**Optimal quantum spatial search on random temporal networks**

S. Chakraborty[1,2], L. Novo[1,2], S. D. Giorgio[1,2], Y. Omar[1,2]

(1) Instituto de Telecomunicações, Physics of Information and Quantum Technologies Group, Lisbon, Portugal.
(2) Instituto Superior Técnico, Universidade de Lisboa, Portugal.

To investigate the performance of quantum information tasks on networks whose topology changes in time, we study the spatial search algorithm by continuous time quantum walk to find a marked node on a random temporal network. We consider a network of $n$ nodes constituted by a time-ordered sequence of Erdös-Rényi random graphs $G(n,p)$, where $p$ is the probability that any two given nodes are connected: after every time interval $\tau$, a new graph $G(n,p)$ replaces the previous one. We prove analytically that for any given $p$, there is always a range of values of $\tau$ for which the running time of the algorithm is optimal, i.e. $O(\sqrt{n})$, even when search on the individual static graphs constituting the temporal network is sub-optimal. On the other hand, there are regimes of $\tau$ where the algorithm is sub-optimal even when each of the underlying static graphs are sufficiently connected to perform optimal search on them. From this first study of quantum spatial search on a time-dependent network, it emerges that the non-trivial interplay between temporality and connectivity is key to the algorithmic performance. Moreover, our work can be extended to establish high-fidelity qubit transfer between any two nodes of the network. Overall, our findings show that one can exploit temporality to achieve optimal quantum information tasks on dynamical random networks.