A Project of the Millimeter Wave Observatory at the Suffa Plateau in Uzbekistan

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Abstract

The project assumes a construction of a 70-m radio telescope operating at short millimeter waves on the Suffa plateau in Uzbekistan at the altitude of 2500 m. We describe the current status of the project, scientific drivers, antenna design and the planned receiver system.

1. Introduction

The main goal of this project is to construct a 70-m radio telescope (RT-70) operating at short millimeter waves. It is performed by Russia and Uzbekistan in the framework of the intergovernmental agreement. The tasks of the instrument include fundamental and applied research in the fields of astrophysics, geophysics, etc. The telescope is located on the Suffa plateau in Uzbekistan at the altitude of 2500 m, 260 km from Tashkent and 150 km from Samarkand. The intergovernmental agreement includes special measures against radio interference. No potential sources of interference signals can be located within 50 km radius from the telescope.

This radio telescope can be used as a single-dish instrument and as an important part of the national and international ground based and ground-space interferometer networks. It can provide an extremely high sensitivity and angular resolution for both continuum and spectral measurements. To the present time about 70% of the infrastructure objects have been built and about 50% of the telescope components have been manufactured and mounted. A new electric power station on the Suffa plateau was built.

2. Scientific drivers

Scientific drivers for RT-70 are numerous. In short, they include Milky Way studies (star forming regions, diffuse interstellar matter, circumstellar envelopes and planetary nebulae, exoplanets, millimeter wave emission of stars, etc.), extragalactic studies (properties of interstellar matter in nearby and distant galaxies, AGN), cosmology (deep surveys at millimeter waves, Sunyaev-Zeldovich effect, first galaxies, spectral distortions of CMBR, etc), solar system studies (sun, planets and their satellites, comets). In addition, a possible usage for radar studies of near space is considered.

3. Antenna and instrumentation

Several Russian organizations conduct scientific research on the development of modern systems of the radio telescope RT-70. Performed finite element and electrodynamics modeling of the telescope, confirmed the feasibility of obtaining the accuracy characteristics of the telescope, providing its operation at short millimeter waves up to 1 mm. For this purpose, the basic design of the telescope will be equipped with reflecting panels further elaborated by a specially developed original technology with standard deviation less than 50 µm in accordance with their weight, temperature and wind deformations during operation of the telescope.

The panels will be installed on specially designed for the RT-70 compact actuators with a precision up to 1 µm and a maximum displacement of up to 10 mm based on the roller screw transmission. Control of the panels and elements of the mirror system of the telescope, including sub-reflector and the third mirror, will be in active mode.
Correction of sub-reflector and third mirrors will be performed by mechanisms with six degrees of freedom, such as hexapod and will be managed by a distributed intelligent control based on neural networks.

Main drive of the telescope, taking into account the global trends in antenna design fundamentally changed compared to the analog and will be single channel single band digital drives. Telescope pointing system is also reviewed and will be part of a multi-level control system of RT-70. At present, for all systems performed calculations, experimental models of equipment and research stands are designed and built.

The receiver system is under consideration. According to the present plans it will include single-pixel receivers (for continuum, VLBI, spectral lines) covering several bands from ~ 22 GHz to ~ 270 GHz, array (multi-beam) receivers including bolometer arrays for 1.3 mm and 2 mm with a maximal possible number of pixels and heterodyne array receivers for 80-115 GHz and/or for 210-270 GHz. At the Institute of Applied Physics a dual band (3 and 2 mm) receiver for atmospheric transparency monitoring has been developed recently and will be installed at the telescope site this year.

5. Conclusion

Currently, agencies of Russia and Uzbekistan are negotiating the draft charter of the Suffa international observatory (IRAO “Suffa”) and several other documents in order to follow the state registration of this organization and the opening of the financing from the Russian side for the completion of the observatory complex with the radio telescope RT-70. After this IRAO “Suffa” will be opened in accordance with the Agreement for accession of other countries and international organizations.