Preface

Current problems of nonlinear-optics effects and processes in the atmosphere

Nonlinear optics of the atmosphere has formed now as a branch of the contemporary atmospheric optics, and it mostly studies the interaction of high-power laser radiation with the atmospheric matter (gases, aerosols, hydrometeors), propagation of coherent radiation in the atmosphere as a multicomponent, inhomogeneous, random, and nonlinear medium, and diagnostics of the atmosphere with the use of nonlinear optical effects.

This issue includes the papers of well-known specialists from Russian research centers dealing with the problems of laser application to environmental studies. Atmospheric-optics studies are the main subject of these papers. Besides, the issue includes the papers on nonlinear optics of suspensions and on linear optics of the environment with the experimental methodology close to that of nonlinear-optics problems.

The issue is opened with two reviews devoted to applications of lasers with unique parameters to solution of promising fundamental and applied problems of atmospheric optics.

The first paper (authors: V.P. Kandidov, O.G. Kosareva, E.I. Mozhaev, M.P. Tamarov) describes the principles of a new field of the atmospheric optics – femtosecond nonlinear optics of the atmosphere. Actually, the use of femtosecond lasers in atmospheric research opens wide promises in obtaining unique results. High-power femtosecond radiation gives rise to nonstationary self-focusing and ionization of a medium, and this effect can be used as a new means for sensing the atmosphere.

The second paper (authors: V.M. Osipov, I.A. Popov, Yu.A. Rezunkov) presents unique results of many-year complex (field, laboratory, and theoretical) studies on propagation of high-power radiation of repetitively pulsed CO_2 lasers through the atmosphere.

These papers clearly demonstrate tendencies in the current nonlinear optics of the atmosphere. On the one hand, fundamental studies on application of laser technologies of the 70's and 80's are now completed and their practical implementation started in such fields as long-distance transfer of laser energy, atmospheric electricity removal from clouds by a laser beam, reaction laser-plasma engines, etc. On the other hand, femtosecond laser technologies open up new possibilities, and call the corresponding fundamental problems for the study.

A large group of papers deals with the description of the interaction of high-power laser radiation with the substances in the atmosphere (authors: A.A. Zemlyanov, Yu.E. Geints; S.D. Tvorogov; V.P. Kochanov, Yu.V. Mal'tseva; Yu.D. Kopytin, V.I. Starikov; V.P. Lopasov; V.G. Borodin, V.M. Komarov, S.V. Krasov, et al.; N.N. Bochkarev, A.M. Kabanov, V.A. Pogodaev). Most of these papers are characterized by completeness and novel results. Besides, the papers stating new problems (Yu.D. Kopytin, V.I. Starikov; V.P. Lopasov) are included.

The results on nonlinear optical effects in suspensions (G.V. Grigoryan, S.D. Zakharova, M.A. Kazaryan, et al.) are reviewed. This research field is very close to the problems of nonlinear optics of atmospheric aerosols.

This section emphasizes that the research field of laser radiation interaction with atmospheric components is still far from being exhausted. The high-quality results obtained indicate that interesting scientific schools have formed in this field.

The next section is devoted to description of experimental and theoretical researches on various aspects of laser radiation propagation through the atmosphere. The paper by V.V. Valuev, M.I. Dukhin, Yu.A. Konyaev, et al. presents the experimental results on the directional pattern of a wide-aperture continuous-wave CO_2 laser in the atmosphere. The paper by A.A. Zemlyanov, Yu.V. Kistenev, V.V. Kolosov, et al. is devoted to the theoretical study of propagation of chemical-laser radiation along high-altitude long paths. F.A. Starikov in his paper considers theoretical results on propagation of high-power partially coherent radiation through random amplifying media.

Adaptive correction of a focused laser beam under conditions of strong intensity fluctuations is the subject of the paper by V.P. Lukin and B.V. Fortes. A.N. Kucherov in his paper reviews the bulky data on formation of contrails behind an aircraft and presents the results on the capability of clearing up such media. Such investigations are very interesting from the viewpoint of evaluating the ecological state of the upper troposphere.

It can be concluded from this section that studies of laser radiation propagation in the atmosphere have complex character and investigations in the fields of atmospheric optics and laser physics influence each other. The domain of applicability of high-power laser radiation in atmospheric optics becomes wider.

The last papers in this issue are the papers devoted to diagnostics of natural media. Certainly, the results discussed here are very attractive from the viewpoint of their practical implementation (authors: V.V. Sterlyadkin; N.A. Vorob'eva, A.I. Grishin, A.P. Zotikova, et al.; I.V. Aleshin, S.A. Vitsinskii, A.G. Zhurenkov, et al.). The methodology of these papers stimulates the corresponding investigations in diagnostics of natural media using methods of nonlinear optics in the near future.

The editor is thankful to all authors who contributed to this issue and Dr. A.M. Kabanov for his help.

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0235-6880/00/05 393-01 $02.00