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The new 50-cm multipurpose telescope of the Russian-Cuban Observatory

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Abstract. The international collaboration between Russia and Cuba in astronomical research first began in 2017. The first 20-cm robotic telescope of the Russian-Cuban network has been operating since 2021 in Havana. The construction of the second 50-cm telescope has been underway since 2023, and it is expected to be finished and installed in 2025 near Kislovodsk (Russia). By 2030, the plan is to build the third 1-m telescope at Valle de Picadura (Cuba). We describe the main parameters and scientific equipment of the new 50-cm telescope and discuss its role in the Russian-Cuban distributed global telescope network.

Keywords: telescopes; methods: observational; instrumentation: photometers, spectrographs; stars: variables: general

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1 Introduction

Since 2017, the Institute of Astronomy of the Russian Academy of Sciences (INASAN), Moscow, Russia, and the Institute of Geophysics and Astronomy (IGA), Havana, Cuba, have been developing a joint international project with the aim of building a distributed multitask network of optical telescopes: the Russian-Cuban Observatory (RCO).

At the beginning of 2021, the first telescope was installed at the IGA in Havana (Bisikalo et al. 2022). In 2023, the second optical telescope of a 50-cm aperture began being built in Russia (Ibrahimov et al. 2023). According to the current plan, the third custom 1-m wide-field telescope with spectroscopic, astrometric, and photometric capabilities is going to be installed in 2030 at Villa de Picadura located 80 km east of Havana.

Global optical telescope networks are efficient tools for many observational tasks requiring long continuous observing series of the studied objects. The location of the two telescopes in Cuba and Russia is significantly important for the functionality of the Russian-Cuban network both in terms of global coverage and observing modes. The time difference of 8 hours (120°) between Cuba and Kislovodsk allows continuous observations of up to 16 hours.

As an example of continuous observation importance, we can reference the detection and tracking of newly discovered asteroids (Bisikalo et al. 2018), photometric studies of variable stars (Naroenkov et al. 2022), and the study of optical transient events, e.g., the sources of gamma-ray bursts and tidal disruption events.

At least two types of telescopes should be included in the network: the wide-field survey telescopes and the middle-aperture follow-up telescopes equipped with cameras and spectrographs.

The first telescope of the RCO network is a wide field-of-view 20-cm robotic telescope. It is a multipurpose astrometric and photometric instrument. Having more than a 3° field of view, it is capable of detecting a large number of already known and new celestial objects and providing $UBVRI$ broadband photometry. The most interesting new objects discovered by the 20-cm wide-field telescope are going to be studied in more detail with larger telescopes both in spectroscopic and photometric modes. For this purpose, a new telescope is under construction in the framework of the RCO network development. The second telescope will have an aperture of 0.5 m and two scientific instruments, a camera and a spectrograph.

The second node of the RCO network will be built at the site of the INASAN Kislovodsk Observatory. This site has relatively good astronomical seeing for the central part of Russia. The observatory already has all key infrastructure and is well accessed from the closest city of Kislovodsk.

For the RCO observing station nearby Kislovodsk, the well-proven RC500 telescope produced by Astrosib (Russia) was chosen. It has a 0.5-m aperture Ritchey–Chretien optical system with a 508-mm primary mirror housed in a carbon-fiber truss-design optical tube assembly and a two-lens field corrector. The equivalent focal ratio is $F/8$ and the focal length is 4000 mm.

The telescope is mounted on an Astrosib FMDD-700 equatorial fork mount equipped with direct-drive motors and 26-bit absolute encoders. For the telescope's dome, a well-proven Astrosib ASD-4.5 all-sky dome (4.5 m) was made and mounted on an original hyperboloid 5.4 m high pier designed at INASAN.

2 Scientific instruments of the 50-cm telescope

The 50-cm telescope has two main modes of operation: photometry and spectroscopy. Both modes are available anytime by using the telescope's folding mirror without the need to interchange the camera and spectrograph manually. The switchover time between the two instruments is less than 1 minute, which allows a very flexible observing program every night.

The main instrument for spectroscopic research is the Basic Echelle Spectrograph (BACHES). It is a compact, lightweight and inexpensive medium-resolution ($R = 20\,000$) echelle spectrograph manufactured by Baader Planetarium GmbH, well suited for remote autonomous operation at a robotic observatory. With a 0.5-m telescope, BACHES is capable of obtaining spectra of 10^{m} targets with SNR = 20 at a 30-minute exposure time. BACHES allows the acquisition of spectra of the observed object as well as calibration spectra. The spectrograph is equipped with a tip-tilt active-optics Starlight SXV-AO-USB module, which allows long spectroscopic observations with an exposure time of up to 0.5 hour and longer. BACHES has been successfully used on the 1-m telescope at the INASAN Simeiz Observatory for several years. In 2024 it will be relocated to the new 0.5-m RCO telescope.

The main imaging instrument of the new RCA 50-cm telescope is the sCMOS camera FLI Kepler 4040. It is equipped with a seven-slot filter changer FLI CFW5-7. The first five filter slots will be occupied by the standard Johnson–Cousins–Bessel $UBVRI$ system. The sixth slot of the filter wheel will be used for broadband (integral light) imaging to achieve maximum sensitivity of the telescope, for example, to search for new objects such as asteroids, comets, and space debris. The last seventh slot is kept in reserve for future scientific observing programs.

A GPS/GLONASS receiver provides high-accuracy time signals for the telescope.

The observing facility nearby Kislovodsk is controlled by a set of special software created by INASAN. It allows the control of all devices remotely and autonomously:

the weather stations, lightning detector, GPS/GLONASS receiver, all-sky camera, and surveillance cameras.

3 Summary

The first 20-cm telescope of the Russian-Cuban RCO network has already been built in Havana (Cuba) and the second 50-cm telescope is currently under construction nearby Kislovodsk (Russia). Both telescopes are designed to operate in a fully robotic mode. It will allow the Cuban and Russian astronomers to conduct research remotely, both in photometric and spectroscopic modes. Until 2030, the third 1-m telescope is expected to be built at Valle de Picadura (Cuba), which will significantly improve the Russian-Cuban network functionality both in terms of global coverage and observing modes, including more precise spectroscopy and photometry.

Some other telescopes from Russia and worldwide can be used for follow-up observations in the framework of the RCO: the INASAN 1-m and 2-m telescopes at the Simeiz and Terskol Observatories, respectively; the 0.5-m telescope of the Ussuri Department of the Institute of Applied Astronomy of the Russain Academy of Sciences; several 0.5-m – 1.5-m telescopes in Uzbekistan and Tajikistan.

Together, all the above sites allow observations along an arc of 214° (or 14.3 hours). Taking into account the length of the observing nights (6 to 12 hours), it is possible to carry out a practically round-the-clock monitoring and alert observations using the above sites. International cooperation with other countries is highly welcomed.

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