Introduction Lectures in Atom Optics

The Workshop on Atom Optics was held at the University of Adelaide in September 1995. It was attended by approximately 40 physicists from Australia and New Zealand. The venue for the workshop was the new Institute for Theoretical Physics at the University of Adelaide which provided excellent facilities for lectures and discussion. Atom optics is a field which has grown rapidly since its beginning approximately five years ago. There are now several groups in Australia and New Zealand pursuing research activities in both theoretical and experimental aspects of atom optics.

The objective of the workshop was to give a series of lectures which would give an overview of the field of atom optics suitable for graduate students and also researchers new to the field. This special issue contains papers by each of the lecturers and each paper is based closely on the material presented in these lectures. The contents of each paper can be briefly summarised as follows:

Professor Dan Walls from the University of Auckland gave a series of lectures on 'Quantum Measurements in Atom Optics', describing measurements based on the entanglement of quantum states of a light field with atomic external degrees of freedom. Examples include quantum non-demolition measurement of the photon number in a cavity and the measurement of atomic position.

Dr Craig Savage from the Australian National University presents an 'Introduction to Light Forces, Atom Cooling, and Atom Trapping'. The emphasis in this pedagogic paper is on the basic physics of light forces on atoms and how these forces may be used for the cooling and trapping of atoms.

In the next paper Professor Geoff Opat from the University of Melbourne describes the 'Reflection and Diffraction of Atomic de Broglie Waves by Evanescent Laser Waves', a theoretical investigation of the reflection and diffraction of atoms by gratings formed either by standing or by travelling evanescent laser waves.

Professor Gerard Milburn from the University of Queensland gave a set of lectures on 'Nonlinear Dynamics in Atom Optics'. The basic concepts in nonlinear dynamics are reviewed and the techniques applied to the motion of atoms in time-dependent standing waves and to the atomic bouncer. The quantum dynamics for the case of regular and chaotic classical dynamics are discussed.

Dr Weiping Zhang from Macquarie University described the 'Vector Quantum Field Theory of Atoms'. This paper investigates the interaction of an ultracold atomic ensemble with a light wave in the framework of a vector quantum field theory. A general formalism of nonlinear atom optics for a coherent atomic beam is also developed.

Finally, Dr Ken Baldwin from the Australian National University presents an overview of 'Experiments in Atom Optics' which have occurred since the mid 1980s. Applications of this new technology are reviewed and the paper concludes with a useful synopsis of work in this field currently being undertaken in Australia and New Zealand.

We hope that these papers based on the workshop lectures will help those new to the field gain a rapid understanding of the subject.

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