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Ring Laser Gyroscopes (RLG) are instruments measuring inertial rotations locally and in real-time without the need for an external reference system. They are sensitive to variations in the instantaneous rotation vector, therefore they are considered as a complement to space geodetic techniques for studying Earth rotation. In the work described in the four enlisted papers I examined the possibility of using RLG observations for monitoring changes of the Earth rotation vector. For this purpose I used observations from two ring lasers, the G-ring located at the Wettzell Geodetic Observatory and the ROMY instrument located at the Geomagnetic Observatory Fuerstenfeldbruck by Munich, both in Germany.

I started with verification of the usability of RLG observations for estimation of nutation rates. I investigated possibilities of computing those parameters from only one ring laser and I simulated the usage of several instruments. I also combined simulated RLG observations with actual Very Long Baseline Interferometry (VLBI) data and compared them with real Wettzell RLG data. Obtained results attested to the theoretical possibility of estimating nutation rates, albeit with a number of restrictive assumptions, not possible to fulfill at the current accuracy level of the RLG technology.

In the next step of the investigation I decided to focus on the possibility of monitoring rapid changes of rotation with daily and sub-daily resolution. For this purpose I reviewed how the known high frequency signals in Earth rotation parameters, including the diurnal polar motion, diurnal and semidiurnal ocean tide effects in polar motion and UT1 and librations, prograde diurnal in polar motion and semidiurnal in UT1, contribute to the RLG observable, the Sagnac frequency. Obtained results suggested that at the current accuracy level of the instruments, the signals coming from diurnal polar motion and ocean tides should be taken into account in analysis while the influence of libration can be neglected. I also pointed out that the contributing signals are superimposed upon each other and can hardly be separated from the data from a single instrument. The study was done taking parameters of the RLG at the G-ring instrument, however, I also considered how the strength of a particular signal depends on the geographic location of a horizontally mounted instrument. Finally, I discussed the relationship between the geographical location and terrestrial orientation of RLG and its consequence for the observed Sagnac signal.

Given that RLG are also sensitive to changes in their terrestrial orientation, a natural next step was a review of the contribution of the known phenomena causing site deformation to the Sagnac frequency. Therefore, I studied the impact of solid Earth tides, ocean tidal loading and non-tidal loading phenomena (atmospheric pressure loading and continental hydrosphere loading). Also, I evaluated the differences between available models

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dr hab. inż. Konrad Lewczuk, prof. uczelni of the phenomena and the importance of the Love numbers used in modeling the impact of solid Earth tides. In the end I compared modeled variations in the instrument orientation with the ones observed with a tiltmeter. Entire investigation was conducted for the Wettzell G-ring. The results proved that at the present accuracy of the RLG technique, solid Earth tides and ocean tidal loading effects have significant effect on RLG measurements, and continental hydrosphere loading can be actually neglected. Regarding the atmospheric loading model, its application might introduce some undesired signals. I also showed that discrepancies arising from the use of different models can be neglected, and there is almost no impact arising from the use of different Love numbers. Finally, I discussed differences between data reduced with tiltmeter observations and these reduced with modeled signal, and potential causes of this discrepancies.

Eventually, thanks to cooperation with colleagues from the Wettzell observatory I had a contribution to reporting on the construction and operation of a four component, tetrahedral laser gyroscope array and demonstrating that reconstruction of the full Earth rotation vector can be achieved with sub arc second resolution over more than six weeks.

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