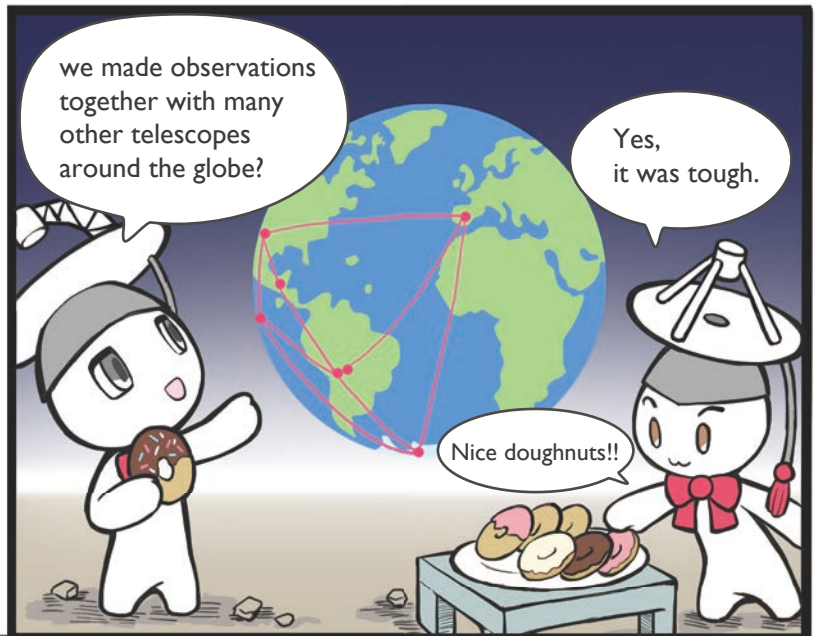




Do you remember that time...

So yummy.

yum
yum

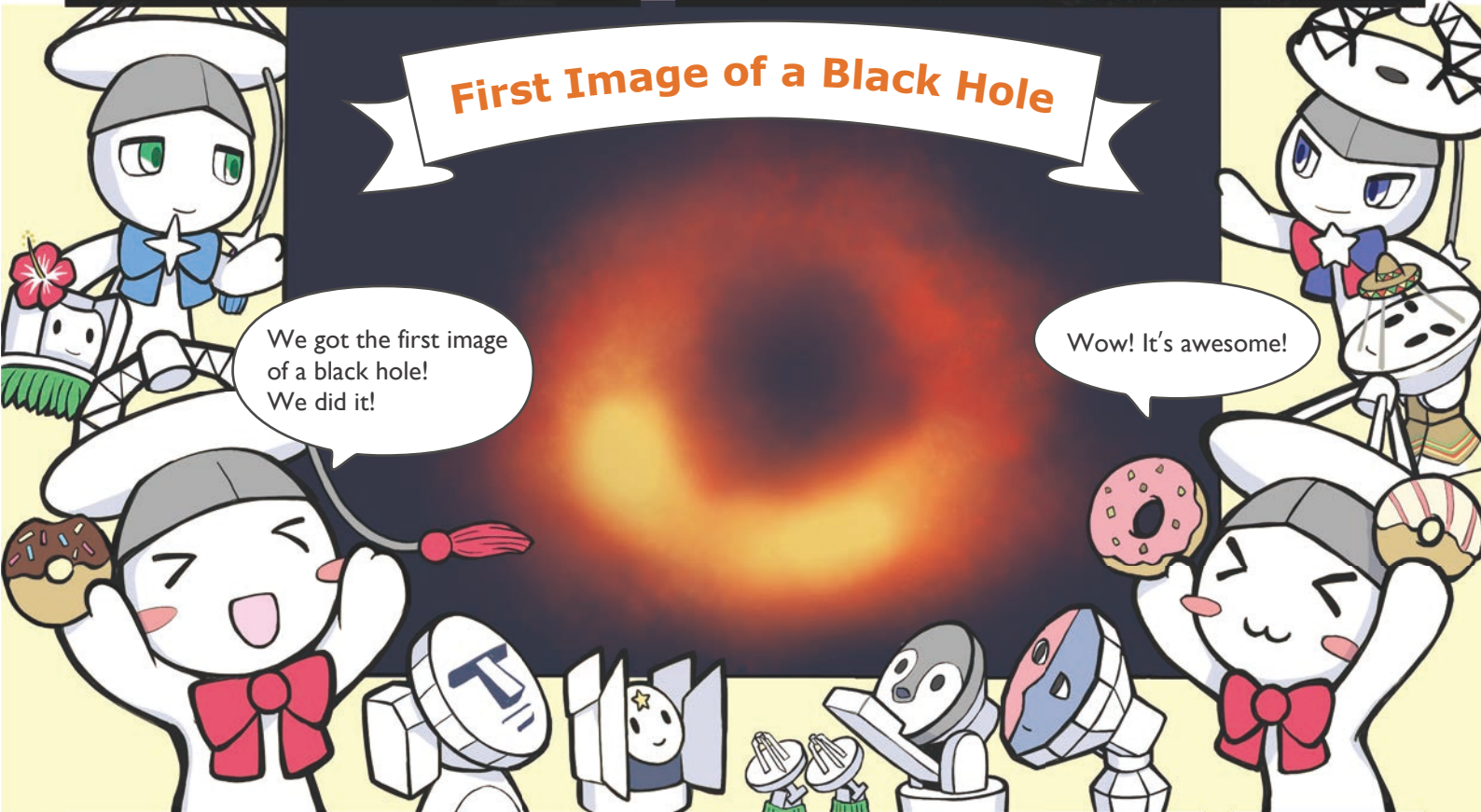


we made observations together with many other telescopes around the globe?

Yes, it was tough.

Nice doughnuts!!

First Image of a Black Hole



We got the first image of a black hole! We did it!

Wow! It's awesome!



What?

You've heard a lot about black holes before?

What a big doughnut



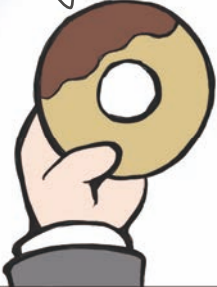
Well, yes. But we had never obtained an image of a black hole before.

Hey, don't eat our black hole picture!

Back in 1967...

Do you know

the true nature of these mysterious objects; something like holes in the Universe?



Einstein

In 1915, the legendary scientist Albert Einstein established the theory of general relativity.

$E=mc^2$

And...

Dr. John Wheeler

$ds^2 = -\left(1 - \frac{2GM}{c^2 r}\right) c^2 dt^2 + \frac{dr^2}{1 - \frac{2GM}{c^2 r}} + r^2(d\theta^2 + \sin^2\theta d\phi^2)$

$r=0$ 特点

$r=R_s = \frac{2GM}{c^2}$

It is difficult...

in 1916, a physicist Karl Schwarzschild found a weird but interesting solution to Einstein's equation.

Karl Schwarzschild

His solution shows that it is theoretically possible for something to have such strong gravity that ...

even light cannot escape.

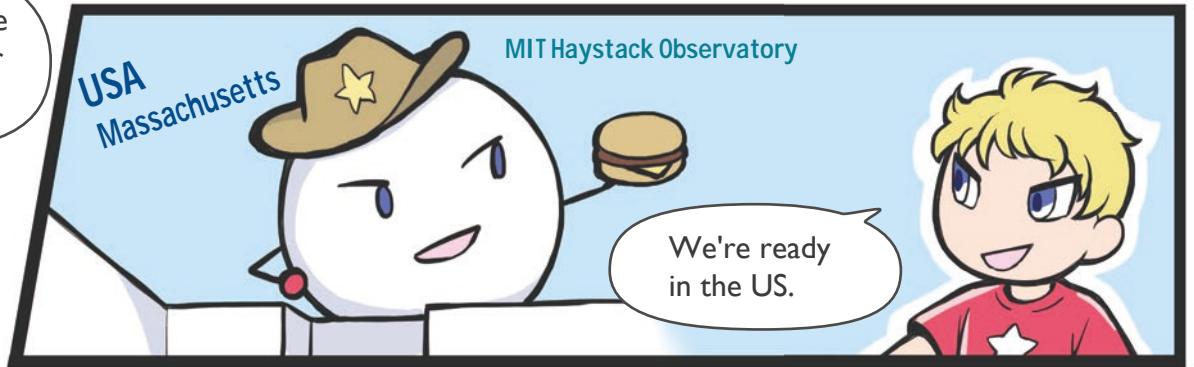
It is something like a bottomless hole in the Universe. Now we call this...

a "BLACK HOLE."

In 1982...

... this is only the first try,

but it could enhance the capability of our radio telescope



Well done!



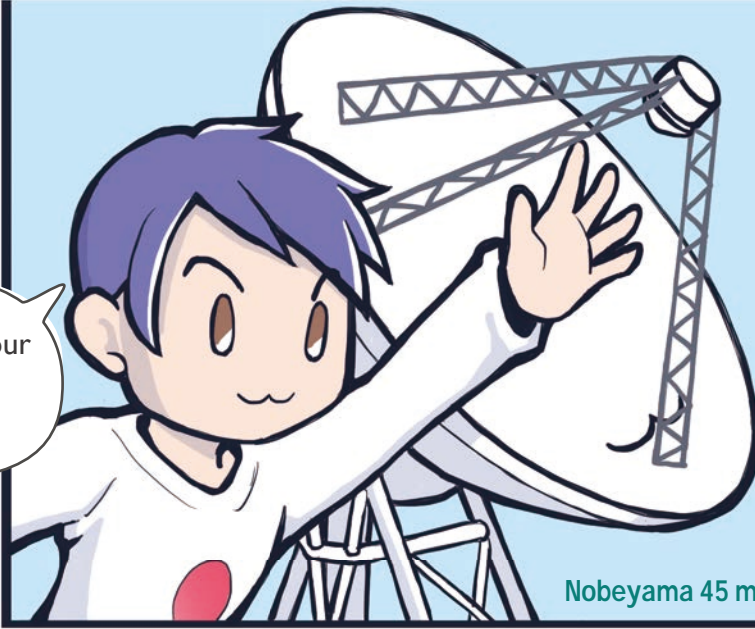
It looks like we succeeded.

Yeah, then how about extending the array further?



In 1985...

We'll help with our Nobeyama 45 m telescope!



Welcome, Japan!

We succeeded in making transatlantic observations, so the next step is to go global.

Japan

Nobeyama 45 m Telescope



Let's include an Asian telescope to enhance the telescope power.

We now have new telescopes too.

OVRO 40m

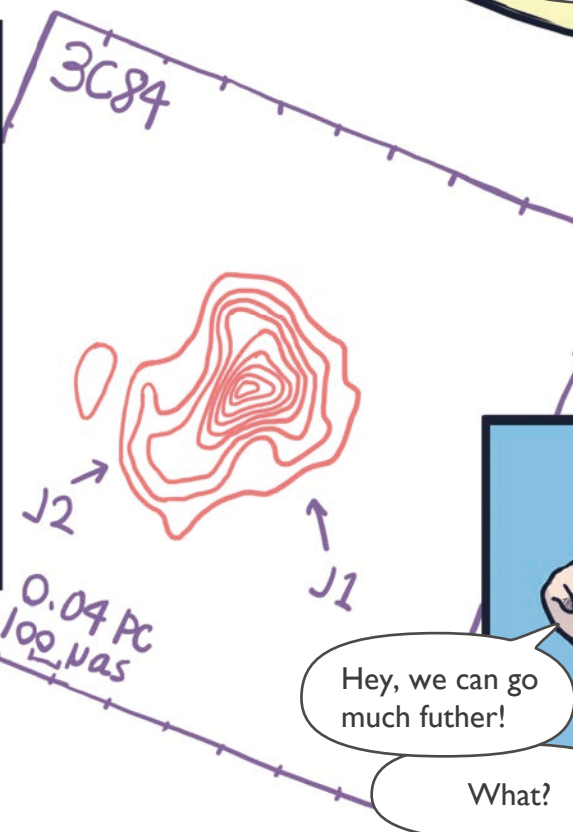


Good!



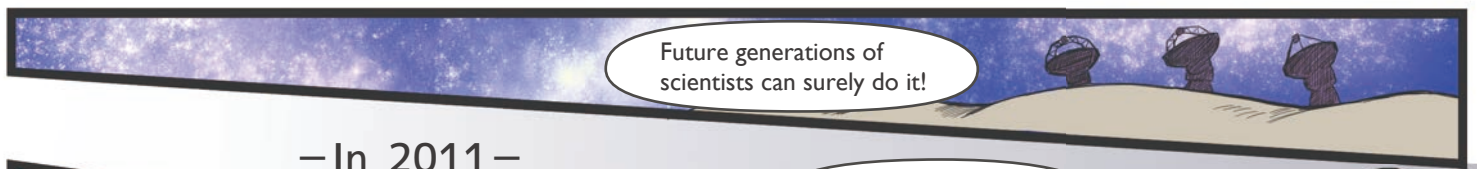
We got even higher resolution!

The future of this project is really promising.



Hey, we can go much further!

What?



— In 2011 —





Finally!

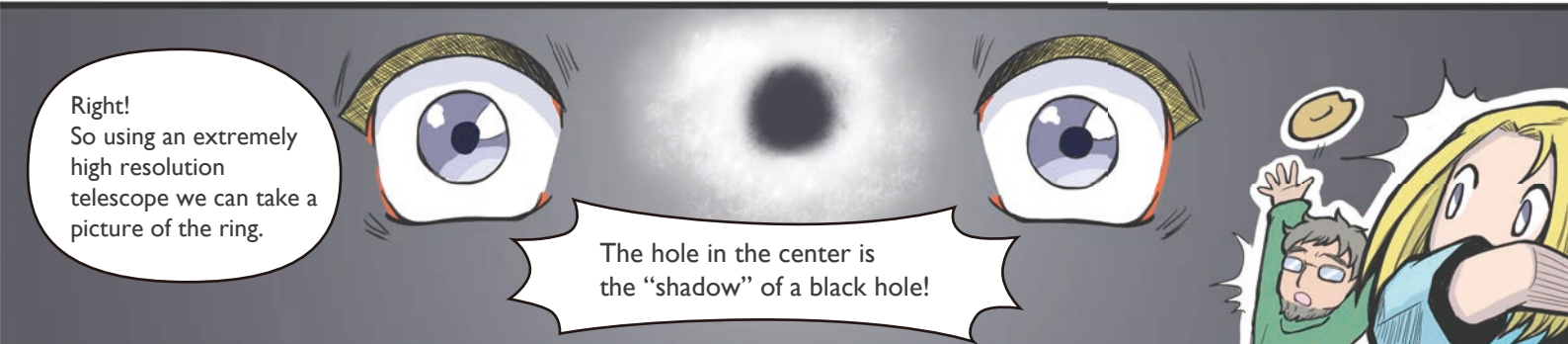
Wait, even light can not escape from a black hole. How can we take an image of such an invisible hole?

Good question! But there is no problem.



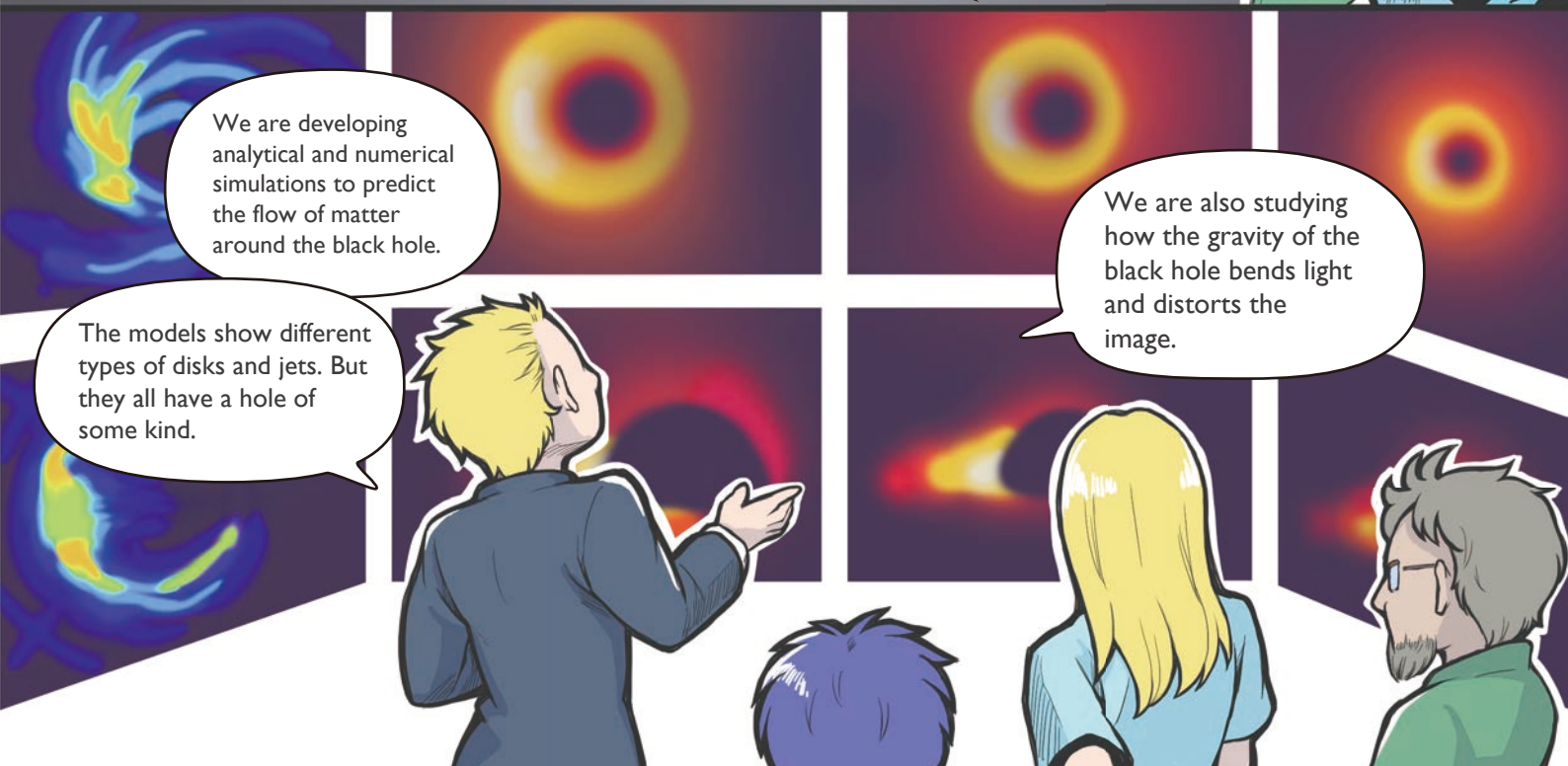
There should be a disk of hot gas around a black hole.

Aha, then the disk will emit radio waves.



Right! So using an extremely high resolution telescope we can take a picture of the ring.

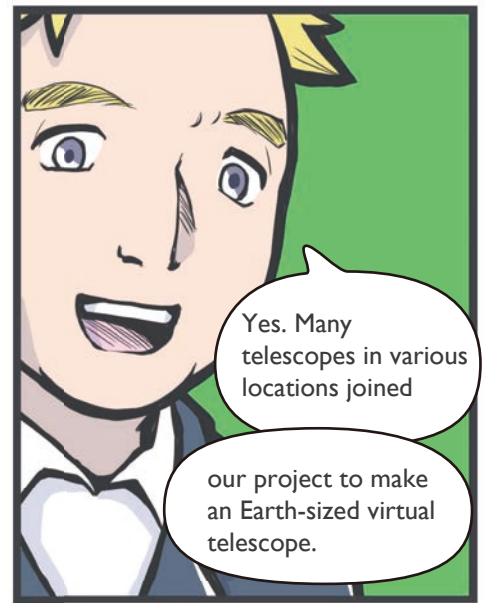
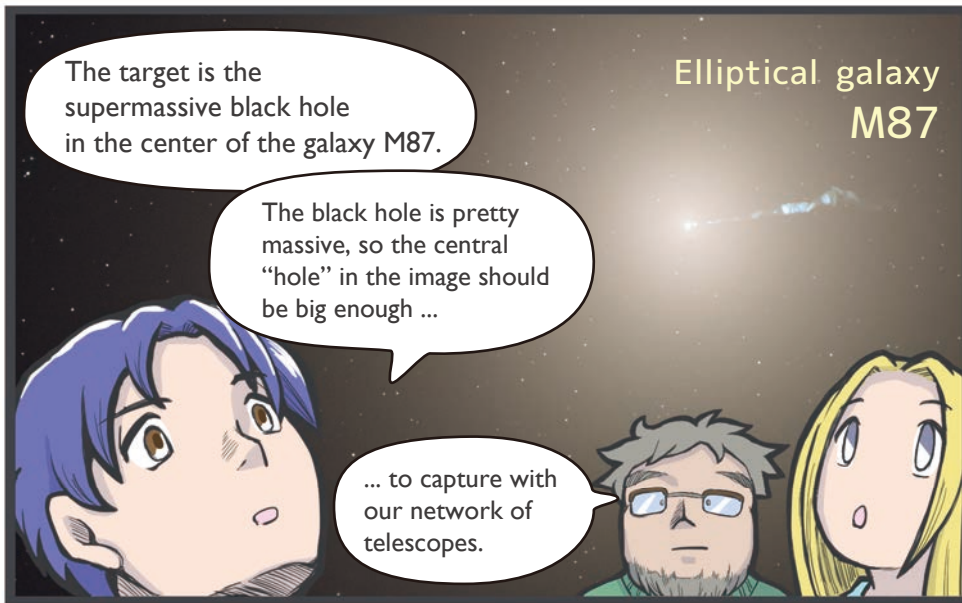
The hole in the center is the "shadow" of a black hole!



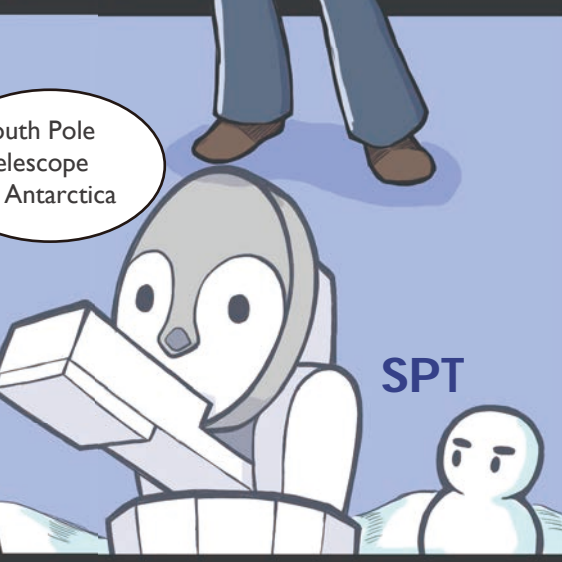
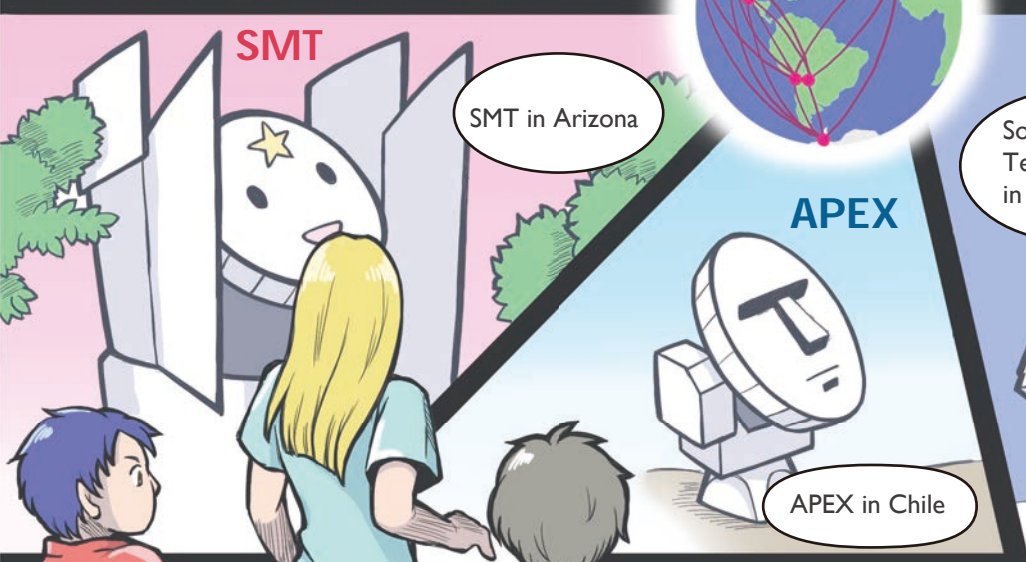
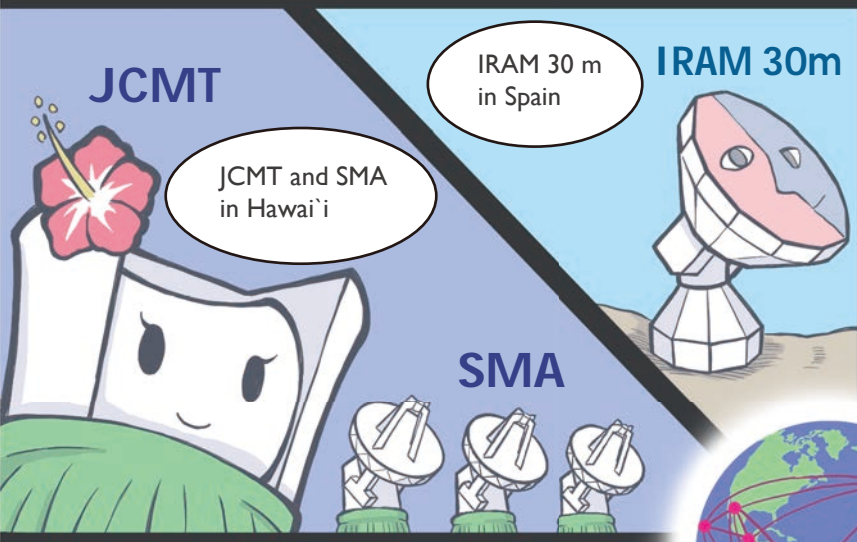
We are developing analytical and numerical simulations to predict the flow of matter around the black hole.

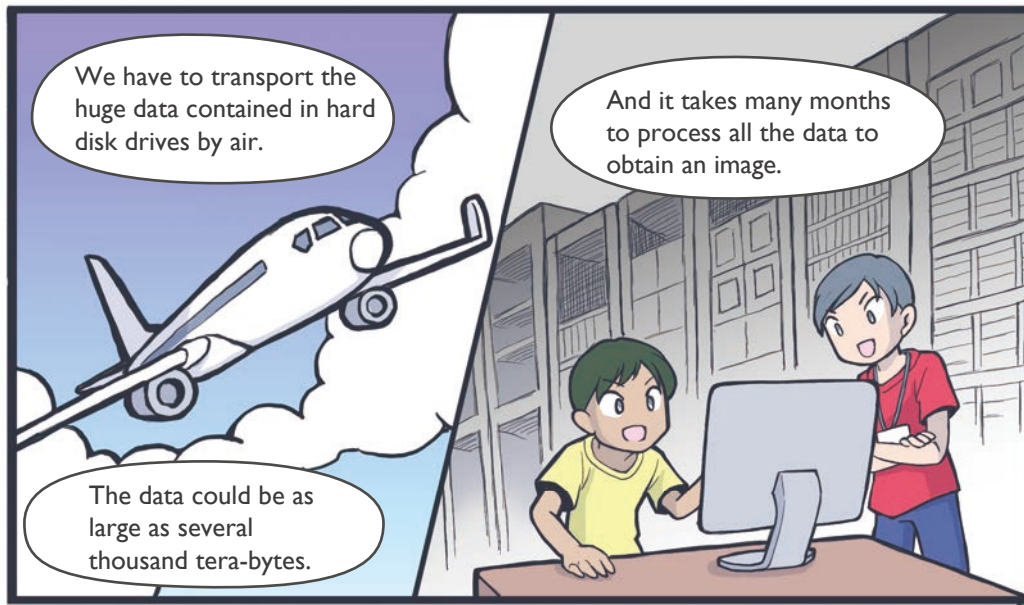
The models show different types of disks and jets. But they all have a hole of some kind.

We are also studying how the gravity of the black hole bends light and distorts the image.



Credits: NASA, ESA and the Hubble Heritage Team (STScI/AURA); Acknowledgment: P. Cote (Herzberg Institute of Astrophysics) and E. Baltz (Stanford University)

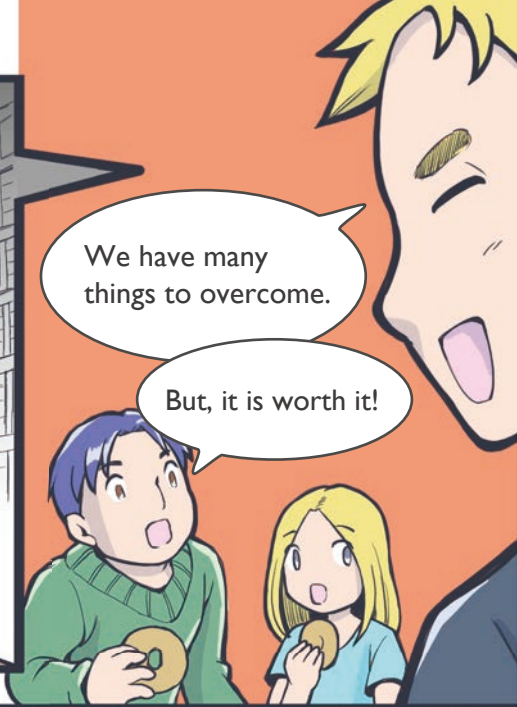




We have to transport the huge data contained in hard disk drives by air.

And it takes many months to process all the data to obtain an image.

The data could be as large as several thousand tera-bytes.



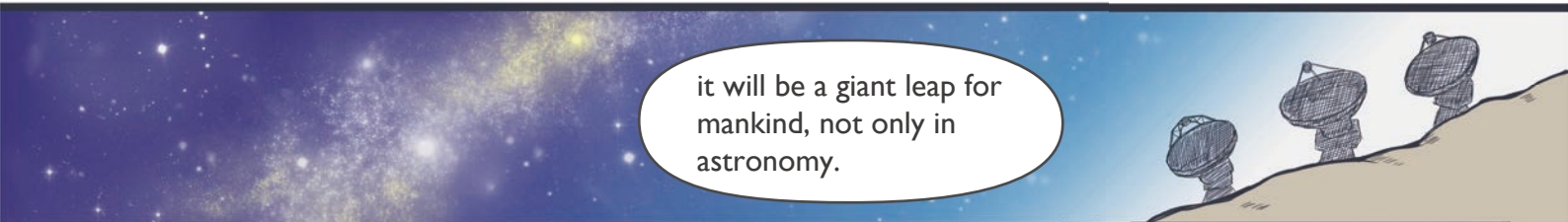
We have many things to overcome.

But, it is worth it!



It is our dream

to take a real photo of a black hole and



it will be a giant leap for mankind, not only in astronomy.



Yes, we got the image, but this is just the beginning.

Hey guys!

Right!

We can do more!



How about starting a BLACK HOLE doughnut shop?

BLACKHOLE Doughnut



That's "one" thing we can do.