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EDITORIAL

This special issue of *Quantum Information and Computation* (QIC) contains six contributions that are based on presentations made at the Sixth International Conference on Quantum Communication, Measurement and Computing (QCMC'02). QCMC'02 was held from July 22-26, 2002 on the campus of the Massachusetts Institute of Technology (MIT). It drew together 318 researchers from 28 countries and covered topics in quantum information theory, theoretical and experimental aspects of quantum computing, quantum communication systems, quantum cryptography, new quantum effects and their experimental realizations, generation detection and applications of nonclassical light, quantum noise, quantum measurement theory, and quantum control. Earlier this year, Rinton Press published the QCMC'02 Proceedings, which contained extended summaries of 115 papers from the conference. A select group of authors were then invited to submit full-length papers for publication, after full peer review, in QIC. Rather than attempt encyclopedic coverage of the many topics considered at QCMC'02, the papers in this issue focus on the photonic aspects of quantum communication, measurement and computing.

Entanglement and superposition are intrinsic features of quantum mechanics, features that underlie proposals for a panoply of quantum information processing schemes. The first paper in this special issue, by Lamas-Linares, Irvine, Howell, and Bouwmeester, addresses the fundamental quantum-mechanical nature of entanglement. These authors propose generalized Bell inequalities that can be tested using the states produced via the parametric downconversion process, and they present experimental results for one such inequality. The second paper, by Uren, Banaszek, and Walmsley, takes an engineering approach to entanglement generation. It describes practical techniques for eliminating distinguishing information in photon pairs obtained from parametric downconversion, and goes on to demonstrate the effect of such information on a nonlinear-sign shift logic gate.

Parametric downconversion is again the theme in the third paper, by Peters, Altepeter, Jeffrey, Branning, and Kwiat. Here, however, the focus is on superposition, rather than entanglement. The authors present theory and confirming experiments for the generation of arbitrary photonic qubits, in which polarization codes the quantum information. Photonic qubits are "flying" qubits. Thus they are the prime means for long-distance transmission of quantum information. Storing quantum information, however, requires "standing" qubits, such as provided by atoms or ions. In the fourth paper, Julsgaard, Schori, Sørensen, and Polzik show that off-resonant light/matter interactions can be a feasible quantum memory system. Their paper demonstrates, through theory and experiment, that the spin state of an ensemble of cesium atoms is sensitive to the quantum polarization fluctuations of an illuminating laser beam, thus making possible the squeezing of the collective atomic spin and the entanglement of separate atomic samples.

The final two papers of this special issue address the application of photonic technology to quantum information tasks. Grosshans, Cerf, Wenger, Tualle-Brouri, and Grangier discuss continuous-variable quantum cryptography. Their work shows that simple coherent-state transmission with homodyne reception suffices for protocols that can be secure against Gaussian attacks in the presence of loss. The final paper in this collection, by Franson, Donegan, Fitch, Jacobs, and Pittman, is concerned with linear-optics quantum computing. Here the authors report their progress in developing a single-photon source, a single-photon quantum memory, and a variety of quantum logic gates based on linear optical elements and post-selection.

Jeffrey H. Shapiro
Hoi-Kwong Lo
Guest Editors