Development of methods for creating sensitive receivers for the detection of distant quasars

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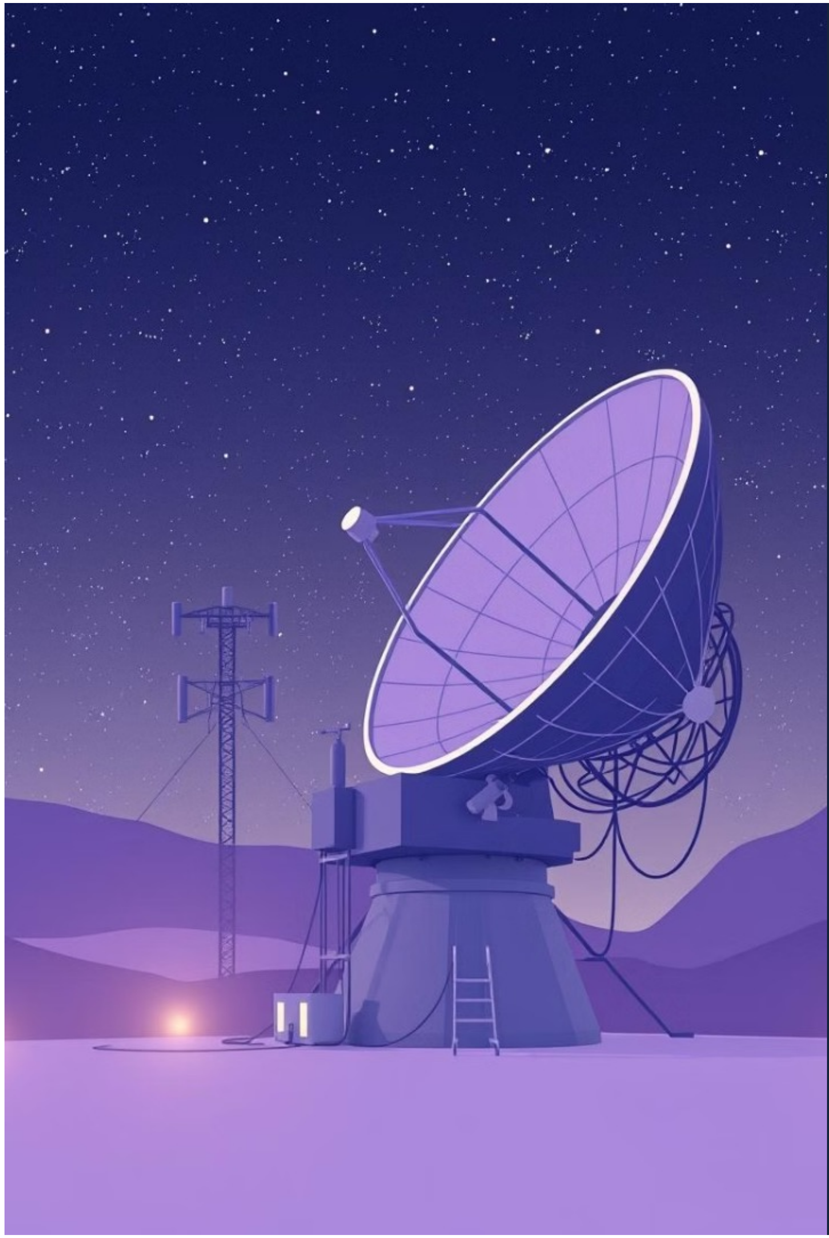
Our this presentation is dedicated to the problems of developing methods for creating sensitive receivers for the detection of distant quasars. It consists of two parts: the justification of the necessity and relevance of the development of appropriate sensitive receivers and the study and development of the methods of creating these receivers. And now we will present only the first part of the mentioned work, which is dedicated to presenting the requirements and conditions necessary for the creation of these sensitive receivers, noting in advance the strict necessity of these requirements and conditions for solving many space problems. Specifically, we study the radiation characteristics of quasars with an absolute magnitude of -23 at certain distances, in order to make sure that we can detect all quasars at those distances.



With the help of quasars, one can form ideas about the distribution of matter in distant regions of the universe. It is so because quasars are the brightest sources in the universe, but their luminosities differ from each other quite large. It can reach up to 10 stellar magnitudes, which means that the luminosities of quasars can differ up to 10,000 times.

That enormous size allows us to assume that some of the quasars cannot be detected at great distances. However, ideas about the structure of the universe are mainly determined by quasars. We study the structure of the universe with the help of extragalactic sources, and most of the analysis is due to quasars. In order to imagine how quasars are distributed in the universe, let's consider a domain that we studied and where there are a large number of quasars.

As a sample, we use the distribution of quasars in the range with a radius of 6 degrees around quasar 0851+20. About 1,600 quasars have been discovered in that range. Their redshifts reach up to 5.2. In that range there is a quasar whose absolute magnitude is less than -29.

Absolute magnitudes were estimated using formula 1:

$$M=m-5\lg R-25$$

where M is the absolute magnitude, m is the apparent magnitude, and R is the distance from the observer to the source (in megaparsecs).

The obtained data show that the luminosity (L) of the brightest quasars is approximately 10^{13} times greater than the luminosity of the sun, and this means that the energy radiated by quasars is ten times or even more than the energy of supergiant galaxies. Even faint quasars exceed supergiant galaxies in their radiated energy, which is why they are detected at greater distances. However, many quasars cannot be detected at great distances, which causes problems for estimating the real distribution of quasars. In this work, we discuss what kind of sensitive detectors are needed to discover quasars at large distances. We are discussing having a sensitive detector with the help of which it will be possible to detect weak quasars whose redshifts reach up to 3-4 values. There are several methods to detect such quasars:

1. Since quasars are rich in hydrogen, it is necessary to observe with the help of H_{alfa} (6565 angstrom),
2. Lyman alpha: L_{alfa} (1200 angstrom) lines.

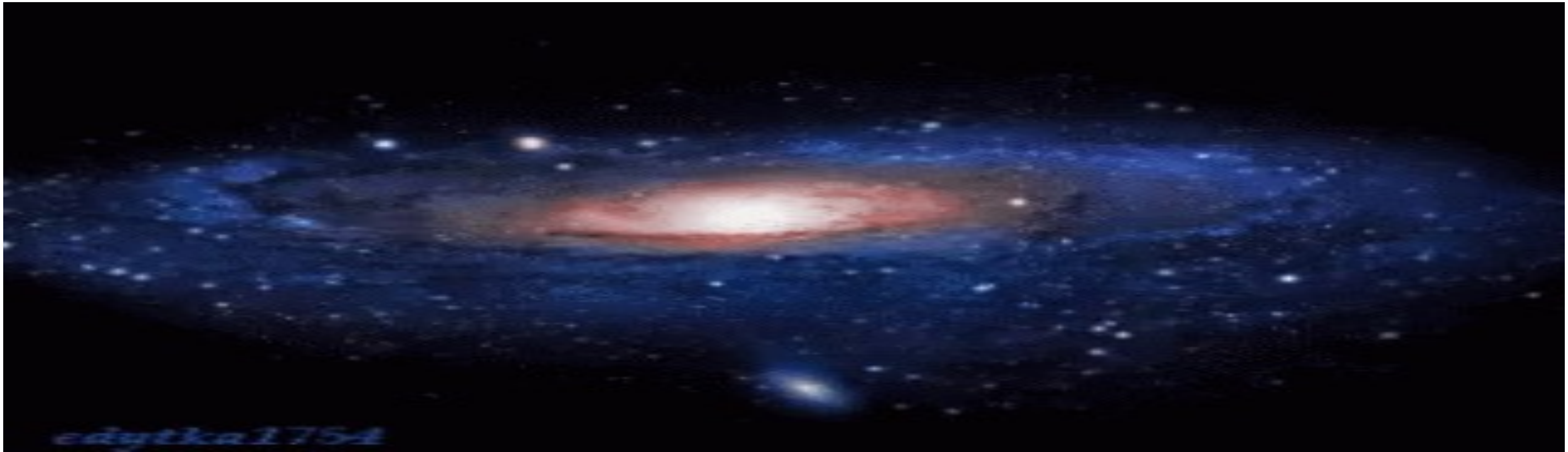
And in the case of Z= 4, the Halfa line moves to the infrared range of 32825 angstroms, and the L_{alfa} line moves to the red range: 6000 angstroms. In that way, there are many sensitive receivers that are able to observe distant quasars and determine their redshifts, but there are quite big difficulties in that direction.

Considering these difficulties, we are trying to develop methods for shorter waves, which will allow us not to change the observation range (optics, X-ray, etc.). If we have a sensitive receiver in the X-ray range, we can determine the red deviations of the object with the help of lines in that range. Since in the case of Z= 4, several angstrom wavelengths are moved to a longer range which is also the X-ray range.

For example, 4, 5 angstrom waves are moved to the 20, 25 angstrom range. 4, 5 and 20, 25 angstrom ranges are in the x-ray range and the method for their studying is the same. This means that in the cases of values of Z= 0 to 4 and X-ray range, one can observe these quasars with the same receiver and determine their distances, because there are strong lines of several elements in the range of 3-5 angstroms and in the case of their detection, the redshifts of quasars and their distances will be identified.

Development of methods for creating sensitive detectors in the X-ray range will allow the detection of all quasars with Z equal to 4 redshifts. We believe that the application of the channeling phenomenon will help to solve this problem.

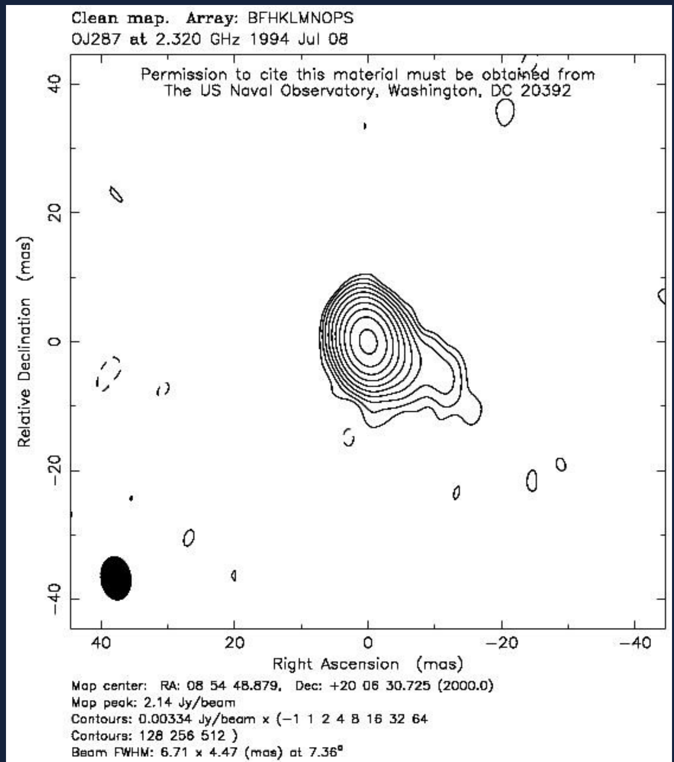
To clarify the parameters, let's discuss the properties of quasar 0851+20 and the distribution of quasars around it.



0851+20 quasar studies

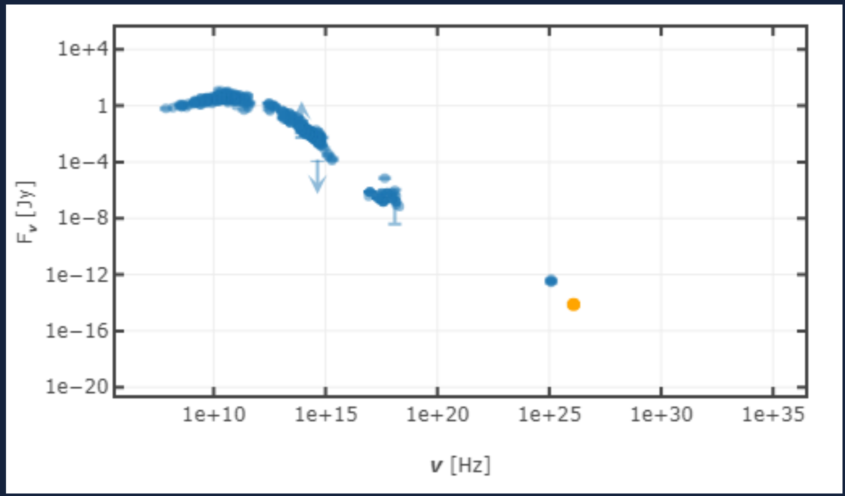
Quasar 0851+20 has an angular size greater than 20 minutes in the radio range, which was obtained in the frequency range of 2320 MHz It can also be seen from the picture that it has a somewhat elongated extended appearance in the north-east direction.

The quasar 0851+20 is quite close and quite bright (z=0.3056 and m= 14.0). The brightness of the quasar has made it possible to perform quite a large number of spectral studies and to have more accurate data about it. However, that quasar would not be detected at a distance of z=4 due to its faintness, at that distance m is greater than 18 (visible stellar magnitude).



The dark image on the left side of the picture is the antenna diagram, which shows at what distances 2 different sources can be separated from each other.

In the optical domain, a quasar looks like this.



It can be seen from the picture that the quasar is a very compact, special optical source specific for quasars.

Spectral studies show that the spectrum in the radio range of frequencies from 100 megahertz to 10 gigahertz is quite flat, which is also a typical property of quasars. In other words, radio-optical studies show that quasar 0851+20 is a source of the class of classical quasars and has all the properties specific to quasars. It is very well studied.

Study of the distribution of quasars around quasar 0851+20

There are 1603 quasars inside the cone with a radius of 6 degrees surrounding the quasar 0851+20, which is quite a large number and the distribution of quasars by distance up to the z=2.2 redshift level is quite reliable. The histogram of the distribution of quasars according to z is shown in Figure

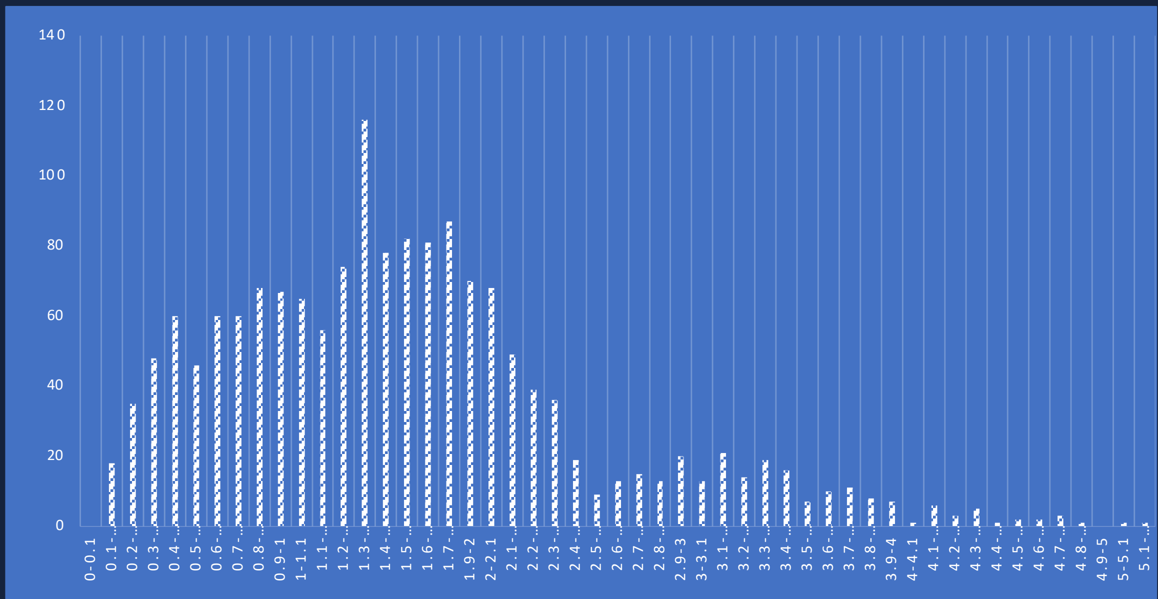


Figure shows that at small z quasars are relatively few. this is due to the fact that their number in the near distance is actually small as that phase has remained in the past. The number of quasars increases depending on z and reaches its maximum value at z=1.6. After 1.6, that number begins to decrease, which is due to the difficulties in detecting quasars.

Quasars, being the brightest objects in the sky, can be found at great distances. It is very important to find the distances where all quasars of magnitude -23 can be detected, and this means that the number of quasars detected at those distances will be complete, and only in that case we can talk about the complete distribution of quasars.

Conclusion:

Conducted studies allow to us assess what kind of sensitive receivers are needed to detect a quasar with an absolute magnitude of -23 at a distance where Z equals 4, particularly by analysing the relationship between the energy emitted by quasars and the energy emitted by the Sun.

The energy emitted by a quasar with an absolute magnitude of -23 is, as mentioned above, is about 10^{13} times stronger than the energy emitted by the Sun. The quasar at a distance of Z equals 4, emits energy of 10^{56} Joules, which corresponds to a energy of 0.42 Joules if the quasar is a billion light years away.

The energy of one quantum is on the order of 10^{-16} Joules, so the power of the emitted energy is equivalent to the energy of 10^{11} quanta. As of the above, it is necessary to estimate and ensure the necessary sensitivity of needed X-ray receivers that can register such energy.

We are confident that by using the phenomenon of channeling in the X-ray range, we can develop receivers with a needed sensitivity and achieve the detection of quasars with an absolute magnitude of -23 at distances up to Z=4, which we will attempt to accomplish in the next stages of our work.

References

1. A.H. Bridle, M.M. Davis, D.A. Meloy, et al, Giant radio galaxy NGC 315. Nature, 262 (1976) 179, https://doi.org/10.1038/262179a.
2. R. Chen, B. Peng, R. G. Strom, and J. Wei, Mon. Not. R. Astron. Soc. 2012420, 2715–2726.
3. V.S. Artyukh, M.A. Hovhannissian, S.A. Tyulbashev, Observations of the radiogalaxies NGC 315 and 3C 219 at 102 MHz, PAZh, 20/**A** (1994) 178-183, Bibcode:1994AstL20146A.
4. V.S. Artyukh, M.A. Hovhannissian, A Largescale Void in the Distribution of Compact Radio Sources, SvAL, 14/**A** (1988) 377-378, Bibcode:1988SvAl14277A
5. L. Rudnick, S. Brown, and L. R. Williams, The Astrophysical Journal, 671 (2007) 40Y44, 10.
6. E.B. Fomalont, S. Frey, Z. Paragi, et al, The VSOP 5 GHz Continuum Survey: The Prelaunch VLBA Observations Astrophys, J. Suppl. Ser., 11 (2000) 95, https://doi.org/10.1086/317368.
7. D. M. Worrall, M. Birkinshaw, R. A. Laing, W. D. Cotton, and A. H. Bridle, MNRAS, 380/**1** (2007), 2–14.
8. K. Lakhchaura, N. Truong, H. Werner, Correlations between supermassive black holes, hot atmospheres, and the total masses of early-type galaxies 019, Mon. Not. R. Astron. Soc., 488/**1** (2119) L134–L142, https://doi.org/10.1093/mnrasl/slz114.
9. G.A. Verdoes Kleijn, S.A. Baum, P.T. de Zeeuw, C.P. O'Dea, Radio and Optical Emission in the Nuclei of nearby FR I Radio Galaxies, Astron. J., 123 (2002) 1334, https://doi.org/10.1086/339177.
10. S. B. Dabagov, Channeling of neutral particles in micro- and nanocapillaries, Physics Uspekhi (Reviews of Topical Problems), 46/**10** (2003) 1053–1075.

Thank you