



Contribution ID: 636

Type: Talk in the parallel session

Measurement of the gravitational redshift effect using the satellite Spectr-R in the "RadioAstron" mission

Tuesday, 6 July 2021 10:30 (20 minutes)

We report on the recent results of testing one of the aspects of Einstein's principle of equivalence - the effect of gravitational redshift, by means of its precision measurement using the Spectr-R as part of the VLBI mission Radioastron.

Satellite Spectr-R and two tracking stations (Green Bank (USA)) and Pushchino (Russia) were equipped with hydrogen frequency standards with relative stability no worse than 10^{-14} . Comparison of the onboard and ground standards made it possible to measure the frequency shift due to the difference in gravitational potentials on the ground and in orbit. Each measurement session consisted of alternating segments communication with carrier synchronized according to the onboard standard (1w mode) and according to the ground standard of the Pushchino station (2w mode). The use of a combination of both modes made it possible to compensate for the dominant 1st order Doppler effect and tropospheric shifts. The ionospheric shift was eliminated by measurements at two different carrier frequencies. The Doppler effect of the second order and the systematic error of the difference in the nominal values of the standards are compensated for when passing to the measurement of the modulation component of the gravitational shift during the orbital motion of the satellite, which is 10% of the stationary value due to the large ellipticity of the orbit. We report success in revising the bias value by re-processing the accumulated data from 5% to 15%. This makes it possible to bring the error of correspondence of the measured gravitational shift to the calculation formula of general relativity to the level of 10^{-3} . Although this is rougher than the result achieved with the Galileo satellites, it should be noted that never before has the gravitational redshift been measured with such accuracy at such large distances from the Earth of 350,000 km.

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Session Classification: Experimental Gravitation

Track Classification: Precision Tests: Experimental Gravitation