The RadioAstron Space VLBI Project

Y. Y. Kovalev[1] , N. S. Kardashev[1], K. I. Kellermann[2], P. G. Edwards[3] and the RadioAstron Team

[1] Astro Space Center of Lebedev Physical Institute, Profsoyuznaya 84/32, 117997 Moscow, Russia;
phone: +74953332167; email: yyk@asc.rssi.ru, nkardash@asc.rssi.ru
[2] National Radio Astronomy Observatory, 520 Edgemont Road, Charlottesville, VA 22903, USA;
phone: +14342960240; email: kkellerm@nrao.edu
[3] CSIRO Astronomy and Space Science, P.O. Box 76, Epping NSW 1710, Australia;
phone: +61 2 9372 4717; email: philip.edwards@csiro.au

Abstract

The RadioAstron project is an international collaborative mission centred around the Spektr-R satellite, which was launched in July 2011, carrying a 10-m space radio telescope (SRT) into an elliptical Earth orbit. The aim of the mission is to use the space telescope for radio astronomical observations using Very Long Baseline Interferometry (VLBI) techniques in conjunction with ground-based VLBI networks located in Australia, China, Europe, India, Japan, Korea, Russia, South Africa, Ukraine, and the USA.

The orbit of the RadioAstron satellite evolves with time and has an apogee between 280,000 and 350,000 km, a perigee between 1,500 and 80,000 km, a period of 8 to 9 days, and an initial inclination of 51 degrees. RadioAstron operates at the standard radio astronomical wavelengths of 1.19-1.63 cm (K-band), 6.2 cm (C-band), 18 cm (L-band), and 92 cm (P-band). The space to ground VLBI observations using RadioAstron are providing morphological information on galactic and extragalactic radio sources with fringe size as small as 7 microarcseconds at the highest frequency. This is the highest angular resolution ever achieved by any astronomical instrument.

The RadioAstron mission began with an In-Orbit-Checkout (IOC) commissioning period. The first part of the IOC included an engineering commissioning with a spacecraft bus checkout, the unfolding of the space radio telescope, receiver checks and tests of the radio astronomy antenna in single-dish mode (bore-sighting), and communication tests with the tracking stations. The second part of the IOC was a scientific commissioning phase that consisted of VLBI tests using the space radio telescope science payload in conjunction with a number of large ground radio telescopes. Fringes were found at all four bands of 92, 18, 6, and 1.3 cm. This IOC phase smoothly transitioned into a scientific verification phase — the Early Science Program (ESP) – in February 2012, continuing to June 2013. The ESP objectives were designed to provide a bridge between the initial "experimental" mode of operations, observing, and data processing, and the "routine" operations that started after completion of the ESP. Observing time with the RadioAstron was committed for ESP observations, and these were coordinated by Working Groups on Active Galactic Nuclei, masers, and pulsars.

The RadioAstron mission has subsequently released two Announcements of Opportunity soliciting proposals from the international astronomy community. The AO-1 period runs from July 2013 to June 2014, with the AO-2 period starting in July 2014 and running for one year. The AO-1 period focused on seven Key Science Projects, designed to optimize the science return from a time-limited mission: the AO-2 period has additionally been opened to smaller Guest Observing Time proposals.

This presentation will outline the elements of the RadioAstron project – satellite, tracking stations, ground radio telescopes, orbit determination, and correlators. It will describe a number of key results obtained to date. This includes the measurements of very high AGN brightness temperatures which strain conventional models of synchrotron radiation and Doppler boosting, and the detection of quasars, pulsars and masers large projected spacings up to more than 250,000 km. A particularly surprising result has been the unexpected detection of 92 cm fringes from the pulsar B0950+08 at spacings up to 220,000 km with unanticipated important implications for the nature of plasma inhomogeneities and turbulence in the interstellar medium.

The RadioAstron project is led by the Astro Space Center of the Lebedev Physical Institute of the Russian Academy of Sciences and the Lavochkin Scientific and Production Association under a contract with the Russian Federal Space Agency, in collaboration with partner organizations in Russia and other countries.

978-1-4673-5225-3/14/$31.00 ©2014 IEEE