Optimal discrimination of quantum sequences

Tathagata Gupta[1] , Shayeef Murshid[2], Vincent Russo[3] and Somshubhro Bandyopadhyay[4]

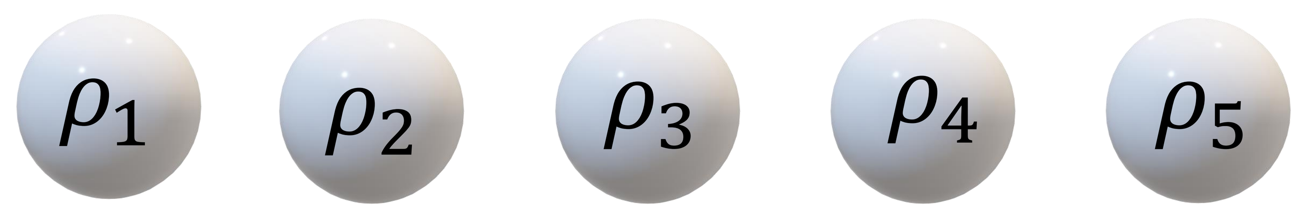
[1]Physics and Applied Mathematics Unit, Indian Statistical Institute, India; tathagatagupta@gmail.com

[2]Electronics and Communication Sciences Unit, Indian Statistical Institute, India; shayeef.murshid91@gmail.com

[3]Unitary Fund; vincent@unitary.fund

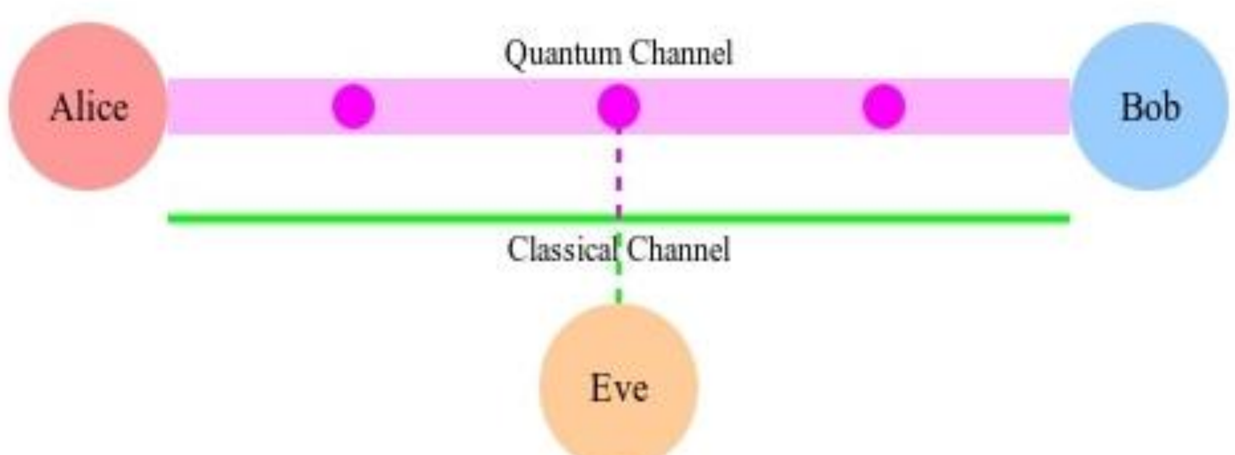
[4] Department of Physical Sciences, Bose Institute, India; som@jcbose.ac.in

Quantum sequences



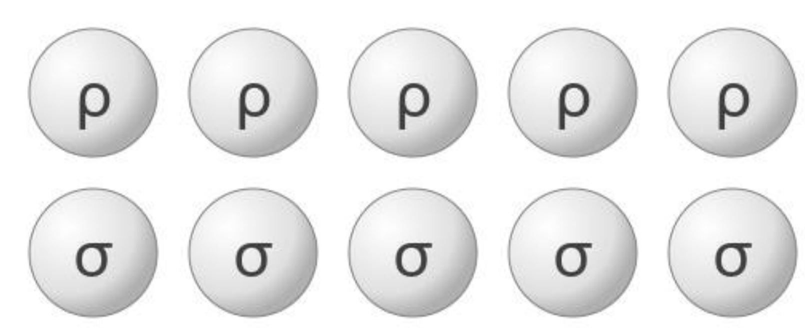
- A quantum sequence is a string of unentangled quantum states
- The objective is to identify the state of the sequence, both in minimum-error or unambiguous paradigm

Examples



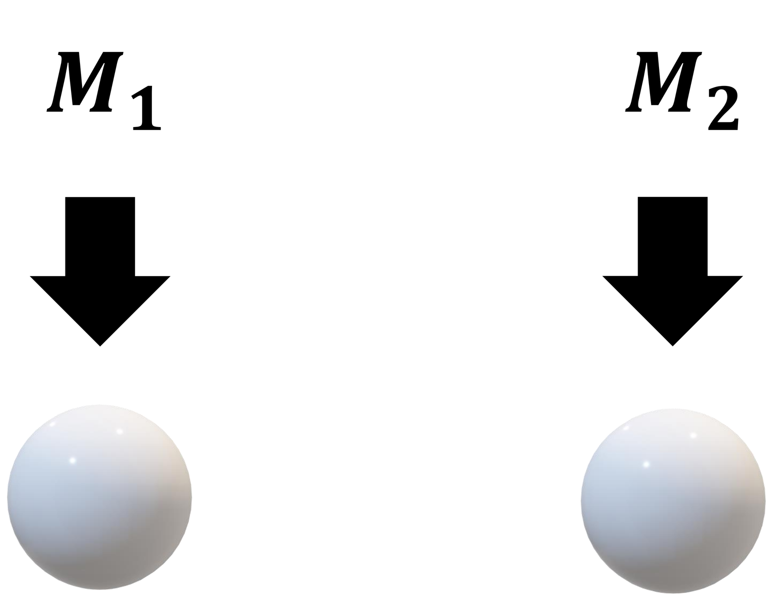
Quantum key distribution[a]

Quantum change point[b]

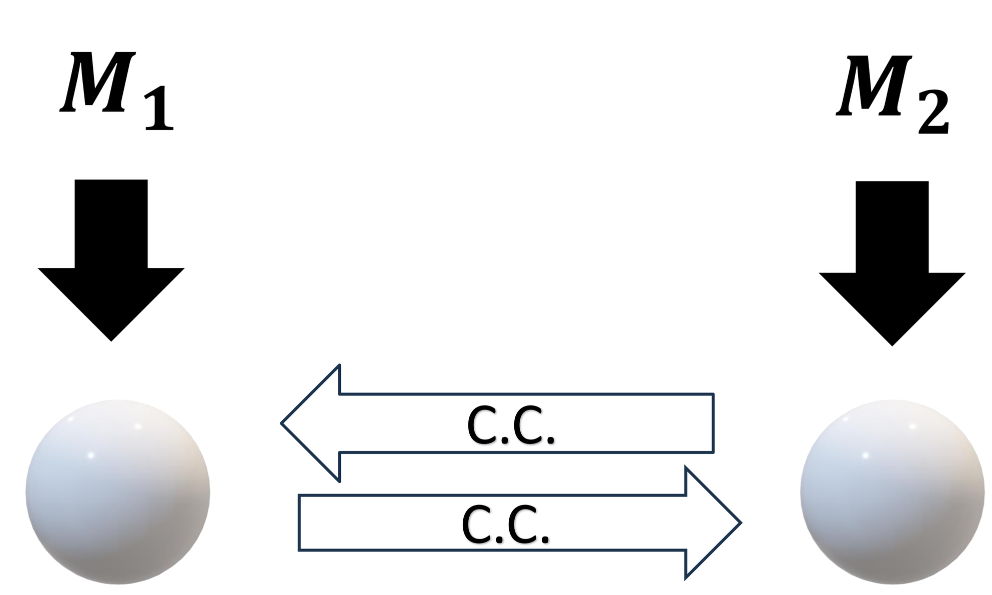


Multicopy state discrimination[c]

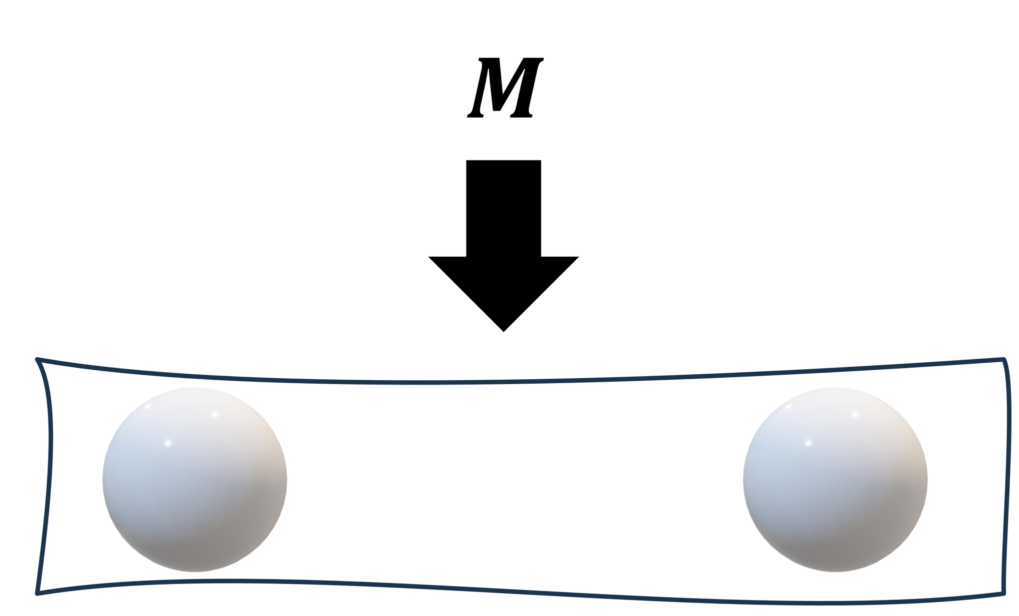
Sequence discrimination



Fixed local strategy

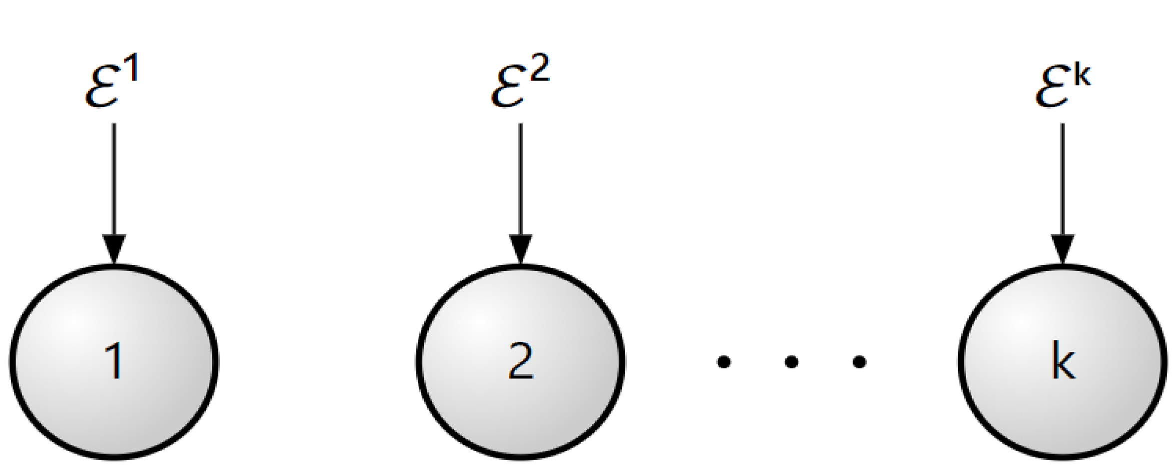


Adaptive local strategy



Global strategy

Optimal discrimination



For quantum sequences whose states are independent of each other, fixed local measurements are optimal.

- $\mathcal{E}^i = \{(\eta^i_j, \rho^i_j) : j = 1, \dots, \ell_i\}$. These ensembles are known *a priori*.
- The state at position i of the sequence, has a probability η^i_j of being ρ^i_j .
- This makes them independent but *non*-identically distributed sequences of quantum states.
- The k-length sequences form the ensemble $\mathcal{E}_{seq} = \{\eta^1_{x_1} \dots \eta^k_{x_k}, \rho^1_{x_1} \otimes \cdots \otimes \rho^k_{x_k} \mid x_i \in [\ell_i] \text{ for all } i \in [k]\}$.
- The optimal measurement strategy for discriminating $\mathcal{E}_{seq}$ constitute performing on the i^{th} particle, the optimal measurement for discriminating $\mathcal{E}^i$.

Theorem: Let p_{seq} and p_i denote the optimal probability for minimum-error or unambiguous discrimination of the ensembles $\mathcal{E}_{seq}$ and $\mathcal{E}^i$, respectively. Then $p_{seq} = \prod_{i=1}^{k} p_i$

[a]C. Bennett *et al.*, Theoretical Computer Science **560**, 7 (2014). [b]G. Sentis *et al.*, Phys. Rev. Lett. **117**, 150502 (2016). [c]A. Acin *et al.*, Phys. Rev. A **71**, 032338 (2005).