

# Institute for Quantum Information

## Activities – 2000-2001

### Personnel

The primary goal of the Institute for Quantum Information (IQI) is to carry out and facilitate research in Quantum Information Science (QIS). The IQI is an NSF-supported collaboration of Caltech's Divisions of Engineering and Applied Science and of Physics, Mathematics, and Astronomy. It is led by four Caltech faculty members: John Preskill (Director and co-PI, Professor of Theoretical Physics), Jeff Kimble (PI, Professor of Physics), Leonard Schulman (co-PI, Associate Professor of Computer Science), and Hideo Mabuchi (Assistant Professor of Physics). Other affiliated Caltech faculty include John Doyle (Professor of Control and Dynamical Systems, and Electrical Engineering), Michelle Effros (Assistant Professor of Electrical Engineering), Michael Roukes (Professor of Physics), and Axel Scherer (Professor of Electrical Engineering, Applied Physics and Physics). Administration of the IQI is supervised by Ann Harvey (IQI Administrative Assistant).

In 2000-01, Andrew Doherty (Physics), Peter Lodahl (Physics), and Ashwin Nayak (Computer Science) were IQI Postdoctoral Scholars. (In the fall of 2001, 6 additional postdoctoral fellows will be added.) Over 20 graduate students (and also at least 6 undergraduate researchers) were involved in the project.

### Visitors

The IQI sponsors a vigorous visitor's program. Among those visiting for two weeks or longer in 2000-01 were Dorit Aharonov (UC Berkeley), Dave Bacon (UC Berkeley), Todd Brun (Institute for Advanced Study), Harry Buhrman (CWI, Amsterdam), Richard Cleve (University of Calgary), Steven van Enk (Bell Labs), Salman Habib (Los Alamos National Laboratory), Patrick Hayden (Oxford), Alexei Kitaev (Microsoft Research), Debbie Leung (IBM), Gerard Milburn (University of Queensland), and Frank Verstraete (KU Leuven, Belgium). Habib and Milburn were salaried participants. Six of our visitors were graduate students from other institutions.

## Workshops

The IQI sponsored three workshops this year. At our November 15, 2000 IQI workshop, leading researchers reflected on the question “What can the study of quantum computation and quantum information tell us about physics?” We hosted the Southwest Quantum Information and Technology Network (SQuInT) Workshop on March 2-5, 2001, which was largely devoted to assessing the status of various experimental approaches to coherent quantum information processing. The Quantum Electromechanics Pow-Wow on April 18-20, 2001 brought experimentalists and theorists together to discuss the prospects for exploring quantum effects in mechanical systems. Programs for the workshops are available at our website: <http://www.iqi.caltech.edu/>.

## Research Activities

IQI researchers are among the world leaders on both the theoretical and experimental sides of Quantum Information Science. Preskill’s group studies the theory of fault-tolerant control of quantum systems, and of quantum cryptography. Schulman’s group develops new quantum algorithms that could outperform classical algorithms. Kimble’s group works on both the theory and practice of manipulating quantum information encoded in single atoms and in photons. Mabuchi (with Doyle and Effros) is involved in both theoretical and experimental aspects of quantum control, quantum measurement, and quantum coding theory.

More details can be found in the Findings section of this Annual Report.

## Education and Training

IQI faculty have developed two innovative courses relating to Quantum Information Science: John Preskill’s course on quantum computing and Hideo Mabuchi’s course on quantum mechanics (which places strong emphasis on the information-theoretic underpinnings of the subject). Both courses have frequently visited websites on which lecture notes and problem sets are posted. Links to these sites can be found at the IQI site: <http://www.iqi.caltech.edu/>.

IQI participants Kimble, Preskill, Mabuchi, Doyle and Schulman are training graduate students working on both the theoretical and experimental sides of QIS – a total of over 20 students. During the summer of 2000-01, Mabuchi, Preskill, and Schulman will sponsor undergraduate research programs in QIS, and Mabuchi will lead a project in science and media for which undergraduates will develop educational materials related to QIS.