EFFECTIVE METHOD OF CALCULATING FIELDS IN OPTICAL CAVITIES WITH CYLINDRICAL SYMMETRY AND SHADED AXIAL ZONE

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It is proposed to calculate (in the diffraction approximation) fields in optical cavities with shaded axial zone and large mirror aperture, in a cylindrical coordinate frame, using a new algorithm based on the use of the stationary-phase method. Unlike the already known ones, the method has high efficiency in the region of large Fresnel numbers, and is close in speed to the method of fast Fourier transformation. The procedure is described and specific calculation results that illustrate the proposed method are presented.

INTRODUCTION

The most effective presently known numerical method of calculating fields (in the diffraction approximation) in optical cavities is based on the fast Fourier transformation (see, e.g., [1]). It is optimal, in particular, for cavities made up of rectangular mirrors, with natural use of a Cartesian frame and with representation of the field as an expansion in plane waves. Satisfaction of the boundary conditions is somewhat more complicated in the case of circular mirrors, but even then the use of the fast Fourier transformation (FFT) offers a substantial increase of the computation speed [2].

The situation is entirely different in the description of radiation in a thin cylindrical layer, typical for example of lasers with annular active media [3]. It is known that optical cavities with shaded axial zones [4] are widely used in such systems. It is easily understood that in the case of a thin tubular active medium, particularly at large mirror apertures, the FFT method becomes ineffective because too many points of the computation mesh land in the internal shaded region of the cavity, where there is no field.

The most natural in this situation is representation of the field by a series in angular harmonics and cylindrical (Bessel) functions. A highly effective procedure, based on such an approach and using the FFT method in individual intermediate computation stages, was developed in [5]. This approach was used there, in particular, to calculate the field in a laser cavity with annular active medium. It must be noted, however, that the speed of this procedure is much lower than that of the FFT. It is important furthermore that the efficiency of this method decreases rapidly with increase of the Fresnel number of the calculated cavity. The latter restricts its use in the investigation of cavities with large-aperture mirrors.