EARTH-BASED OREPS TO MEASURE VARIATIONS IN PLANETARY SPIN. I. V. Holin, Space research institute, Moscow, holin@mail.cnt.ru

Introduction: Spin vectors $\mathbf{\Omega}$ of terrestrial planets can vary with time both in magnitude (librations) and orientation (precession, nutations) regularly (forced and free motions) or stochastically (wobble). Measurement of all possible variations in $\mathbf{\Omega}$ may give valuable information about the spin dynamics, interiors and evolution histories of inner planets. Today the best approach allowing direct remote measurements of instantaneous spin components from Earth with monochromatic signals is OREPS (optimized radar estimation of planetary spin).

Theory: OREPS was created entirely and exclusively on the basis of the statistical synthesis and analysis procedure (SSAP) with using no information about any other techniques of measuring spin. SSAP is based on the functional of Gaussian probability density L wich in turn is determined by the STCF (space-time correlation function) of the sum of the radar echo field with an additive "white" noise. The solution of the equation $\partial L/\partial\mathbf{\Omega}=0$ gives the optimum OREPS value $\mathbf{\Omega}_0$ with minimum errors caused by input noises. Calculation of the second derivatives $\partial^2 L/\partial\Omega_t^2$, $\partial^2 L/\partial\varphi^2$, $\partial^2 L/\partial\Omega_t\partial\varphi$ gives the limiting OREPS accuracy of joint estimation of the absolute value Ω_t and orientation φ of the instantaneous transverse spin vector $\mathbf{\Omega_t}$.

It follows from the above that STCF should be investigated at first. Initial [1] and recent [2] research showed a high degree of the long-range or far coherence of an order of 0.9999 (1. max) over very long baselines compared with the diameter of Earth. The SSAP solution gave the analytical expression for L (that is the OPA – optimum processing algorithm) and the limiting OREPS accuracy in $\mathbf{\Omega_t}$ [3] (references to SSAP can be found in [3] as well).

Experiments: It was shown in [3] that the optimized RSDI (radar speckle displacement interferometry) can approach in accuracy the OREPS limits. Hence there are two ways to achieve the limiting OREPS accuracy: 1) to use directly the OPA or quasioptimum processing algorithms, 2) optimization of the RSDI techniques. Any of these ways can be used in current radar experiments where accuracies are still too far away from the OREPS limits.

The OREPS limits with the present radar facilities are of an order of 10^{-5} for terrestrial planets. Future radar facilities can be characterized by an order of magnitude improvement. Achievement of these limits will allow precise measurement of variations in spin vectors of Mars (e.g. nutations), Mercury (librations), Venus.

References: [1] Holin I. V. (1988) Izv. Vyssh. Ucheb. Zaved.: Radiofizika, 31, 515 [2] Holin I. V. (2004) Solar system research, 38, No. 6 [3] Holin I. V. (1992) Izv. Vyssh. Ucheb. Zaved.: Radiofizika, 35, 433.