THIRD YEAR ANNUAL EXAM

PRESENTED BY FARZAD KIANVASH

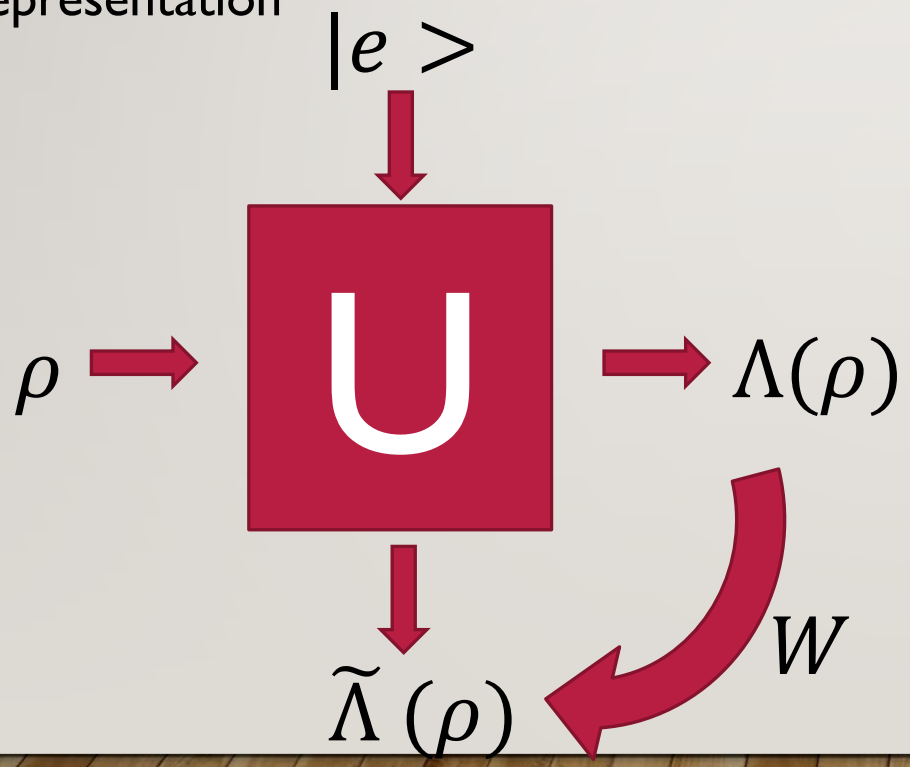
SUPERVISED BY PROFESSOR GIOVANNETTI

LIST OF SCIENTIFIC ACTIVITIES

- Articles
  - Marco Fanizza, Farzad Kianvash, and Vittorio Giovannetti, Phys. Rev. Lett. 125, 020503 – Published 8 July 2020
  - Farzad Kianvash, Marco Fanizza, and Vittorio Giovannetti, Bounding the quantum capacity with flagged extensions (arxiv)
- Conferences
  - Contributed talk on TQC (2020)

PRELIMINARIES

- Any Completely Positive Trace Preserving (CPTP) map can be represented in Stinespring representation



W Is degrading channel

$W \circ \Lambda = \tilde{\Lambda}$

PRELIMINARIES: QUANTUM CAPACITY

Alice wants to send an arbitrary state ρ to Bob, using n times the noisy channel Λ. Alice encodes her state to ρ_n and Bob decodes the received state to obtain the original state ρ. The maximum achievable rate $\frac{\log_2 Dim(\rho)}{n}$ for large n is the quantum capacity.

$$Q(\Lambda) = \lim_{n\to\infty} \frac{1}{n} Q_n(\Lambda),$$

For degradable channels $Q(\Lambda) = Q_1(\Lambda)$

$$Q_n(\Lambda) = \max_{\rho_n} I_c(\Lambda^{\otimes n}, \rho_n) = \max_{\rho_n} S(\Lambda^{\otimes n}(\rho_n)) - S(\Lambda^{\otimes n} \otimes I(|\rho_n \gg\ll \rho_n|))$$

I. Devetak, IEEE Trans. Inf. Th. **51**, 44 (2005).

QUANTUM FLAGS AND NEW BOUNDS ON THE QUANTUM CAPACITY OF THE DEPOLARIZING CHANNEL

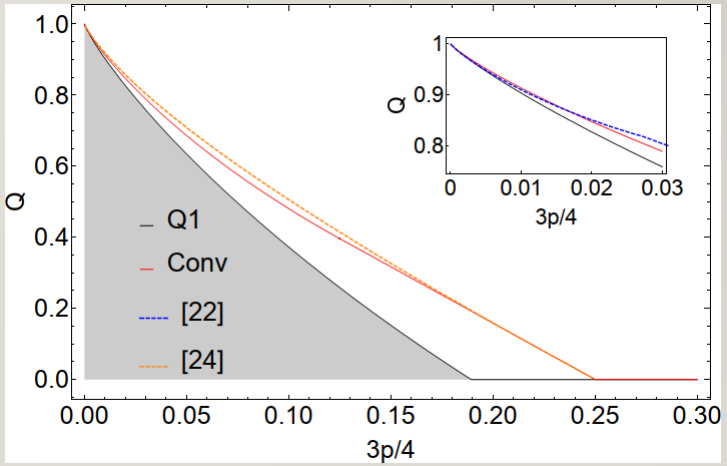
$$\Lambda_p(\rho) = (1-p)\rho \otimes \sigma_0 + p\frac{I}{d} \otimes \sigma_1$$

We choose $\sigma_0 = c^2|0><0| + \left(1-c^2\right)|1><1|, \qquad \sigma_1 = |0><0|.$

Then, we showed that for

$$c^2 < \frac{1-2p}{2-2p}$$

Λ_p is degradable and we compute $Q(\Lambda_p) = Q_1(\Lambda_p)$.



Our results are analytic and works in any dimension.

BOUNDING THE QUANTUM CAPACITY WITH FLAGGED EXTENSIONS

Given the following flagged channel

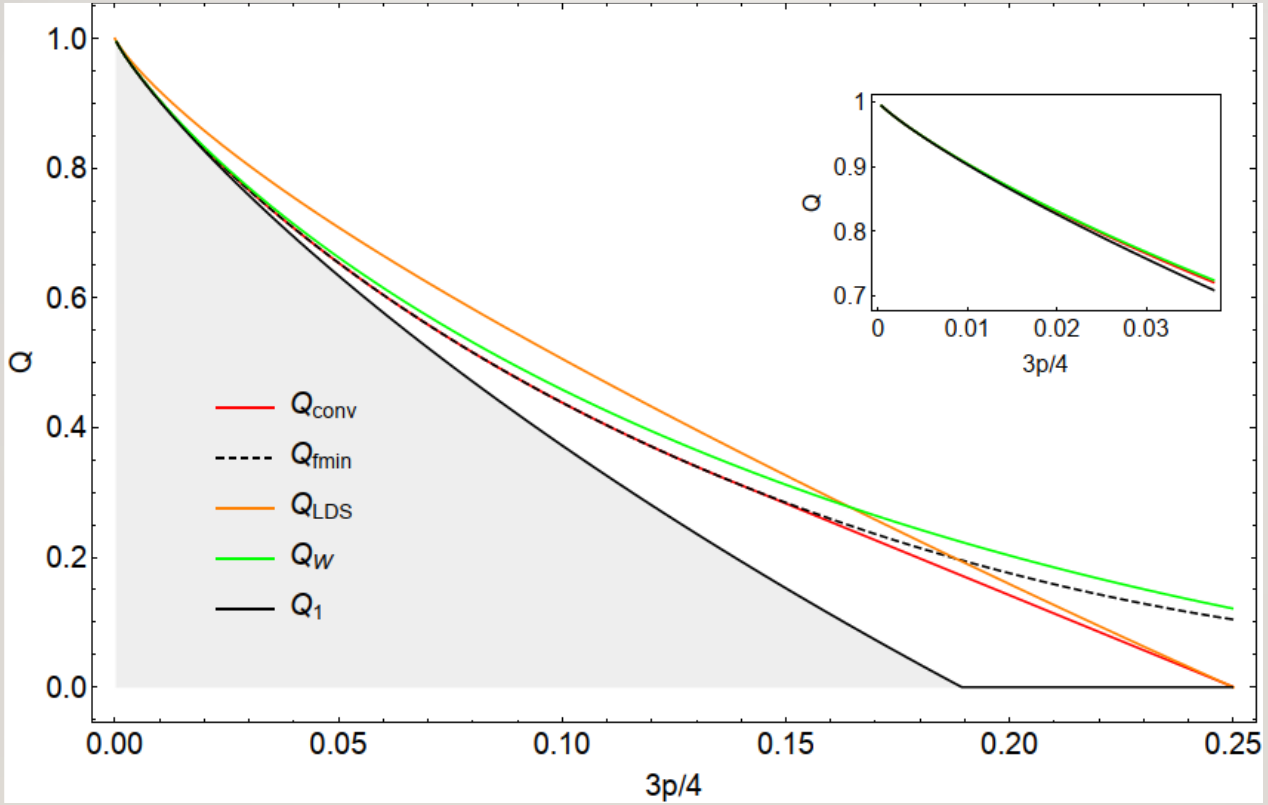
$$\Lambda[\rho] = \sum p_i \Lambda_i[\rho] \otimes |\varphi_i >< \varphi_i|$$

we found the sufficient conditions for the degradability.

We have improved the previous upper bounds on the quantum cap of depolarizing channel, generalized amplitude damping channel, BB84 channel.

Our results are analytic and works in any dimension.

UPPER BOUNDS ON THE QUANTUM CAPACITY OF DEPOLARIZING CHANNEL



FUTURE WORK

- Many uses flagged channels
- Using flagged extensions to study continues variable systems.
- Studying two way quantum capacity using flagged extensions.