Giant Metre-wave Radio Telescope

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Characters

Arun…student

Amit…student

Ma

Professor

Teacher

Announcer

Arun: Loudly…Ma, where is my bag? I have to reach school early today.

Ma: It is in your cupboard!

Arun: talking to himself…She keeps it in a new place every day. Can’t find anything on time.

Ma: have you found it yet?

Arun: Yes…I have found it.

Ma: Why do you have to go early to school today?

Arun: A group of scientists is visiting our school today to interact with us.

Ma: And what are you going to talk about?

Arun: Ma …you know that I love Astronomy, so I have prepared some questions which I want to ask them. My friends Amit and Ankita will be with me.

Ma: You father had bought you a telescope last year…have you used that or not?

Arun: Of course Ma…it is such a useful instrument. Well then, I must be going…my friends will be waiting for me.

Change of scene…School general din. Sound of a bell ringing

Teacher: Children…assemble at the Auditorium, please.

Arun: Let’s go Amit. Seems like the scientists are here.

Amit: Which scientist should we talk to, first?

Arun: The Notice had said that the individual scientists in the group would focus on different topics. I like Astronomy, so I had chosen it…what option have you exercised?

Amit: Me too.

Arun: So, let’s go to where the Board says ASTRONOMY.

Arun, Amit: Namaste Sir.

Professor: Namaste children. Come here, please. What are your names?

Arun: I am Arun. He is Amit.

Prof: We are awaiting the arrival of some more children.

Arun: Yes. They must be on their way…but may we begin our chat?

Prof: Let me introduce myself first. I am employed at the University and am working at the Astrophysics Department. I carry out research on this subject and teach it too.

Arun: Sir, Astrophysics and Astronomy have huge scope…what is the specific area of your study?

Prof: I study Radio waves.

Amit: Are these the same waves that enable us to listen to songs that are broadcast by the radio?

Prof: the very same!

Arun: So how are these waves of any interest to Astronomy? I mean these are more useful for Communication technologies….aren’t they?

Prof: Yes you are right… but these waves are of immense interest and use in Astrophysics and Astronomy, too.

Amit: (in amazed tones) Radio waves…in astronomy and Astrophysics…how?

Prof: We use Radiowaves to study heavenly bodies.

Arun: But aren’t celestial bodies studied using telescopes?

Prof: Yes…but you are perhaps talking about those telescopes that rely on the visible part of the Spectrum to work. However, there are those telescopes that use the radio waves of the Electromagnetic spectrum to work.

Arun: What about my telescope? Does it work using the visible spectrum or the radio waves of the EM spectrum?

Prof: This is an optical telescope and it works in the visible region of the spectrum. However, you know that Astronomy is an applied Science. People from different civilizations relied on naked-eye observations to correct the calendars they used and thus to make accurate calanders. However, the naked eye can only see a limited number of celestial bodies…such as the Sun, Moon, Venus, Mercury , Mars etc. Later, telescopes were pressed into service to carry out astronomical observations. The images as seen through a telescope were clearer than those seen by the naked eye. Now, celestial objects emit not just light in the visible part of the spectrum but also radio waves, X-rays, Gamma rays, neutron and other high energy particles as cosmic radiation. The Earth's atmosphere, is an opaque barrier to much of the electromagnetic spectrum, although the Earth’s atmosphere is transparent for radio waves . This is why radio waves can reach the Earth easily.

Arun: Sir why should this happen only to the radio waves?

Prof: This is because the wavelengths of radio waves are quite large as compared to the wavelengths of the optical part of the spectrum.

Amit: I have heard that the Indian scientist J C Bose discovered radio waves as a means of communication.

Prof: Very right. In 1895, Sir J C Bose gave his a public demonstration of radio waves, using them to ring a bell remotely and to explode some gunpowder. This catalysed the use of radio waves for other purposes too. In 1927, Karl Jansky found out that radio waves also originate from the centre of our galaxy---the Milky Way.

Arun: So this means that we have known about radio waves for about a century or so.

Prof: The use of radio waves was limited during the period up to the Second World War. After that the production of equipment such as Radar, Communication systems and all that began in real earnest. This is when we found out that stars do not emit strong radio waves. We learnt a lot about stars by studying photographs taken by telescopes that used optical wavelengths. Later, we discovered, when we began to use radio wave telescopes that these photographs of what appeared to be stars were not those of actual stars after all.

Amit: That’s very interesting, Sir. But Sir , how are the radio waves used to study celestial objects…what is the principle involved?

Prof: The radio telescope uses simple equipment such as antennae and receivers. The antenna collects the radio waves emitted by the celestial bodies. Then, these images are processed using the software available to give photographs that are studied. These studies tell us all about the celestial bodies.

Amit (in amazed tones): You mean these telescopes are just like our ordinary radios?

Prof: Yes…almost. However, the first radio telescopes that were made did not give photographs with good resolution and the clarity of the images was poor as compared to those that were given by optical telescopes. This is why radio telescopes could be used only for celestial objects that were at least the size of the Moon. Smaller sized celestial objects just did not give clear images.

Arun: But why not, Sir?

Prof: You see, the wavelengths of radio waves is roughly a thousand times longer than the wave lengths of light in the optical range. To collect these radio waves you would need an antenna that was at least 10 km long. This was impossible in those days.

Amit: An antenna 10 km long!! How interesting. How did the scientists manage to overcome this challenge?

Prof: Well, the scientists did find a way out…they actually found a totally new way to increase the resolution of the images they had got. They called it Aperture synthesis.

Amit: Aperture Synthesis? What is it?

Prof: The radio waves sent by the far away heavenly bodies are not constant. These change over time. This process uses an array of small mirrors to create a large virtual mirror. The smaller components can be moved according to the necessity to collect the radio waves coming from different sources. This is done till the virtual mirror is fully covered and missing spaces are filled in by software.

Amit: have any such telescopes been made in India?

Prof: Yes indeed. Significant work has been done in this area, in our country. We have The Giant Metre wave Radio Telescope in India. It is located about 90 km away from Pune, at a place called Khodad. It is operated by the National Centre for Astrophysics, which works under the Tata Institute for Fundamental Research or TIFR.

Amit: I was not aware that India could boast of such a facility.

Prof: India set up this facility to encourage research and development. Today we use it to study solar activities, solar wind, pulsars, the magnetic field of the galaxy and the mysteries of the universe. Post independence, this is an incredible advance in the field of research and development.

Arun: Sir, please tell us about the GMRT in detail…this is such an interesting topic.

Prof: Well…I happen to have a CD that relates to the National Centre for Radio Astrophysics. Let me play it for you.

Arun: Thank you Sir, let's do it.

Sounds of CD being inserted …let's go friends.

Sound of a lady announcer

"The National Centre for Radio Astrophysics NCRA is an institute under the Tata Institute of Fundamental research or TIFR. It is currently located on eth campus of Pune University. It is a leading institute in the field of Astronomy and Astrophysics in the country. This institute was set up in 1989. Astronomy began to be studied at TIFR in 1964. It was then that Dr. Homi Bhabha extended an invitation to Prof. Govind Swarup to join the institute. It was under his guidance that the first radio telescope was built at Kalyan, near Mumbai. This radio telescope had 32 parabolic dishes with average diameter of about 1.8 m. This telescope worked at a frequency of 610 mega hertz. This telescope was not fabricated in India. Rather it was a gift to TIFR from Prof. J.L. **Pause of the Australian Institute called CSIRO.** This telescope was fruitfully used from 1965 to 1968. It was instrumental in helping scientists make many interesting observations about radio waves emitted by the sun.

This was followed by TIFR's endeavour to design, fabricate and set up the radio telescope at Ooty. This is called ORT. This was one of India's premier radio observatories. It had parabolic cylinders which were 530 m long and 30 m wide and operated at a frequency of about 327 MHz. The reflecting surface of the telescope is made of 1100 thin stainless-steel wires. **The unique feature of ORT is that its axis of movement is the same as that of the Earth's rotation**

Usually radio telescopes are mounted such that it can be steered along both the axes so that it can compensate for the Earth's rotational movement.

The Ooty Radio Telescope has been designed and fabricated fully indigenously and at a very low cost. . The ORT is one of the most sensitive radio telescopes in the world. Although it was set up to study the size of the orbits of celestial objects, observations made using this telescope have led to important findings in the study of Quasars, supernova, and pulsars

After 1980, scientists at TIFR created a telescope based on Giant Aperture Synthesis which came to be known as GMRT. It was a huge telescope. And its parabolic dishes covered an area of 30 km. It has 30 dishes with diameter of 45 m.

Each dish is connected by optical fibre cables to a Central Electronics Building for collection and further processing. The GMRT can be operated at six different wavelengths ranging between 50 to 1450 Mega hertz. It represents the capabilities of the Indian scientist and is a witness to the team spirit that exists among them because of which such a sophisticated instrument could be set up at such a nominal cost. The weight of the dishes has been kept quite low and each dish has been joined to the frame in such a way that these form a huge parabolic shape. The three arms of the ‘Y’ shaped array are each about 14 km long. 12 antennas are placed near the centre and 18 others are placed in the Y shaped arms.

The GMRT is used to make astronomical calculations and is one of the most sensitive Aperture Synthesis telescopes in the world. All the signals received by the antennae are combined at one place to yield the final signal and software is used to do image-processing to analyse that celestial body from which the radio waves originated.

Final tune indicating end of the video.

Prof: You have learnt, children, how the technical capabilities of Indian scientists have contributed immensely to the field of Astronomy.

Amit: Really Sir, this documentary ahs made it clear to us, for the first time that India has enormous capability in the field and that there is such a lot of opportunity in this area of study.

Arun: Sir…thank you so much. I am certain that information such as this is invaluable to students like us who want to take up science as a career option.

Prof: That is good. Now, come along I will introduce you to the Director of the Institute.

Interaction with Director

Prof: Thank you children for listening so attentively to us.

Arup: Let’s go and find out about other scientific achievements.

Director

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1. How does GMRT works?
2. What are the major areas of research done for which this meterwave Telescope is used?
3. What arepulsars and how is this telescope useful in the study of pulsars?
4. How many similar types of telescopes are available in the world?
5. How one can enter this field?
6. Any important facts related to GMRT, which you can share with the audience.
7. Is there any plan to built a telescope more powerful than GMRT?