Simeiz 22-m VLBI Station

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Abstract

We summarize briefly the status of the 22-m radio telescope as an IVS Network Station. We also present estimates of the annual irregularity of the plate motion.

1. Current Status and Activities

Figure 1. Simeiz VLBI station.

The 22-m radio telescope RT-22 of the Radio Astronomy Laboratory is located at the foot of mount Koshka ("The Cat") at the shore of Black Sea about 20 kilometers west from the city of Yalta (Figure 1). Radio astronomical station Simeiz was founded in 1965. First single dish observation was made in 1966. First VLBI observation was made in 1969. Radioastronomical station Simeiz was included to the International VLBI Network in 1980. The Laboratory provides observing facilities for astronomers from the international community and for its own staff.

Parameters of the 22 meters radio telescope are presented in Table 1.

Table 1. The antenna parameters of the Simeiz station.

Diameter D, m	22
Surface tolerance, mm (root mean square)	0.25
Wavelength limit, mm	2
Feed System	Cassegrain system or primary focus
Focal length F, m	9.525
Focal ratio F/D	0.43
Effective focal length for Cassegrain system, m	134.5
Mounting	Azimuth-Elevation
Pointing accuracy, arc sec.	10
Maximum rotation rate, degree/sec	1.5
Maximum tracking rate, arcsec/sec	150
Working range in Azimuth, degrees (0 to South)	-270 ± 270
in Elevation, degrees	0 - 85

The current projects:

1. Very Long Baseline Interferometry.

Facilities for VLBI observations at frequencies 612 MHz, 1.6, 2.3, 5.0, 8.4 and 22 GHz are available. RT-22 has participated in VLBI investigations since 1969. The highest resolution was achieved in the experiments in collaboration with USA antennas. The velocities of wind in the southern and northern hemispheres of Venus were measured in the course of the VEGA-project. Geodynamical VLBI program started at RT-22 in 1994 (Clark, et al., 1995). The position of the Simeiz station was determined with an accuracy of several millimeters.

Estimates of the horizontal velocity of the station Simeiz were calculated using VLBI observations carried out under geodynamics programs during the years 1994-2004. The complete set of 3 million VLBI observations has been analyzed and it was found that the station moves with respect to the Eurasian tectonic plate considered as a rigid with a rate 2.8 ± 0.9 mm/yr in a North-North-East direction (Petrov et al., 2001; Volvach et. al., 2004).

Several hundreds of radio sources were studied during the past years. It was found that they had similar structure of core-jet type and movements of the components in jets occurring with relativistic velocities. The obtained VLBI maps are compared with the data on mm variability of radio sources. We suggest that the mm burst is unlikely to produce a detectable new VLBI component. An earlier detection of radio bursts and, consequently, the associated sources in the cores requires single-dish observations, for example, in the millimeter band.

2. Multi-wavelength monitoring of Active Galactic Nuclei.

Millimeter wave observations of extragalactic radio sources were started at the 22-m Crimean Astrophysical Observatory radio telescope in 1973. 3.8 cm–1.1 mm variability of several dozens of AGNs was monitoring at the Crimean observatory together with the Metsahovi Radio Station (Finland). Since 1973, over 20000 observations of some 200 sources have been obtained. Data for several dozens of sources of extensive monitoring were combined with the other observations to derive separate quiescent and flare component spectra, which are crucial to gain an understanding of structure and evolution of compact radio sources. The simple shape and the overall evolution of the flares agree in far greater detail with the shock–in–jet model. As extended monitoring

programs have demonstrated, there are unpredictable outbursts, quiescent periods, minimum flux levels and secular trends. It follows from the analysis that the flare evolution can be divided into 3 phases: the rapid flux increase; the plateau, where the flux is relatively constant; and the slow intensity decrease. The variations of mm radiation of more than 30 extragalactic radio sources were studied as well as the data on their burst maximum and burst amplitudes were obtained (Volvach, et al., 2006).

3. Multi-frequency molecular line observations.

Study of the star-forming regions in molecular lines has been started in 1978. Two main types of observation are carried out at the radio telescope: 1) observations of maser sources (hydroxyl masers, water masers, SiO masers) at the frequencies of 1.6 GHz, 4.8 GHz, 22 GHz and 86 GHz. 2) observations of millimeter molecular emission at the frequency range from 85 GHz to 115 GHz. The radio telescope is equipped with high-sensitive cryogenic receivers with noise temperatures of: 1) 30 K at 22 GHz, 2) 39 K at 4,8 GHz, and 3) 70 K at frequencies from 85 GHz to 115 GHz. Characteristics of the antenna for 3 mm range: beam width 40 arcsec, effective aperture area 100 m^2. Spectrum analyzers for line observations: 1) 128 channels filter bank spectrum analyzer with frequency band 12 MHz; 2) digital spectrum analyzer for maser observations with the frequency band 4 MHz and frequency resolution of 8 kHz; 3) 64 channels filter bank spectrum analyzer with frequency band 64 MHz.

4. VLBI radar method.

The sounding of investigated objects by radio signals of powerful radar and the receiving of reflected echo-signals with array of radio telescopes in VLBI mode and differential VLBI mode. Scientific goals: Study of short-periodic variation of proper rotation for the Earth group planets, precise determination of their trajectories in Radio Reference Frame coordinate system; Researching the asteroids, crossing the Earth orbit (NEA), improving their trajectory knowledge; Investigation of space debris population at geostationary and high-elliptic orbits (including statistical measurements of cm-sized objects). VLBI radar experiments to research the Earth group planets, the near-Earth asteroids and space debris objects were arranged: the echo-signals were detected, the main period of rotation and the size estimations for 25 space debris objects, Venus and Mars planets were obtained. The RT-22 was equipped with specialized NearRealTimeVlbi Terminal. This allows to transfer the radar echoes through Internet from the radio telescopes to the near real-time correlator in Noto. A near real-time system can provide quickly the results of radar observations.

2. The Estimate of Annual Irregularity of Motion of the Lithospheric Plates

The fundamental geodynamics area "Simeiz-Katsively" is situated on the coast of the Black Sea near the village of Simeiz 20 km west of the city of Yalta in Ukraine. It consists of two satellite laser ranging stations, a permanent GPS receiver, a tide gauge and the radiotelescope RT-22. All these components are located within 3 km.

The positions of the points in the Simeiz geodynamics test area have been determined by special Third GPS survey campaign by Main Astronomical Observatory.

Absolute offsets of reduction points of the radio telescope RT-22 and two satellite laser ranging stations from 1994 to 2004. Results are presented in Table 2.

The catalog of the National Earthquake Information Center, U.S. Geological Survey for 1964-1990 was used for analysis of more than 130 thousand worldwide earthquakes with magnitude $M \geq 3.0$ (VX DAT,1928-1990). An annual period with a high statistical probability was revealed for

Table 2. Offsets for 10 years of the coordinates of points in the Simeiz area.

Station	dX	dY	dZ
RT22G	-0.216	0.126	0.077
KATS-SLR	-0.200	0.137	0.032
SIMI-SLR	-0.230	0.134	0.069

number of earthquakes with $M < 5.0$ (Gorkavyi et al., 2000). The annual period was more clearly detected in medium latitudes ($\varphi \sim 38^\circ - 61^\circ$) for both the northern and southern hemispheres, but phase oscillations in the North and South are almost opposite. Maximum of number of earthquakes fall on a local spring season. Average amplitude of oscillation is $\approx 15\%$ from annual seismic activity averaged for 27 years. It was shown that the annual period in seismicity has a clear link to the seasonal periodicity of angular momentum of atmosphere (impulse of wind) (Gorkavyi et al., 2005). These seasonal variations of atmospheric pressure can interact with Earth's crust and oceanic flows and can generate variations in speed of tectonic plates and in number of earthquakes. Annual variations of speed of a tectonic plate were estimated to be $\triangle V \approx \pm(0.5 - 0.6) cm/yr$ (Gorkavyi et al., 2005). Phase and value of estimated variation of a plate's speed agree with annual variation of lithospheric parameters from direct measurements by VLBI, GPS and satellite laser ranging (Titov et. al., 2003).

3. Future Plans

The activities in 2007 at "Simeiz-Katsively" area will consist of: (1) carrying out modernization of site's VLBI (Mark 5B system), SLR-1 and SLR-2 with the purpose to increase their level of equipment according to the international standards; (2) realization of observations on site's VLBI and SLR for maintenance in territory of Crimea the International Terrestrial Reference Frame (ITRF) and high-precision connection (at a level of several millimeters) to permanent GPS stations of the network to ITRF; (3) creation of a prototype of a system to monitor geodynamic phenomena of mountain region of Crimea and geotectonics of the Black Sea basin.

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