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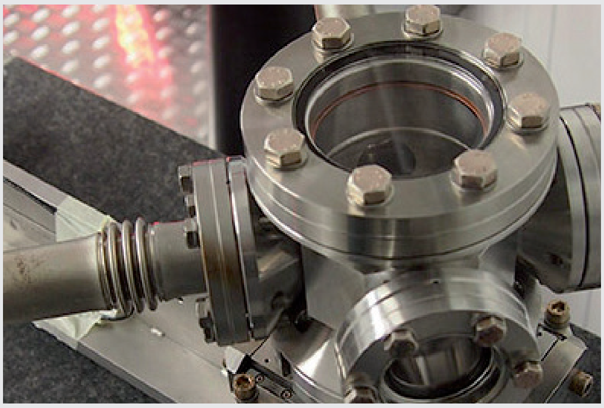

GINGERINO: THE MOST SENSITIVE METER OF THE EARTH'S ROTATION IS AT THE GRAN SASSO LABORATORIES

In the bowels of the Gran Sasso, under 1,400 metres of rock, in addition to the big experiments for dark matter and neutrinos research, the INFN National Laboratories are home to the world's most sensitive instrument for measuring the Earth's rotation. We are speaking of Gingerino (Gyroscopes in General Relativity), a device whose unique features will enable researchers to test a particular aspect of General Relativity: the Lens-Thirring effect. The phenomenon, one of the consequence of Einstein's Theory, predicts that in its rotational motion, the Earth deforms the spacetime grid, twisting it in the direction of its movement. The effect has never been comprehensively verified experimentally because it has virtually unperceivable implications. As a consequence of the spacetime torsion, in fact, a change in the speed of Earth's rotation of less than one billionth of a degree per second is expected: a change so small as to require measuring instruments with extremely high accuracy.

A prototype of what will be the most powerful and sophisticated final experiment (GINGER), Gingerino consists of a laser gyroscope, a kind of ring of light that can measure the tiniest variation in the rotation of the planet. The instrument uses two laser beams that run along the perimeter of a 3.6 x 3.6 metre square, guided by a set of perfectly smooth mirrors. Moreover, to protect the electronics of the instrument against humidity, Gingerino is enclosed in a sort of thermal cradle, a sealed chamber heated with infrared lamps. The spacetime distortion due to the rotation of the Earth influences – as predicted by General Theory of Relativity - the path of the laser beam which runs in the direction of the rotation, slightly increasing its extension and thus giving rise to a difference in the path of the two beams. A difference which, although equal to only a few billionths of a metre, is sufficient to change the frequency of the photons by a measurable quantity.

Although the accuracy needed to confirm the effect has not yet been reached, the optimisation of the Gingerino prototype is an excellent result and an absolute record: ensuring unprecedented levels of sensitivity and robustness, it allows the instrument to work continuously for months without the need

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for intervention and to detect the slightest alteration in the Earth's speed of rotation.
An initial confirmation of the Lens-Thirring effect, still with quite a large margin of error (5%), came in 2016 thanks to the Lageos and Lares satellites, launched by NASA and the Italian Space Agency (ASI). The previous result, obtained in 2011 by the Stanford Gyroscope Experiment, Gravity Probe B (GPB), produced an agreement with the predictions of the General Theory of Relativity with a margin of error of 19%. The expected accuracy of GINGER in measuring the Earth's drag would reduce the margin of error to 1%, thus allowing the phenomenon predicted by Einstein's GTR to be confirmed. To reach this result, GINGER's experimental data will be also compared with data collected independently by IERS (International Earth Rotation and Reference Systems).
The data coming from Gingerino, and in the future from GINGER, will also be useful in many areas. Besides proving the spacetime distortion caused by the Earth's rotation, the instrument will, for example, be able to measure the solid tides caused by the gravitational attraction of the Moon and the rotation transmitted to the ground by seismic waves, a hitherto little studied aspect of earthquakes which, thanks to Gingerino, has already been monitored and measured during the earthquake that struck central Italy. ■