

# Volterra–CIRM International School

## Quantum computer and quantum information

Levico Terme, Italy, July 25–31, 2001

Centro V. Volterra Roma, Università di Roma Tor Vergata  
Centro Internazionale per la Ricerca Matematica (CIRM), Istituto Trentino di Cultura

The theory of quantum information and computing is undergoing a tremendous development in the past years. The activity in this field is now beginning to go beyond the academic environment and to involve industries who try to transform into effective products some of the proposals of the quantum information community.

In the development of classical information and computer theory mathematicians, from Pascal to Babbage, from von Neumann to Kolmogorov, have given outstanding contributions.

The problems coming from the quantum analogues of these theories are not less deep and fascinating for mathematicians, physicists, engineers, computer scientists who are not afraid of multidisciplinary interactions.

Among these problems: what is a quantum algorithm? can some quantum algorithms qualitatively outperform classical algorithms? Is quantum information qualitatively different from classical information? If such differences exist, how are they reflected in the measurement, coding and decoding of this information? Can we effectively build some physical devices to implement the new algorithms?

The school will be addressed to these questions with particular emphasis on clarity of exposition and precise definitions of the notions involved. The topics dealt with will be include:

1. tutorial of finite–dimensional quantum mechanics
2. tutorial of classical complexity theory: polynomial algorithms, P and NP problems: basic examples
3. general principles of quantum computation (q–bits, computational bases, gates, discrete Fourier transform, ...)
4. the three basic quantum algorithms: Schor, Grover, Ohya–Masuda. description, structural differences, complexity

5. Classical and quantum codes
6. quantum cryptography
7. Information, entropy and capacity: classical and quantum
8. Teleportation
9. Introduction to quantum control and filtering

## Main lecturers

- L. Accardi (Università degli Studi di Roma “Tor Vergata”)
- V. Belavkin (Nottingham University)
- M. Ohya (Tokyo Science University)
- K.R. Parthasarathy (Indian Statistical Institute)
- D. Petz (Technical University of Budapest)
- I. Volovich (Steklov Institute Moscow)

Additional seminars will be announced during the school.

**Participation fee: 800.000 italian lire** inclusive of: full board and meals, coffee breaks, social trip, lecture notes.

A restricted number of grants for financial support of either living or travel expenses are available. The assignment of these grants will be decided in July 30. The deadline for Applications is July 20.

Those interested to apply for such a grant should send via e-mail the Application Form below to:

Mr. Micheletti Augusto  
Secretary of the School  
CIRM  
Istituto Trentino di Cultura  
38050 Povo (Trento), Italy  
michelet@alpha.science.unitn.it  
Fax 0039/0461/810629  
Tel. 0039/0461/881628

**Organizers of the School: L. Accardi, M. Ohya**