METHODS OF SOLVING SOME PROBLEMS FROM RADIO ASTRONOMY

Khotamov Jakhongir Abdumalikovich
To`rayeva Gulida Davlat qizi
Jizzakh State Pedagogical University

Annotation: This article shows the importance of teaching radio astronomy in pedagogical higher education institutions and ways to solve some issues related to this science.
Key words: Radio astronomy, radio telescope, radio frequency, black hole, pulsar

Enter. Today, the development of the science of radio astronomy helps to find solutions to many puzzles of the universe. Therefore, preparing students as mature and qualified personnel of this field remains an urgent problem of the present time. The fact that this field of science is new and there is not enough literature on this subject in the Uzbek language creates difficulties in teaching the subject. It is necessary to give great importance to the teaching of radio astronomy in pedagogical higher education institutions, to further strengthen the knowledge of students, to increase their imagination, to solve problems from radio astronomy. In general, a problem that is solved using logical conclusions, mathematical operations, and laws in radio astronomy is called a radio astronomical problem. It is known that the work of students on radio astronomy problems leads to an increase in their world view of science.

Literature analysis and methodology: Understanding the science of radio astronomy, since the processes shown in the science are complex processes, working with this science is an integral part of the teaching process, and it greatly helps to form concepts related to radio astronomy. In educational literature on the science of radio astronomy The following cases are widely used in the methodology of solving problems:

- ✓ when describing a new topic ;
- ✓ in creating a problematic situation by posing a problem to the student;
- ✓ in the formation of practical qualifications and skills;
- ✓ testing the strength and depth of knowledge acquired by students;
- ✓ strengthening, summarizing and repeating the topic;
- ✓ in the development of students' creative thinking skills.

Results: By solving the problem, students' interest in science, independent thinking, determination to achieve the set goal are nurtured. Now let's consider the methods of solving the following problems.

1. At ~15GHz, the Green Bank Telescope can reliably detect flux densities down to 0.2 mJy. Below this, the telescope begins to enter its "confusion limit," where there are so many objects of the same flux density that a single object cannot be detected. Given this perturbation limit, *what is the maximum distance at which we can detect thermal emission from a neutron star* ($T \sim 10^5$ K, radius R ~ 10km)? The nearest neutron star is 85pc away, and the most sensitive radio telescopes *can detect about 1 μJy* . Comment: Can humans detect thermal emission from neutron stars? Consider what astronomers can try to have a better chance of detecting thermal emission from a pulsar.

Answer: We know that current for small angles $S_v = I_v = I_v p\, R^2/D^2$, where D is the distance to the star. Thus, if the star is determined.

$$D \leq \sqrt{I_\nu \frac{\pi R^2}{S_{\lim}}}; I_\nu = B_\nu = \frac{2kT\nu^2}{c^2}$$

the latter we can use to consider thermal (blackbody) emission in the RJ approximation. So to simplify...

$$D \leq \frac{\nu R}{c}\sqrt{\frac{2\pi kT}{S_{\lim}}}$$

Thus, when GBT's 15GHz interference threshold is converted to MKS units,S_v = 2×10 $^{-30}$ WHz $^{-1}$ m ^{2} , we can connect them and get

$$D \leq \frac{(1.5\times10^{10})(10^4)}{3\times10^8}\left(\frac{2\pi\times1.4\times10^{-23}\times10^5}{2\times10^{-30}}\right)^{1/2}$$

This gives us $D \leq 3\times10^{-5}$ parsec ≈10 ^{12} m ≈7AU. So it basically had to be in the solar system! It seems that there are no pulsars in our solar system, and it seems that we have no way to detect even the nearest pulsar in the radio range (known $D \propto \nu\, S_{\lim}^{-1/2}$ and radio frequencies up to ~ 1 THz). Fortunately, pulsars also emit non-existent rays.
thermal emission, which allows us to detect them at great distances. Moving to higher frequencies can help us (eg thermal emission from neutron stars detected at optical/X-ray wavelengths). Note that at these frequencies the Planck relation is used rather than the Rayleigh-Jeans limit used above. You can also use Wien's law to determine the peak frequency/wavelength of emission at this temperature, which is in the optical range.

2. Most cell phones send and receive 4G data on the 1900 MHz wavelength. A "low power" transmitter in a cell phone can transmit about 2W of power transmitted over a 30 kHz bandwidth. What current density would you observe for an active emitting cell phone at lunar distance when a ground-based radio telescope is observed at 1900 MHz ? Hint: consider the mobile phone as an isotropic emitter. What does this mean about its force per unit angle?

Answer: A cell phone transmits isotropically, so it sends *P = 2W of power* in all directions , *covering 4p.* steradians and transmits over a 30 kHz bandwidth. In the small-angle limit, cosθ ~ 1 and the current density

$$S_v = I_v\ \Omega\text{source}\ .$$

Ω_{source} = *dσ It is safe to assume that* /*D* ^{2} , where *D* is the distance to the source. Thus, for an unresolved isotropic emitter:

$$S_\nu = \frac{dP}{d\nu}\cdot\frac{1}{4\pi D^2}$$

and $D_{\text{month}} \approx 3.8\times10^8$. *And so* ,

$$S_v = \frac{2W}{(4\pi\ sr)(3\times10^4\ Hz)(3{,}8\times10^8 m)^2} = 3{,}6\times10^3 Jy$$

one of (if not the) brightest point sources in the sky *is at the same frequency* !

3. We get a lot of information about radio sources based on the measurement of flux density as a function of frequency (spectral *energy distribution*). Most of the discrete radio

sources that make up the "radio" background in ERA Figure 1.4 (shown above) have power-law spectra of the form

$S \propto n^{a}$

Hereα *indicator* called the spectral index. In the figure, the slope of the straight line representing the radio source background is approximately +0.3. *Estimate* the average spectral indexα resources that make up this radio background.

Answer: The axes of the figure are such that the "radio" line has a power-law spectrum:

$$\frac{d\log(\nu I_\nu)}{d\log(\nu)} = +0.3$$

where

$I_v \propto S \propto v^{\alpha}$

and

$vI_v \propto v \cdot v^{\alpha}$

log(v I_v) = (1 +α)log(v) + const

And so on...

$$\frac{d\log(\nu I_\nu)}{d\log(\nu)} = +0.3 = 1 + \alpha \quad \rightarrow \quad \alpha = -0.7$$

This is the average spectral index of the sources; coincidentally and coincidentally, it is also the average power-law spectrum of optically thin synchrotron emission.

Summary. Taking into account the importance of solving problems in teaching radio astronomy, pedagogy shows students of higher education institutions that it is necessary to pay more attention to problem solving lessons in practical training in radio astronomy curriculum. The formation of students' ability to work logically correctly leads to an increase in their outlook on science. A future teacher working on astronomical and radio-astronomical issues in a simple form will give students more understandable knowledge.

List of references:

1. L. Ronald, E. Stanley, M. Jonathan "Fundamentals of Radio Astronomy" Taylor & Francis 2019.
2. Kurbaniyazov S., Ajabov A. "Basics of Radio Astronomy", educational methodological complex. Samarkand-2017.
3. Diane Fisher Miller. "Basics of Radio Astronomy" California JPL 1998.
4. https://web.njit.edu/~gary/728/
5. TL Wilson, S. Huttemeister "Tools of Radio Astronomy Problems and Solutions" Springer 2021.