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Simulation of the change in power and chromatic aberration of the aging human eye

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To analyse the aging human eye, we create eye models for several different ages. The geometrical parameters used in these models are based on published experimental evidence for the aging human eye (Navarro, *Journal of Vision,* 2014). In our modeling, we use an anatomically correct gradient refractive index (GRIN) crystalline lens (Bahrami & Goncharov, *Journal of Biomedical Optics*, 2012). The GRIN distribution within this lens is based on the concept of iso-indicial contours. These iso-indicial contours are obtained by scaling the external surface of the lens. An example of the GRIN lens that we use in our modeling is shown below in fig. 1, where dashed lines illustrate the iso-indicial contours. If the refractive index profile along the optical axis is known, the iso-indicial contours allow the refractive index to be obtained at any point. We define the refractive index along the optical axis by a power law profile. This profile has been shown to give good agreement with experimental measurements. An example of the power law profile is given in fig. 2. The refractive index is lowest at the lens surface and highest at the lens center.

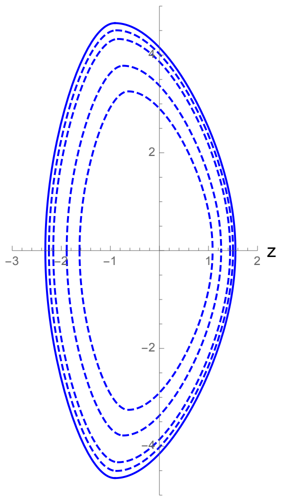

Fig. 1.

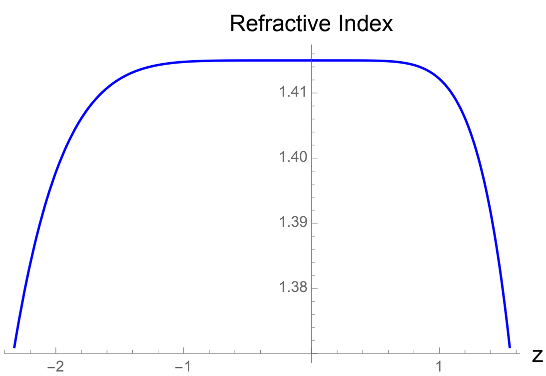

Fig. 2

All geometrical parameters and all refractive indices, except the lens central refractive index, are fixed for each eye model. We optimize the lens central refractive index to make each eye model emmetropic. After optimization, we find that the lens central refractive index and power of the eye must decrease with age. Both these results agree with experimental observation. Next, we define the dispersion of each medium and calculate the longitudinal chromatic aberration (LCA) of each eye model. We find that the LCA remains constant throughout aging, which agrees with experimental evidence. Finally we investigate the transverse chromatic aberration.