SEMINAR ON QUANTUM PROCESSING

Mathematics, Physics and Technology

Sponsored by CRM, ICFO, FME (UPC) and SCM (IEC)

The aim of the seminar is to present basic ideas about the mathematics, physics and technology related to quantum information processing, and its likely impact in the coming years. It should be particularly useful to master and doctoral students of mathematics, physics and engineering.

There is no registration fee. However, for organizational reasons, we request you to let Núria Fuster to know about your intended participation. Please send a message to nfuster@iec.cat, or call her at (+34)93 324 8583. Room capacity is limited to 90 people.

Note. The lecture by **Ignacio Cirac** is part of the *Jornada von Neumann* organized by the FME of the UPC on Wednesday, 24/02/2010. The remaining lectures will be delivered at the IEC on Thursday, 25/02/2010.

CRM	*Centre de Recerca Matemàtica*
ICFO	*Institut de Ciències Fotòniques*
IEC	*Institut d'Estudis Catalans* (C. del Carme, 47. Barcelona)
FME	*Facultat de Matemàtiques I Estadística* (C. Pau Gargallo, 5. Barcelona)
SCM	*Societat Catalana de Matemàtiques*
UPC	*Universitat Politècnica de Catalunya*

Wednesday 24/02/2010 (FME, *Sala d'Actes*)

11.45-12.45

Ignacio Cirac

Informática y Física Cuántica

El mundo microscópico está plagado de fenómenos que parecen sacados de una película de ciencia ficción. Todos ellos son explicados por la Física Cuántica, una teoría que surgió hace un siglo y en cuyo desarrollo participaron los más ilustres científicos. Esta teoría nos proporciona, además, una nueva visión sobre la Naturaleza, en donde nosotros definimos la realidad según realizamos observaciones. En esta conferencia explicaré de una manera sencilla algunos de los fenómenos cuánticos más impactantes, la posibilidad de construir nuevos sistemas informáticos y de comunicación basados en estos fenómenos, así como algunas implicaciones filosóficas.

Thursday 25/02/2010 (IEC, *Sala Pere Coromines*)

09.30-10.30

Sebastià Xambó

The mathematical essentials of a quantum computer

A mathematical model of a quantum computer, or q-computer, will be presented, together with related concepts such as q-gates, q-computations and q-algorithms/programs. The possible physical realizations of the model, and their potential power, will be analyzed using an axiomatic version of quantum mechanics.

11.00-12.00

Juanjo Rué

Algorithms in the quantum computing framework

In this talk we will look at the key features of the quantum computing paradigm, including quantum parallelism, that allow to devise algorithms that are exponentially faster than their classical rela-

tives. This will be illustrated with a detailed discussion of the algorithm of Shor for factorizing integers in polynomial time. Other examples, such as Deutsch algorithm and Grover's search algorithm, will also be discussed.

15.00-16.00

Maciej Lewenstein

Anything goes, or everything fails?

I will try to remind what are the critical issues, and that the devil mainly cares about the details. I will talk about limitations and challenges of quantum communications (such as quantum memories), and about limitations and challenges of quantum computing (such as quantum simulators).

16.30-17.30

Antoni Acín

Quantum Communication

The coding of information in quantum particles opens new possibilities for the communication between distant parties. Quantum communication is the branch of quantum information theory that studies these new possibilities and the most relevant application is Quantum cryptography. The goal of this talk is to present these ideas and concepts, fundamentally from a theoretical point of view. In addition, we will also consider the experimental challenges faced by practical implementations of a quantum communication protocol.

17.45-18.45

Morgan Mitchell

Physics of quantum processing: Quantum optics methods

A great variety of quantum systems have been proposed, developed, and demonstrated for processing of quantum information, including atomic, ionic, photonic, solid-state, and hybrid systems. I will review some of the more successful methods, and current work to extend their capabilities.