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SCOPE OF NON-PARAXYITY OF BEAMS IN THE FORMATION OF IMAGES BY SPHERICAL MIRROR

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The classical geometric optics manuals indicate that paraxial homocentric beams, when refracted on spherical surfaces, can form clear images of small spherical elements being placed perpendicularly to the optical axis. In particular, a spherical concave mirror when placing an object – a luminous point – in its focus should display it at infinity, that is, forming a plane-parallel beam. In reality, the notion of paraxiality is relatively arbitrary and any rays reflected by the mirror are more or less parallel to the optical axis.

The report presents the results of an analysis of the light field formation after the reflection of light from a spherical mirror when a point source is placed in focus. The basic expression for a spherical mirror is known to connect an object and an image and is especially convenient for analysis when one of them is placed at characteristic points at an infinitely distance or in focus. To reveal the real scale of the non-paraxiality of the beams, even when the point source is used, the rays emerging from the focus and incident on the spherical surface at different distances from the optical axis are considered. The aperture of the outgoing beam is determined by the angle θ, which varies from zero to π/2 and more. Correspondingly reflected rays with increasing angle θ deviate more and more from the axis under the angle γ. Obviously, as the aperture of the θ increases, the point of intersection of the reflected ray with the optical axis approaches the mirror, this distance is indicated by parameter *h*. The reflection parameters, depending on the magnitude of the angle θ, are related to each other by simple geometric relations.

$$\gamma = \left(\theta - 2\arcsin\left(0.5\sin\theta\right)\right),$$

$$h = \frac{2a\left(\theta - \arcsin\left(0.5\sin\theta\right)\right)}{\tan\left(\theta - 2\arcsin\left(0.5\sin\theta\right)\right)},$$

here *a* – is a radius of mirror.

As the calculations show the beam incident from the focus to the spherical mirror at right angles to the optical axis has a nonparaxiality parameter of the order of one hundredth radian and such a small divergence, however, will lead to the formation of a point image at a distance of about 10 meters from the spherical mirror radius 0.1 m. In this case, a phenomenon similar to spherical aberration occurs when rays pass through a thin lens, when the image of a point source located at infinity stretches on the optical axis in a line.

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