

Mathematics Department Colloquium

BITS Pilani, K K Birla Goa Campus

Title: Optimal Quantum Alert Systems: Detecting Sudden Changes in Infinite-Dimensional Systems

Speaker: Dr. Tiju Cherian John
Department of Mathematics, BITS Pilani, K K Birla Goa Campus

Abstract

Rapidly detecting sudden, critical changes is vital for various fields—from monitoring manufacturing quality to identifying faults in sensitive systems. In the emerging field of quantum technology, we face an analogous problem: how to optimally detect a change in the state of a quantum system as quickly as possible.

We generalise the Quantum CUSUM (QUSUM) algorithm—the optimal strategy for quantum change detection—to the complex, real-world setting of infinite-dimensional quantum systems. This theoretical leap is essential for applications involving continuous-variable systems, such as quantum optics and quantum sensing platforms (like those using Gaussian states of light). Our work proves that the QUSUM strategy retains its ultimate speed and accuracy in this expanded domain. The fundamental performance limit is universally determined by the quantum relative entropy (an information-theoretic distance) between the ‘before’ and ‘after’ states.

This finding immediately enables the development of optimal, high-sensitivity monitoring schemes. For instance, by adding tiny amounts of quantum entanglement to a standard laser communication signal, the ability to detect a sudden drop in channel performance (like a wiretap) can be dramatically boosted. This enhancement significantly reduces the detection time without slowing down the communication rate.

This talk is based on joint results recently accepted for publication in *Physical Review Letters* and the *IEEE Information Theory Workshop (ITW)*, 2025.

All are cordially invited to attend.