Gwangju Institute of Science and Technology

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Professor Byoung S. Ham discovers a new core principle of quantum sensing

☐ A quantum is the smallest unit of physical entity that can no longer be broken down in physics. Quantum sensing* technology uses quantum properties to detect and measure a physical quantity that goes beyond the limitations of classical physics, such as overcoming the standard amount self-limit. It is expected to be used in various technologies for human health and safety, such as autonomous driving using quantum sensors, semiconductors, medical bio-imaging, and micro-sensing technology.

* quantum sensing: A technology that detects ultra-fine changes in the quantum state and realizes ultra-high sensitivity and ultra-high resolution that overcome the limitations of classical sensors in the field of physical quantity sensing such as photons, magnetic fields, and gravity.

☐ GIST (Gwangju Institute of Science and Technology, President Kiseon Kim) School of Electrical Engineering and Computer Science Professor Byoung S. Ham has discovered a new core principle of macroscopic quantum sensing, which can completely replace existing quantum sensing technology and can secure more than 100 times the resolution of classical refraction system using a laser.

- Professor Ham secured original technology with a new concept that completely replace the existing quantum entanglement* pair, which is essential to current quantum sensors, with de Broglie waves. This new principle of coherence**

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with de Broglie waves secures new technology in the field of quantum sensors autonomous driving, drones, and inertial navigation.

* quantum entanglement: It is a series of non-classical correlations that can exist between two sub-systems. Entanglement can exist even if the two-part systems are spatially separated from each other. For example, when two particles are placed in a constant quantum state so that the spins of the two particles are always opposite (the singlet state of the two spins), according to quantum mechanics, the state of the two particles is unknown until measured. However, if a measurement is made, the state of the limit is determined at the moment, and the state of another system immediately intertwined with the system is also determined. It is as if information has moved from one system to another in an instant.

** coherence: An ideal property of waves that allows interference when the frequency and waveform of two wave sources are identical and their phase difference is constant.

□ Photonic de Broglie waves (PBW) is a key principle of quantum sensors and quantum mechanics that overcome the limitations of the classical measurement systems and standard quantum limits by using a high-dimensional quantum entangled photon pair, which is the core principle of quantum metrology. However, the highest ordered quantum entangled photon pair to date is only 18, which is far short of 100 to meet quantum sensing supremacy*, making it difficult to implement quantum sensors.

* quantum sensing supremacy: In contrast to quantum supremacy in a quantum computer, for quantum sensors this is the smallest number of quantum entangled photon pairs that can occupy a technological advantage over a classic sensor, and is generally considered around 100. Currently, the maximum number that can be secured is only 18, so quantum sensor applications are practically impossible.

□ On the other hand, the coherence of the de Broglie waves completely excludes the quantum entangled photon pair in current quantum sensors (or quantum measurement) and provides the core principle for the next-generation quantum measurement technology that will achieve the supremacy of quantum sensing using only a classic laser. It can be used as a next-generation source technology for inertial navigation devices that are essential equipment for autonomous driving, drones, and underground/tunnel/subsea navigation.

□ Professor Ham said, "The results of this study are most significant in that they provide the core principle for next-generation quantum measurement technology to achieve quantum sensing supremacy with a classic laser by simply excluding the quantum entangled photon pair in current quantum sensing devices. This is expected to provide new clues to expand quantum physics, which is currently limited to the micro-world, into the macroscopic world."

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