Physicists propose new approach that could unlock barriers to global scale quantum network

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Interference (excess noise) to quantum signals from sunlight has slowed down the creation of a global scale quantum communications network,

but now physicists at Heriot-Watt University have proposed a way to tackle this "daylight noise"' issue, paving the way for all-day satellite transmission.

While satellite quantum key distribution (SatQKD) offers global connectivity, it struggles with daylight noise. At present operations are limited to night time, limiting applications and connectivity.

Filtering out the daylight noise is essential to allow quantum systems to operate reliably, especially for applications like SatQKD that aim to secure communication over long distances.

Now a team at HWU has proposed that using alternative encoding—the process by which data is converted into a quantum state—could allow SatQKD to operate, even at dawn and dusk.

The team's research has been published in the journal *Optica Quantum*.

They have proposed that using time and phase encoding could extend and enhance operations by three or four hours each day, which is significant.

Early simulations indicate that time and phase encoding unlocks the capability to filter in polarization, yielding a reduction in detected daylight and allowing SatQKD to be performed at dawn and dusk due to the daylight noise being partially polarized.

Dr. Ross Donaldson, Associate Professor, School of Engineering & Physical Sciences, Institute of Photonics and Quantum Sciences, explains, "Current mitigation techniques are not yet sufficient to make daylight tolerable for SatQKD.

"While all current SatQKD systems are polarization-encoded,

polarization filtering has not been investigated—until now.

"We believe that by using time- and phase-encoded SatQKD, it is possible to filter in polarization, allowing SatQKD to be performed at dawn and dusk, and paving the way for daylight SatQKD.

"One way to think about it is, if you put on a pair of polarizing sunglasses, you'll see some parts of the sky darker than others, because those parts are more polarized than others.

"We can use this filtering to overcome the issue of daylight 'noise' and eventually facilitate quantum communications via satellite, around the clock."

The team will leverage their involvement in two missions (Quantum Communication hub's Space Platform for Optical Quantum Communication (SPOQC) and Quantum Encryption and Science Satellite (QEYSSAT) being launched in 2025, to demonstrate their simulations experimentally.

More information: Cameron Simmons et al, Dawn and dusk satellite quantum key distribution using time- and phase-based encoding and polarization filtering, *Optica Quantum* (2024). DOI: 10.1364/OPTICAQ.527880

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