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Tesis: **"POLARIMETRY EMPLOYING CLASSICAL ENTANGLEMENT OF LIGHT"**

Resumen:

In this thesis we present the theory, simulation and experimental results obtained for an experimental setup, which allows us to obtain the experimental Mueller matrix of a transparent birefringent sample. The experimental setup proposed was inspired from a theoretical description given by Professor Töppel and his work group. An important advantage of this experimental setup with respect to other experimental setups described by different methods (the Ideal Polarimetric Arrangement method, IPA, for example) is that, this setup uses a single unconventional polarized beam (a radially polarized beam) to analyze the sample. By contrast, the IPA method uses at least four different polarized beams (conventional polarized, for example p-polarized, s-polarized, +45-polarized and right-handed polarized) to do that. In this sense, the main goal of this work is demonstrate that we can obtain useful information through determination of the Mueller matrix (associated to a transparent birefringent sample) by using classical entangled polarization modes (radially polarized beam). In order to do this, we are going to generate and analyze a radially polarized beam through a passive method by using a commercial device called S-waveplate. Then, we are going to use this beam in order to analyze a transparent sample (air, for example) and obtain its Mueller matrix associated, through the determination of the polarization modes.

Two main improvements to the theoretical proposal (Professor Töpple and his work group) for the determination of the Mueller matrix using classical entangled polarization modes (radially polarized beam) are presented. One of them is realized experimentally by substituting photodetectors, who provide a single number associated to a spatial average intensity over a solid angle, by a CMOS camera, which provides a spatial distribution. The other improvement consists in a modification of the original theoretical setup proposed, where now all the measurements are realized along two different arms only, not along the six arms originally considered. A new tool, recently proposed by our GIPYS Group, is applied to measure quantitatively the quality associated to the cross-section of any classical entangled or, more generally, to any unconventional polarization mode (the Symmetrical Average Symmetry metric). The characterization of the commercial passive converter employed, shows some mistakes present within the manufacturer´s manual. As a way to prove the setup system proposed, each main part is tested, in order to detect any probable mistake. The experimental Mueller matrix of the air is obtained by using a single incident unconventional (spatially non-homogeneous) polarized beam and two different methods. The radially polarized beam carries all polarizations at once in a classically entangled state. That important characteristic, allows us to use a single radially polarized beam as an incident beam over the sample in order to analyze the output beam, once, it has interacted with the sample. According to Professor Töppel, one possible representation of a radially polarized beam is as a superposition between a horizontal Hermite-Gaussian polarization mode (with horizontal polarization) and a vertical Hermite-Gaussian polarization mode (with vertical polarization). In other words, we are using two mutually orthogonal polarization beam modes entangled. The nature of the radially polarized beam indicates us, that it is necessary split mutually

orthogonal polarization modes within it, in order to analyze the polarization that carries each of them. It was described by Professor Töppel an experimental setup, which allows us to do that, it is called transverse-mode beam splitter. Experimentally, we observed that it does not provide the expected results. In other words, we have observed experimentally that this optical device does not split the mutually orthogonal polarization modes. On the other hand, the simulation of the transverse-mode beam splitter shows us that it works very well when an incident radially polarized beam, which is generated as a superposition of two mutually orthogonal polarization modes, travels through it. We conclude that this is due to the generation method employed, who probably is based only in a basis set constituted by two mutually-orthogonal Hermite-Gauss polarized modes, without the presence of a couple of two mutually-orthogonal Laguerre-Gauss polarized modes.