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Diattenuation of the Human Eye at the Fovea

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Abstract

Purpose: The human eye exhibits complicated polarization properties: birefringence, dichroism, depolarisation and diattenuation. Birefringence has been perhaps the most widely studied in the past. However, diattenuation (the relationship between the polarization of the incident beam and the transmittance through the eye) may also play an important role in ophthalmic instruments and techniques. We propose a procedure to estimate the diattenuation of the human eye in the fovea by means of a polarimetric technique.

Methods: We used a double–pass polarimeter to measure Mueller matrices in the living human eye. These matrices are obtained from 16 double–pass retinal images and completely describe the polarization properties of the eye. Mueller matrcices were experimentally measured in 3 normal subjects at the fovea for a 2–mm pupil and red light (633–nm wavelength). In particular, diattenuation was computed from the elements of the first row of the Mueller matrix. Axes of diattenuation were also calculated and compared with those of birefringence.

Results: Diattenuation at the central fovea was about 0.1 on average. It must be considered that diattenuation values range between 0 and 1. The axes of diattenuation were found to be different in each eye. Polarization states providing maximum ocular transmittance were in general elliptically polarized. These axes differ much from the axes associated to ocular birefringence. Dichroic ratios obtained from diattenuation values were in agreement with previous non–polarimetric measurements.

Conclusions: Diattenuation at the central fovea of the the living human eye has been obtained by using a double–pass Mueller matrix polarimeter. Experiments reveal that values of ocular diattenuation are much lower that birefringence but not negligible. Whereas birefringence is directly related to the thickness of some ocular structures and is usually used for glaucoma detection, diattenuation could be used to improve retinal imaging by optimizing the amount of light transmitted through the eye. Morever this parameter could also be potentially used in the analysis of eyes with some retinal pathologies and even may be useful to improve ophthalmologic diagnosis techniques.

Keywords: imaging/image analysis: non-clinical