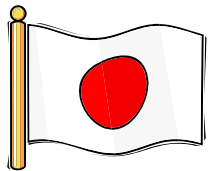


Let's make an original and  
beautiful **flower** shape to  
learn the principle of  
**retroreflectors**

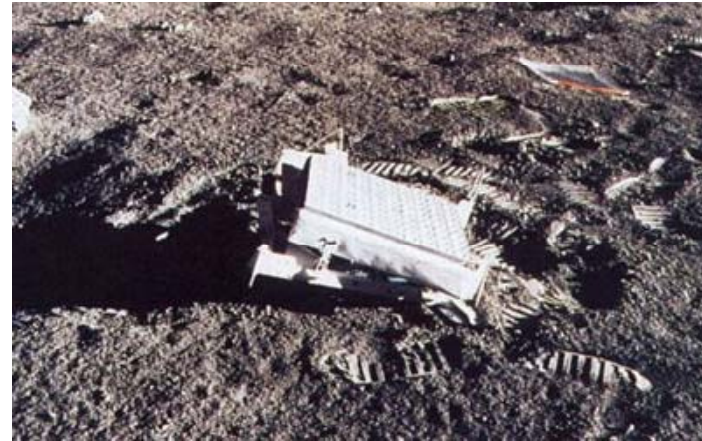


Toshihiko Mikami, Japan

青森市立造道中学校

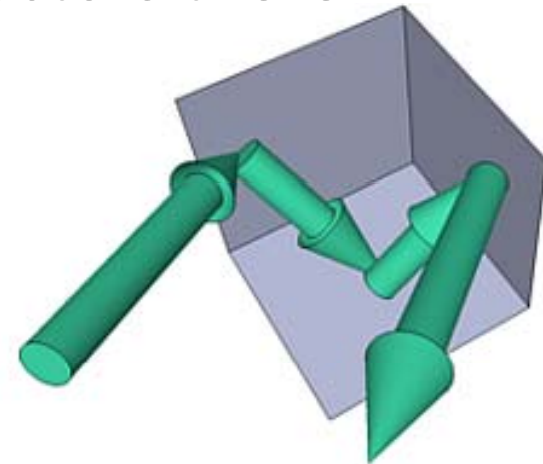
三上敏彦

# What's a **retroreflector** ?



An Apollo mission set these retroreflectors there .

Mirrors set at  $90^\circ$  can **return** laser beams to the Earth in order to measure the **distance**.



Can we explain this principle **simply**?



This reflection seems complicated.



**Monkiri Asobi**, the art of cutting *origami*, is the solution.



I found it works at angles that are not only  $90^\circ$ .

What's *Monkiri Asobi*?

Let's **make**



**Don't begin until I**  
**say to start because**  
**you need to know**  
**how to make it first.**

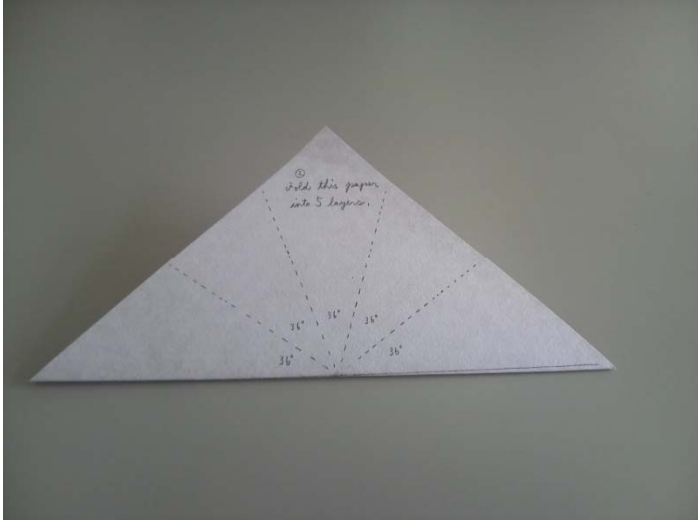
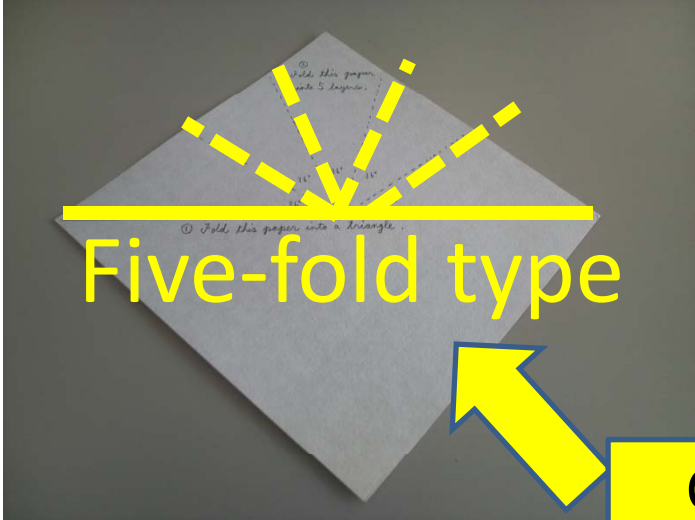
# The Finished Product!



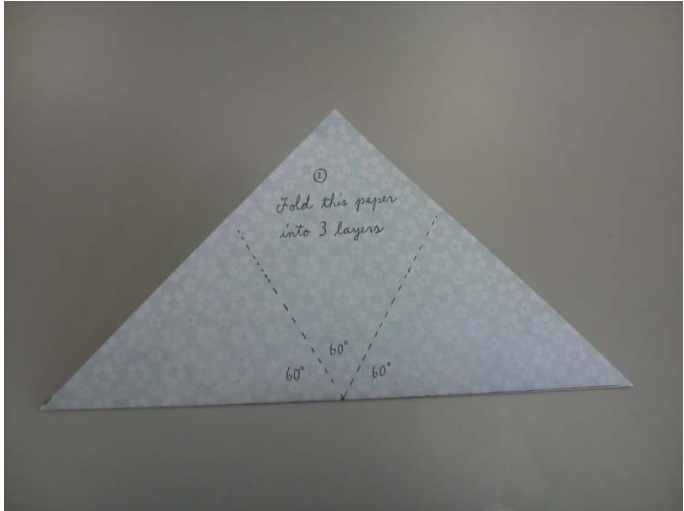
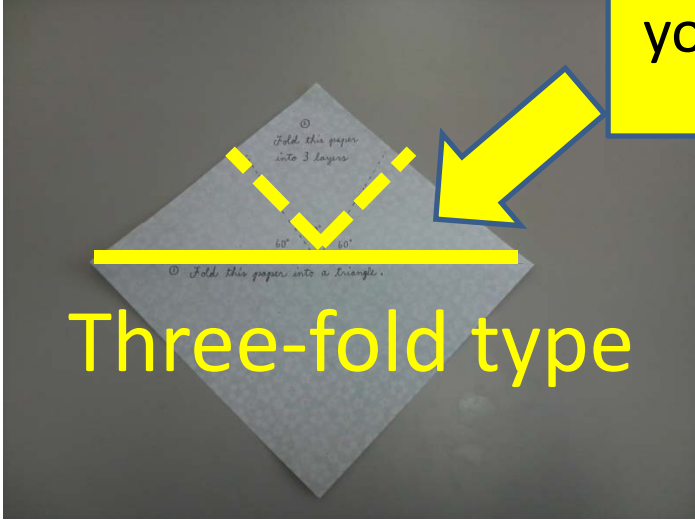
Paste them on an *uchiwa* ( fan ).

You can take the *uchiwa* home.

# Fold a piece of paper into a triangle.

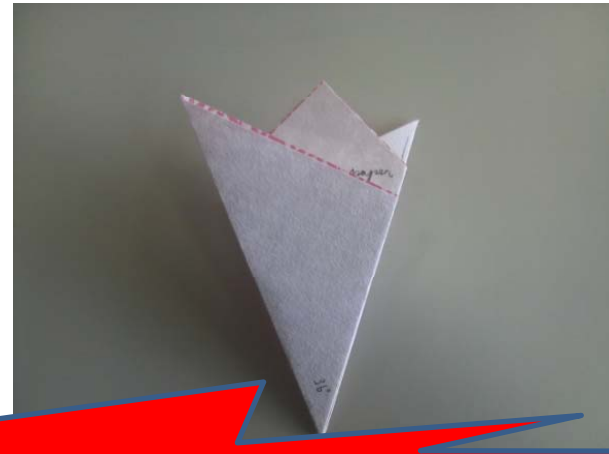
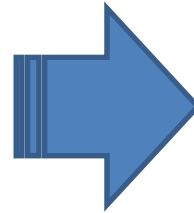
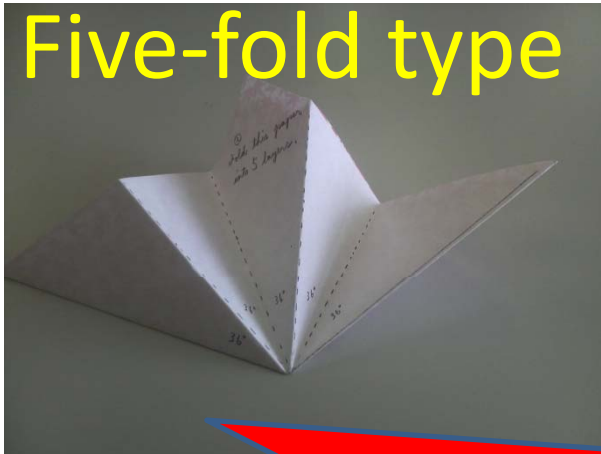


Choose whichever you prefer.



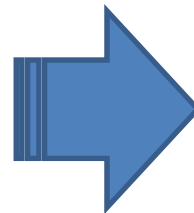
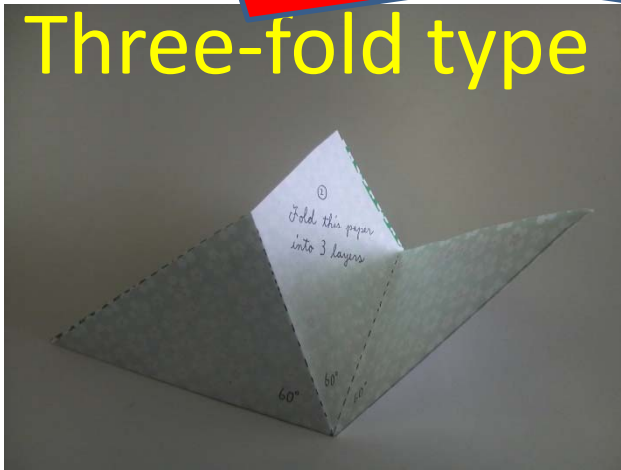
# Fold it along the perforated lines.

## Five-fold type

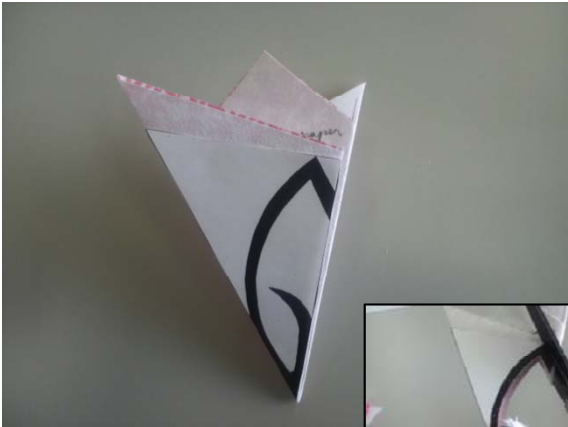
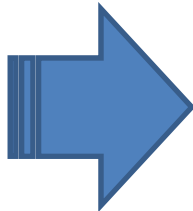
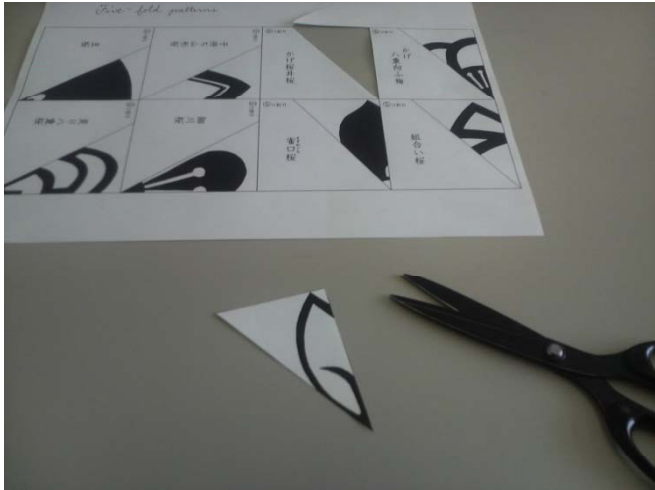


**Fold like an accordion .**

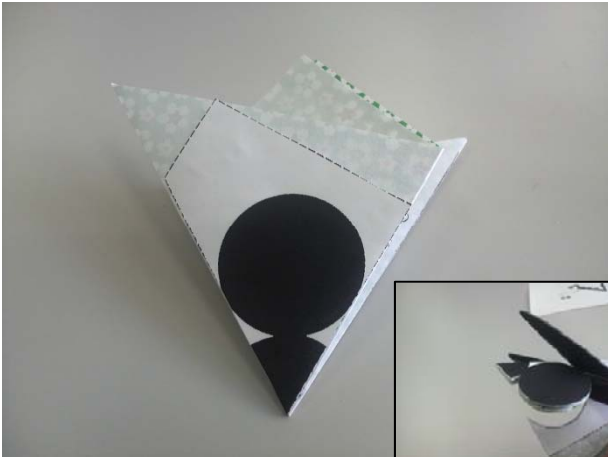
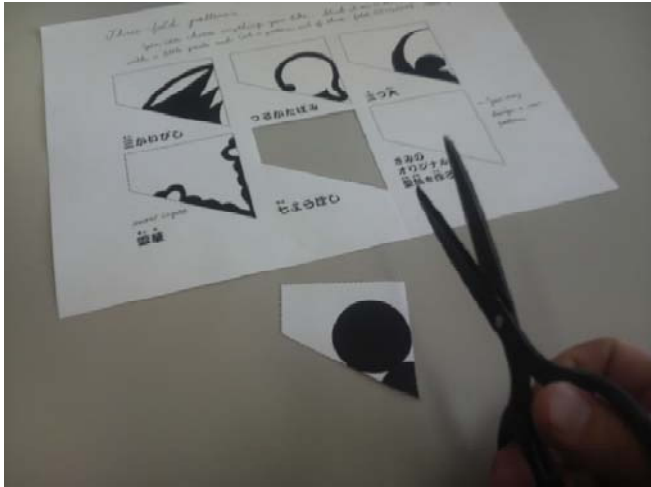
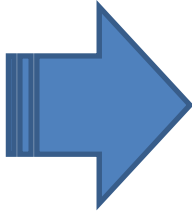
## Three-fold type



Choose a pattern, paste it, and cut it out.



A little  
paste





# Open it.

It's important to choose a pattern.



# Make an *uchiwa*(a Japanese fan)!



Set newspapers  
in a cardboard box.



Spray paste on the back of  
the Monkiri and fix it to  
the white paper.

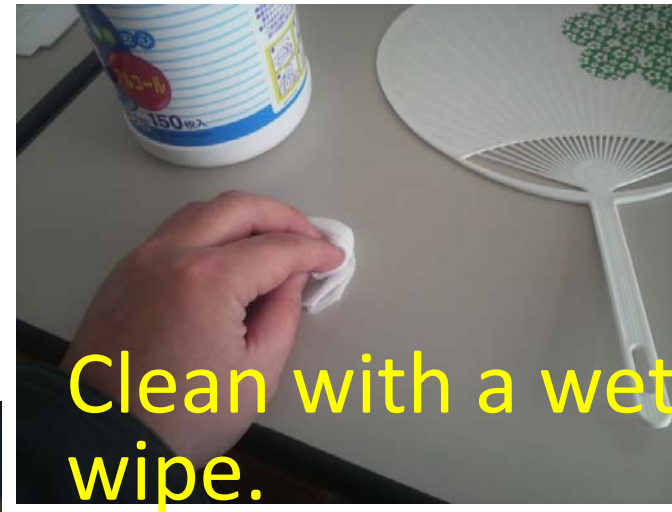


Spray paste on the frame  
and paste it .



# If you have finished ...

You can make one more flower pattern and paste it.



Let's make an original and beautiful flower shape to learn the principle of retroreflectors.

Choose the best beautiful shape  
for you!

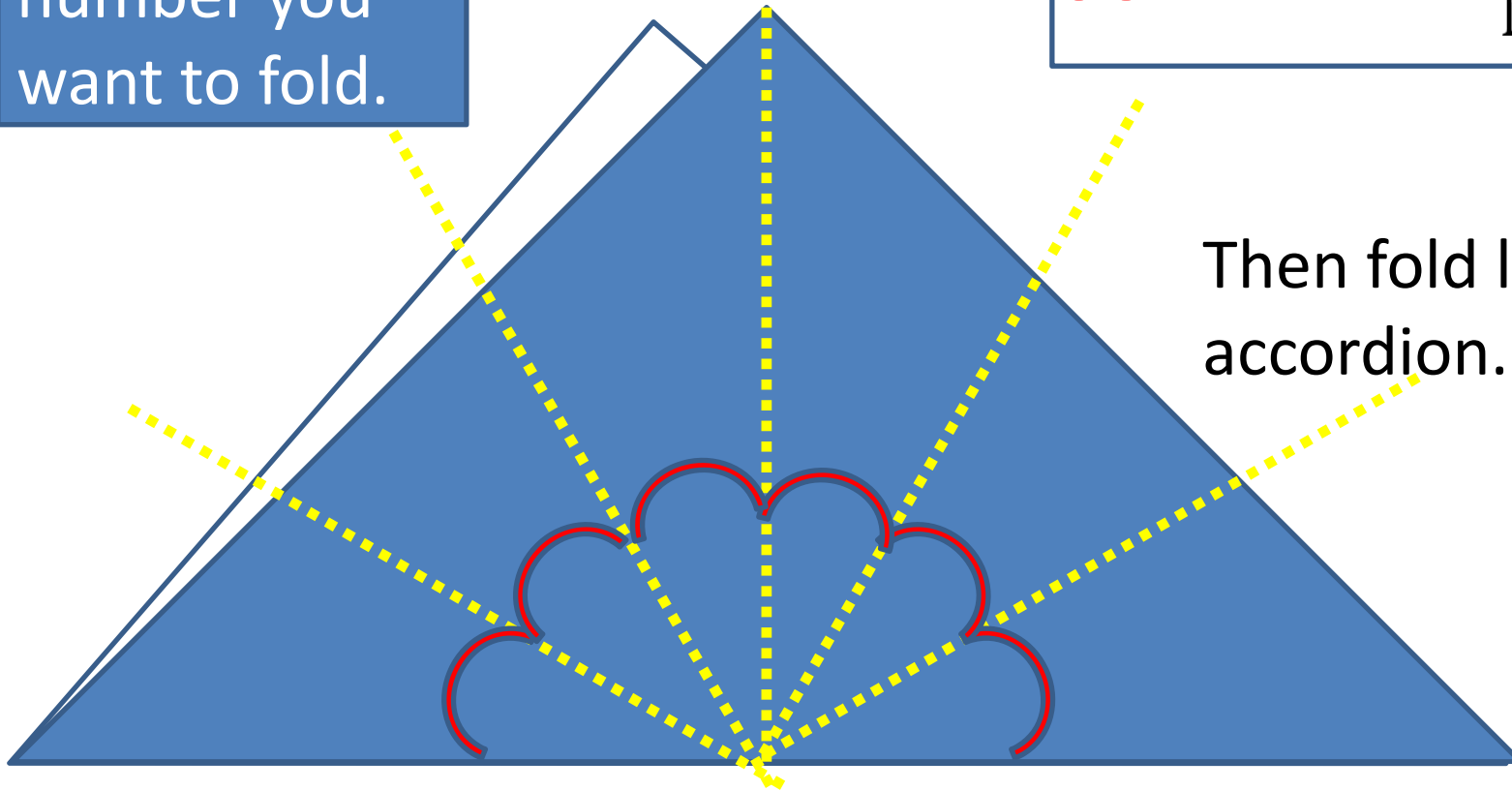
✂ When you have decided,  
you can begin to make it.

# If you want to make six-fold flowers...

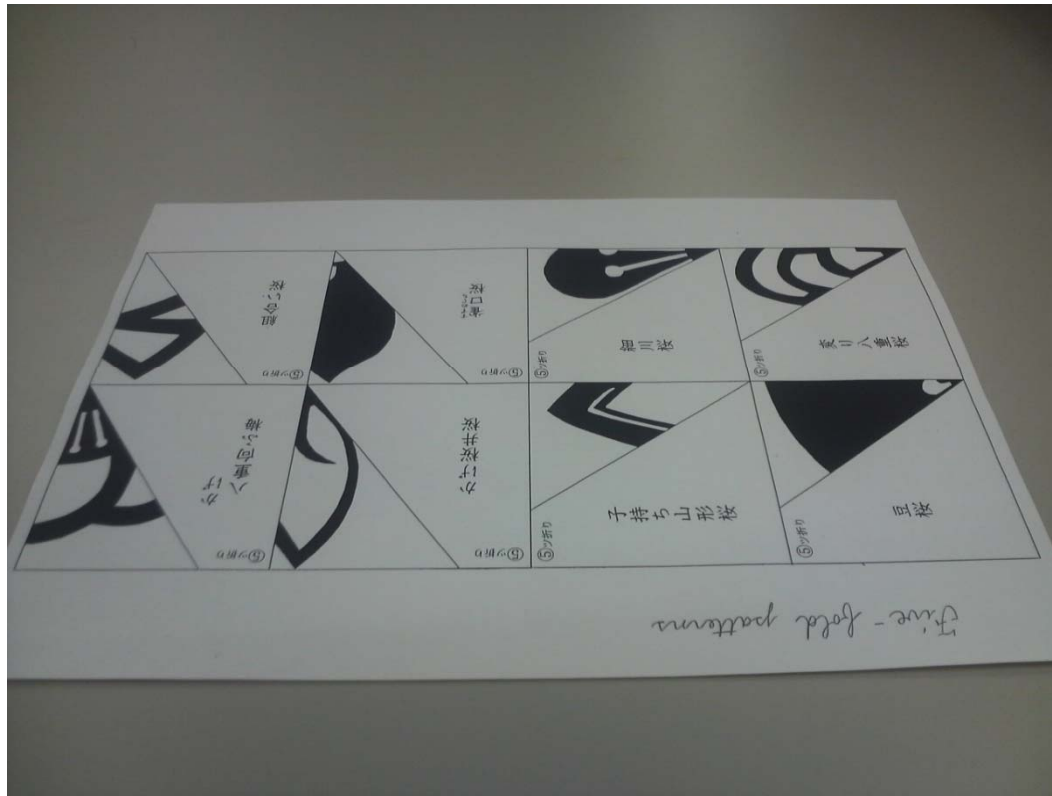
N is the  
number you  
want to fold.

$$X^\circ = \frac{180^\circ}{N}$$

Then fold like an  
accordion.



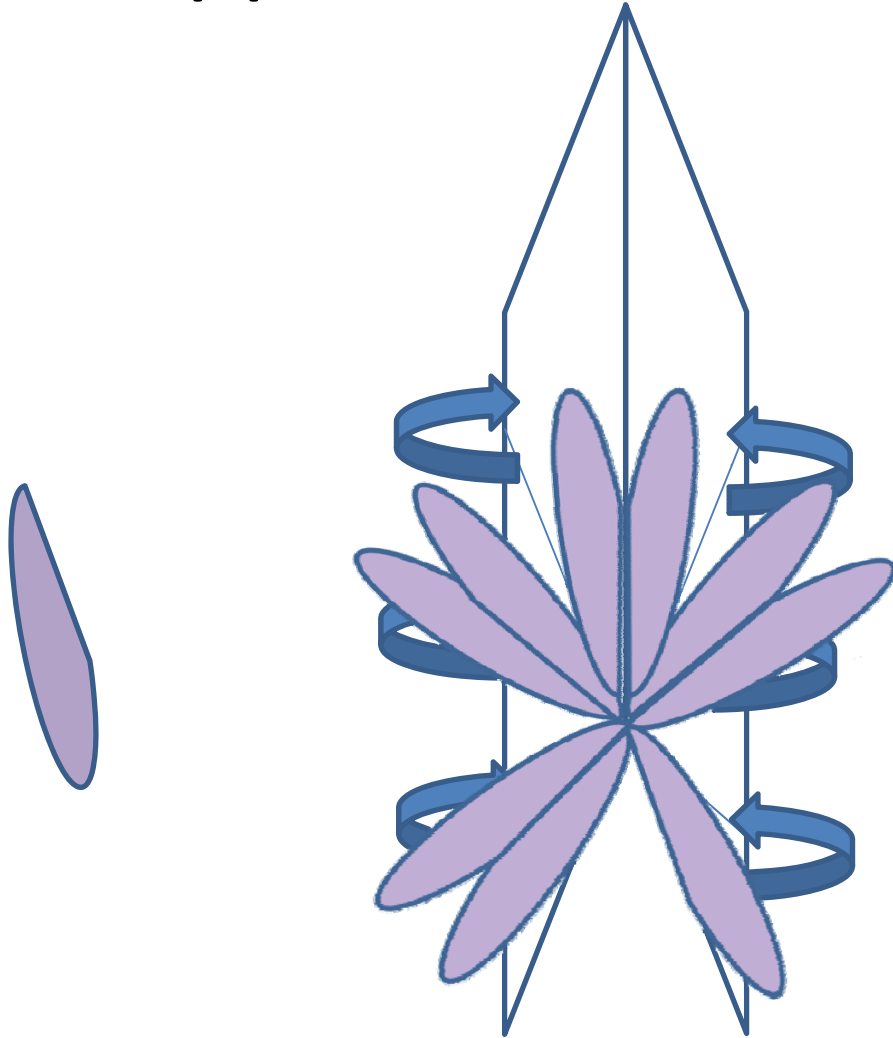
How do you know the shape  
before you cut it out?



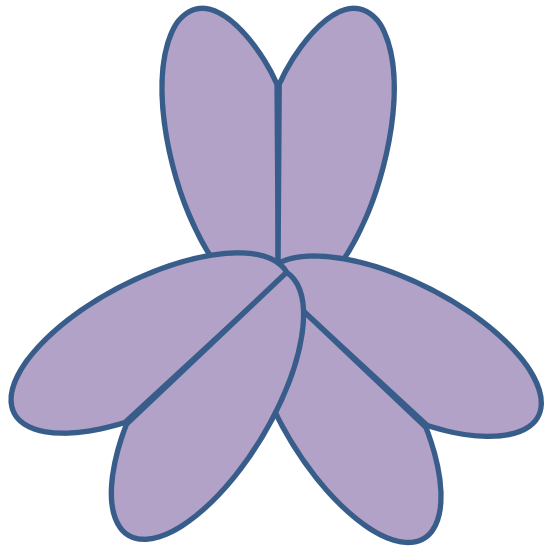
Use double  
mirrors

Let's try!

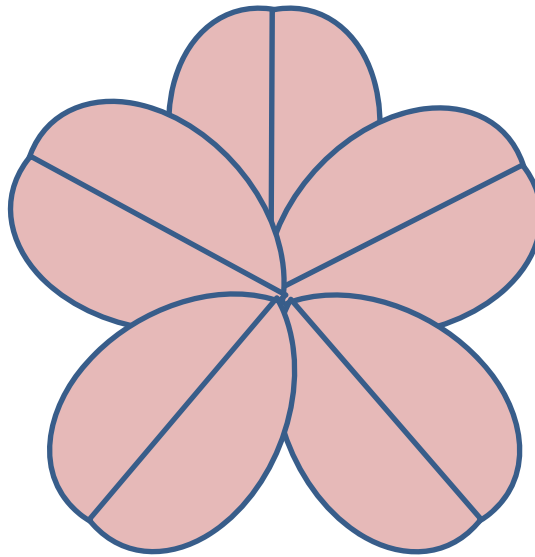
The double mirrors repeat the  
opposite of the opposite.



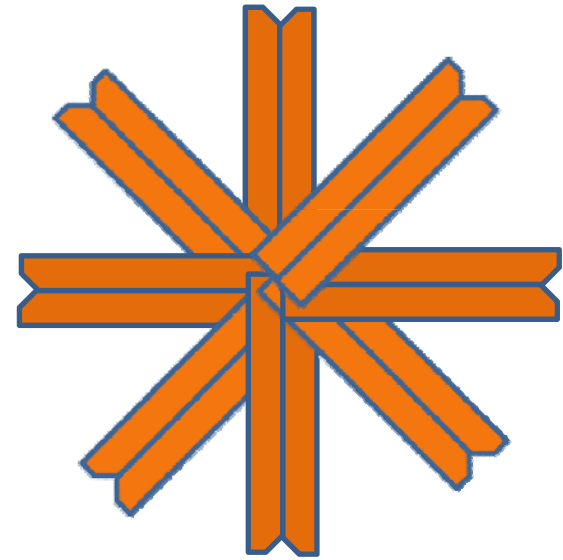
That is why flowers are beautiful .



A spiderwort



A cherry blossom



A cosmos



**You can make an original shape.**

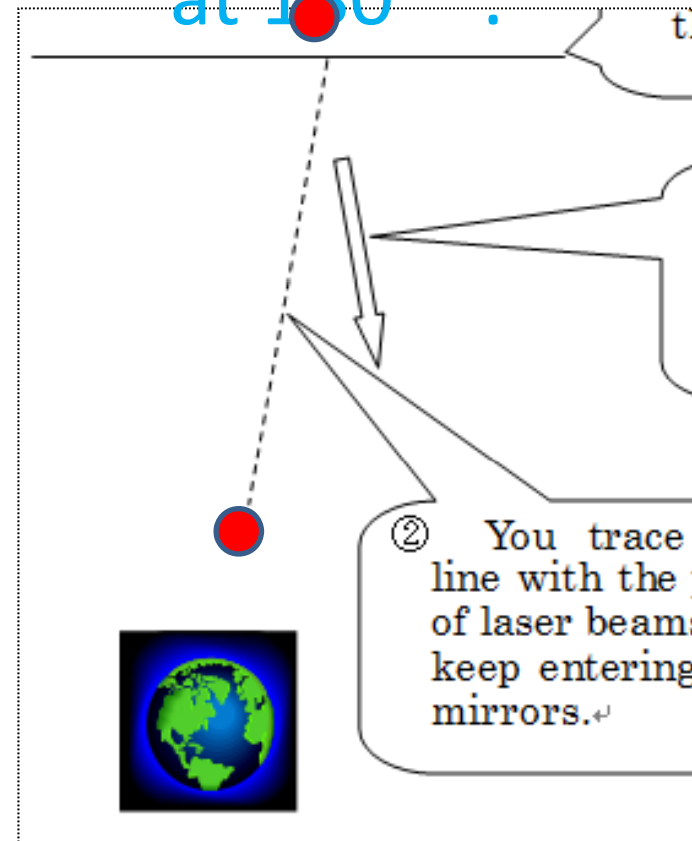
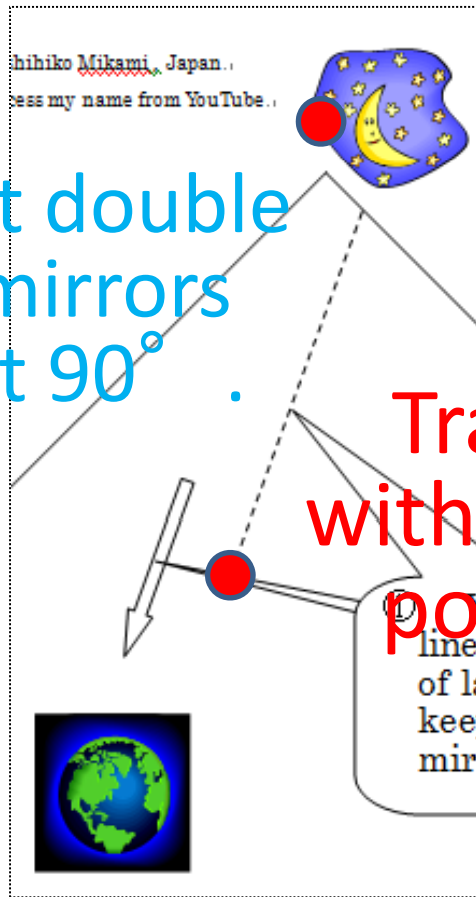


# Unlock the mystery of reflectors.

Set double mirrors at  $180^\circ$ .

Set double mirrors at  $90^\circ$ .

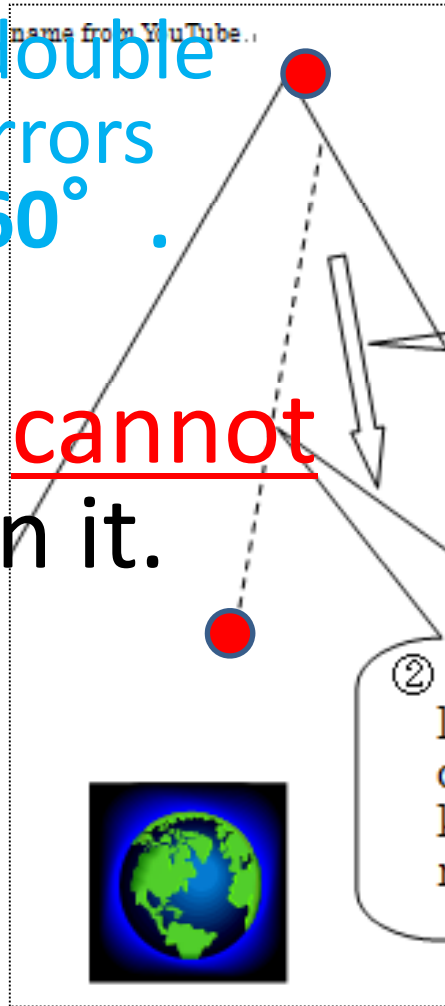
Trace with laser point.



Try  $60^\circ$  (3-fold) and  $45^\circ$  (4-fold).

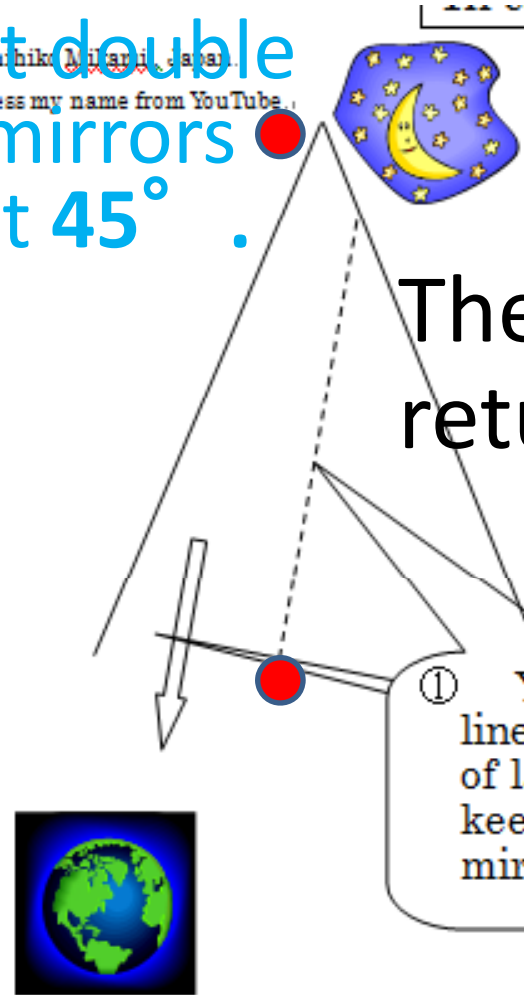
Set double mirrors at  $60^\circ$ .

They cannot return it.



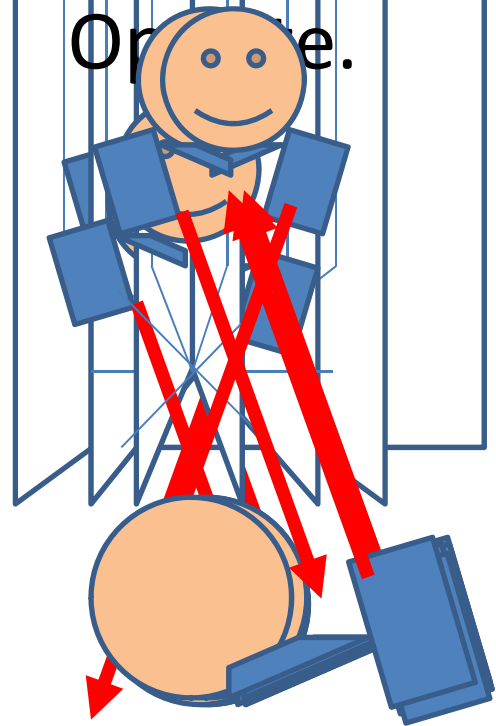
Set double mirrors at  $45^\circ$ .

They can return it.



Opposite times a multiple of two.

The Opposite of the  
The Opposite of the  
The Opposite of the  
The Opposite of the  
The Opposite of the



90° (2-fold):It can return the image.

60° (3-fold):It cannot.

45° (4-fold):It can.

30° (5-fold):It cannot.

22.5° (6-fold):It can.



Let's make an original and beautiful flower shape to learn the principle of retroreflectors

- We can design a beautiful shape, like a flower, with double mirrors repeating the opposite of the opposite.
- The angles formed where two mirrors of retroreflectors cross each other are not only ninety degrees but also such angles as even numbers of repetition of the opposite.

Do you have any questions?

Thank you very much for  
your attention.

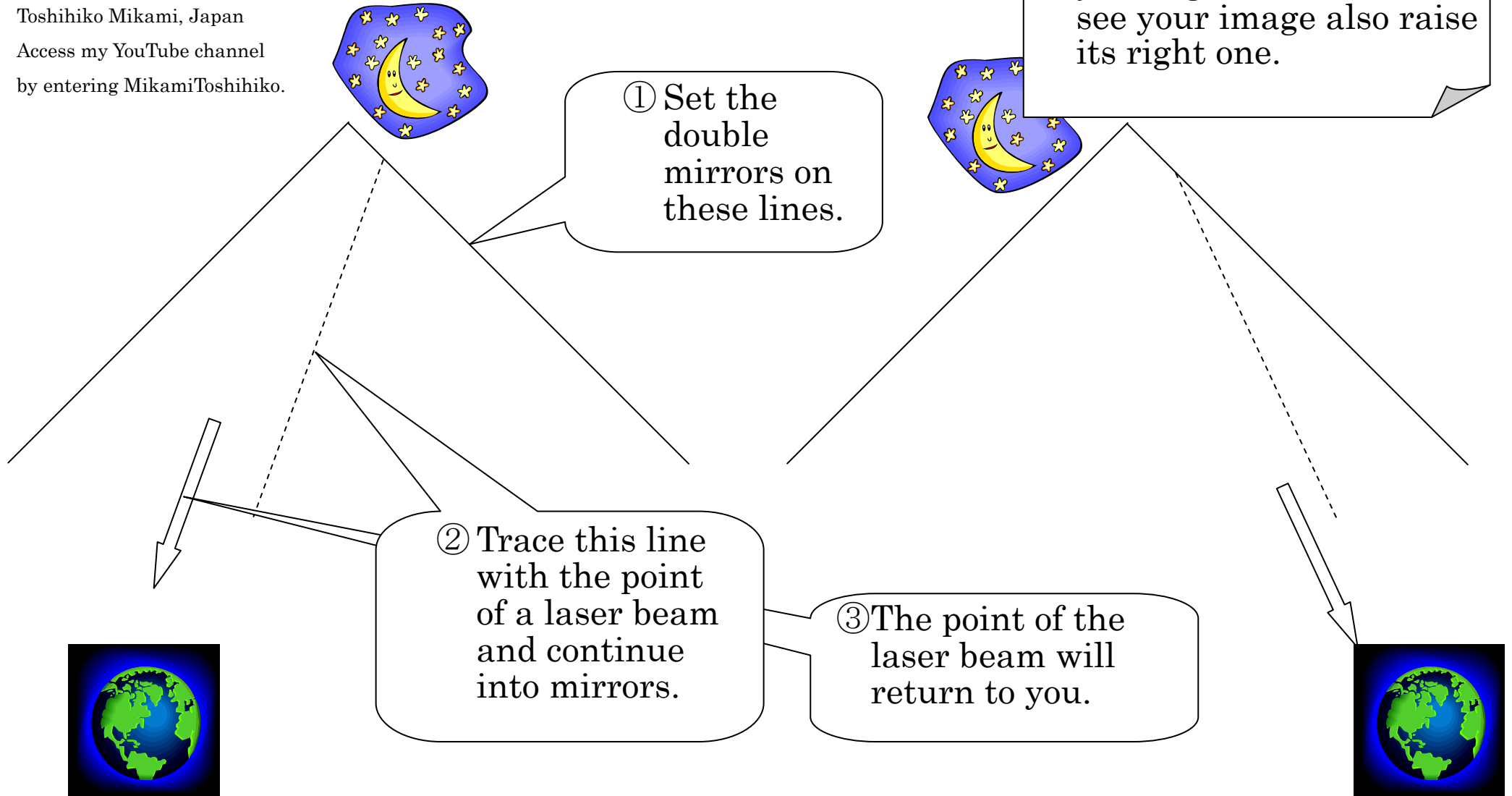
Let's make an original and beautiful flower shape to  
learn the principle of retroreflectors.

- Toshihiko Mikami, Japan
- 青森市立造道中学校  
三上敏彦

# Can laser beams return to Earth?

Toshihiko Mikami, Japan  
Access my YouTube channel  
by entering MikamiToshihiko.

In the case of  $90^\circ$



# Can laser beams return to Earth?

Toshihiko Mikami, Japan  
Access my YouTube channel  
by entering "MikamiToshihiko".

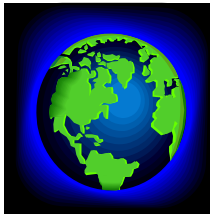
In the case of  $180^\circ$

① Set the double mirrors on these lines.

④ If you don't have a laser pointer, look at yourself in the mirror and raise your right hand. You will see your image raise its left one .

③ The point of the laser beam will not return to you. The distance is getting farther and farther away.

② Trace this line with the point of a laser beam and continue into the mirrors.





# Can laser beams return to Earth?

In the case of  $60^\circ$  (3-fold *Monkiri*)

Toshihiko Mikami, Japan

Access my YouTube channel

by entering "MikamiToshihiko."

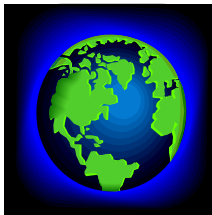
① Set the double mirrors on these lines.

③ The point of the laser beam will not return to you. The distance is getting farther and farther away.

② Trace this line with the point of a laser beam and continue into the mirrors.

④ If you don't have a laser pointer, look at yourself in the mirror and raise your right hand. You will see your image raise its left one.

What are you going to do now?



# Can laser beams return to Earth ?

In the case of  $45^\circ$  (4-fold *Monkiri*)

Toshihiko Mikami, Japan

Access my YouTube channel

by entering "MikamiToshihiko."



① Set the double mirrors on these lines.

② Trace this line with the point of a laser beam and into the mirrors.

③ The point of the laser beam will return to you.

④ If you don't have a laser pointer, look at yourself in the mirror and raise your right hand. You will see your image also raise its right hand.

