

Instructional workshop on
The Functional Analysis of Quantum Information Theory
at IMSc, Chennai, India
December 26, 2011 - January 6, 2012

The workshop

This workshop will be devoted to the mathematical framework of quantized functional analysis (QFA), and illustrate its applications to problems in quantum communication.

The speakers

The lecturers at this workshop will be **Gilles Pisier** of Paris and Texas A&M, **K.R. Parthasarathy** of ISI Delhi, **Vern Paulsen** of Houston, and **Andreas Winter** of Bristol.

Topics hoped to be discussed

Operator Spaces and Completely bounded maps
by *Gilles Pisier*

- The Ruan axioms
- The Arveson-Wittstock-Hahn-Banach theorem
- The Grothendieck program relating Banach space tensor products to mapping spaces, and its quantum analogues
- The landscape of new phenomena in the quantum context (e.g., the notions of nuclearity and local reflexivity)
- The relationship between the Bell and Grothendieck inequalities in both the classical and quantum contexts
- Hasting's counterexample via the recent method related to versions of Dvoretzky's Theorem

Schmidt number and Schmidt rank of bipartite entangled states
by *K.R. Parthasarathy*

Abstract: We have three objectives:

- We shall briefly recall the definition of the Schmidt number of a pure bipartite state and search for subspaces in which every unit vector has Schmidt number exceeding a given k . This leads to an interesting open problem (in elementary algebraic geometry).
- We shall define the Schmidt rank of a mixed bipartite state and describe the Horodeckii-Terhal criterion for a state to have Schmidt rank exceeding k .

- We shall compute the Schmidt rank of a generalized Werner state which is a mixture of a maximally entangled state and an isotropic state.

Operator Systems and Completely Positive Maps

by *Vern Paulsen*

- Completely Positive Maps on Matrices
- Operator Systems and Completely Positive Maps
- Matrix Ordered Spaces and Abstract Operator Systems
- Tensor Products of Operator Systems and Nuclearity
- Applications of Operator Systems

Operator Methods in Quantum Information

by *Andreas Winter*

- Hoeffding type tail bounds for random matrices (matrix inequalities)
- Strong subadditivity and its equality conditions (multiplicative domains)
- Transmission vs. identification of quantum information (quantum channels; completely bounded vs. naive norms on maps)
- Zero-error capacity of quantum channels (operator systems; quantum error correction)
- Asymptotic quantum Birkhoff property (bistochastic quantum channels; relation to Connes' embedding problem)

Participants

Participants need only be familiar with the elements of classical functional analysis including the spectral theorem for bounded self-adjoint operators, and a superficial acquaintance with the matrix models for observables and states.