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On the noise and physical realizability of experimental polarimetric images

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Abstract. Optical polarimetric images are usually calculated from a set of intensity images recorded with different states of polarization of light [1]. Because these latter states are setup dependent, propagation of experimental noise to polarimetric images is governed by the architecture of the polarimeter. In the case of Mueller polarimeter with rotating wave plates, polarimetric noise is distributed according to a scheme that involves 4 uncorrelated blocks of 2x2 adjacent matrices, each matrix containing 4 correlated elements [2]. When minimal 4x4=16 intensity images are used to extract Mueller images, the 4 elements in the middle m22, m23, m32, m33 feature variances that are 4 times higher than the variance of the intensity measurements. These highest polarimetric variances only equalize the intensity variance when 8x8=64 intensity images are used for assessment. Polarimetric accuracy referred to as "physical realizability" of Mueller images can be checked on the spectrum of a particular 4x4 real matrix built with the Minkowski space tensor G=diag([1 1 1 1]) together with the Mueller matrix M [3]. Because the defined estimator has undesirable statistical properties such as an unfavorable bias, any test on Mueller images of non depolarizing samples would lead to negative results almost all the time. A correct checking procedure would be to take into account the previously exhibited properties of polarimetric noise. This is formally equivalent for overpolarizing tests, to consider a correctly computed shifted ellipsoid rather than the usual centered sphere [4].

References

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