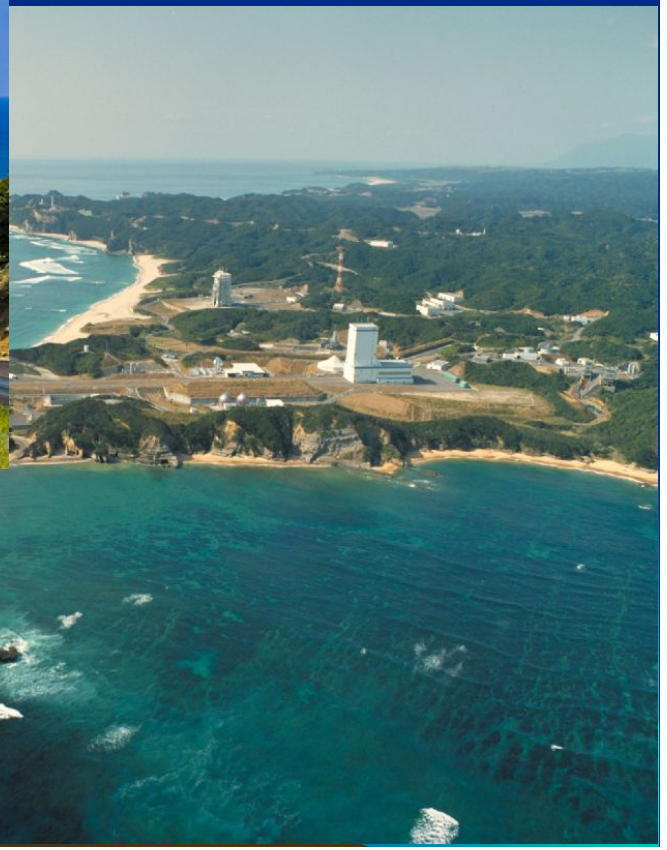


Tanegashima rocket launching site



Uchinoura rocket launching site

A typical artificial satellite launched from Uchinoura

In space where there is no force of gravity,

even actions like changing one's posture, or trying to face a desired direction are difficult to perform.

To change orientation in space either a small rocket (Thruster) is used, or the rotation of a top is put to use.

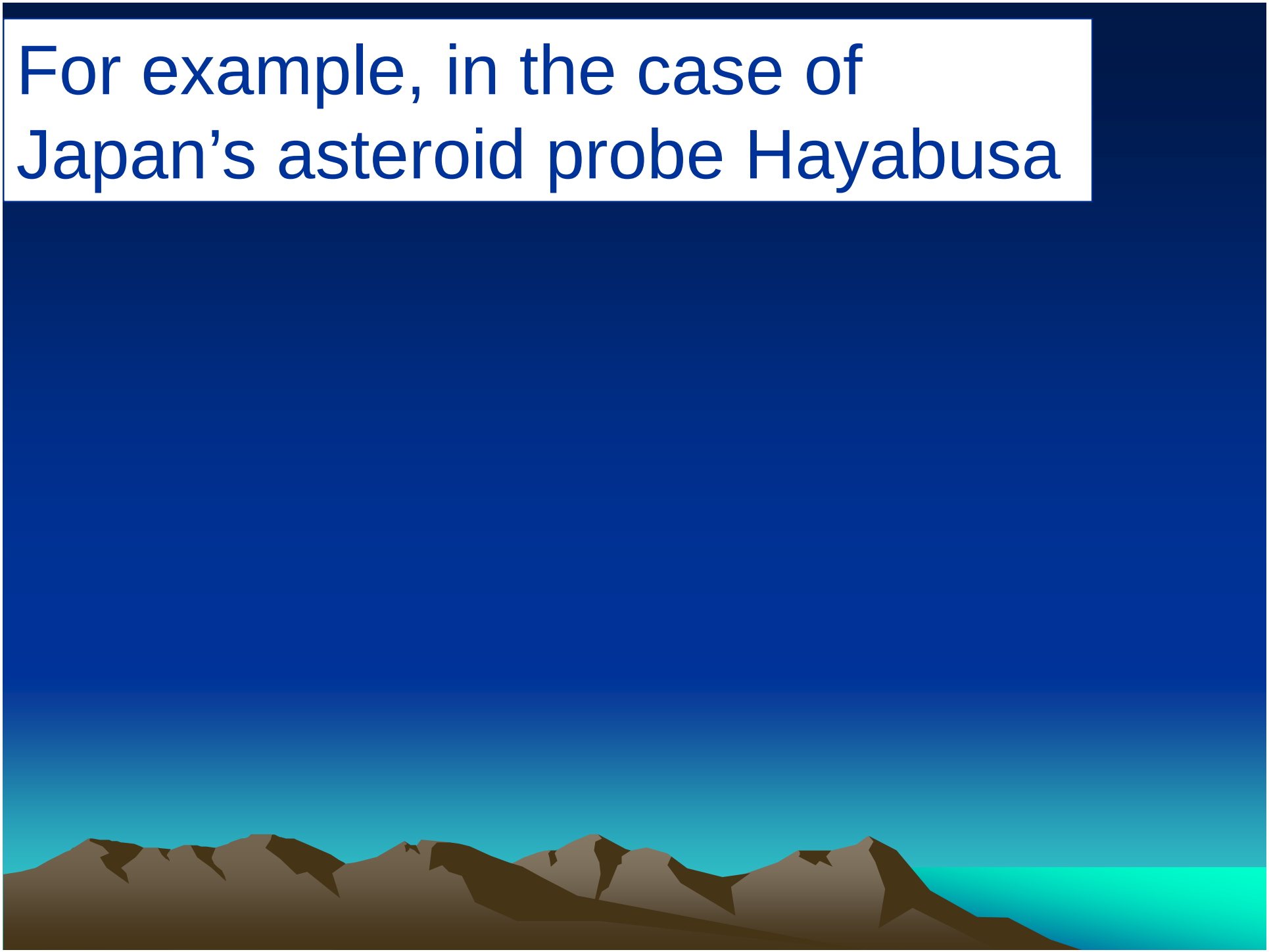
Control in space where there is no gravitational force

However, because a large amount of movement takes place, there are times when making slight movements are difficult.

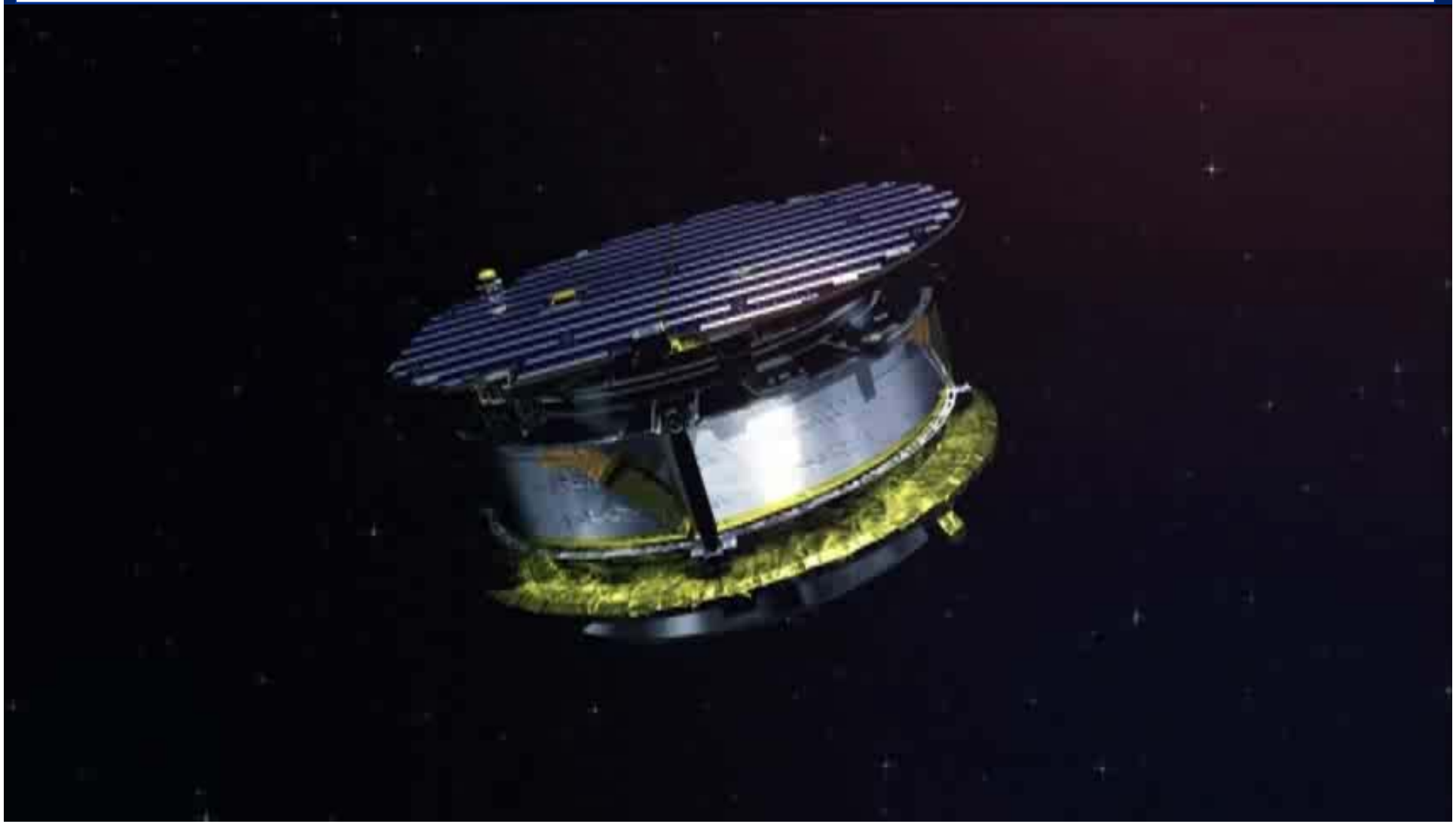
Thus, the principle of a very fast rotating top is used.

As the top rotates, it stands upright at a small point, and rotates in a stable manner. This is called the gyro effect.

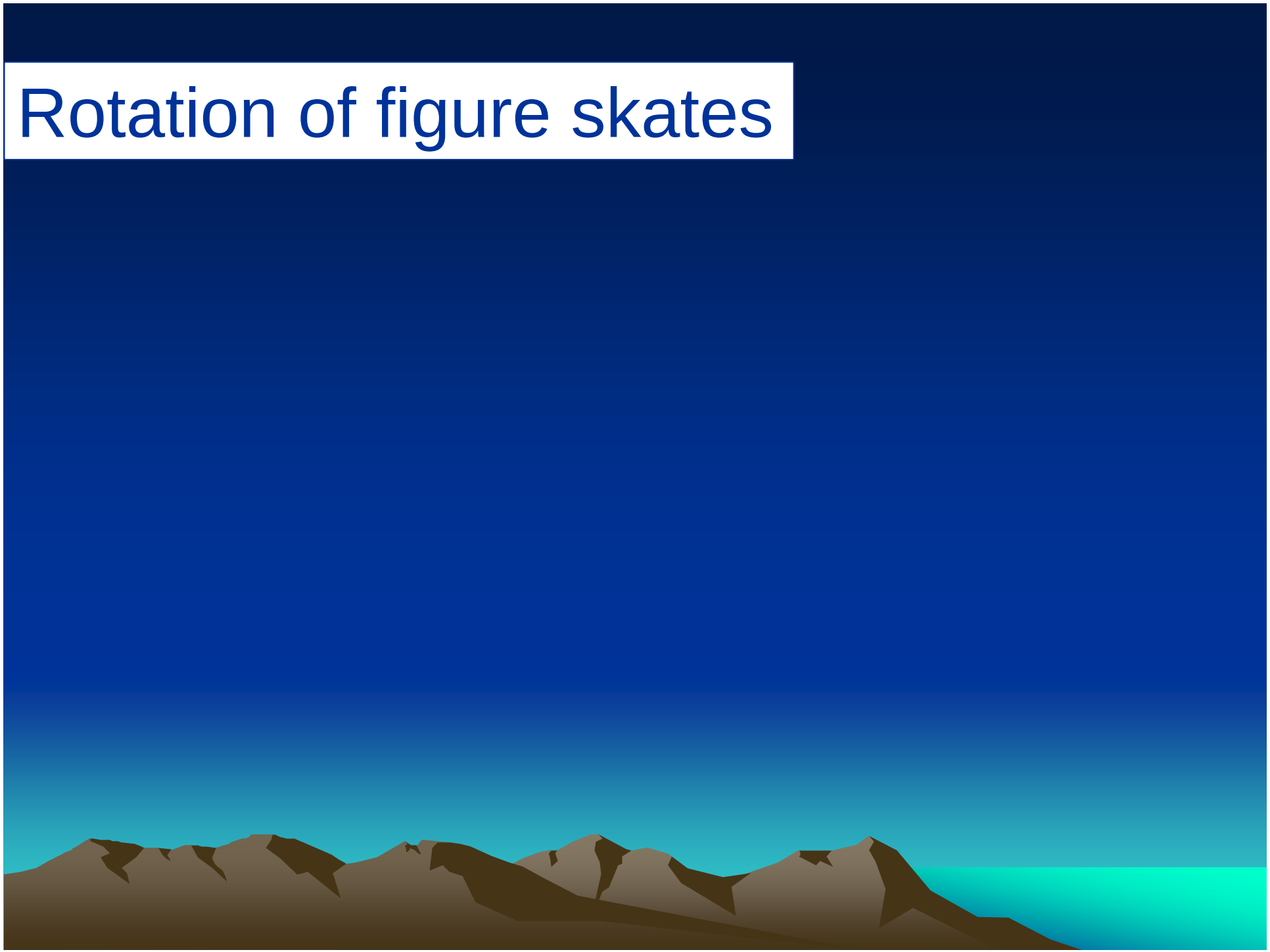
For example, in the case of Japan’s asteroid probe Hayabusa



Furthermore, in the case of IKAROS, rotation was used for controlling the orientation and for drawing out a wide sail.

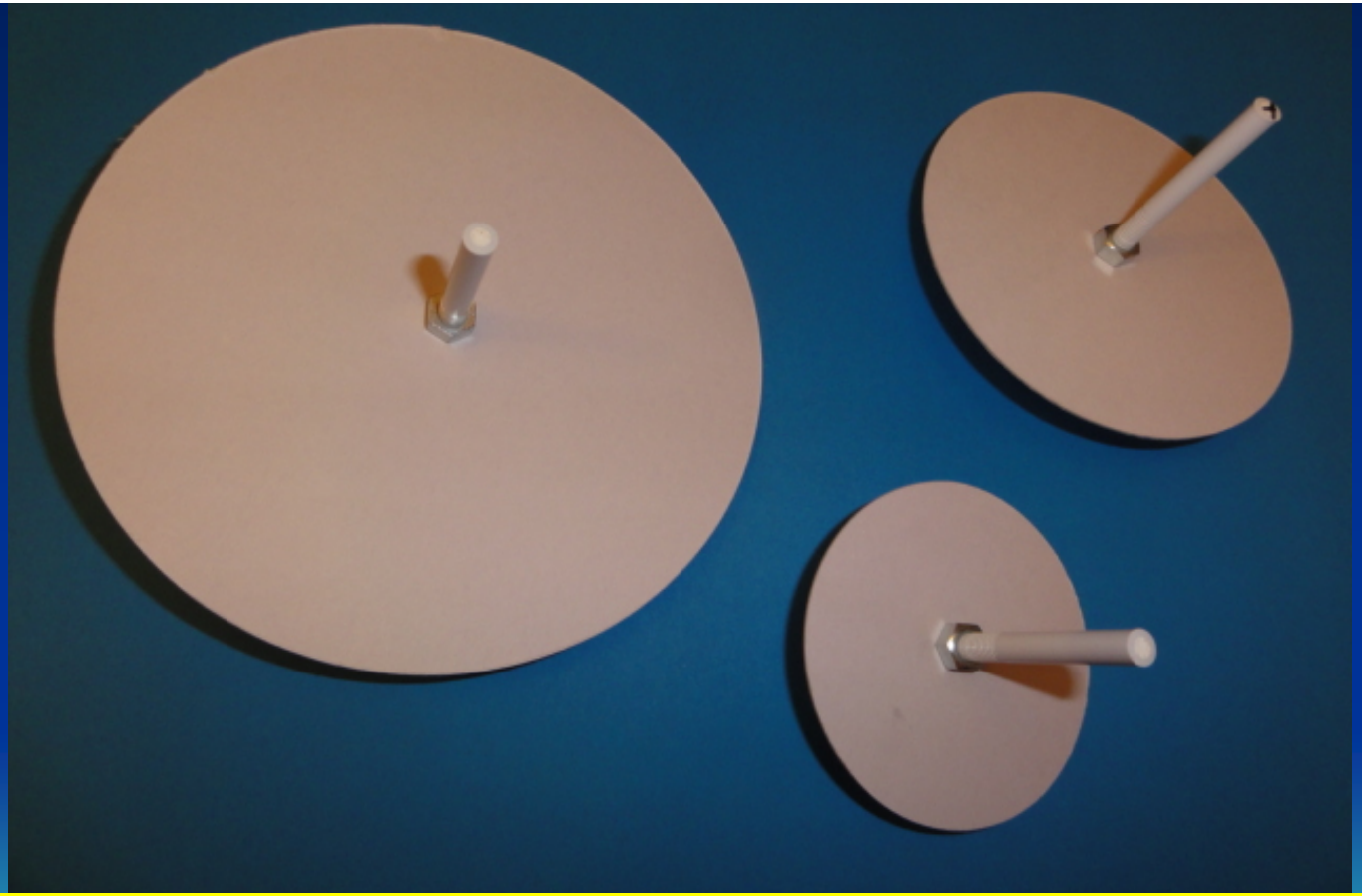


Rotation of figure skates



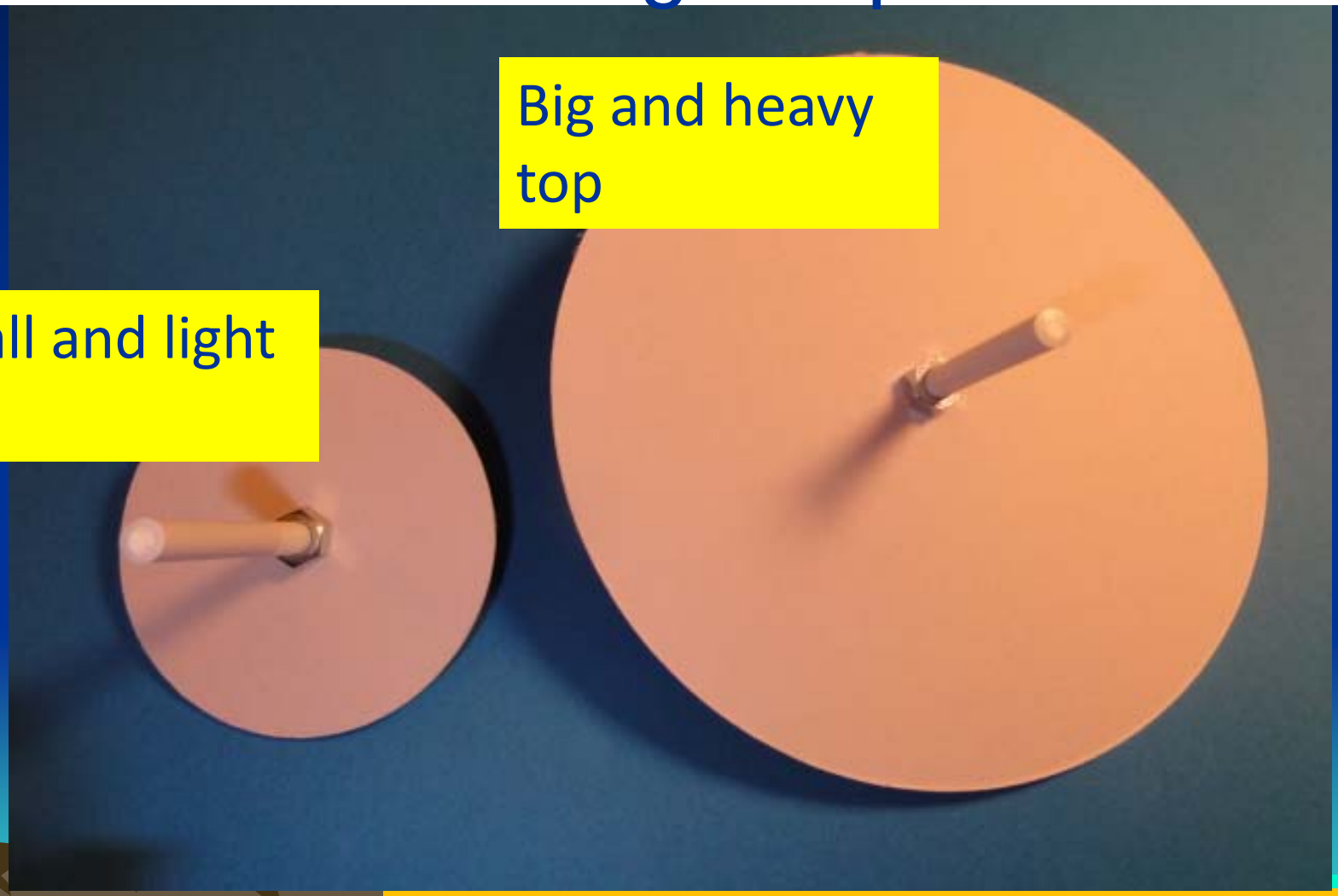
Rotation of figure skates

Which top do you think will rotate well?



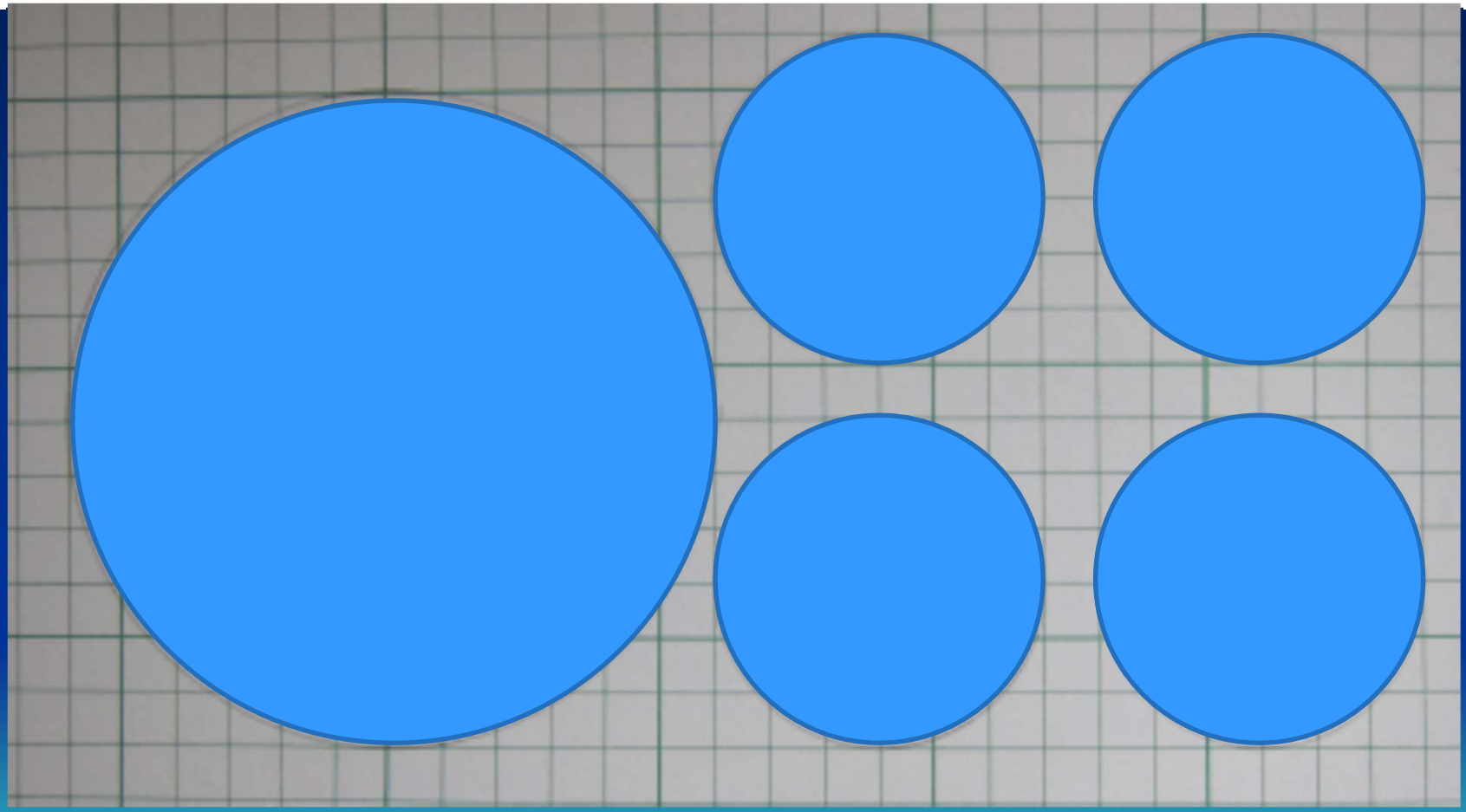
Let’s try out different cases such as size, weight, etc.

A big and heavy top and a small and light top



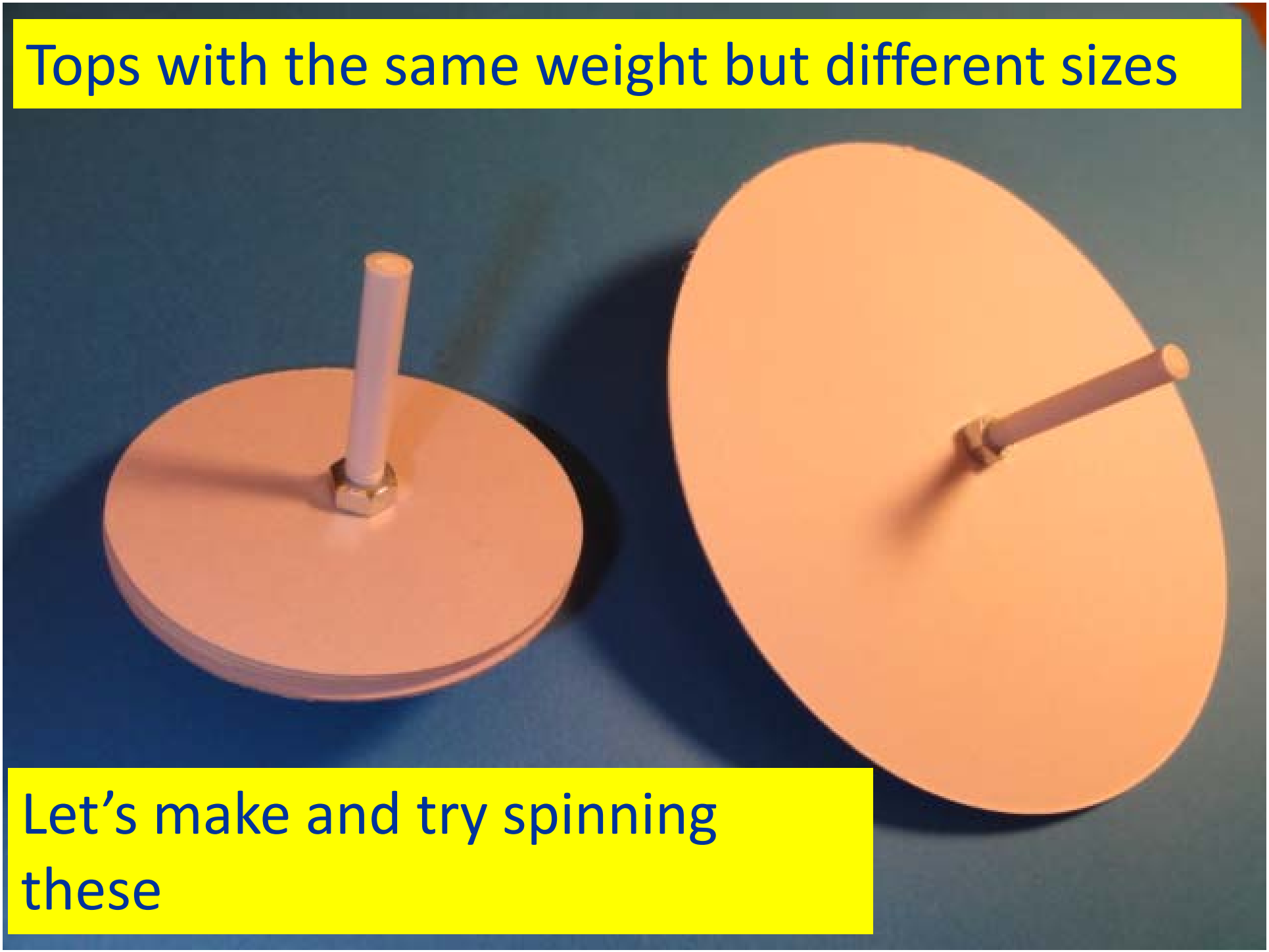
Which top will rotate for a longer time?

Tops having the same weight but different sizes

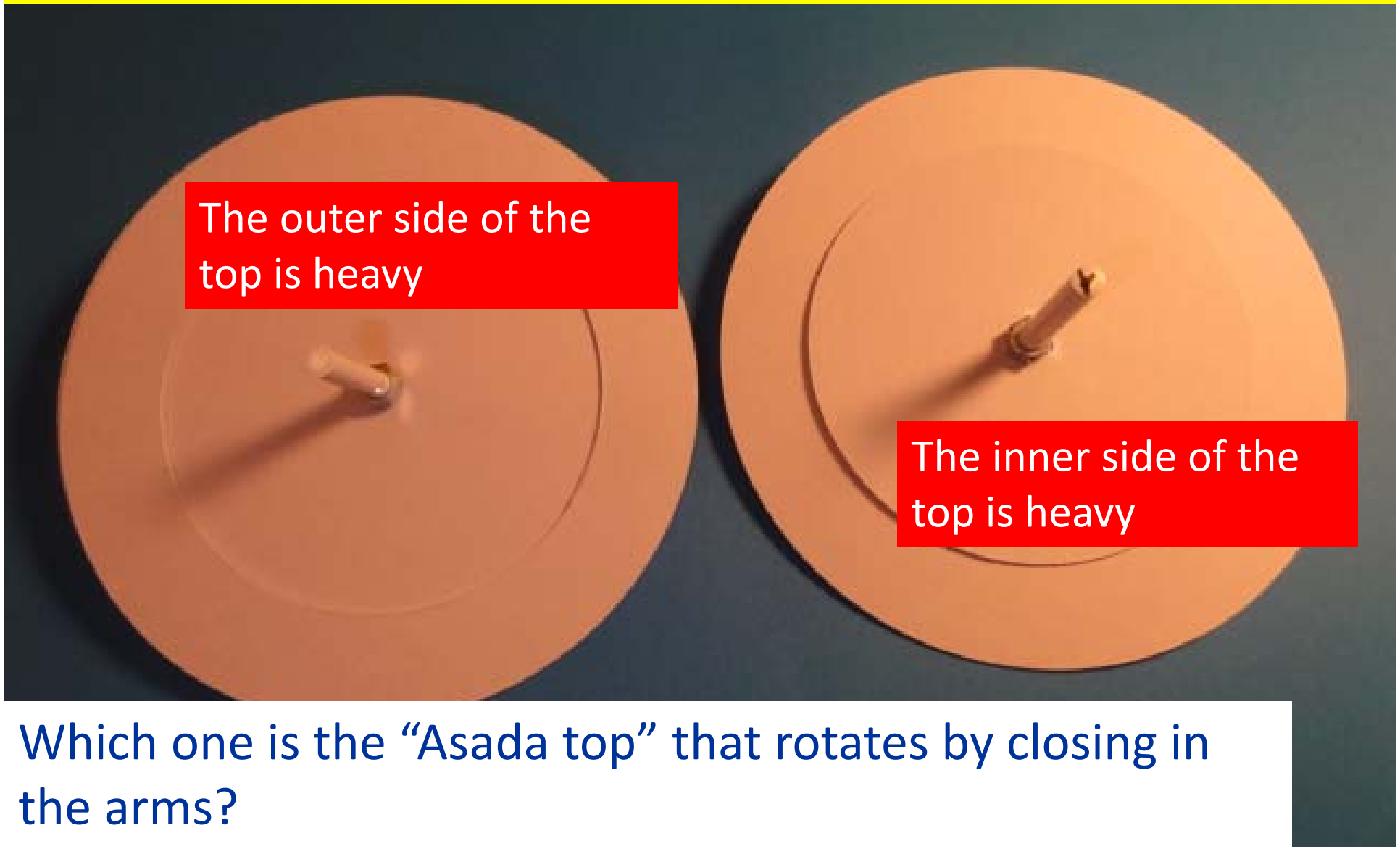


Make one circle of 6cm radius with a compass

Make four small circles of 3cm radius with a compass


Tops with the same weight but different sizes
Let’s make and try spinning these

Make two tops having the same size and the same weight



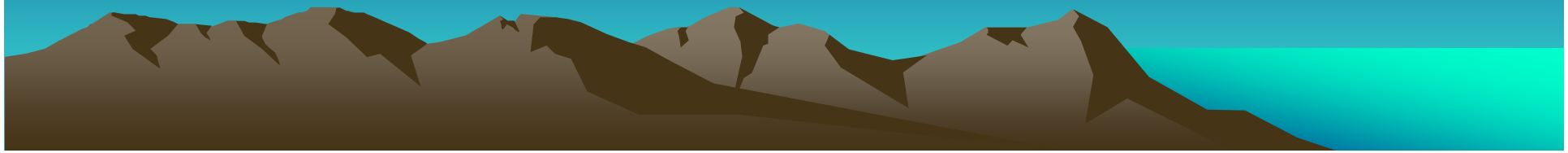
Which one is the “Asada top” that rotates by closing in the arms?

Gyro effect used in space

This is gyro

There are several examples of this around us too!

Let’s all look for them together!



Slide 1	Good morning everyone! My name is Shoichiro Arimizu. I am an elementary school teacher in Japan!
Slide 2	I have come from Japan so that today we all can have some fun making spinning tops and playing with them!
Slide 3	This is what Japan looks like. It is a beautiful country surrounded by sea, which separates it from other countries. I live in the Kagoshima prefecture, which is right here.
Slide 4	If you take a closer look, this is what it looks like. Don't you think it has a very interesting shape? Kagoshima consists of two large peninsulas and around 600 large and small islands. The islands stretch over a span of 600 km from North to South.
Slide 5	This is the shrine from where Kagoshima got its name. It's called "Kagoshima-Jingu." It pays homage to the Gods who created Japan. There are several such buildings still seen in Kagoshima that give a feel of Japan.

Slide 6	The Yaku island, which is considered a World's natural heritage, and Sakurajima, which is a magnificent volcano, are located in Kagoshima. Also, the Amami islands called the Eastern Galapagos are also located here. Nature is bountiful here. These are just a few of the many photographs of the island… (I will add more photographs)
Slide 7	Now, I will introduce to you Izumi, the city where I live. Izumi is located in the North part of the Kagoshima prefecture. It is situated at the border between prefectures, therefore, several historical buildings can still be seen here.
Slide 8	These are cranes. Of the cranes immigrating to Japan, the largest number of them can be seen in Izumi. This year more than 12,000 birds have flown in from faraway places like China and Siberia. At the end of February, these birds will fly back to China and Siberia.

Slide 9	This is the elementary school where I teach. It is a very old elementary school founded 129 years ago. Don't you think the children are so cute!
Slide 10	Let's go back to Kagoshima! While Kagoshima is bountiful, it is very close to space. This is because there are two launching sites here.
Slide 11	This is Tanegashima's space base. The launching site is surrounded by the sea, and it is said to be the most beautiful launching site in the world.
Slide 12	And this is the launching site in Uchinoura. This launching site can launch small to mid size rockets. The rocket shown in the picture here is the M-V.
Slide 13	The historical artificial satellite "Hayabusa" was launched from here. As you may be aware, Hayabusa is an artificial satellite that brought back stellar fragments from the asteroids. Now, let's proceed to the main subject.
Slide 14	In space where there is no force of gravity, maintaining or changing one's posture is extremely difficult.

	In order to maintain one's posture or change the direction, a small rocket called a Thruster, and the rotation of spinning tops is used in satellites.
Slide 15	This is a famous Japanese robot character… Many such small rockets are attached to its back. Frankly speaking, many small rockets have been attached unnecessarily, and I am not so sure from where the fuel is loaded…
Slide 16	However, if the thrusters are used, there is a large amount of movement, and as a result, there are times when it is unsuitable such as when only a slight change in the direction is desired.
Slide 17	Thus, a very fast rotating top is used. When a top is rotated, it stands upright at a small point and rotates in a stable manner. This is called the "Gyro effect."
Slide 18	This is the gyro that was installed inside Hayabusa. This is how it rotates and changes the direction.
Slide 19	Next, see the case of IKAROS. When the posture of several artificial satellites is to be controlled as shown in the photograph, the rotating force is used.

	This is exactly like in the case of figure skating. Speaking of figure skating...
Slide 20	Did anyone notice anything? That's right! If the wings are spread, the rotation becomes slower. The same thing can be seen during the rotation of a figure skater.
Slide 21	It's the same in space as well. In an experiment performed by an astronaut, a triple axel, which cannot be seen on the ground, can be seen!
Slide 22	So let's check the differences in rotation by changing size and weight of actual tops!
Slide 23	Let me quickly tell you that this is just a toy! How one rotates it will also differ from person to person, and it is not necessarily the same for everyone. First of all, let's prepare and rotate a big and heavy top and a small and light top! Which top will rotate for a longer time? We saw that the big and heavy top rotated slowly for a longer time! However, what will happen if the weight is the same, but the size is different? How many think that the bigger one will rotate better?
Slide 24	Make one circle having a 12cm diameter and 4 small circles having a 6cm diameter. This will enable you to make circles having the same weight. In order to understand the difference in rotation, please try it out for yourself!

Slide 25	Which one will rotate slower? And which one will rotate longer? Congratulations to those who guessed this right! On the ground, the same thing can be seen in the case of figure skating. The same thing occurs in space as well. The rotation varies simply by spreading out or closing in ones arms.
Slide 26	Alright then, here is a quiz! If the size is kept the same, but the distribution of weight is varied, what kind of difference would be seen? Which top will rotate easily? Also, which top will rotate slower and which will rotate longer?
Slide 27	As I said in the beginning, gyro is used in space. However, there are several examples of its use around us too!
Slide 28	We all must definitely look for those. For example, this toy can also be made. It can be made very easily, and if you throw it like you would throw a football, you can make it fly higher than I can!
Slide 29	