Wavefront aberrations in off-axis spherical mirror systems

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Adaptive optics retinal imaging systems use spherical mirrors in an off-axis arrangement to relay the image and pupil planes [1-7]. Most of the designs where the optical axes of all elements are on a common plane (planar configuration) have off-axis aberration problems. Laser resonators with several mirrors are often used in different applications [8], where the design goal is to find off-axis configurations that are free of astigmatism; in other words, the output beam has a regular shape, and the resonator does not have thermal lens effects. Off-axis mirror spectrographs [9,10] present design restrictions mainly in the resolving power and in the off-axis aberrations. In summary, when using off-axis spherical mirrors in a planar arrangement, such as in the previous systems, the resulting instruments are limited by astigmatism in most of the cases. Recently Gómez-Vieyra *et al.*[11, 12], demonstrated that by folding the meridional plane of pairs of spherical mirrors in a prescribed three-dimensional configuration, the astigmatism can be cancelled out at a single off-axis point on the field of view. Spherical aberration and coma are the residual aberrations in third order theory, but the behavior of all aberrations is not yet fully understood.

Here, we will present a more complete analysis than that given by the third order aberration coefficients, including some important higher order aberrations, based in our previous work [13]. Using the principle of the optical path difference principle, we developed the mathematical expressions that describe the third order wavefront aberrations in a spherical mirror system. We discuss here the implication of the off-axis aberrations and their dependence on the magnitude of the angle of incidence. These approximations are calculated under the assumption that we have a small pupil and a small angle of incidence. They can be used to design and analyze cavities, spectrographs and retinal adaptive optics imaging systems.

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