

Scaling up gyroscopes: From navigation to measuring the Earth's rotation

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Accurately sensing rotation is important to a variety of technologies, from today's smartphones to navigational instruments that help keep submarines, planes, and satellites on course. In a paper accepted for publication in the American Institute of Physics' journal *Review of Scientific Instruments*, researchers from the Technical University of Munich and New Zealand's University of Canterbury discuss what are called "large ring laser gyroscopes" that are six orders of magnitude more sensitive than gyroscopes commercially available.

In part, the increased sensitivity comes from the scaled-up size – the largest of these gyroscopes encloses an area of 834 square meters – meaning these instruments are no longer compatible with navigation applications. In addition, a very involved series of corrections must be made when using these instruments to account for a variety of factors, including the gravitational attraction of the moon. According to the researchers, however, the progress in these devices has made possible entirely new applications in geodesy, geophysics, seismology, and testing theories in [fundamental physics](#) such as the effects of [general relativity](#).

Ring laser gyroscopes rely on [laser beams](#) propagating in opposite directions along the same closed loop or "ring." The beams interfere with one another forming a stable pattern, but that pattern shifts in direct proportion to the rotation rate of the whole laser-ring system (called the "Sagnac effect"). Large ring laser gyroscopes are attached to the Earth's crust so that a shift in that pattern (seen as an observed beat note in an actively lasing device) is directly proportional to the rotation rate of the

Earth.

Perturbations in that rotation rate capture the momentum exchange between the atmosphere, hydrosphere, and lithosphere, and so large ring laser gyroscopes could be used to indirectly monitor the combined effects of variations in global air and [water currents](#), for example. They may also be used both to supplement and improve calculations currently made with Very Long Baseline Interferometry (VLBI) techniques for measuring the orientation of the instantaneous rotation axis of the Earth and the length of day.

Additionally, changes in the ring's orientation also shifts the beat note of the interferometer, making the large ring laser gyroscope useful for detecting tilts in the Earth's crust, which current seismometers cannot distinguish from horizontal acceleration.

More information: "Large Ring Lasers for Rotation Sensing" is accepted for publication in the journal *Review of Scientific Instruments*. rsi.aip.org/resource/1/rsinak/v84/i4/p041101_s1

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