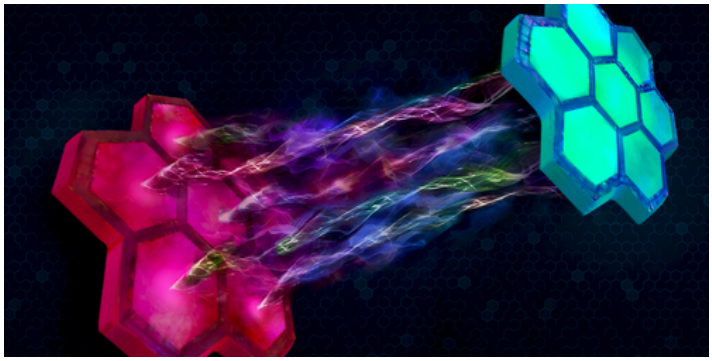
Quantum Steering That's Robust to Loss and Noise

Researchers demonstrate a loss-tolerant method for so-called quantum steering, a phenomenon that could give quantum communication networks complete security.

By **Katherine Wright**

Quantum systems are bizarre. One lesser-known quirky quantum behavior is the entanglement phenomenon known as quantum steering. Like other entanglement phenomena, quantum steering is easily destroyed by noise, limiting its use in applications. Now Mehul Malik of Heriot-Watt University, UK, and his colleagues demonstrate noise-robust, loss-tolerant quantum steering, increasing its technological potential [**1**].

When two parties—Alice and Bob—share a pair of particles in a strongly correlated entangled state, any measurements made on the particles are linked such that measurements made by Alice can be used to predict the outcome of measurements made by Bob. In quantum steering, this correlation goes a step further: by making certain measurements on her particle, Alice can "steer" the quantum state of Bob's particle to take on a specific form.



Credit: V. Srivastav/Heriot-Watt University

Quantum steering can be used as a verification step to show that a line between Alice and Bob remains secure, even when Alice doesn't trust her devices or the channel in between. It has more relaxed requirements than other device-independent verification methods, making it interesting for future communication networks. But quantum steering has the same noise and information-loss problems. So far, methods that attempt to overcome those problems have required impractically large numbers of measurements.

The protocol developed by Malik and colleagues uses photon pairs that have "high-dimensional" entanglement—they can be entangled in 53 dimensions rather than the normal two. This high-dimensional entanglement makes the quantum correlations between the photons stronger, which reduces the susceptibility of the system to noise. The team successfully used their protocol to steer entangled photons through the equivalent of 79 km of telecommunication fiber. Malik says that "having a loss-tolerant method for steering entanglement opens a pathway toward practical quantum communication networks with the ultimate security."

Katherine Wright is the Deputy Editor of ***Physics Magazine***.

REFERENCES

1. V. Srivastav *et al.*, "Quick quantum steering: Overcoming loss and noise with qudits," **Phys. Rev. X 12, 041023 (2022).**