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Astro Space Center
RadioAstron Newsletter
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RadioAstron has switched to a backup synchronization mode

The hydrogen maser onboard the RadioAstron space Radio Telescope has finished its operations in July 2017 after six years of perfect performance, due to the exhaustion of its neutral hydrogen. This was consistent with its expected lifetime.

The RadioAstron science and technical operations working group has performed a number of checks of two other methods of synchronization: one utilizing the onboard rubidium standard, and the other being the so-called closed–loop mode of operations. The latter uses the ground atomic clock located in Pushchino (Russia) or Green Bank (USA) tracking station. Both modes have successfully delivered interferometric fringes. At the same time, best results are achieved with the closed–loop mode, as expected. This mode of synchronization is being used right now as the default for observations in the AO5 science program.

RadioAstron AO6 proposals will be due by January 22, 2018 for observations from July 2018 – June 2019. An announcement of the proposal call will be made in the near future.

Testing Einstein's general relativity

The RadioAstron Key Science Program on the gravitational redshift experiment has completed its data collection stage. The observations for the experiment were supported by EVN, NRAO, and several geodetic radio telescopes (Badary-Russia, Effelsberg-Germany, GBT-USA, Hartebeesthoek-South Africa, Onsala-Sweden, Svetloe-Russia, VLBA-USA, Wettzell-Germany, Yarragadee-Australia, Yebes-Spain, Zelenchukskaya-Russia). The goal of the project is to test Einstein's Equivalence Principle — the basis of general relativity. Specifically, the team aims to verify Einstein's formula for the gravitational redshift effect or, equivalently, the gravitational time dilation due to a nearby massive body. For the RadioAstron spacecraft the effect due to the Earth is about -58 microseconds per day relative to an observer at the Earth's surface — time actually flows faster aboard the spacecraft hence the minus sign. The most accurate test of this kind to date was performed in 1976 by the NASA-SAO Gravity Probe A mission. That experiment proved the validity of Einstein's formula with an accuracy of about 0.01 % using a suborbital probe equipped with a hydrogen maser frequency standard. The experiment with RadioAstron is based on a similar approach, depicted in Figure 1, but benefitted from a better performing hydrogen maser and a favorable highly eccentric orbit, which allowed the team to perform their measurements multiple times. All this, coupled with an evaluation of the quality of the collected data, make the team believe they'll be able to supersede the result of their renowned predecessor by an order of magnitude. This anticipated result will mark an important milestone in our challenge to find the level at which general relativity breaks down and a more general theory, such as string theory, is beginning to reveal its subtle features. The team have recently published a paper (Litvinov et al. `https://doi.org/10.1016/j.physleta.2017.09.014`), presenting their techniques and giving a status update of the experiment. Figure 2 illustrates the results of preliminary data processing of one of the experiments. While the data processing is far from finished, the currently achieved accuracy is already at the level of that of Gravity Probe A.

Nikolai Kardashev (nkardash@asc.rssi.ru)
Yuri Kovalev (yyk@asc.rssi.ru)

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.

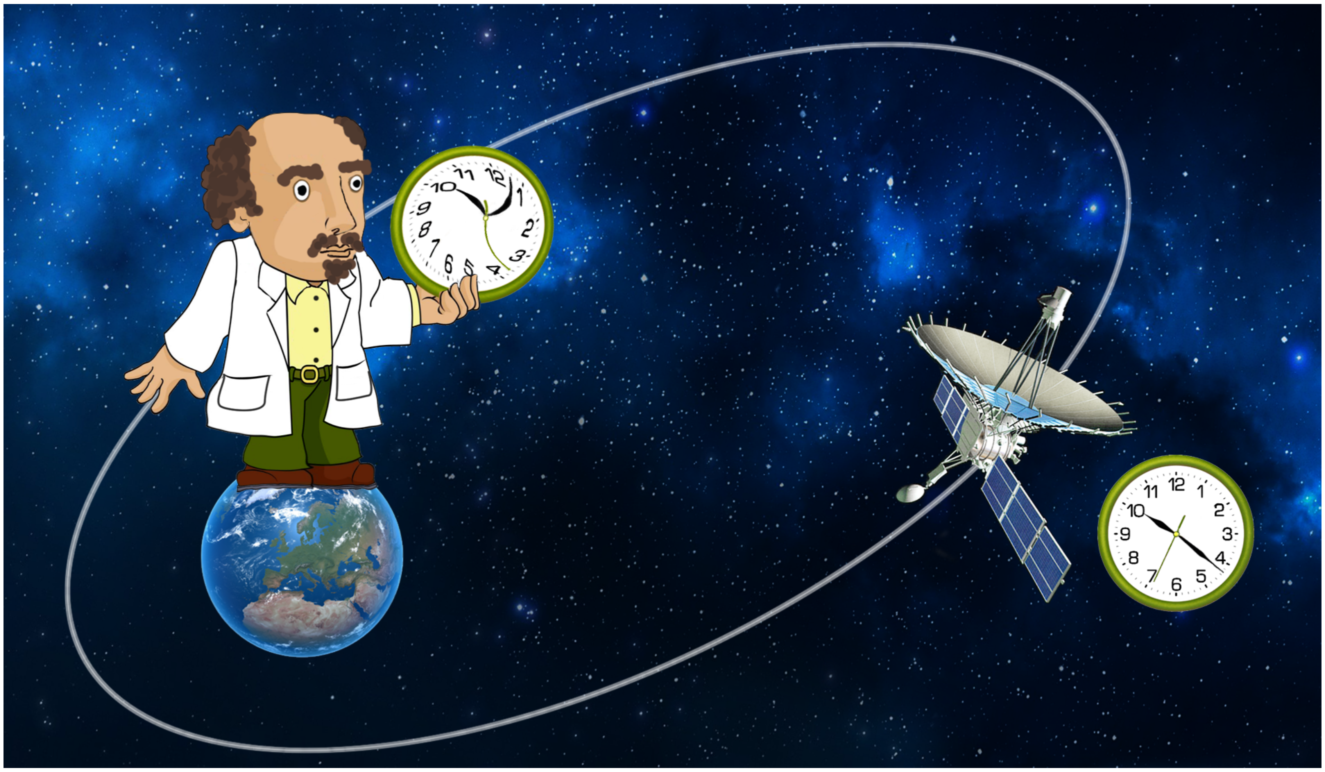

Figure 1: Schematic of the experiment.

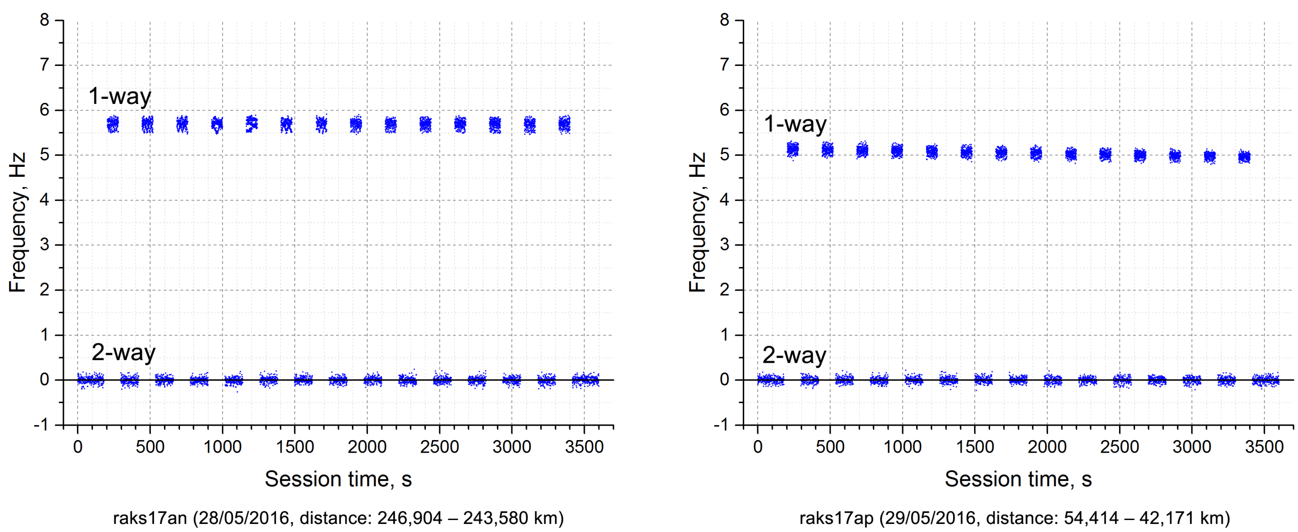

Figure 2: Results of the data processing of an experiment performed in May 2016. The experiment consisted of three observations at greatly varying distances, each 1 hour long, supported by the Effelsberg, Onsala, Svetloe, Wettzel (Wz and Wn) telescopes. The two panes of the figure depict the residual frequencies of the 1- and 2-way 8.4 GHz downlink signals from the RadioAstron spacecraft measured with the Onsala 20-m telescope, for the two outermost observations. The 1-way signal contains the useful gravitational redshift, while the 2-way signal is used to suppress the contribution of the nonrelativistic Doppler shift. The observations were performed using the interleaved measurements approach with a switching cycle of 4 min. The 1-way frequency residuals are not corrected for the gravitational redshift. This makes the variation of the gravitational redshift between the two outermost observations clearly visible (varying from 5.69 Hz to 4.96 Hz).