Quantum electrodynamics of the interaction of atoms and photons

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C. Cohen-Tannoudji, J. Dupont-Roc, and **G. Grynberg** *Atom-Photon Interactions: Basic Processes and Applications*, John Wiley and Sons, New York, 1992.

The recent fruitful synthesis of the ideas of atomic and laser physics has led to the discovery of a number of very interesting effects in the interaction of laser light with atoms. They include the following:

1) laser detection of single atoms;

2)direct observations of quantum jumps in experiments with single ions in a trap;

3) laser control of the motion of atoms and, especially, deep cooling of atoms down to submicrokelvin temperatures, when the motion of the atoms in the field becomes quantized;

4) suppression of spontaneous emission with low mode density;

5) generation and detection of squeezed states of light, for which the level of the seemingly irremovable shot noise of the photons decreases;

6) nonperturbative (and, especially, nondestructive) detection of atoms in a given quantum state;

7) nondestructive detection of photons (!), and so on.

This impressive list of discoveries is the result of a much deeper understanding of the interaction of light, especially coherent light, with atoms than can be found in classical textbooks on quantum mechanics and quantum electrodynamics. New theoretical results are spread over thousands of original works in tens of journals. For this reason, the publication of modern monographs in this field is very timely, especially if the monographs are written by active and original investigators. John Wiley and Sons, the publishers of the monograph under review, have made precisely such a fortunate choice.

One of the authors of the monograph, Professor C. Cohen-Tannoudji, is the successor of Professor A. Kastler's school and director of an active laboratory at the Ecole Normale Superiere in Paris. His group has achieved outstanding results, in particular, in the investigation of mechanisms of deep cooling of atoms with laser light. This, of course, has made possible the modern profound level of the monograph.

The monograph consists of six sections: 1) amplitudes of transitions in quantum electrodynamics; 2) some elementary processes (emission, absorption, scattering, multiphoton effects, radiative corrections, photon exchange); 3) calculation of the transition amplitudes without the use of perturbation theory; 4) controlling equation for particles when the radiation is regarded as a reservoir; 5) Bloch's optical equations; and, 6) method of "dressed" atomic states.

A distinguishing feature of this book is its "two-level" presentation. First, in every section the foundations of the theory are presented, and every section is concluded with an extensive appendix in which different particular cases are considered in greater detail. This approach is more convenient for the reader. But the reader must be adequately prepared: He must know well the fundamentals of quantum mechanics. For this reason, this book is intended not for beginning students, but rather for prepared upperclassmen (for example, students at the Moscow Physicotechnical Institute or the Ecole Normale Superiere), graduate students, and researchers.

In reviewing a book it is customary to talk about its shortcomings, but I can only give suggestions to the authors for their next edition (or for the next volume). It is very important to study quantum optics effects, based on the interaction of laser light with atoms, and quantum effects in the motion of an atom in a laser field.

Of course, at present it is difficult to expect a translation of this remarkable book into Russian, but every good university and the central libraries of Russia should still have this book on their shelves.

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