Preface

This number of the *Journal of Modern Optics* (JMO) is a special issue devoted to the burgeoning field of quantum information processing. It is fair to say that this subject arose first in the area of quantum optics, as the initial ideas for quantum cryptography and quantum teleportation were developed as optics proposals. The JMO recognized these developments very early on, with its first special issue on the subject in 1994 (1994 Special Issue on Quantum Communication, edited by S. M. Barnett, A. K. Ekert and S. J. D. Phoenix, *Journal of Modern Optics*, **41**(12)). In that issue the topic of the day was quantum cryptography, but since then the discoveries of powerful quantum algorithms and effective quantum error correction have been revolutionizing the field of quantum information processing.

The subject has grown far beyond the boundaries of quantum optics, and many developments (for example, experimental quantum computation using nuclear magnetic resonance spectroscopy or solid state physics) are outside the scope of this special issue. But the present volume contains contributions representing the full range of work on quantum information theory in modern optics today.

In preparing this special issue we have attempted to group papers into several sections so that the reader can easily navigate through the material.

The issue begins with an overview by Preskill in which a programme for the coming century in quantum information theory, and its implications for both experimental physics and fundamental theory, is explored. Several other papers develop this connection to the foundations of quantum mechanics, with considerations of delayed choice, quantum cloning, and precision measurement.

As Section II shows, quantum teleportation continues to be a fertile area for both theoretical and experimental investigation, perhaps pointing the way towards the realization of other quantum algorithms (Grover's is investigated here).

The next several sections show the many fruitful directions which are now being explored in the area of quantum information theory (Section III) and the analysis of quantum entanglement (Section IV). New results on quantum super-dense coding, on fault-tolerant quantum computation, on quantum channel capacity and on the properties of entanglement of formation, are presented.

Next (Section V) come a variety of proposals for the realization of new types of quantum logic gates. In particular, there is a thorough review of a new concept for using cold neutral atoms trapped in optical lattices, and a proposal for realizing the quantum c-NOT gate using 'hot' trapped ions.

Finally (Section VI) come a set of contributions in the original setting of quantum information processing, quantum cryptography. Several new develop-ments, including very long-distance key distribution and secure transmission through open air, are discussed.

Concluding this Preface, we express our thanks and gratitude to all authors of the papers in this issue. A great job has been done by referees who in the most collegiate way reviewed manuscripts and helped to improve the quality of

presentations. We also thank Chris Knight for her endless effort in handling all the correspondence associated with this issue.

A great deal has transpired in the five years between the first JMO special issue on quantum communication and the present one. We can hardly guess how the third special issue in this area will look after another five years of remarkable progress.

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