Simulation analysis of achromatic phase shifting using transformation of geometric phase

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Abstract

We report on simulation and testing of achromatic phase shifting techniques based on the geometric phase transformation. We present results of numerical simulations made with real data of individual components used.

Introduction

In common methods, the defined phase delay is introduced by the change of the dynamic phase through the variation of **the optical path difference** (OPD) of interfering waves, which is inversely proportional to wavelength λ.

In [1] a concept introducing **wavelength independent** geometric phase via cyclic transformation of polarization state was proposed.

One of the configurations providing a change of the geometric phase is shown in Figure 1 together with visualization of the polarization transformation on the Poincare sphere.

Here we present results of testing of two typical setups for achromatic phase shifting using a rotating polarizer [2] and a wave retarder [3, 4].

Aim of the work

- Measurement of polymer and achromatic crystal wave retarders
- Simulation of four different setups for achromatic phase shifting using measured data
- Evaluation of spectral dependence of the phase error

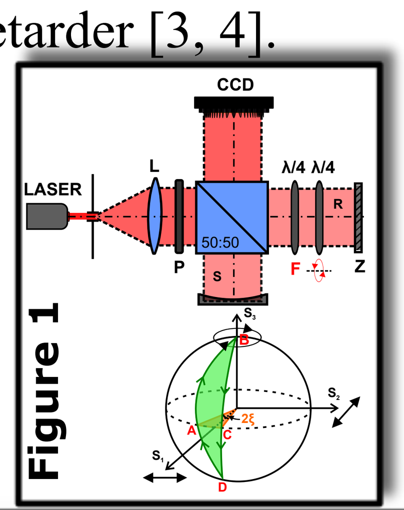


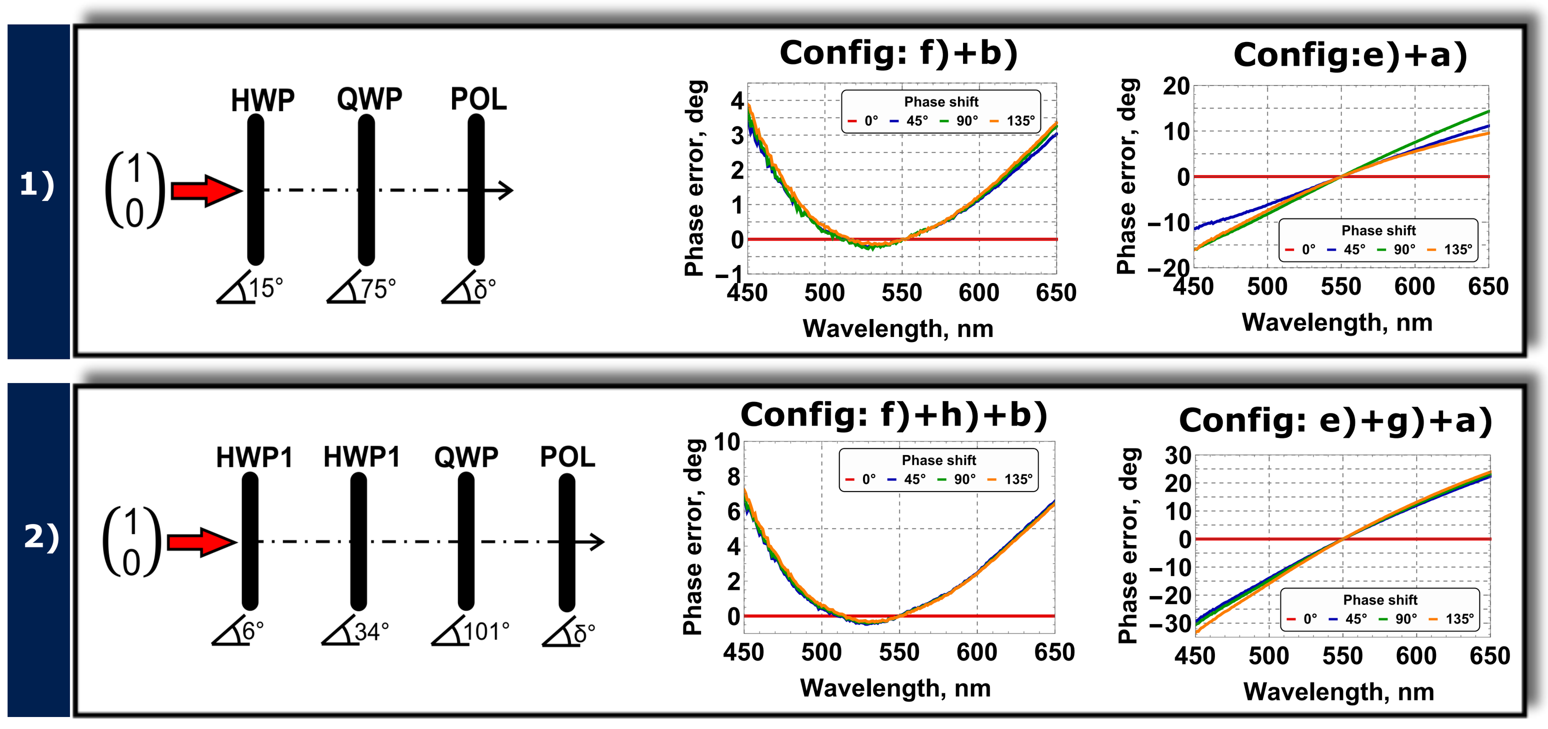
Figure 1

Simulation

Simulations are based on numerical implementation of Jones calculus with real data of used component.

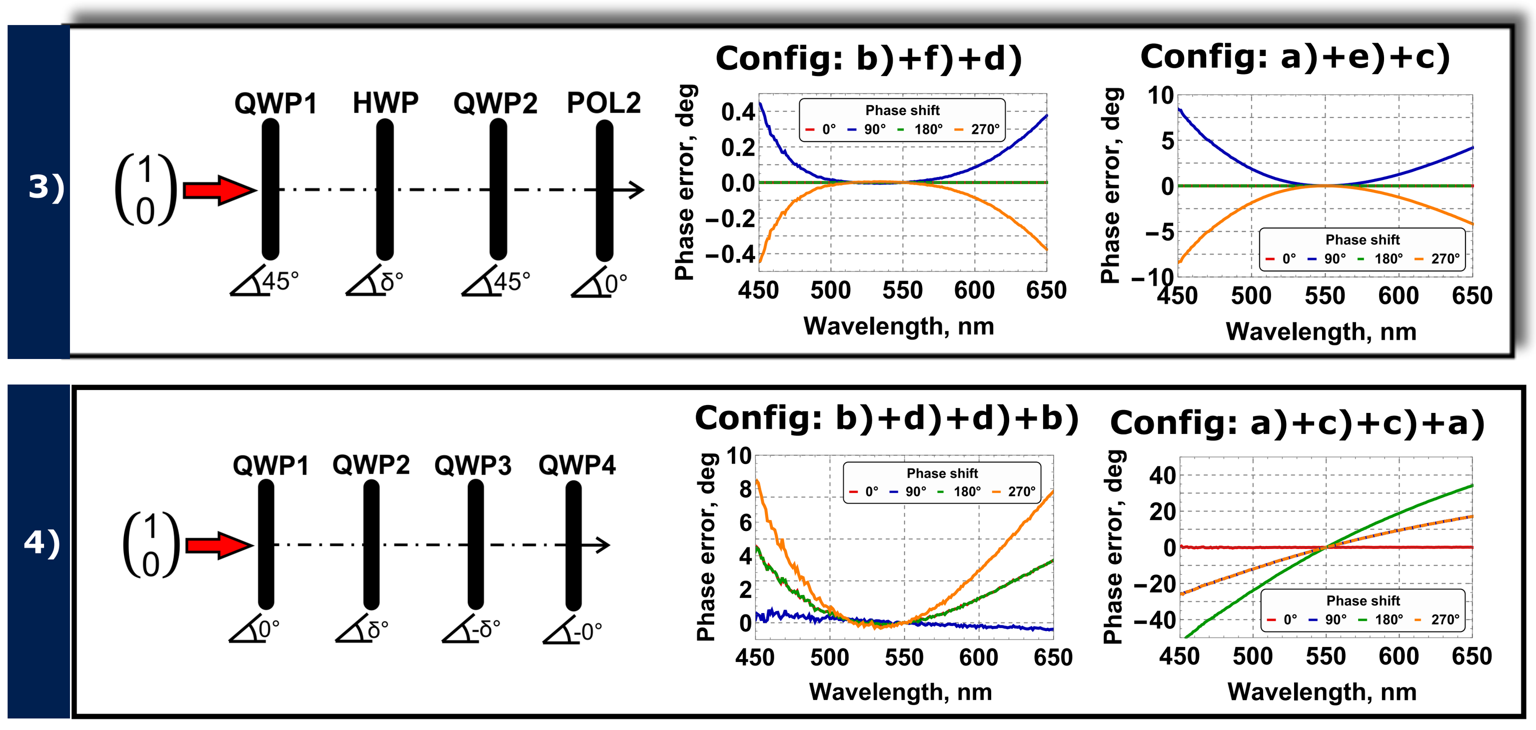
First type of achromatic phase shifters is based on passing circularly polarized light through the **rotating polarizer**.

Rotating polarizer



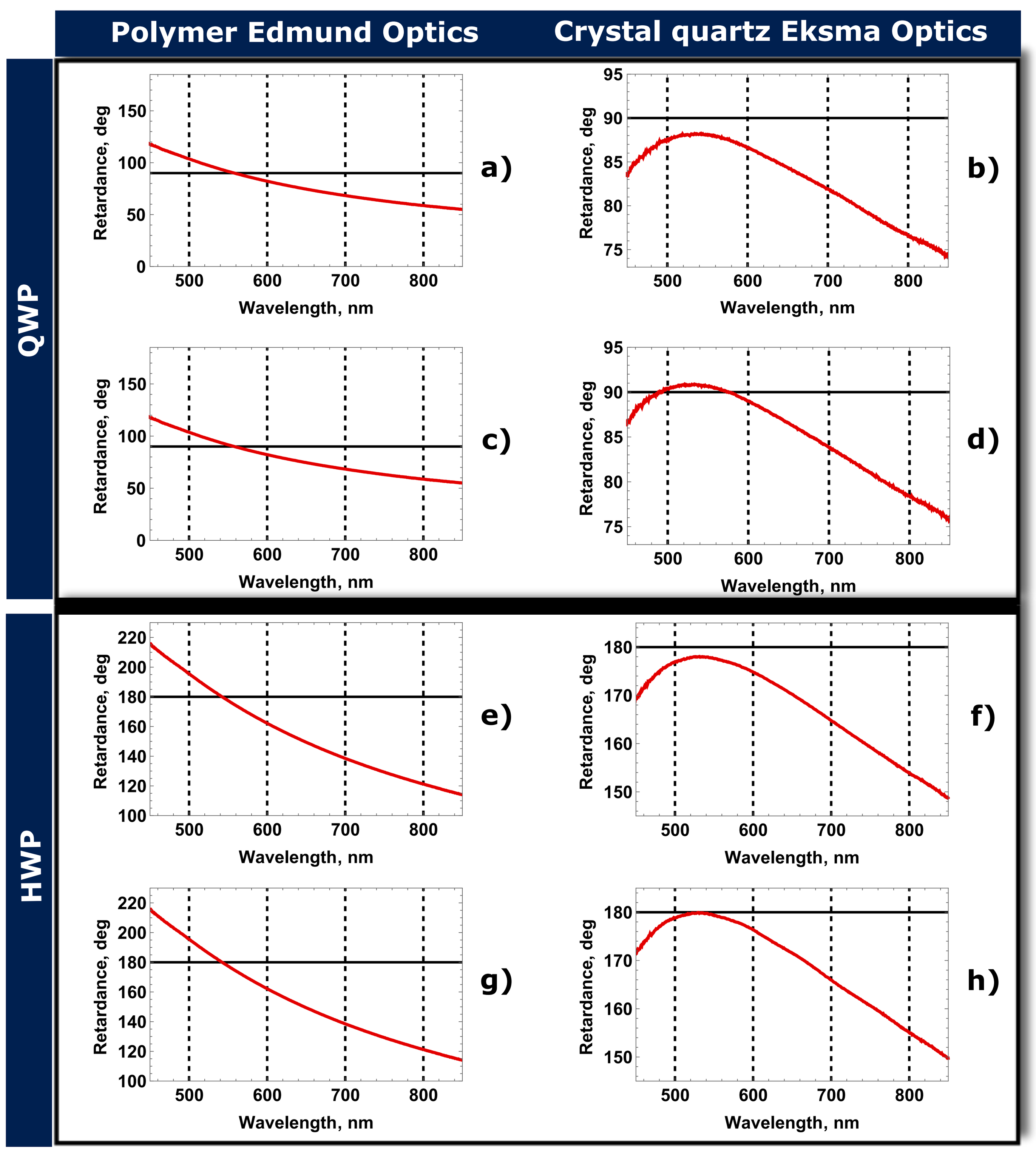
In the second type of achromatic phase shifters the cyclic transformation of polarization state is achieved via **rotation of wave retarders**.

Rotating retarder



Waveplates measurement

Phase retardation of used waveplates measured with a **polarimeter**:



Results

- Simulation model in Matlab was created
- Optimal combination: setup 3), error less than 0.4 degree for VIS
- Better achromatized phase shifts for crystal wave retarders
- Combination 1) is simpler and phase error is smaller than in the setup 2)

Conclusion

Due the analysis of available optical components the optimal configuration introducing achromatized phase shift was found. Achromatic wave retarders in simulated achromatic phase shifting systems play a crucial role. The optimal achromatic combination obtained by the numerical simulation can by applied in the phase shifting technique in short-coherent interferometry and quantitative phase reconstruction in the digital holography.

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