SEARCH FOR MONOCHROMATIC 927-MHz RADIO EMISSION FROM NEARBY STARS

V. S. Troitskii, A. M. Starodubtsev, L. I. Gershtein, and V. L. Rakhlin

Radiophysics Institute, Gor'kii State University
Translated from Astronomicheskii Zhurnal, Vol. 48, No. 3, pp. 645-647, May-June, 1971
Original article submitted June 2, 1970

A search for narrow-band emission from certain stars up to tens of light years from the earth is reported. Signals were sought in a 2-MHz band around 927 MHz by means of a 25-channel detector each channel of which had a passband of 13 Mz and a noise temperature of 60°K. An antenna 15 m in diameter was used. No monochromatic emission above $2 \cdot 10^{-21}$ W/m^2 was found at this wavelength during the search.

This study was part of the search for signals from extraterrestrial civilizations. A theoretical treatment seems to show that a highly developed civilization probably exists within 100-1000 light yr of the sun [1-4]. Analysis of the nature of the of the possible signals leads to the conclusion that one can expect extremely narrow-band monochromatic signals (see [3], pp. 97-112). We designed and built suitable apparatus and carried out observations of 12 sources. The search is described below.

It is the search for monochromatic emission which significantly distinguishes this study from the first measurements made by Drake in 1960 [5] for two sources at 21 cm.

Monochromatic cosmic signals were sought with a parabolic antenna 15 m in diameter at the Radioastronomy Station of the Scientific-Research Institute of Radiophysics at Zimenkie. The receiver is of the superheterodyne type with a parametric amplifier at the input and a noise temperature of 60°K; it is tuned to 927 MHz and has a pass band of 2.2 MHz. The first local oscillator is excited through a series of multipliers from a quartz crystal oscillator which permits transient instabilities of only $5 \cdot 10^{-9}$ in the oscillator frequency. The 75-MHz intermediate-frequency voltage is supplied to the input of a monochromatic-signal analyzer, where there is a second conversion into a frequency band from 3.4 to 5.6 MHz.

The second local oscillator is based on a quartz oscillator whose frequency can be easily changed, linearly, through 4 kHz. The frequency-change period is 28 sec.

There is provision for changing the frequency at any other rate by means of an external control-voltage source. The amplified voltage in the range 3.4-5.6 MHz is analyzed successively by 20 filters. The bandwidth of each filter is 100 kHz; together, they cover a band of 2 MHz. Each filter singles out a single channel for analysis. The channels can be switched either automatically at intervals of 28 sec or manually.

The output voltage from any filter is again converted into the frequency band 0.2-0.3 MHz. This third conversion stage also uses a voltage from a quartz crystal oscillator. Twenty quartz crystals which are switched along with the filters are used for stepped changes in the oscillator frequency. A set of narrow-band filters 4 kHz apart is connected to the output of the last intermediate-frequency amplifier. The output signals from all the filters are connected in succession by an electronic switch to an oscilloscope and examined on a screen with a 0.05-sec horizontal sweep time; the screen has some afterglow. In this manner 25 bands each 13 Hz wide are examined simultaneously. A period of 10 min is required for automatic scanning of the 2-MHz band.

In the fall of 1968 and 1969, observations were made of stars taken from a catalog prepared especially for this purpose under the direction of B. V. Kukarkin. A list of the stars is shown in Table 1;

TABLE 1

No.	Star	Equatorial coordinates		Observation time		Distance, light yr	Spectrum
		δ 1963,0	α				
2	2	3	4	5		6	7
1	380 Ursae Majoris	49°36′54″	$10^h09^m31^s$	08.12.68 09.12.68	09^h02^m 07 45	14.7	dM0
2	Andromeda nebula	41°06′00″	00 41 00	17.10.68 18.10.68 21.10.68 22.10.68 23.10.68 20.02.69	12^h30^m 11 53 11 00 03 26 12 40 08 00	—	
3	τ Ciet	−16°06′38″	01 42 40	21.10.68 22.10.68 20.02.69	23^h00^m 00 00 21 08 21 14 23 00 23 24 11 00	11.9	G_8V_p
4	ε Eridani	−09°33′48″	03 31 30	21.10.68 22.10.68 20.02.69	23^h30^m 23 40 00 40 21 33 21 43 23 20 11 30	10.8	K_2V
5	47 Ursae Majoris	40°35′46″	10 57 44	17.10.68 21.10.68 22.10.68 23.10.68 24.10.68 	08^h00^m 11 50 07 55 08 20 08 50 06 00 08 30 12 28 07 08 07 39	44.7	G0V
6	β Canum Venaticorum	41°31′32″	12 32 16	16.10.68 17.10.68 21.10.68 22.10.68 23.10.68	07^h30^m 12 10 07 00 07 15 23 33 07 20 07 00	30.2	G0V
7	ρ Comae Berenices	28°02′06″	13 10 25.6	16.10.68 17.10.68 21.10.68 22.10.68 23.10.68 24.10.68	08^h00^m 13 10 06 30 07 10 07 51 13 03 06 47	27.2	G0V
8	η Herculis	38°58′49″	16 41 40	08.12.68 09.12.68 	12^h00^m 11 38 11 48	61.6	G_8 III—IV
9	π′ Ursae Majoris	65°07′48″	08 36 28	08.12.68 09.12.68 20.02.69	11^h40^m 11 55 08 13 11 30	50.2	G0V
10	ψ_5 Aurigae	43°36′36″	06 44 30.3	08.12.68 09.12.68	12^h45^m 07 10	48.6	G0V
11	ι Persei	49°29′47″	03 06 49	08.12.68 09.12.68 20.02.69	08^h33^m 12 10 12 25 08 40	38.8	G0V
12	η Bootis	18°33′26″.8	13 53 09.6	16.10.68 17.10.68 21.10.68 22.10.68 23.10.68	07^h05^m 08 30 07 30 07 45 07 40 07 30	31.9	G0IV

the second column shows the name of the star, the third and fourth show their equatorial coordinates (1969), and the fifth column shows the mean Greenwich observation time. Each observation lasted 10 min. No monochromatic signals from these objects were discovered above the noise level, which is equivalent to a threshold power flux of $2 \cdot 10^{-21}$ W/m.

LITERATURE CITED

1. A. G. W. Cameron (editor), Interstellar Communication, Benjamin, New York (1963).
2. I. S. Shklovskii, The Universe, Life, and Intelligence [in Russian], Nauka, Moscow (1965) [Trans.: I. S. Shklovskii and C. Sagan, Intelligent Life in the Universe, Holden-Day, San Francisco (1966)].
3. Extraterrestrial Civilizations [in Russian], Izd. AN ArmSSR (1965).
4. Extraterrestrial Civilizations [in Russian], ed. S. A. Kaplan, Nauka (1969).
5. F. D. Drake, Project Ozma, Phys. Today, 14, 40 (1961).