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Preface

The subject of quantum computation represents a highly fertile synthesis of the principles of quantum physics with those of computer science. Its scope ranges from providing a new perspective on fundamental issues about the nature of physical law to prospective commercial exploitation by the computing and communications industries. Since the pioneering work of Feynman and Deutsch in the early 1980s it has been realized that quantum effects may be harnessed to provide remarkable new modes of computation, and in some cases this leads to an exponential enhancement of computing power over any known classical computational method. Furthermore, quantum effects have been seen to give rise to new modes of communication. The discovery of an efficient quantum factoring algorithm by Peter Shor in 1994 stimulated a great deal of activity in the field, particularly with regard to the experimental implementation of quantum computation.

The aim of this Discussion Meeting was to bring together experimental physicists, theoretical physicists and computer scientists to provide an overview of the extensive recent developments in the subject and directions for further work. The topics that were addressed included theoretical aspects of quantum computation, current work on experimental implementations, assessment of the problem of decoherence, and features of quantum communication such as quantum teleportation, dense coding and entanglement purification. The possible significance of quantum effects in biological systems was also discussed, as well as the relevance of quantum computation for the high-tech industry where the drive to increasing miniaturization is beginning to transgress the classical–quantum boundary for the representation of information. The papers in this volume cover all of these issues. At the broadest level, two significant themes appear to emerge. First, there is the remarkable role of quantum entanglement in underlying almost all of the novel features discussed. Second, there is the difficulty of experimentally implementing extended quantum computation, which remains an open challenge.

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