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The Universe at Very Low Radio Frequencies

S. Ya. Braude, A. A. Konovalenko and A. V. Megn

Institute of Radio Astronomy, National Academy of Sciences of Ukraine, 4 Chervonopraporna St., 61002, Kharkov, Ukraine

Abstract. The world biggest decameter wavelength radio telescope UTR-2 and VLBI system URAN, as well as main observational programs carried out with the above mentioned instruments, are described.

At the beginning of the 1970's the Ukrainian T-shaped Radio telescope, second modification (UTR-2), was built near Kharkov (Braude et al. 1978). It has the following parameters: operating range: 8 – 40 MHz; beam width at 25 MHz for zenith direction: 25′; maximum effective area: 150,000 m^2; number of array elements: 2040; sector of beam steering: 70° from zenith for both coordinates; the time of electrical beam directing to every point of the sector: less than 0.1 s; step of beam moving: about 4′; the whole number of beam positions in the sector: about 2×10^6; the number of simultaneously working beams: 5 – 8; the side lobe level: regulated in range from −13 dB to −30 dB; system temperature corresponding to brightness temperature of galactic background: about 30,000 K at 25 MHz; sensitivity (3σ level, band width of 10 kHz, integration time 60 s): about 10 Jy at 25 MHz. It is possible to work simultaneously at every frequency of the operating range and independently using the North-South (1800 m × 60 m) and West-East (900 m × 60 m) antennas.

The radio telescope is equipped with various analog and digital devices for receiving and registration. They are used correspondingly to performed scientific programs and to kind of received radio emission. The telescope equipment includes multi-channel receivers of continuous emission, correlation spectral analyzers, an acoustic-optical analyzer, dynamic spectrographs, polarization measurement devices, a heliograph, magnetic tape recorders and computer systems for data collecting. The telescope is controlled using personal computers.

On the base of radio telescope UTR-2, the decametric VLBI system URAN was built (Megn et al. 1997). Besides the UTR-2, it includes another four radio telescopes of smaller size. URAN-1 and URAN-4 belong to Institute of Radio Astronomy. URAN-2 is owned by Gravimetric Observatory of NASU (Poltava) and URAN-3 belongs to Institute of Physics and Mechanics of NASU (Lviv).

The system has bases from 40 km to 900 km. The angular resolution reaches 1 angular second (which corresponds to the fundamental limit imposed by scattering in the interstellar medium at these frequencies). Its ideology is analogous to that of high frequency VLBI networks. Comparatively narrow analysis band (up to several tens of kHz) and long wavelengths give the possibility to use rubidium frequency standards instead of hydrogen ones. Besides, quality commercial video recorders and personal computers for correlation data processing are employed. Now, the measurements with URAN are limited to determina-

tion of visibility function module for different bases and hour angles (Megn et al. 1998).

During the years of operation of UTR-2 and the URAN system, a great amount of new astrophysical information was obtained (Braude 1992; Konovalenko 1996). Most of the Universe's objects, including Earth's near space, the Solar system, the Galaxy, as well as the farthest objects such as radio galaxies and quasars, became accessible for investigation. It was proved that decameter wave radio astronomy could be very informative. Precise measurements of widely varying energetic, spatial, spectral, timing and polarization characteristics of space radio emission convey information about processes of the Universe scale, as well as fine atomic effects.

Among the main observational programs are the following: survey of extra galactic sources and composition of corresponding catalogue; investigation of radio emission parameters and spectra of quasars, galaxies, and galaxy clusters; investigation of distributed non-thermal radio emission of Galaxy; investigation of emission nebulas and ionized gas regions; investigation of supernova remnants and their interaction with interstellar medium; radio spectroscopy of interstellar medium with low frequency spectral lines of different kinds; investigation of impulse and continuum emission of pulsars; investigation of decametric emission of flare stars; investigation of sporadic and quiet emission of the Sun; investigation of emission from Jupiter and other planets of solar system and search for exoplanets; investigation of interplanetary medium and solar wind; decametric radar study of solar system objects; investigation of fine spatial structure of radio sources with VLBI, Moon occultation and scintillations methods.

In spite of high UTR-2 and URAN efficiency and big amount of positive astrophysical results, there are good perspectives of the future instrumentation and investigation development and even of the creation of new generation giant very low frequency radio telescopes.

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