Tokyo Tech Research Units

Quantum Navigation Unit

Overview

The introduction of satellite navigation, particularly GPS, has resulted in the stabilization of ship and aircraft operations for marine vessels, public shipping devices, and all land-based traffic systems. However, the navigation precision under the ground or water is much worse than the case on the ground level since we can not utilize the satellite positioning system. Even on the ground surface, there are various problems such as jamming or spoofing, threatening our safety and security. This research unit develops and implements cutting-edge technology covering classical to quantum areas and aims to establish revolutionary navigation technology to expand the human being's active region to the underwater or deep space. Furthermore, cutting-edge navigation technology is fully utilized and pioneered for examining the inner regions of the Earth, thereby assisting in the prevention and reduction of the effects of natural disasters and developing new applications for the practical use of navigation sciences.

Research Unit Leader **Mikio Kozuma**

Profile

2021 Professor, Institute of Innovative Research, Tokyo Institute of Technology
2013 Professor, Department of Physics,Tokyo Institute of Technology.
2001 Associate Professor, Department of Physics, Tokyo Institute of Technology.
1998 Assistant Professor, Institute of Physics, University of Tokyo.
1997 Post-doctoral research fellow at National Institute of Standards and Technology.
1997 Completed Doctoral Course from Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology.

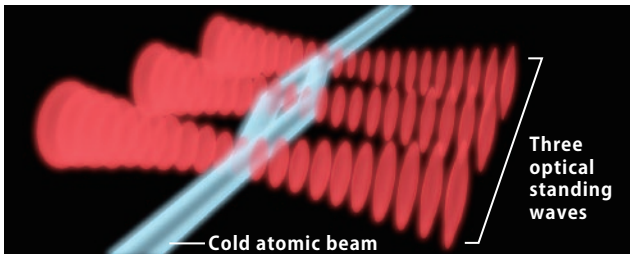
WEB www.qnav.iir.titech.ac.jp/en/

Research Goals

Due to the COVID-19 pandemic, globalization has come to a halt, and society and the economy across the whole world have fallen into disarray and malfunction, beginning in the United States and spreading to Europe. The established world order has been disturbed, and many countries around the world have had struggled in developing new systems to guarantee their country's safety and security. When designing such a system, the following three factors must be considered: energy, disaster prevention, and food and water rationing. These elements are related to various sustainable development goals (SDGs), although this unit focuses on SDG7 (affordable and clean energy), SDG11 (sustainable cities and communities), and SDG13 (climate action). More concretely, we are planning to realize worldwide contribution from viewpoints of "streamlining marine resource exploration," "risk assessment of the large scale of the earthquake," and "data acquisition under Arctic sea ice." Fusing quantum technologies to traditional navigation methods can realize such contributions to SDGs. The mission of this research unit is to realize a safe, secure, and wealthy society based on quantum navigation technology.

Research for Non-GPS Navigation Underwater, Underground, and Outer Space Regions

Inertial navigation using accelerometers and gyroscopes is a typical example of a non-GPS navigation. Currently, the precision of inertial navigation is limited by the performance of the gyroscope. The ultra-precise gyroscope can be developed using a quantum interferometer, where three optical standing waves are used to split, reflect and combine a cold atomic beam.



atom interferometer gyroscope