Processing the analytical optical signals by the means of the system of the nickel nanostripes, deposited on the glass substrate and the chromium nanofilm

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In this work the reflection properties of the system of the nickel nanostripes, deposited on the glass substrate and the chromium nanofilm, are discussed. The method of processing the analytical (analog) and digital optical signals by the means of the system is proposed.

By the mathematical language, if a function f of a matrix $\mathbf{A}$ is analytical in the local of $\|\mathbf{A}\| < 1$, then the function can be represented as the power series of $\mathbf{A}$, that is

$$f(\mathbf{A}) = f_0\mathbf{I} + f_1\mathbf{A} + f_2\mathbf{A}^2 + \ldots .$$

For example, it appears to be, in theoretical meaning, helpful in calculation of the approximate inverse of a matrix $\mathbf{R}$ if $\|\mathbf{R}\| < 1$.

$$\left(\mathbf{I} - \mathbf{R}\right)\left(\mathbf{I} + \mathbf{R} + \mathbf{R}^2 + \mathbf{R}^3 + \ldots\right) = \mathbf{I} .$$

When imaging a corresponding calculator (see Fig. 1), the following question arises. How to objectify the formula above in practice? Do optical beams with the defined Stocks parameters superpose with each other linearly? Yes, the magnetic and electric fields satisfy linear Maxwell equations. So that, the resulting signal is the essentially vector superposition of the additive fields. Then, does it apply to the corresponding Stocks matrices of each signal? Do the matrices add linearly, as vector fields? For non-coherent beams resulting intensity is just sum of the intensities of the superposing beams. This is the first parameter in the Stokes vector but the rest are depending on the ratio between the different polarization components. Therefore, it is more practical to use Jones vectors and Jones matrices to interpret the above formulas, for instance, for the operation of summation. But, the Mueller calculus disregard a coherence between beams and operates on intensity parameters (the example of the element of the Mueller matrix is given in Fig. 2), and the operator of summation of the superposing signals has quite difficult definition through the Stokes parameter. And, the corresponding operator needs to be discovered and defined, for example, for lens or the set of mirrors that direct all beams into one location in space (the detector of an analyzer). Further, what is the restriction, imposed by the sizes of the optical devices used to sum up the signals? Can be the summation realized over the optical beams in the micro- or nano-scale? Roughness of the surface, roughly saying, in the optical region needs to be less than 50 nm, and for many reflections even more severe requirements for the quality of the surface apply. The uniformity of the quality of the surface, the dependence on the temperature, the humidity and pollution of air the systems is exposed and so on, - all are affecting the properties of the system. What about the rate? For an optical path of about 1cm in the optical region, the rate for the multicomponent representation is of the order of 30 GHz. 100$^{\text{th}}$ order over 1 cm corresponds to around 100 μm step-distance (see Fig. 3). At this point note, that 100 μm distance between the two reflecting plates (as in Fig. 3) generates interference picture because of diffraction regardless of the length of the plates. Nevertheless, the calculations have advantage in the rate. We can imagine that the rate is the multiplication of the number of terms in the approximating series because the terms are calculated independently physically.

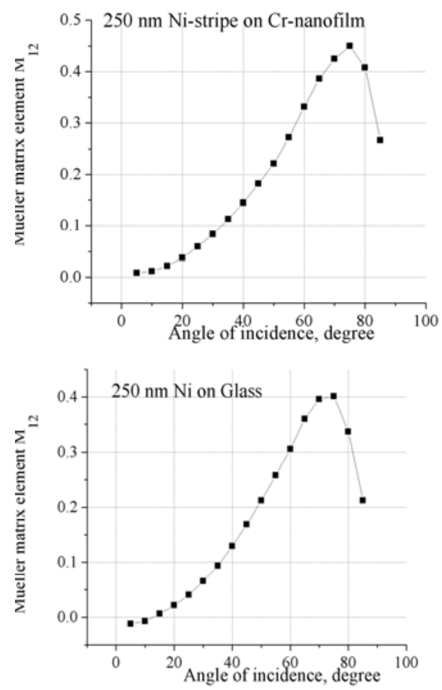

Fig. 2. Example of the element M_{12} (or/and M_{21}) of the Mueller matrix as the function of the angle of incidence at the nickel nanostripe thermally deposited on the glass plate (at the temperature of the glass about 250 °C) and chromium nanofilm. The thickness of the Ni stripe is about 250 nm.

Let us suggest the following principal scheme:

Fig. 1. The primitive principal scheme of an optical devise to represent a matrix series

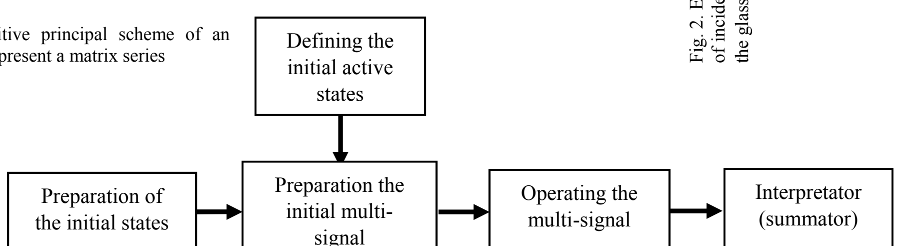

Fig. 3. The scheme of the series of multiple reflections as the optical representation of a matrix series. The block "Operating the multi-signal"