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Variations of earth rotation from ring laser gyroscopes: one hundred years of rotation sensing with optical interferometry

Earth Rotation and Orientation are providing the link between the terrestrial (ITRF) and celestial reference frames (ICRF). Traditionally the Earth orientation parameters (EOPs) are observed by radio interferometry. The fixed positions of the quasars, along with measurement redundancy of a sufficiently large network, provide the long-term stability of the observations. For the short-term and the access to the instantaneous rotation axis of the Earth, VLBI is depending on suitable models, which still have some deficiencies. Optical interferometric rotation sensing with ring lasers in contrast provide direct access to the Earth rotation axis, a high resolution in the short-term, but are suffering from tiny non-reciprocal laser behavior causing drift in the long-term. Now, one hundred years after George Sagnac's important paper published in Comptes Rendus in 1913 the tools of modern quantum optics have matured to a point where they make ring lasers more than 12 orders of magnitude more sensitive than the early instrumentation in this field. The single component prototype ring laser G in Wettzell now resolves rotation rates of 10e-12 rad/s after one hour of integration and has demonstrated an impressive sensor stability over several month. The combination of VLBI and ring laser measurements offers an improved sensitivity for the EOPs in the short-term and the direct access to the Earth rotation axis. At the same time the progress in controlling the backscatter coupling in ring lasers has succeeded to reach the domain of 3 parts per billion for the relative uncertainty of the measured Earth rotation. This paper explores the prospects of optical Sagnac Interferometry in Geodesy at the Centennial of the Sagnac effect.

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