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Scientific Motivations of GINGER and its Road Map

The Sagnac Effect is based on the fact that two light beams counter-propagating inside a ring complete the path at different time Δt, if the ring is rotating with angular velocity Ω. These gyroscopes are sensitive to the absolute angular velocity. Large-size ring lasers can reach very high sensitivity and accuracy; pushing to the shot noise limit, their performance makes possible not only important measurements on Geodesy, but as well General Relativity tests. Soon after the introduction of the general theory of relativity, it was manifest that the relative motion between an observer and a massive source should produce peculiar effects on the gravitational field measured by the observer. In particular, the proper rotation of a massive source gives a dragging of the inertial frames, or Lense-Thirring (LT) effect. An unequivocal measurement of the LT effect performed on the Earth using a laser gyro will complement what has been done so far with measurements already performed, and in progress, in space and will allow to shed new light on the reliability of those measurements. Optical laser gyroscopes, exploiting the Sagnac effect, equipped with super-mirrors with an extremely high reflectance (R > 99.999%) and built with sizes bigger than a few tens square meter, are able to detect and measure angular movements with an extremely high sensitivity. The 16 m^2 square G gyrolaser, located in the laser ranging station of Wettzell, Bavaria, has a sensitivity for rotations better than 10^{-12} rad/s, attained in approximately one hour of data taking, and is at present the most accurate ring-laser in the world. The measurement of LT effect requires an accuracy around 10^{-14} rad/s which implies that the Earth angular velocity must be measured with accuracy of one part in 10^9. This can be achieved by increasing the gyro dimension, and by increasing long term stability by carefully controlling the geometry of the square ring and by Kalman filtering techniques. GINGER (Gyroscopes IN GEneral Relativity) is an INFN proposal for measuring LT effect in an Earth laboratory environment [1]. It will consist in a structure in three or more gyroscopes mutually orthogonal with about 6 m of side, located in a deep underground location, the Gran Sasso INFN laboratory could be a possible location. The small prototype G-Pisa has been recently installed inside Hall B of LNGS, the first results and the future plan, which is pointing toward the direction of making GINGER real, will be described.

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