Appl. Phys. B 60, 71–72 (1995)

Applied Physics B Lasers and Optics

Editorial

Fundamental Systems in Quantum Optics

"... we are not experimenting with single particles, any more than we can raise Ichthyosauria in the zoo." This sentence of E. Schrödinger from 1952 comes to mind, when today we observe the non-classical features in the fluorescence light from a single ion stored in a Paul trap. We are reminded of it again, when a Paul-Straubel trap allows us to find an extremely narrow line of a single indium ion pushing so the limits of frequency stabilization beyond expectations. Likewise, we are taken by the fascination surrounding the micromaser – an amazing maser driven by a single atom. These are only three of many impressive examples of single-particle physics, demonstrating the experimental capabilities of current quantum optics. Should we have chosen instead the experimental verification of the Jaynes-Cummings revivals in the interaction between a single mode of the radiation field and a single atom? Why not use the delayed-choice version of quantum beats, relying on the atomic excitation by a single photon? This phenomenon brings out most clearly and makes a definitive decision in favor of the Copenhagen interpretation of quantum mechanics: The past has no existence, except as it is recorded in the present. As impressive as these single-particle experiments are, the phase transitions of many ions stored in a Paul trap or in a miniature storage ring and the formation of ordered structures have opened a new field in few-body physics and is now a paradigm in chaos theory.

All these phenomena we associate with the name of Herbert Walther. On the occasion of his 60th birthday it is appropriate to highlight his impact on the field of quantum optics by summarizing the state of the art of this branch of physics. Under the heading of *Fundamental Systems in Quantum Optics* we have asked many of our colleagues to contribute to a feature issue, devoted to this topic and dedicated to Herbert Walther. Their response was overwhelming: The space of a single issue was not enough to include all accepted papers, covering topics ranging from the physics of ion traps via the micromaser to novel laser devices. We were therefore forced to distribute the articles over two parts. We have assembled the papers according to the topics of Herbert Walther's own research interests: The first part starts with the introductory articles of the three Nobel laureates and contains papers on ion traps, cold atoms and atom traps, atom and neutron optics and closes with fundamental problems. The second part, to be published as a Supplement to Applied Physics B, deals with the physics of the micromaser and cavity QED, non-classical light, atomic coherence effects, high precision spectroscopy, nonlinear dynamics, nonlinear optics and concludes with laser devices. To bring out the unity of the two parts of this issue we have included the table of contents of the Supplement after this editorial.

We want to thank all our colleagues who have contributed to this feature issue and have made it into an up-to-date collection of articles summarizing the state of art of quantum optics. We are also most grateful to our referees for their help and their cooperation in promptly providing their reports. Finally, we acknowledge the substantial help of Dr. K. Vogel and the editorial support of Dr. H. Lotsch and Dr. H. Riedesel from the Springer-Verlag. We express our special thanks to Dr. W. Skolaut

from Springer-Verlag, who helped to prepare this feature issue in the shortest time possible. It was a great pleasure to work with him on this project.

We dedicate the issue in its two parts to Herbert Walther on the occasion of his 60th birthday. Happy Birthday! May success and health continue to follow you.

Konstanz — *Gerhard Rempe*
Ulm — *Wolfgang Schleich*
January 1995