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NEUTRAL HYDROGEN OBSERVATIONS OF EXTENDED GALACTIC STRUCTURES

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ABSTRACT. *Using the Large Pulkovo Radio telescope and the RATAN-600 radio telescope observations were made of several extended galactic structures of different nature in the 21 cm neutral hydrogen radio line. The distribution of HI emission with fixed velocities was derived and compared with the positions of HII and dust clouds. The results of such comparison are given in the contribution.*

На радиотелескопах БПР и РАТАН-600 были проведены наблюдения на волне 21 см в радиолинии HI на волне 21 см нескольких протяженных галактических структур разной природы. Получено распределение излучения на фиксированных скоростях и сделано сравнение с расположением зон HII и пылевых облаков.

1. INTRODUCTION

For study of extended galactic structures of different nature in the interstellar neutral hydrogen radio line the most convenient way for presentation of HI observational data during last decade is revealed to be the position-position contour maps of temperature generated for fixed velocities taken often enough.

These maps could be directly compared with those for other spectral ranges: infrared, H_α and so on. This comparison gives an information about the velocity behaviour of common details and their environs.

2. TELESCOPES, METHODS OF OBSERVATIONS AND REDUCTIONS

Two transit radiotelescopes, at first the Large Pulkovo radiotelescope and then the RATAN-600 in Zelenchukskaya were used during many years for systematic study of the galactic neutral hydrogen radiation at λ 21 cm radio line. The parameters of the telescope in Pulkovo are: the beamwidth at this wavelength is $6' \times 5^{\circ}$, 10 spectral channels with bandwidths of 20 kHz. For the RATAN-600 the quantities are: $2.5' \times 2.5^{\circ}$, 40 channels of 30 kHz. But by middle of 1991 additional panels were fixed on every element of the RATAN-600.

The difficulties of the frequency adjustment due to immobility of our telescopes could be overcome by changing the frequency adjustment of receivers during the observations. This procedure was done often enough for keeping the frequency in every spectral channel constant relative to the local standard of rest.

The most efficient method of spectral observations with our transit telescopes seems to be obtaining of "drift curves" which lasted many hours at the same setting of the telescope on fixed elevation. These drift curves formed the lines of the matrix being the base for generation of the maps of HI emission at some fixed velocities, but after taking the measures to exclude the seasonal spill-over effects.

The full extent of the beams of our two telescopes is still unknown from zenith to horizon, and the direct calculation of the seasonal amount of stray radiation is hardly possible. But the sidelobes are, of course, present, their extent was partially revealed when the Sun was either rising or setting behind the elements of the telescopes during observations of other objects.

An indirect method was used for excluding, at least partially, the seasonal spill-over effects. The HI emission consists of two components and the structural one is free from stray radiation in contrast to the "structureless" component (Bystrova, 1980). Such a division into two components is quite easy when using 24-hour drift curves, but a wide set of declinations makes problems when the observations lasted only a few hours. Before the maps of the HI distribution at fixed velocities are generated the two-stage procedure of the structural component extraction is realized. The spline interpolation is the first stage and the corrections of the positions of some nodes are made taking into account the Pulkovo sky survey where the scans lasted 24 hours.

3. HII FILAMENTS AND HI DISTRIBUTION

Several extended zones were observed with our telescopes. They were previously suggested to be supernova remnants: the regions of the Sco OB-2 association, of λ Orionis, filaments in Cetus-Eridanus. In all of them the HI behaviour was interpreted earlier as shells expanding from a common center of expansion.

But after the marvellous observations made by Sivan (1974) faint filaments were revealed when the main HII-zone was overexposed. And then it became obvious that these filaments were unambiguously associated with HI distribution. These filaments play the dominant role in the HI distribution and control its behaviour.

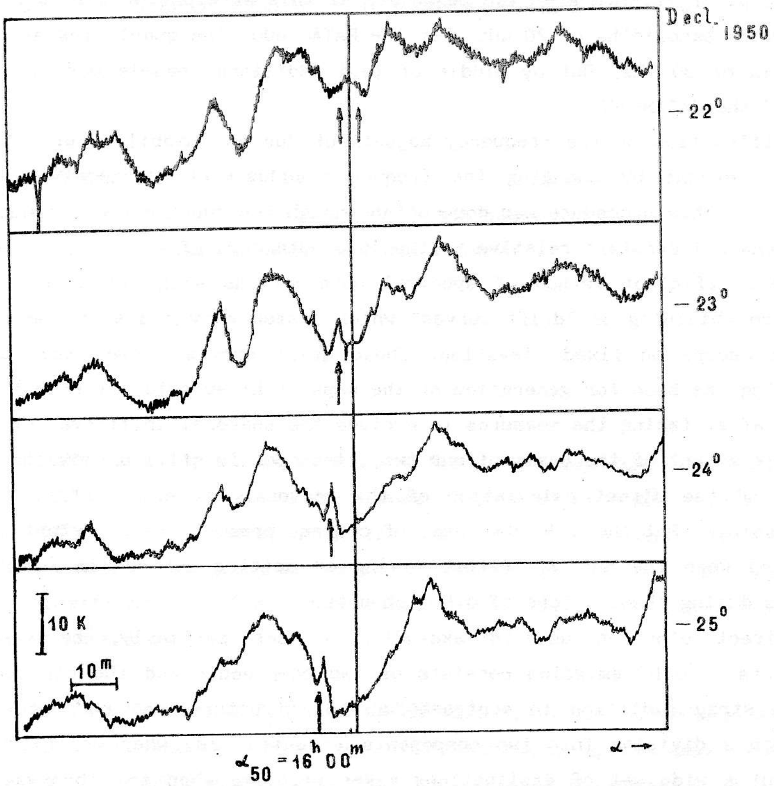

Fig. 1. *Four drift curves obtained at the RATAN-600. Arrows show the new detail described in the text 3.1. The scales in right ascension and antenna temperature are shown.*

3.1. The region of Scorpius OB-2 association

Already in 1979 our results obtained with the Large Pulkovo radiotelescope were published. They showed the certain connection of HI distribution with outer filaments belonging to the S7 and S1 nebulae. Till now no other observations of these filaments at λ 21 cm line are present, possibly because such details could be missed when the observations were made using the prearranged net of positions (Cappa de Nicolau et al., 1986). Our RATAN-600 observations confirmed the results and gave some new details. The most prominent of them are those situated directly against the S7 nebula itself. These details could be registered only after diminishing the vertical size of the beam of the RATAN-600 to 1.6 deg. Preliminary positions and antenna temperatures are given in the Table.

Table

Dec_{1950}	RA_{1950}	T_A
-22°	$16^h\ 00^m.0$	
-23	15 57.0	Approximately 3-5 K
-24	15 54.5	
-25	15 52.6	

The source at -22 deg is double.

According to photographs taken with shorter exposures which were presented by Sivan (1974) this narrow HI ridge is connected with filaments being in the nebula itself. The halfwidths along this unique ridge are less than one minute in RA. Its velocity is +2.4 km/s. The fact that the positions of the remarkable detail found at -12 km/s in Dwingeloo (Sancisi and van Woerden, 1970) and those of HI emission at approximately -6.1 km/s do not coincide remained unexplained in this region. This was confirmed using gauss-analysis of the profiles observed in the Sco OB-2 region (Cappa de Nicolau et al., 1986).

3.2. The surroundings of λ Orionis

After the detection of HII filaments to the west of the overexposed HII region itself (Sivan, 1974) our HI observations showed the gas in the next spectral channels to be connected with different HI loop and filaments (Bystrova, 1980). Now, after the comparison of HI distribution with far infrared dust emission the conclusion could be made that the HII filaments are possibly more distinctly connected with neutral hydrogen distribution than the dust details. Although the brightest and narrow HI signal lies between the western border of the main HII-zone and the bright extended dust detail being more to the west. This HI signal has additional $T_A \sim 12$ K, halfwidth in RA $\sim 1^{\circ}.2$ at a velocity of -0.8 km/s.

3.3. Filaments in Cetus-Eridanus

Till now it remains unanswered why inside the suggested expanding huge HI shell (Heiles, 1976) there is neutral hydrogen belonging to the same spectral channel as is the gas situated at the border of the shell. This border is shown by the long HI ridge (Bystrova and Rachimov, 1976). Both ridges outside and inside the adopted shell are accompanied by long H_{α} filaments. These facts wait for their explanation.

4. ANOTHER EXTENDED STRUCTURES

Several structures of different nature have been also studied at λ 21 cm line. There are Orion's great dust cloud, the surroundings of the nebula around ζ Ophiuchi and the ring-shaped detail around the South galactic pole visible to us. Some preliminary conclusions are given.

4.1. The Orion's great dust cloud (GDC)

The clear far infrared image of dust clouds, in particular of the dense ones, makes such pictures a convenient material for study them together with the neutral hydrogen distribution at a range of velocities. Using the observations at Pulkovo we see that the HI contours cover the whole GDC at velocities from -6.1 to +9.7 km/s. This interval is broader for the western brighter part of GDC: against this part of the cloud the HI contours project with velocities from +4.5 to +15 km/s.

Very remarkable is the behaviour of the HI at the borders of the GDC. At the velocity +25.6 km/s between the declinations -2° and $+12^\circ$ the main body of HI around the galactic plane begins exactly at the eastern border of the GDC and of the details connected with λ Orionis. To the south of declination -2° this border joins the HI at +15 km/s. At the south-western direction HI cloud belongs to the GDC at -0.8 km/s till declination -10°. Exactly at the western border of the GDC the known bright cloud is studied which stretches itself for 12-13 degrees up to declination $+3^\circ$, T_A being near 6 K and the central velocity -11.3 km/s. Some concentrations of HI project on this cloud at +9.7 and +15 km/s. Further to the north at this border of the GDC is the gas at -6.1 km/s. The whole picture of the HI motion in the area studied will possibly be obtained using the RATAN-600 observations after their full reductions.

4.2. The surroundings of nebula around ζ Ophiuchi

Special set of observations at the RATAN-600 was made to study the HI distribution around S27 (ζ Ophiuchi) nebula. Almost 20 cross-sections with a one degree interval in declination were realized. The large size of this nebula needed the duration of the records not less than 3 hours. In the equatorial coordinate system the HI distribution is not symmetric relative to the center of the nebula. Many details are seen as projected on the HII-zone.

4.3. The maps of HI distribution around the south galactic pole

Using the data obtained at Pulkovo the polar maps were generated in the galactic coordinate system to the latitudes $\pm10^\circ$. The maps were made at 10 velocities from -21.8 to +25.6 km/s in intervals of 4.2 km/s separately for the two components of the

HI emission. One of the prominent details in the southern galactic hemisphere is "the ring at negative velocities" (Cleary et al.,1979). In Pulkovo approximately half of this ring is seen. The latter is easily found on the maps at the pages 7, 11, 15 and partially 19 for the structural component of HI emission (Bystrova, 1980). The values of radial velocities of the ring are from -16.6 to -6.1 and even to -0.8 km/s LSR. At -0.8 only a part of the ring in the first quadrant remains, and at -16.6 parts in the second and third ones remain. The angular dimensions of this rather ellipse are approximately 100x50 degrees. The direction of the major axis is from the longitude 100 to 280°. These coordinates make doubtful the connection of the ring with Gould's Belt.

The -110 km/s details studied by Cohen (1981) project themselves on the brightest part of the ring (its northern part). Therefore a special search with the RATAN-600 was made to find some details having the velocities around -110 km/s in the other parts of the ring up to the southern limit of the ring visibility. The data are being processed now.

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