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FUNDAMENTAL PROBLEMS OF LASER VISUALIZATION OF PLASMA MICROSTRUCTURES WITH RAPID EVOLUTION *)

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The study discusses the fundamental problems of visualizing inhomogeneous plasma microstructures in the field of coherent laser radiation registered by an optical lens system. The problem of describing diffraction of laser radiation by plasma formations is considered in detail in order to identify the key changes in the intensity and phase shift of the probing radiation. To this end, the scalar Helmholtz wave equation is solved in the first Rytov approximation. The propagation of the angular spectrum of the diffracted wave in free space behind plasma objects is modeled. The comprehensive data on the changes in the radiation characteristics in the output plane of plasma objects and in their near-filed region are obtained in terms of generalized diffraction patterns. Additionally, the problem of registering the plasma diffraction patterns by an optical lens system in the presence of positive and negative defocus is considered. It is shown that even in the simplest approximations the passage of laser radiation through inhomogeneous plasma is accompanied by complex diffraction effects. These effects are enhanced in the near-filed region and significantly distort the brightness and phase patterns of plasma microstructures, which in turn undergo changes when they are recorded by an optical lens system. Owing to the numerical analysis, it was possible to more accurately describe the visualization of plasma formations in the field of a coherent laser beam recorded by an optical lens system. The results of the numerical analysis were verified experimentally and are in good agreement with the experimental data. The results of the study can find wide application in processing laser shadowgrams and interferograms of plasma microstructures recorded in the presence of strong diffraction effects.

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References

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