

The way a lab in Bengaluru is leading India to QuIC-ly catch up in the quantum race

by PSA Content Team

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With the WhatsApp policy changes lately, conversations on how safe the information we share on social media in general and the portal in particular, are back. As most of us switched to virtual environments to communicate for work post-COVID19, a lot of which has sensitive information, the issue of security of this information was front and center. The work of a laboratory, based in Bengaluru on quantum cryptography, which was highlighted as a ground-breaking innovation in 2020 ([here](#) and [here](#)), is something we all need to know about.

The Quantum Information and Computing or QuIC lab based in the Raman Research Institute, Bengaluru is the first laboratory in India to work exclusively on photonic quantum science and technologies. Led by Dr. Urbasi Sinha, Professor at RRI, it is “one of the first labs in India to manufacture and establish the usage of heralded and entangled photon sources towards various applications in quantum technologies,” says the [lab’s website](#).

Information transfer protocols have a secret “key” possessed by the sender and receiver to encrypt and decrypt the message/s. But this process is vulnerable to eavesdropping, which means it allows third-party unwarranted access to a piece of information that is otherwise private. Dr. Sinha’s team found the solution to this using Quantum Key Distribution. Quantum Key Distribution, QKD for short, works by transferring data using photons instead of bits (read more about QKD [here](#)). A confidential key, shared in this manner, cannot be copied or intercepted imparting enhanced security against eavesdroppers. A cryptographic method, QKD’s augmentation of the security of communication has its underpinnings in the principles of quantum mechanics – Heisenberg’s uncertainty principle, no-cloning theorem, and quantum entanglement.

“The team achieved the first successful implementation of a highly secure, and efficient Quantum Cryptographic scheme for end-to-end free space Quantum Key Distribution (QKD) in India,” says Dr. Sinha. This is India's first published free-space Quantum Key Distribution protocol. Dr. Sinha’s team also reported the development of a complete end-to-end simulation toolkit named “qkdSim”. This technological innovation will play a pivotal role in ushering in quantum-enabled security in India and beyond.

Read the complete paper on qkdSim [here](#) and its coverage by Nature India [here](#).

Another major scientific milestone that the team achieved last year was the development of a novel quantum state estimation protocol and its successful demonstration in the lab using quantum interference as a resource. This is called "Quantum State Interferography".

In classical physics, the state of a system is described with a set of numbers; hence devising a procedure to measure the state of the system is straightforward. In contrast, quantum mechanics, owing to its underpinnings in Heisenberg’s uncertainty principle and no-cloning theorem, make this measurement cumbersome. The RRI team showed that without changing any settings in the experimental setup, it is possible to infer the unknown quantum state of a quantum bit. This method is also shown to be, in principle, extendable to a higher dimensional system.

This work presents a novel method for quantum state estimation and quantum entanglement quantification. This interferometry-based technique developed by Dr. Sinha’s team provides a user-friendly and efficient tool entailing a tremendous scaling advantage over conventional tools. Moreover, the work also indicates how this technique could lead to miniaturized devices in the long run, which could then be used for quantum state estimation at a commercial scale. Precise quantum state estimation is of crucial significance

towards enabling higher precision in cutting-edge quantum technology applications such as quantum computing and quantum communications. The team partnered with Harish-Chandra Research Institute, Prayagraj for this work.

Read the complete paper on Quantum State Interferography [here](#) and a story on it by Nature India [here](#).

Further reading:

[DST researchers come up with simulation toolkit to safeguard secure quantum communication platforms](#)

<https://www.psa.gov.in/article/way-lab-bengaluru-leading-india-quic-ly-catch-quantum-race/2487>