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Book Review

The High-Power Iodine Laser

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[pp. i–ix + 184, with 46 Figures]

The book is a short monography of one type of a gas laser, the iodine laser, excited by photodissociation of fluorinated alkyl iodides. Such lasers have now become efficient and reliable tools in fusion-oriented plasma experiments. Laser Plasma Division of the Max-Planck-Institut für Quantenoptik in Garching gained significant experience in building large scale iodine laser systems and their exploitation. If such a book, based on the accumulated experience of the authors during years of their research work is to be compiled, it must also contain many items of valuable information collected from a number of sources. An earlier development of the CO_2 laser and high-power Nd-glass laser, having many common features with the iodine laser, made it possible to use available technologies to develop rapidly an iodine laser of extremely high output power exceeding one terawatt (285 J, 280 ps FWHM). Hence, design of a system with the output energy of the order of 10^5 J and pulse duration of 100 ps, based on the present technology seems to be feasible.

The book contains six chapters. The first three, on the physical principles of the iodine laser and general conditions of its operation, are followed by the description of the technical aspects and possible versions of iodine laser systems that have been and can be built for their main field of application, namely for laser fusion research.

The chapter *Basic features* deals with the following topics: spectroscopy of the iodine atom with hyperfine structure and stimulated emission cross-sections, photodissociation of alkyl iodides, flashlamp technology and discussion of other pumping sources including excimer lasers and non-optical method of excitation through chemical and direct discharge and comparison of different alkyl iodides as the laser medium. Kinetics of chemical reactions possibility of regeneration of the laser medium and inversion losses by quenching of excited iodine atoms are also included.

Principles of high-power operation. This chapter covers: short pulse generation by Q-switching, gain switching, active and passive mode-locking, and free induction decay; scaling laws, energy storage capabilities of amplifiers, and pulse propagation in amplifier chains.

Beam quality and losses. This chapter discusses different phenomena contributing to wave front distortions, i.e., self-focusing, saturation, refraction index gradient due to inhomogeneous pumping, shock waves in the laser medium, inhomogeneous heating and turbulence, as well as solid particles scattering.

Design and layout of an iodine laser system. The main topics are: scaling and efficiency relationships of amplifiers, criteria for their design, detailed discussion of all laser components, and damage thresholds of optical components. Time and spatially resolved diagnostics are taken into account.

The Asterix III system. This chapter deals with the single-beam iodine laser realized at MPQ Garching. This laser, working for more than three years, is presently capable of delivering an output power greater than 1 TW at an energy level of nearly 300 J and overall efficiency up to 0.1%.

Scalability and prospects of the iodine laser. Based on accumulated experience in the handling of large iodine laser system it is possible to discuss the possibilities of creating a new generation of multibeam systems with additional features, such as pulse shaping and pulse duration control. Considering the present technologies and concepts, energy of the order of 10^6 Joules per pulse can be obtained but due to high cost of such systems the whole potential must be used to enhance the overall efficiency. The authors might, however, slightly overvalue this possibility up to 0.3%, mainly by improving the extraction efficiency from 30 to 55%.

In *Conclusion* the authors discuss future possibilities of improvement of great iodine laser systems. Comparison of exploitation cost of the Asterix III and Lawrence Livermoore Argus (Nd-glass) systems shows that for short pulse length, smaller than 2 ns the iodine laser is more efficient. For longer pulses, there is no appreciable cost difference between the systems. The perspective to reach the aim, i.e., to realize a laser system that could be a driving force for a fusion power plant is still remote, it seems, however, that the iodine way is not the proper direction of research.

At the end of these brief remarks it should be answered who can be interested in studying such a relatively narrow domain of problems. To the authors' opinion expressed in the preface that their book containing all the knowledge relevant to high-power iodine lasers accumulated so far will be useful to many collegues working in laser fusion or related fields it might be added that ordinary lasers constructors or users can also find something useful in it. It is true that extremely large laser systems can be built only in a few laboratories over the world, but it is so, that rally racers have set the task to improve the common driver car.

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