LIMITING RSDI ACCURACY OF SPIN STATES ESTIMATION OF NEAR EARTH OBJECTS. I. V. Holin, Space research institute, Moscow, holin@mail.cnt.ru

Introduction: Spin states of near Earth asteroids (NEAs) can be estimated from optical light curves and by radar remotely from Earth. Since a cometary coma is nearly transparent at radio wavelengths [1], radar should be capable of detection and estimation of physical properties of a cometary nucleus. We analyse below the limiting accuracy of a new Earth-based radar technique, radar speckle displacement interferometry (RSDI) [2–4], to measure spin vectors of near Earth objects (NEOs) independently and with better accuracy.

RSDI Accuracy: The limiting RSDI accuracy of spin components joint estimation by a two-element receiving interferometer with baselength b can be written analytically as [5]

$$\sigma = l\ m\ /\ q\ b\ n \qquad (1)$$

where $l = \lambda R/a$ is the correlation radius of the scattered radar field, R is the Earth-NEO distance, λ is the transmitted wavelength, a is the effective size of scattering area on NEO (e.g. for a NEO of ~ 100 m in diameter we accept a = 20 m), $m = v/v_\Omega$, v is the velocity of speckle pattern displacement [6], v_Ω is a part of v caused by rotation, n depends on asymmetry and orientation of the NEO: for a spherical object n = 1, for asymmetric objects $n \leq 1$ [5], q is the signal-to-noise ratio [2]. As applied to NEOs the limiting accuracy (1) is about an order of magnitude better than that of the delay-Doppler radar. Computer simulation for several particular cases [7] showed that the accuracy close to (1) should be attainable in practice. As applied to Doppler imaging RSDI may give improved unambiguous orientation of the Doppler axis in space (to determine the orientation of the NEO from its image) and resolve the NEO's size ambiguity along this axis through transformation of the scale from Hz to meters already in the first delay-Doppler image obtained.

NEAs: The spin state of asteroid 4179 Toutatis (size ~ 2...4 km) was determined by the delay-Doppler radar during the 1992 apparition (R ~ 0.026 AU) to uncertainty within a few percent [8]. Calculation on (1) for those conditions gives ~ 10^{-3} , i.e. the relative accuracy of ~ 0.001 in absolute value and ~ 3 arcmin in direction of the NEO's aspect angle vector derivative. For a typical NEA of ~ 1 km in diameter at R ~ 0.07 AU the RSDI limiting accuracy is ~ 10^{-2}. Also it follows from (1) that the spin states of smaller NEAs of ~ 100 m in diameter should be measured by today's radar and radio facilities to accuracy of a few percent at R ~ 0.02 AU. In the last two cases it seems to be hardly possible to obtain Earth-based estimates by a radar technique different from RSDI.

Cometary Nuclei: We wish hope that RSDI technique can be especially helpful in determination of spin states of cometary nuclei to the above accuracies. The detection of any rotating substance inside a comet would give valuable information about physics of its nucleus. RSDI can be combined with the Doppler continuous mode radar observations and we hope that RSDI experiments about NEOs will be prepared in near future.

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