RADIO TELESCOPES, THEIR MAIN FUNCTIONS AND THE ROLE OF RADIO TELESCOPES IN OUR LIFE

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Abstract
This The article not only provides information about radio telescopes, their constituent parts and the principle of operation, but also gives a brief overview of the role of radio telescopes in our lives and the radio telescopes that have grown not only in Uzbekistan, but also in many other countries.

Keywords. Radio telescope, radio telescope with parabolic antenna, radio interferometer, directivity level of radio telescope, radio astronomy.

Introduction
By the 30s of our century, it became known that many celestial bodies, including gaseous nebulae, radiate in the radio range . Telescopes designed to record radio rays coming from celestial bodies with a wavelength ranging from millimeters to tens of meters are called radio telescopes. The main parts of radio telescopes are the antenna and the receiver , and the antenna is often made in the form of a paraboloid. The radio rays returned from the antenna are collected in the radiator located at the focus of the paraboloid and directed to the receiver using a special wave transmitter . After the signal is amplified in the receiver, it is detected and then recorded in a special device called a radio signal recorder . The receiver amplifier is designed for the wavelength, the object is observed in that monochromatic radio beam . The requirement for the accuracy of the metal mirror of radio telescopes is much lower than that of optical telescopes (due to the fact that radio waves correspond to the longest wavelength sections of the electromagnetic wave scale), the deviation of the antenna from the exact parabolic surface, $\lambda$the wavelength operating at for a radio telescope$\frac{\lambda}{8}$ should not be greater than For example, the mentioned deviation of the antenna of telescopes operating in the 1-meter range is allowed to go up to 12.5 centimeters.

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Multiple p antennas are sometimes used to record radio waves in the range of several meters to tens of meters . A special characteristic called a directivity diagram is used to determine the resolving power of radio telescopes . The directivity diagram characterizes the sensitivity of the radio telescope to the position of the point source of radio radiation relative to the antenna . The directivity diagram of a radio telescope with a parabolic antenna is symmetrical about the paraboloid axis. The angular resolution of a radio telescope, i.e., the smallest distance between two objects that the telescope can detect as separate objects, is approximately the angle equal to the half-power width of the central "leaf" of the directivity diagram, and is found as :

$$\delta = \frac{\lambda}{D}$$

in this case , l is the radio wavelength used by the radio telescope, and D is the diameter of the antenna. Despite the large diameter of the mirror of radio telescopes , they are inferior to optical telescopes in terms of resolving power due to the fact that they operate at long wavelengths . However, radio telescopes can achieve very high resolution when operating as radio interferometers. A simple radio interferometer consists of two radio telescopes A_1 and A_2 placed at a fairly large distance a from each other, called the base , and the signals recorded by the radio telescopes' emitters from a certain object are transmitted to a single receiver through cables.

If a radio interferometer with a certain base is receiving a signal at a wavelength l from a specific source, then the difference of the path of the rays coming from the object to these two telescopes b is equal to an integer number of wavelengths:

b = a sina = n l

such signals are added to the receiver in the same phase to give a maximum. If not 1 difference:

$b = (n + \frac{1}{2})\, l$

, the signals arrive in opposite phase, and the resulting recorded signal will be equal to the difference of their amplitudes, i.e. zero. As a result, the directivity diagram of a radio interferometer, unlike that of a single radio telescope, when cut by a plane passing through the base, has the appearance of narrow leaves, and the angle between the maxima or minima of two adjacent leaves is △ Ö:

$$\triangle \text{Ö} = \arcsin \frac{(n+\frac{1}{2})\lambda}{a} - \arcsin \frac{n\lambda}{a} = \frac{\lambda}{a} = \delta$$

is found through (see figure). Here d - characterizes the resolving power of the radio interferometer, and it is not difficult to understand that when the a - basis is too large, d - is too small, and the resolving power of the radio telescope is very high. For example: when l = 1 m, base a = 1000 km, the resolving power of the radio interferometer

$$\delta = \frac{1\text{m}}{10^6\text{m}} \cdot 5{,}73 \cdot 60 \cdot 60'' = 0{,}206''$$

will be equal to Therefore, such an interferometer can separate objects located at a distance of 0.2 arcs from each other in the meter range . Also, such an interferometer makes it possible to determine the angular ratio of the object and the distribution of radio brightness ″according to a certain coordinate . In the following years, a method of radio interferometric observation of celestial bodies was developed using antennas and receivers located on different continents. As a result of observation using this method, the resolution of the interferometer ″reached 0.0003. One of the three radio telescopes involved in this observation was located in Australia (65 meters), the second in Russia (22 meters) and the third in the USA.

dozens of highly sensitive radio telescopes are working on different continents of our planet . The diameter of the mirrors is 65 m (Australia), 76 m (England), 100 m (FRG), 600 m (Russia) and 300 m (USA). provides non-stop information from natural radio sources. These telescopes allow us to see the "radio image" of the Universe in fine detail

Parabolic antenna. One of VLA's 27 antennas.

The radio signals coming from these antennas aimed at a space radio source are added and analyzed on a computer, and a radio map of the radio source is created, in which the radio temperature distribution is checked. Such a radio telescope is called based on the synthesis (additive analysis) of apertures (many antennas). Radio source signals fall on the antennas of such radio telescopes for 12 hours (from the time the radio source rises above the horizon to the time it sinks) at different angles and are recorded. The measurement results collected during half a day are analyzed on a computer and a radio map of the radio source is created. In such maps, the internal structure of the radio source was studied in high resolution.

Radio astronomy is one of the new directions of astronomy . It spans the frequency range from a few megahertz (MHz - 100 m) to about 300 MHz (1 mm), thus extending the observable electromagnetic spectrum by several orders of magnitude. The lower-frequency limit of the radio range is determined by the opacity of the ionosphere, and the higher-frequency limit is determined by the strong absorption bands of oxygen and water in the lower layers of the atmosphere. But none of these limitations are absolute, and under favorable conditions radio astronomers can work through holes in the ionosphere in the submillimeter region or during sunspot minima.

At low frequencies, antennas are usually dipoles (like those used in radios and televisions), but to increase the light-gathering surface and resolution, dipole arrays are used - where all the dipole elements are connected together.

The most common antenna is the parabolic reflector, which works like a telescope with an optical mirror. At long wavelengths, the reflecting surface is not necessarily continuous, long-wavelength photons cannot see the holes in the reflecting surface, and therefore the antenna is usually made in the form of a metal mesh. For high-frequency operation, the receiving surface must be very smooth, even in the millimeter-submillimeter range, where radio astronomers install their own radiometers and use large optical mirror telescopes. Surface roughness should be less than 1/10 of the observed wavelength to ensure coherent signal amplification.

The main difference between optical and radio telescopes is their signal recording. Radio telescopes are not imaging telescopes (except for synthetic (man-made) telescopes listed below); instead, a speaker-like radiator at the antenna's focus sends a concentrated signal to the receiver. This saves wavelength and phase information.

The Ö-resolving ability of a radio telescope can be derived from the formula written for optical telescopes, that is, it is λ /D , where λ is the observed wavelength, D is the aperture (antenna) diameter. Since the ratio between the wavelengths of optical and radio rays is about 10,000, antennas several kilometers in diameter are required to achieve the resolution of optical telescopes. In the early days of radio astronomy, one of the biggest obstacles to its recognition and development was its extremely low resolution . For example, the antenna used by Yansky had a fan-shaped signal of approximately 30° of separation in the narrowest direction . Therefore, observations in the radio range cannot be equated with optical observations . There were no opportunities to match radio sources with their optical counterparts .

The largest radio telescope in the world is the Arecibo antenna in Puerto Rico , whose main reflector is fixed and installed in a circular natural valley with a diameter of 305 meters, covered with a metal grid. By the end of the 1970s, its antenna surface and receiver were modernized, as a result of which the antenna was able to operate at wavelengths up to 5 cm. The mirror of the Arecibo telescope is not parabolic, but rather spherical, and the antenna is equipped with a movable transmitter system, which allows observations to be made in an area with a radius of 20° around the zenith.

The largest fully manned radio telescope is the Green Bank Telescope, built in late 2000 in Virginia, USA. It is slightly asymmetric and has a diameter of 100-110 meters. The Green Bank Telescope was preceded by the Effelsberg Telescope in Germany for about 20 years. Its antenna was parabolic and had a diameter of 100 meters. The inner 80-meter dish is made of flat, continuous aluminum panels , while the outer part of the disc has a metal grid structure. Using only the inner part of the telescope, it was possible to observe the wavelength range up to 4 mm. The oldest and perhaps most famous large radio telescope is the 76-meter antenna at Jodrell Bank in Britain, which was completed in the late 1950s.
The RT-70 radio telescope project on the Suffa Plateau of Uzbekistan was started in the mid-80s. At that time, he appeared as an absolute leader in the world. I would like to note that the object is well preserved, it can be continued to be built. If our scientists have such a tool, many things will change. In addition, it joins the family of such devices, significantly complementing it . World science is interested in this.

References

1. Sattorov I. Astrophysics. Textbook for students of higher educational institutions. Ministry of Higher and Secondary Special Education of the Republic of Uzbekistan . — T.: "Educational Publishing House", "Economics-Finance". 2009.
2. Mamadazimov Mamadmusa «Umumiy astronomiya». «Yangi asr avlodi», 2008-yil.
3. M.Kuchkorov, M.Erkinova, “The role of didactic materials in the process of teaching physics”, “Galaxy international interdisciplinary research journal (GIIRJ)” – 2023.
4. I.Eshboltayev, M.Erkinova, “Application of differential equations to physical examples in the study of harmonic vibrations”, “International Journal of Education” – 2024.
5. I.Eshboltayev, M.Erkinova, “Application of differential equations to physical examples in the study of damped vibrations”, “International Journal of Education” – 2024.
6. I.Eshboltayev, M.Erkinova, “Application of differential equations to physical examples in the study of forced vibrations without taking into account the resistance of the medium”, “International Journal of Education” – 2024.