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# Professor Byoung S. Ham proposes a quantum laser that will definitively implement the macro-quantum world

□ GIST (Gwangju Institute of Science and Technology) School of Electrical Engineering and Computer Science Professor Byoung S. Ham (Center for Photon Information Processing director) proposed a quantum laser that can be implemented in the macro world by reinterpreting the existing quantum mechanics limited to the microscopic world with wave properties rather than particle properties of photons.

◦ Professor Byoung S. Ham said that if existing lasers are a light bundle based on the classical coherence theory, the proposed quantum laser is a non-classical light bundle based on quantum * entanglement ** that can drastically solve the single photon detection trap, which is the biggest challenge in quantum sensing and quantum communication.

* quantum: The smallest unit of matter that cannot be further divided.

** entanglement: A phenomenon in which particles correlate in pairs, so that measuring one property of one entangled pair, regardless of distance, immediately knows the property of the other, which is a principle application of quantum communication and quantum computing.

- Above all, the core challenge of autonomous driving, which is the core of electric vehicles, is the physical limit of LiDAR, and the quantum laser proposed this time is expected to solve scan speed, resolution, and visibility at the same time by converting the LIDA paradigm to Quantum LiDAR.

  - The macroscopic quantum entanglement technology proposed in this study implements the entangled light pair by using the existing laser as it is, and the quantum sensing principle is realized macroscopically. By using light itself, not a single photon, as a quantum lidar signal, it solves the overall problem of existing LiDAR *.

    * LiDAR: It is a device that recognizes the surrounding environment in 3D and helps autonomous vehicles drive safely, and the operating principle of LIDA continuously fires millions of laser beams per second and calculates the time it returns to the sensor to measure the distance. It also recognizes obstacles, people, and cars while driving and enables tracking, and can also recognize lane boundaries of roads and traffic lights in front of them with high accuracy.

- In addition, the biggest challenge for existing quantum cryptography communication * are detection traps limited to single photons. However, quantum lasers are inherently free from detection traps and are deterministic in generating quantum signals. Quantum communication at the optical communication level becomes possible.

    * Quantum cryptography communication: A communication method based on quantum mechanics that uses quantum entangled photon pairs as data or encryption keys. Although absolute security is physically guaranteed, single photon pair generation is probabilistic, and above all, it is a fundamental difficulty due to the single photon detection trap. Because of this, the transmission speed and transmission capacity are significantly low, so it cannot be applied to the level of existing communication systems.

- Professor Byoung S. Ham said, "The Copenhagen interpretation, which is currently key to quantum mechanics, is the duality of particles and waves that light has, so far, quantum mechanics has been buried in particleism and has caused its own limitations. Now, it is time to study the wave nature, which is the other axis, to expand the ambivalence of the Copenhagen interpretation with new interpretations and perspectives, as well as to think about quantum

information communication compatible with existing information communication."

- The findings were published online on May 31, 2021, in *Scientific Reports*, a sister journal of *Nature*.

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