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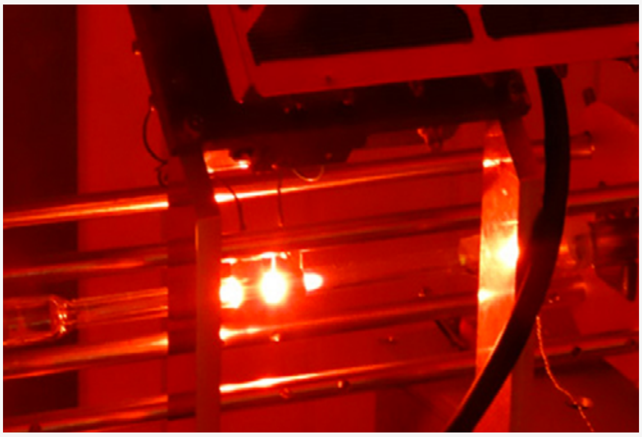

GINGERINO MEASURES THE EARTH'S ROTATION SPEED AND GRAVITATION FIELD

You can precisely measure the rotation speed of the Earth by comparing light signals that propagate with opposite trajectories. An article that appeared on 8 May on the *Springer European Physical Journal C* supports this argument, publishing the results relating to the last analysis conducted by GINGERINO, a ring laser gyroscope housed at the INFN Gran Sasso National Laboratories. The study highlighted the ability of the equipment to provide, with accuracy beyond expectations, values of the Earth's angular speed that agree with those obtained from sophisticated satellite systems and astronomical interferometry, which are today used to monitor the parameters linked to our planet's rotation. The experiment is one of the GINGER (Gyroscopes IN GEneral Relativity) group of activities. GINGER is a scientific collaboration between Italian research bodies led by INFN, which aims to demonstrate the efficacy of devices like GINGERINO in the field of testing General Relativity.

GINGERINO is basically a ring laser, characterised by an optical resonator, consisting of four mirrors positioned at the corners of a square. The cavity is filled with a mixture of helium-neon gas that is excited by a radiofrequency discharge, thus generating two counter-rotating laser beams. In the absence of rotation, the two optical paths are identical and the photons use the same time to close the ring, but that is not true if the cavity is rotating. In this case, the two opposing laser beams will have different frequencies: the difference can be detected by recording the superposed interferometric signal, which is proportional to the rotation speed. This phenomenon is known as the Sagnac effect. Thanks to GINGERINO's symmetrical structure, many of the typical noises of standard interferometry are strongly mitigated, making it possible to precisely measure phenomena described by General Relativity as well.

The use of the Sagnac interferometers was, until today, limited due to the difficulties of analysing the data produced. This analysis must take into account the complex dynamics of the laser that generates the two counter-rotating beams inside the cavity and of the noise produced by the action of external

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forces. This is why the GINGER collaboration researchers decided to use a technological demonstrator: GINGERINO, and to anchor it to the rock of the Gran Sasso National Laboratories. Here, it is sheltered from atmospheric agents so researchers can study solutions aimed at creating a future interferometer with greater sensitivity and to improve its ability to discriminate between data acquired.

The researchers compared data obtained by the experiment over the course of 103 days' operation with those acquired by the proven and accurate systems of triangulating radio signals coming from satellites or from astronomical sources. The latter signals are used to determine the rotation speed of our planet and of Coordinated Universal Time (UTC) - the standard time on the basis of which we adjust our watches - as well as other geodesic parameters, such as the shifting of the poles and the change in the tilt of the Earth's axis. This comparison has highlighted a substantial correspondence between the measurements and an unexpected sensitivity on the part of GINGERINO, equal to fractions of femtoradians (10^{-15} radians) per second, quantities corresponding to the subatomic scale. If confirmed, the result would guarantee the actual ability of the Sagnac interferometers to distinguish between different theories of gravitation and to highlight, in the final analysis, effects capable of reconciling gravitational interaction with quantum mechanics.

Finally, the latest-generation equipment, like GINGERINO, could provide a valid, alternative tool in studying phenomena that influence the rotation of our planet, changes to the tilt of the Earth's axis, and geological features of the areas in which the interferometers are installed.

The GINGER collaboration is led by INFN with the contribution of INGV Italian National Institute for Geophysics and Volcanology. Through the Legnaro and Gran Sasso National Laboratories, the Pisa, Naples, and Turin Divisions, INFN was responsible for the planning and implementation of GINGERINO and is in charge of the data analysis acquisition activities. ■