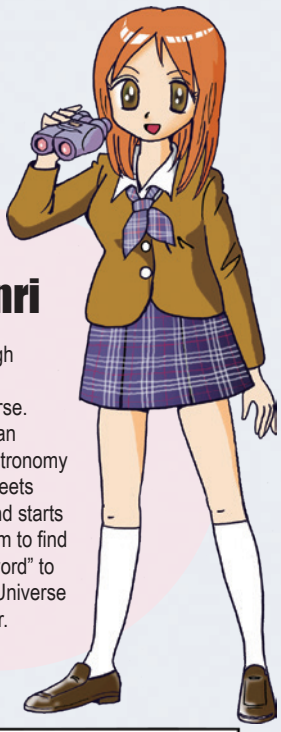
アルマの冒険 ALMAr's Adventure

Issue 08
"The Solar Radio Interferometer being Built by High School Students"

Issue 07 was a side story about "The Start of Japanese Radio Astronomy Investigating the Enigmatic Wartime Giant Parabolic Antenna." In this installment, we return to the main story as the Soten "Deep Blue Sky" High School astronomy club members go to visit Nagoya Prefecture Komagane Technical High School, where the students have made several radio telescopes of their own.

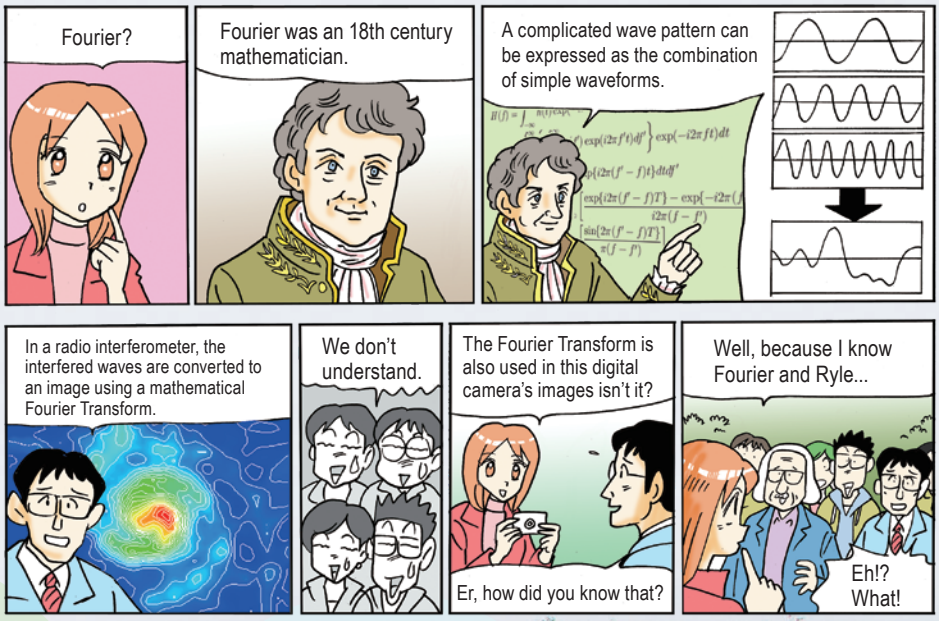


Nao Senri

A Junior at Souten High School. She loves the starry sky and the Universe. Her dream is to become an astronomer. During an astronomy club camping trip, she meets "ALMAr" and "Izayoi" and starts an adventure with them to find "Grand ALMAr's Sword" to save the Radio Universe from danger.

★Summary up through Issue 06
"The History of Radio Astronomy 02"

The Soten "Deep Blue Sky" High School astronomy club members learned about the history of radio astronomy from Dr. Masato Ishiguro and the staff at Nobeyama Radio Observatory. But upon hearing how Ryle had used a radio interferometer and the Fourier transform to make radio wave images, Nao said that she knows Ryle and Fourier. Izayoi sensed that the special Senri family power was further awakening in Nao. But here things take an unexpected turn. (Left: the last scene from Issue 06)



ALMAr

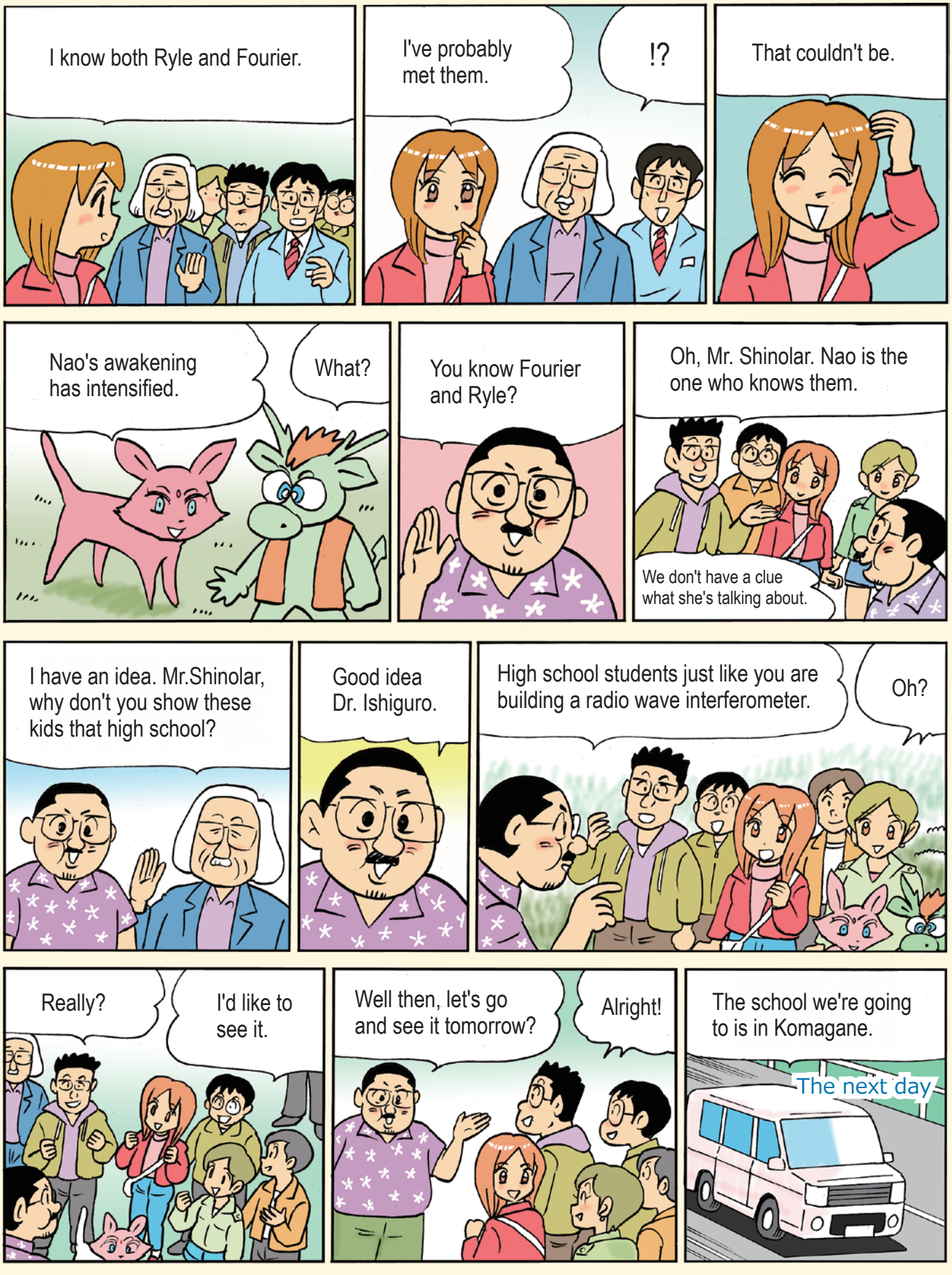
A dragon-child who came to the Visible Light Universe from the Radio Universe. He passed out after being showered by mysterious radio interference known as "Jamming" which poses a threat to the Radio Universe. While he was unconscious, a 9-headed dragon appeared to him and said, "Seek out Grand ALMAr's Sword to protect the Radio Universe." When he awoke, he was in a grassy field in the Nobeyama highlands.

Izayoi

A mysterious female cat who appeared in front of Nao and ALAMr. She has the special ability to see both the Visible Light World and the Radio World. She possesses a rich knowledge of both the Radio Universe and the Visible Light Universe. Somehow she knows about ALMAr's past, the source of the danger to the Radio Universe, and Grand ALMAr's Sword...

A solar radio wave interferometer under construction on the roof of the Komagane Technical High School Information Technology Building. Currently, two parabolic antennas are installed on the rails running East-West and North-South. There will be four antennas when completed. This photo was taken on an overcast rainy day. But we heard that on a clear day you can see a beautiful mountain range.

Chapter 8-1: High School Students are making Solar Radio Telescopes?!



The High School Students who Started Solar Radio Observations

There is a technical high school which built a solar radio telescope and started ongoing observations as part of the festivities for its 50th anniversary.

The Radio Telescope made by Technical High School Students

Located between the Southern and Central Japanese Alps, the Kamiina region spreads along the banks of the Tenryu River. It has eight cities and towns. Among those, Komagane (literally the "Base of Koma") City is located at the foot of Mt. Kiso-Komagatake. It is known as the starting point for climbing the Central Japanese Alps. Formerly dairy and other agriculture made good use of its rich natural resources, but now there are many enterprises dealing with electrical equipment or precision machinery. In addition, factories related to edibles are also increasing. In this Komagane City we find Nagoya Prefecture Komagane Technical High School (hereafter Komagane Technical High School) where they incorporate the motto "Developing people through developing products" into their education. It is a prefectural technical high school with a 55 year history (as of 2018). It has 3 departments, the Machine Department, Electricity Department, and Information Technology Department. You can find many of its graduates in local industries involved in "developing products."

Five years ago in 2013, they decided to take on the construction of a radio telescope and continuing solar radio wave observations as one of the activities to celebrate the 50th anniversary of Komagane Technical High School's founding. And now building on that experience they are going on to fabricate a solar radio interferometer. Exactly what kind of device is this radio interferometer being constructed by high school students? We visited the site to take a tour.

01 Komagane Technical High School located in the fertile region cradled between the Southern and Central Japanese Alps. A solar radio telescope stands in front of the main entrance to the school. A 4-element solar radio interferometer is under construction on the roof of the Information Technology Building in the back left.

The Science Club is even Active in Soubunsai?

Everyone in the Science Club is involved in the solar radio interferometer. They also have received high praise for proactively pursuing other outside activities, such as attending and presenting at the annual meeting of the Astronomical Society of Japan.

They have also presented in the natural science division of the All Japan Senior High School Cultural Federation's All Japan Senior High School Cultural Festival (nicknamed Soubunsai in Japanese), which can be called the varsity level of extracurricular clubs. Representatives from schools all over the country gather at Soubunsai to give presentations and demonstrations in the 19 official categories including theater, wind music, photography, igo, and literature. This year (2018) was the 42nd year. The natural science category was added for the 35th year; it is a category which can be expected to develop more in the future.

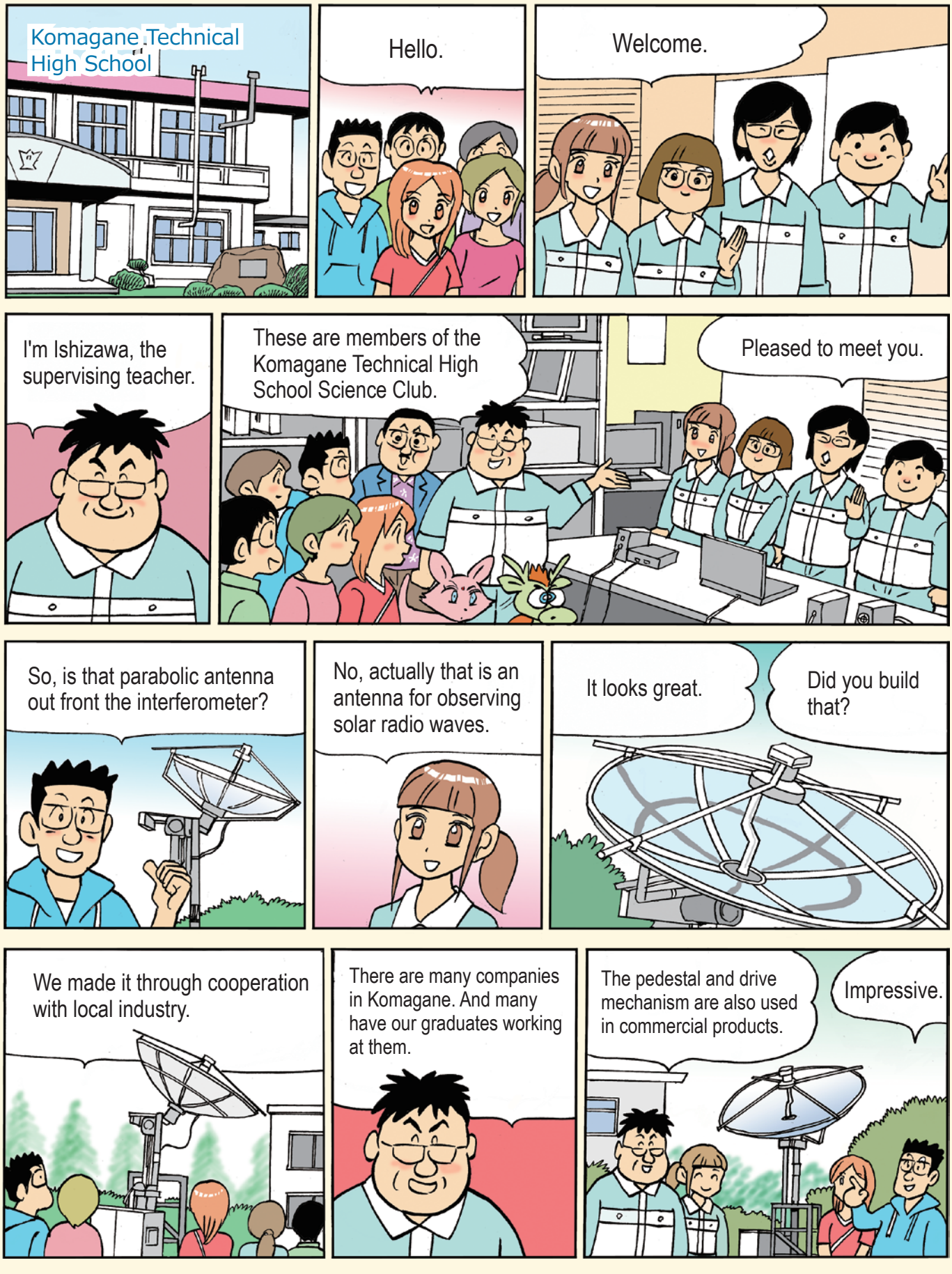
Soubunsai is held in a different prefecture each year. This year the venue was Nagoya. The Komagane Technical High School Science Club was one of the natural science clubs of the host prefecture, so the Science Club members were very busy this summer. Of course there were presentations, but there were also "inspection" field work trips, as well as a tour of Nobeyama Radio Observatory, and showing around participating high school students from the various prefectures.

02 The Science Club conducts various projects and writes activity reports. The biggest event of Summer 2018 was the High School Cultural Festival (Soubunsai). They gave a presentation about internet control of a green house. They also helped with the Soubunsai inspection tour of Nobeyama Radio Observatory and a solar radio receiver experiment for guests at Nobeyama Radio Observatory's Annual Open House Day.

In recent years they are also volunteering at Nobeyama Radio Observatory's Annual Open House Day. Led by Ikuhiro Ishizawa who took responsibility for student guidance again this summer, students could walk around the campus and see what it looks like.

03 When we visited to collect material for this series, they invited us right into the Principal's office. Principal Nobuaki Miyazawa told us about how the school capitalizes on the strengths of the local area and about the many undertakings of the students. We are very grateful to him for taking time out of his busy schedule to help with our news gathering.

Chapter 8.2: The 1.8 m Antenna Captured a Solar Flare.



Extending Common Systems to Scientific Observations

Using techniques they learned in the various departments, students assembled the telescope and succeeded in observing a solar flare.

1.8 m Parabolic Antenna Erected in the Schoolyard

A plan to construct a solar radio telescope at Komagane Technical High School and observe the Sun started from 2012 in cooperation with NAOJ Nobeyama Solar Radio Observatory. For starters they used a 1.2 m parabolic antenna for receiving overseas satellite broadcasts to try to catch solar radio waves in the 4 GHz frequency band.

Then, in 2013 with part of the budget appropriated for activities commemorating the 50th anniversary of the school they bought and assembled a 1.8 m diameter parabolic antenna. Of course they had the help of local industry, but it was fundamentally constructed by students combining their strength and making use of the techniques they learned in the different departments: the Machine Department for the pedestal, basic construction, drive mechanism, etc.; the Electricity Department for the outdoor wiring and power supply installation; and the Information Technology Department for software related matters. In 2014 it started automated observations.

01 The 1.8 m parabolic antenna of the solar radio telescope stretches out roughly in the middle of the Komagane Technical High School grounds, in front of the main entrance. After its erection in 2013, the responsibility for maintenance has passed to current students from those who have graduated. Adjustments are also conducted to improve the sensitivity.

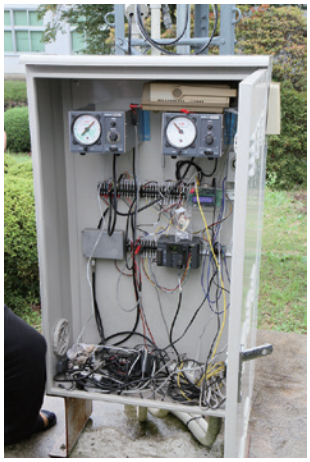
The pedestal drive mechanism uses motors with integrated encoders, capable of moving around two axes: altitude and azimuth. These can be controlled remotely from an indoors computer using satellite tracking freeware. The signal from the receiver is AD converted and sent via LAN to an indoors computer where the data is saved.

02 The vertical drive mechanism to set the altitude pointing of the parabolic antenna (right) and the horizontal drive mechanism to set the azimuthal direction (left). The vertical drive is located behind the antenna and the horizontal drive is incorporated into the iron framework of the pillar. Integrated commercial parts are used for both the motors and the encoder units for detecting their rotation angles.

Vital Statistics of the 4 GHz Band Solar Radio Wave Telescope

Effective Diameter of Parabolic Antenna: 1.8 m
Focal Length: 61.2 cm
F/D ratio: 0.34
Receiver Bandwidth: 3.4 - 4.2 GHz
Output: 1 GHz band
Polarization: Vertical polarization
Linear Range: 0-1 V (Evaluated at Nobeyama Solar Radio Observatory)
Automated Measurement Capability (KEYENCE PLC KV-5000): 4CH A/D converter (altitude, azimuth, receiver output)
Resolution: Voltage (0~5 V, 1/20000), Time 1/100 s
Automated Tracking System: Calsat32 satellite tracking software
Microcomputer Board for Control: PICNIC

Now the solar radio satellite is located in the schoolyard like a monument, continuing to conduct automated solar tracking and logging the received radio wave intensity as digital data.



03 The telescope can be controlled from indoors, allowing the parabolic antenna to track the Sun. The electronics for the drive system and the AD converter to create digital data out of the signal from the receivers are enclosed in a waterproof cabinet and connected to the school network via LAN cables.

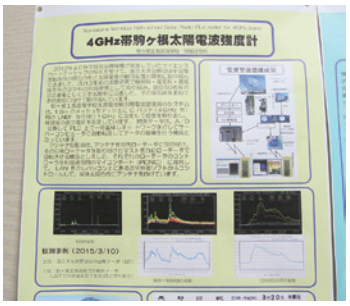
We Caught a Solar Flare!

The 1.8 m solar radio telescope succeeded in collecting data for a solar flare on March 10, 2015. The observational data curve agreed well with data published by what was then Nobeyama Solar Radio Observatory, proving that the telescope has sensitivity good enough to detect a flare.

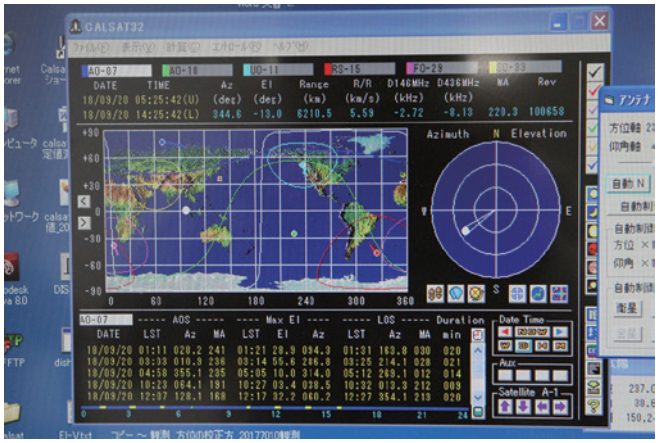
Komagane Technical High School is a "school for making things." Admittedly they had the support of adults with specialized knowledge, but we were still surprised that students were able to build a radio telescope capable of scientific observations on their own.

Now, updates are ongoing, led by Information Technology Department students in the Science Club, to improve the sensitivity of the solar tracking through countermeasures against the noise around the receiver; automate the observational data processing; and open the data to the public.

Ishizawa recounts, "I was surprised when I saw the solar flare in real time. The numbers changed rapidly. At first I thought there was trouble in the system." We hope that by witnessing events like this, the students will develop a deeper interest in radio telescopes and scientific observations.

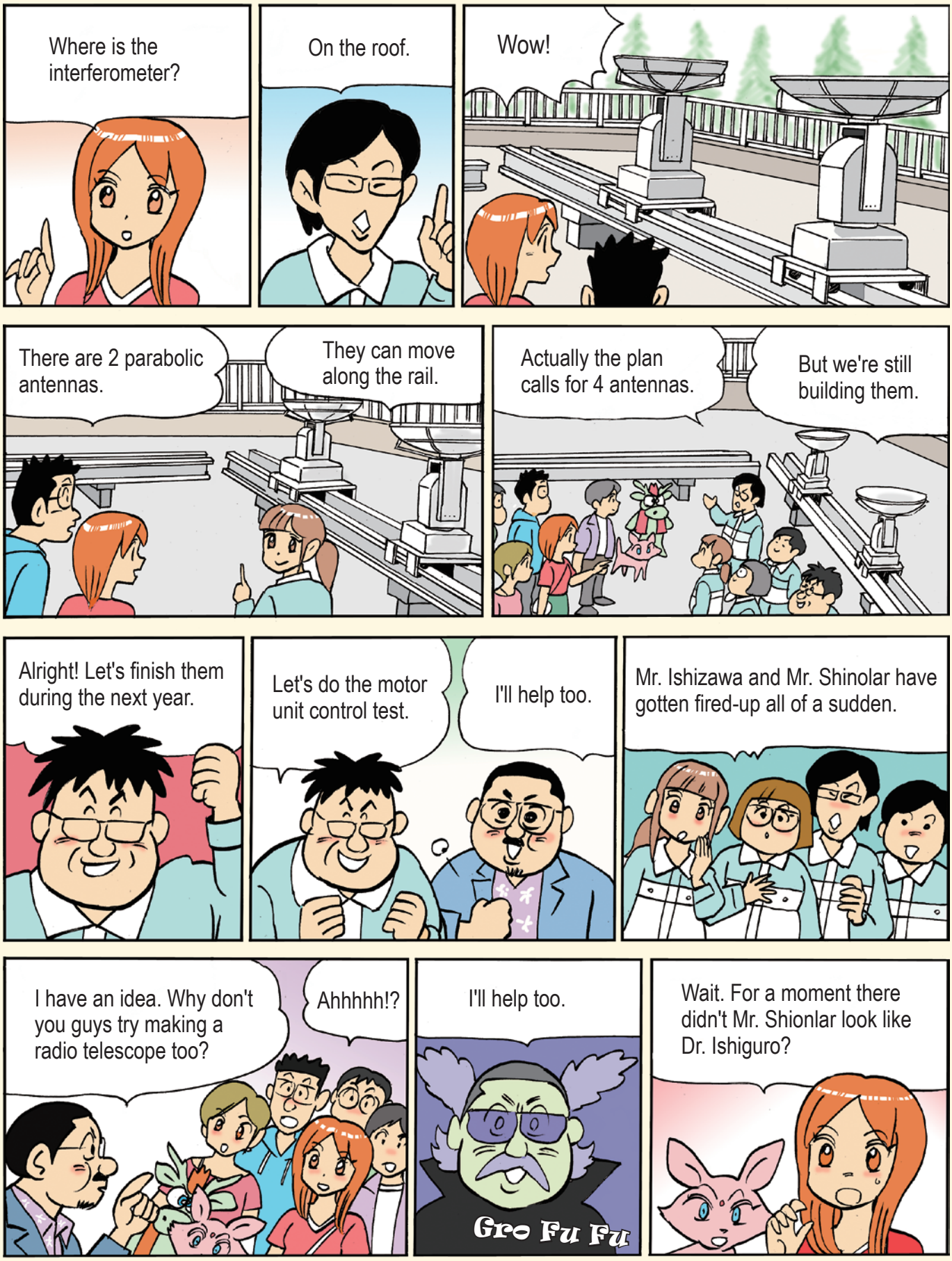


04 In the hallway of the Information Technology Building where the solar radio interferometer is being built, there is a display (a so-called "Wall Newspaper") about the long term solar observations made by students. The changes in radio waves captured by the 1.8 m parabolic antenna during a solar flare are prominently displayed.



05 The Calsat32 software controlling the 1.8 m parabolic antenna is actually satellite tracking freeware. Basically it calculates the positions of artificial satellites and controls the antenna's altitude and azimuth pointing in real time to catch manmade radio waves from satellites. But because it can also calculate the position of the Sun, the students are using it for that.

Chapter 8.3: Two Parabolic Antennas Set on the Roof



Moving up to a Radio Interferometer

A high school career is limited to 3 years. The radio observation plan and techniques are passed from graduates to current students.

Radio Interferometer Construction has also Started

At Komagane Technical High School, they have started a plan for a radio interferometer as an expansion of their solar observations with radio telescopes. When complete, it will consist of four 1.2 m parabolic antennas with interferometric capabilities on the roof of the Information Technology Building. The observation frequency band is planned to be 4 GHz, the same as the 1.8 m parabolic antenna.

They completed installation of the linear ferrous rails in 2016. The rails run 11 m in the north-south direction and 15 m in the east-west direction. In addition, two 1.2 m parabolic antennas are already installed on the east-west rail. A radio interferometer uses antennas in pairs; it is necessary to make various adjustments to the positions and orientations of the antennas in order to catch the radio waves simultaneously. Therefore they devised a system where the parabolic antennas slide smoothly over two parallel inverted-V shaped rails.

Currently, two parabolic antennas have been installed, but they are just the shells, without the pedestal drive motors and signal processing systems such as the receivers. They are still a long way from completion. The computer and software for the correlator are still outstanding issues. "We want to connect the two antennas and soon as possible and get a signal." Says Noriyuki Shinohara of Nobeyama Radio Observatory who has offered much guidance as a collaborating advisor.

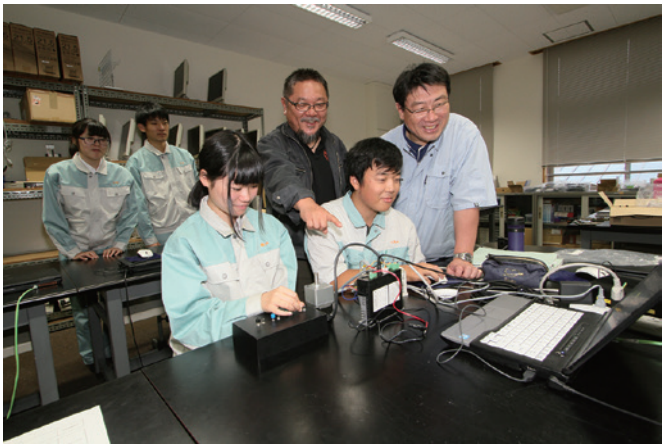
01 On the roof of the Information Technology Building, shortly after it was constructed, first the bases for the radio interferometer rails were installed; then the rails were added. The installation was handled by an ironworks company associated with Komagane Technical High School. The rails extend 15 m east-to-west and 11 m north-to-south. They told us that the height is level to within 0.1 mm.

02 Two 1.2 m parabolic antennas are already installed on the rail, but right now they are just the shells without receivers or motors to drive the antennas. Assembly and control techniques are now under investigation.

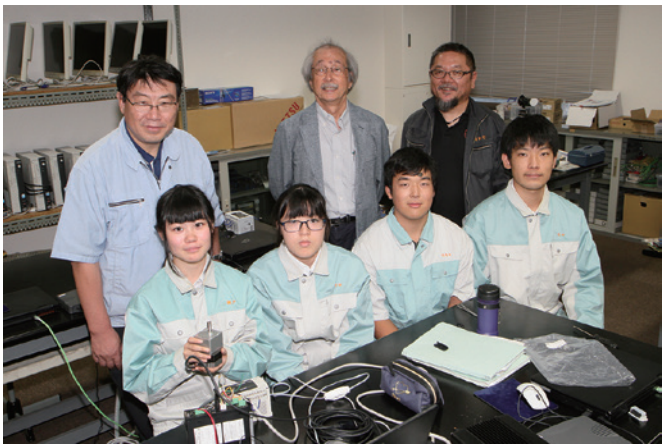
Students Striving to Fulfil the Dreams of Those Who Have Already Graduated

Ishizawa, who looks more like he is working alongside the students than advising them, says, "Unlike a research laboratory or company, in a high school students graduate after only three years. So no one student is involved in production and operation of the radio telescope over a long period. This is a special difficulty for a high school." Currently, it is being developed primarily by Information Technology Department seniors in the Science Club, but while building it they are passing on their experience and results to underclassmen. It is a very fitting style for a high school isn't it?

We will continue to watch the progress of the solar radio interferometer construction, and we would like to see the Komagane Technical High School system spread so that other high schools and Jr. high schools throughout Japan have curriculum to deepen the students' understanding of radio telescopes.



03 After school, the Science Club members gathered in the lab and Ishizawa and Shinohara said the same dialog as appears in the comic, "Alright, today let's do the motor unit control test." They then gathering the necessary machine parts, skillfully connected them to the PC, and promptly started the experiment.



04 A commemorative photo taken with the assembled students on the day of the news material gathering. In the back row from left to right are Ikuhiro Ishizawa, Dr. Masato Ishiguro, and Noriyuki Shinohara of Nobeyama Radio Observatory (who appears in the comics as Mr. Shinolar). In the front row from left to right are the Science Club members Yuno Seto, Sayaka Abe, Mamoru Shirotori, and Toshiaki Makita.

And next issue

The Legendary 4-m Parabola Reborn!

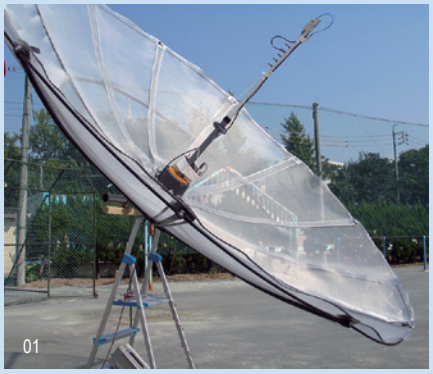
Unearthing an Antenna Previously Made by Dr. Ishiguro

In the comic, it looks like the Soten “Deep Blue Sky” High School students will make their own radio telescope. The idea of "building our own radio telescope and catching radio waves from heavenly bodies" also got started among the "Almar's Adventure" production staff. Of course, instead of using a readymade BS antenna (like was introduced in "Almar's Adventure" Issue 04), they wanted to take on the challenge of making the parabola themselves. That's when Dr. BS (Dr. Masato Ishiguro) appeared. By chance, 15 years ago Dr. Ishiguro had made an actual parabolic antenna himself, and the parts for that antenna were resting in Nobeyama Radio Observatory.

Previously there was an NHK program "Welcome Back Graduates." In this program, famous people from various fields returned to the schools they had attended and explained the importance of their own work while interacting with students at their alma maters. Dr. Ishiguro made an appearance on this program. That time, he assembled a parabolic antenna with the students to help deepen their understanding of radio astronomy. Its diameter was an impressive 4 m. The staff decided to "dig that out and try putting it together again."

Dr. Ishiguro had thought the parabola could be used again to help popularize radio astronomy, but that was 15 years ago and now its whereabouts were uncertain. So the staff returned to Nobeyama Radio Observatory with Dr. Ishiguro to search for it. There they recovered the metallic mesh antenna surface, the most vital and difficult to obtain component. But there were many parts they couldn't find in the limited time, including the pipe frame for the parabola.

Even so, the "Almar's Adventure" staff didn't give up. In the summer of 2018, with the help of Nobeyama Radio Observatory, they launched a renewed search for the "legendary" 4 m parabolic antenna; and deep at the back of the NINS Exhibit Room warehouse (formerly the Interferometer Building) they uncovered all of the missing pieces. If they assemble those parts, they should be able to perform astronomy observations with an original (?) antenna. That's something to look forward to in the next issue.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02


03


04

01 The parabolic antenna used in "Welcome Back Graduates."
02 We caught a glimpse of a bundle of pipes behind a pile of machines and supplies. Wait, that's the frame of the parabola, "Jackpot!"

03 For starters we laid out the parts we found. Nobeyama's public relations staff member Kenzo Kinugasa was a great help. Thank you!
04 The project writer and photojournalist Kawamura discovered the last parts by chance. Why were only these parts wrapped in paper and placed (dropped?) away from the rest of the parts?

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