



NIST
National Institute of
Standards and Technology
U.S. Department of Commerce

COMMERCIALIZATION OPPORTUNITY

Compact Atomic Magnetometer and Gyroscope
Based on a Diverging Laser Beam
Patent Number: 7,872,473
Ref. 07-17

NEW ENABLING TECHNOLOGY

The NIST Compact Atomic Magnetometer is based on a diverging (or converging) beam of light that passes through an alkali atom vapor cell and that contains a distribution of beam propagation vectors. The existence of more than one propagation direction permits longitudinal optical pumping of atomic system and simultaneous detection of the transverse atomic polarization. This design can be implemented with a micro machined alkali vapor cell and light from a single semiconductor laser. **A small modification to the cell contents and excitation geometry allows for use as a gyroscope.** Atomic magnetometers are scalar sensors - they sense the magnitude of the magnetic field, rather than the projection along one spatial direction. This is particularly important for applications on moving platforms since platform motion adds considerable noise to a vector sensor as the angle between the field and the sensor axis changes.

BETTER FASTER EFFICIENT TECHNOLOGY

This technology simultaneously achieves high sensitivity, simple fabrication and small size. For example, the NIST gyroscope's sensitivities for the magnitude and direction of the rotation measurements are 0.033 degrees per second and 0.27 degrees with one second averaging time, respectively. A variety of magnetometer/ gyroscope combinations exist but are expensive.

The NIST compact atomic gyroscope enables multitasking measurement capabilities. It simultaneously measures rotation, rotation angle and acceleration with a single source of atoms. Signal strength and data acquisition speed increased to increase sensitivity measurements. In addition, it features a smaller design for compact systems that can be used in the field.

COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS (CRADAS) AND PATENT LICENSE AGREEMENTS AVAILABLE NOW

- ▶ Gyroscope capability
- ▶ High sensitivity
- ▶ Simple fabrication
- ▶ Small size
- ▶ Multitasking measurement capabilities
- ▶ Measures rotation, rotation angle and acceleration with a single source of atoms

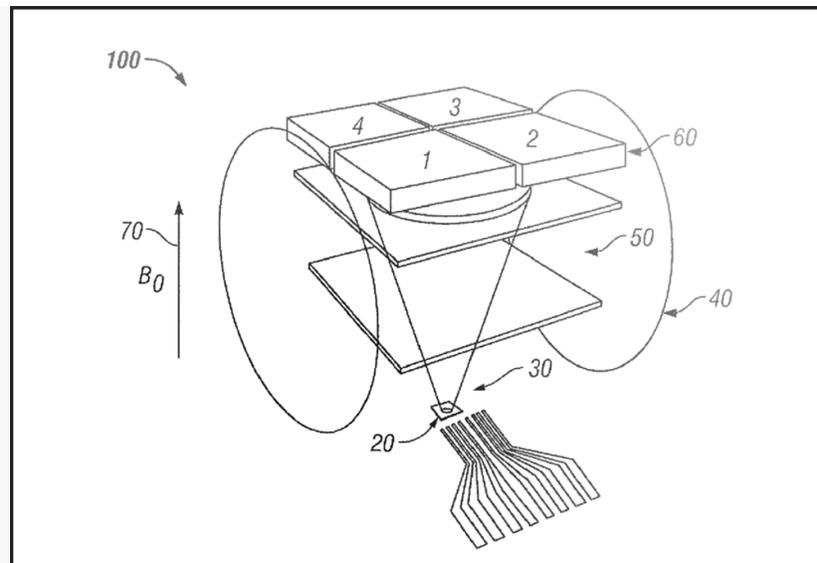


Illustration of an atomic magnetometer **100**. Light is emitted from a semiconductor laser **20**. It passes through some optics **30** that makes the laser polarization circular, attenuates the light beam and changes its spatial mode. A set of radio-frequency coils **40**, positioned about the cell creates an oscillating magnetic field in the cell. The light then enters an alkali vapor cell **50** with some divergence. The magnetic field, B_0 , **70** is oriented along the direction of the average propagation direction of the light field. Alkali atoms in the cell are thereby polarized along this direction by the circularly polarized light field. The transmitted light power is detected by photodetectors **60**.

CONTACT

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SMALLER DESIGN FOR COMPACT SYSTEMS THAT CAN BE USED IN THE FIELD

- ▶ **Multiple Applications of Gyroscopes Exist Within Inertial Navigation System and**
- ▶ **Multiple End-Use Applications Including Manned Aircraft, Automotive and Autonomous Vehicles**

Opportunity for multiple collaborative development relationships with research and development. There is an opportunity for collaboration with fabrication facilities!

THE SOLUTION FOR A HOST OF ISSUES THAT PLAGUE MULTIPLE INDUSTRIES

Gyroscopes sense rotation. In combination with magnetometers, gyroscopes are used in inertial navigation and platform stabilization applications. **The NIST Compact Atomic Magnetometer and Gyroscope is the first to demonstrate simultaneous measurement of rotation, rotation angle and acceleration with a single source of atoms.**

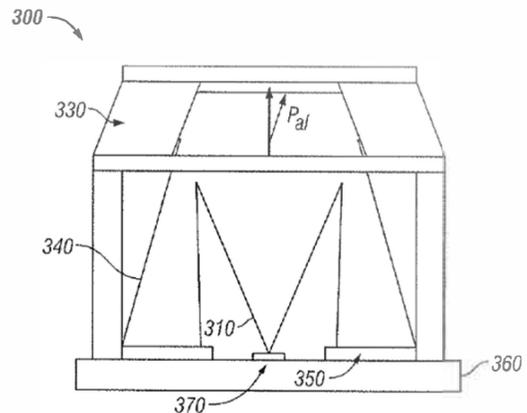
MARKET

Multiple addressable markets exist based on the combined performance of the magnetometer and gyroscope in inertial navigation systems (INS) as well as multiple end-use applications including manned aircraft, automotive and autonomous vehicles. NIST is seeking partnerships via CRADAs and patent license agreements.

PARTNERSHIPS

Cooperative Research and Development Agreements (CRADAs), Patent License Agreements (PLAs) Abound

Gyroscope applications include inertial navigation and platform stabilization (anti-roll systems in cars, for example). Other applications include those requiring ultra-precise navigation with extreme size, weight and power limits, such as on spacecraft or submarines.



A schematic of an implementation of the diverging beam magnetometer or gyroscope **300**. The diverging components of the laser beam **310** are reflected by angled walls inside the alkali vapor cell **330** to form counter-propagation probe beams **340**. These beams are reflected a second time of the opposite wall and the power is detected by photodiodes **350** placed on the base plate **360** with the laser **370**.

THE NIST COMPACT ATOMIC MAGNETOMETER'S DESIGN CAN BE IMPLEMENTED WITH A MICRO MACHINED ALKALI VAPOR CELL AND LIGHT FROM A SINGLE SEMICONDUCTOR LASER.

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