Spin parameters of LARES spectrally determined from SLR data

D. Kucharski\textsuperscript{A}, T. Otsubo\textsuperscript{B}, G. Kirchner\textsuperscript{C}, G. Bianco\textsuperscript{D}

\textsuperscript{A} Korea Astronomy and Space Science Institute, Daejeon 305-348, South Korea
\textsuperscript{B} Hitotsubashi University, 2-1 Naka, Kunitachi 186-8601, Japan
\textsuperscript{C} Space Research Institute of the Austrian Academy of Sciences, A-8042 Graz, Austria
\textsuperscript{D} Agenzia Spaziale Italiana, Centro di Geodesia Spaziale “G. Colombo”, P.O. Box 11, 75100 Matera, Italy
Spin parameters of LARES spectrally determined from SLR data

LARES - LAser RElativity Satellite designed by Scuola di Ingegneria Aerospaziale at “La Sapienza” University of Rome and manufactured by Carlo Gavazzi Space (CGS) under contract to the Italian Space Agency (ASI).

The satellite was launched by ESA on Feb.13, 2012, from the European Spaceport of Kourou (French Guyana), with the maiden flight of the new ESA small launcher VEGA.

LARES was placed in a circular orbit at a height of 1450 km, inclination 69.5°
Spin parameters of LARES spectrally determined from SLR data

This fully passive, spherical satellite is made of a high density tungsten alloy.

It is expected that LARES will achieve important measurements in gravitational physics, space geodesy and geodynamics: in particular – together with the LAGEOS-1, LAGEOS-2 and with the GRACE models – it will improve the accuracy of the determination of Earth’s gravitomagnetic field and of the Lense-Thirring effect.
LARES is equipped with 92 corner cube reflectors (CCRs) for SLR arranged in the form of 10 rings around the polar axis of the body.

The gaps between the prisms on a single ring are constant.

All cubes are of the same type - made from Suprasil 311, not coated.
In order to determine the spectral response of LARES the range residuals are simulated for every incident angle between the laser beam and the spin axis (symmetry axis) of the satellite.
Spin parameters of LARES spectrally determined from SLR data

During the process the spin period of the satellite is set to 12 s (5 rpm) and kept constant. At given latitudes of the laser pointing the range residuals are simulated and spectrally analyzed.

The spin frequency of the satellite is identified as $f_1$. The harmonics ($f_5$, $f_{10}$, $f_{14}$, $f_{16}$) visible in the spectra are generated by various geometrical distributions of the contributing CCRs. When the laser direction is perpendicular to the plane of a given ring, the detected, most powerful harmonic $f_n$ is a product of the body’s spin frequency ($f_1$) and the number $n$ of the CCRs distributed around the ring: $f_n = n \cdot f_1$. 
Spin parameters of LARES spectrally determined from SLR data

LARES pass measured by Graz kHz SLR station on February 22, 2012

Spectrum of the 60s part, T=11.9s

from sim: $f_{5,10,14,16}$
Spin parameters of LARES spectrally determined from SLR data

LARES pass measured by Graz kHz SLR station on February 22, 2012

The data contained in this document, without the permission of KASI, shall not be used, duplicated or disclosed, in whole or in part, for any purpose other than ARGO development.
Spin period of LARES, day 4-235 (Sept.), 1550 SLR passes (10 Hz – 2 kHz) (corrected for the apparent effect)

The half-life period of the satellite's spin is 229.2 days - the spin period doubles after this time.
Spin parameters of LARES spectrally determined from SLR data

The apparent spin is caused by the longitudinal change of the laser vector within the spin coordinate system as the satellite is passing the ground station.
Conclusions

- The initial spin period of LARES was $T=11.64\,\text{s}$, RMS=$0.34\,\text{s}$
- Spin period doubles after 229.2 days (>3 minutes after 2y)
- The initial orientation of the spin axis agrees with the orientation of the launch vehicle at the injection epoch
- LARES spins CW direction
- Question: why some of the CCRs give weaker returns? Physical or mechanical reason?

Thank you.