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SPIE.

Event: Fourteenth International Conference on Correlation Optics, 2019, Chernivtsi, Ukraine

Investigations of polarization distributions of ellipticity states of laser images of punctate samples of cancer patients and legal aspects of their labor adaptation

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ABSTRACT

This research contains materials of experimental studies of the coordinate structure of the distribution of polarization ellipticity of spectral ("red" $\lambda_1 = 0{,}632\mu m$ and "blue" $\lambda_2 = 0{,}414\mu m$) laser images of punctate samples of healthy (group I), preoperative (group II) patients and postoperative (group III) cancer patients.
Two-dimensional distributions of elliptic polarization values of the "red" and "blue" laser images of punctate oncological patients of groups I, II and III are presented and analyzed.
Samples of stationary values of the polarization ellipticity of laser images of punctate samples of three groups of oncological patients were studied and the patterns of their coordinate and spatial-frequency construction were established. On this basis, polarization criteria for the differentiation of laser images of patients of groups I, II and III are established.
The ranges of changes in the statistical moments of the first and fourth orders of the coordinate distribution of polarization ellipticity ("red" $\lambda_1 = 0{,}632\mu m$ and "blue" $\lambda_2 = 0{,}414\mu m$) laser images were studied, and statistical criteria for the differentiation of laser images of patients A, B and C groups were established. Some legal aspects of labor adaptation revealed by the proposed diagnostic methods in labor and social collectives are considered.

Keywords: polarization ellipticity, punctate samples, coordinate distribution.

1. Analysis of coordinate distributions of polarization ellipticity of spectral laser images of punctate samples of cancer patients of groups I, II and III

Analysis of the processes of conversion of the polarization structure of laser radiation scattered by punctate samples of various cancer patients was carried out in experimental locations, the optical schemes[1-12].
The results of a comparative analysis of the coordinate distributions of polarization ellipticity $\beta(x, y)$ of laser images of punctate samples of patients of groups I, II and III in the "red" and "blue" spectral ranges are illustrated by a series of fig. 1, fig. 2.

Fourteenth International Conference on Correlation Optics, edited by Oleg V. Angelsky, Proc. of SPIE Vol. 11369, 113691X · © 2020 SPIE
CCC code: 0277-786X/20/$21 · doi: 10.1117/12.2553977

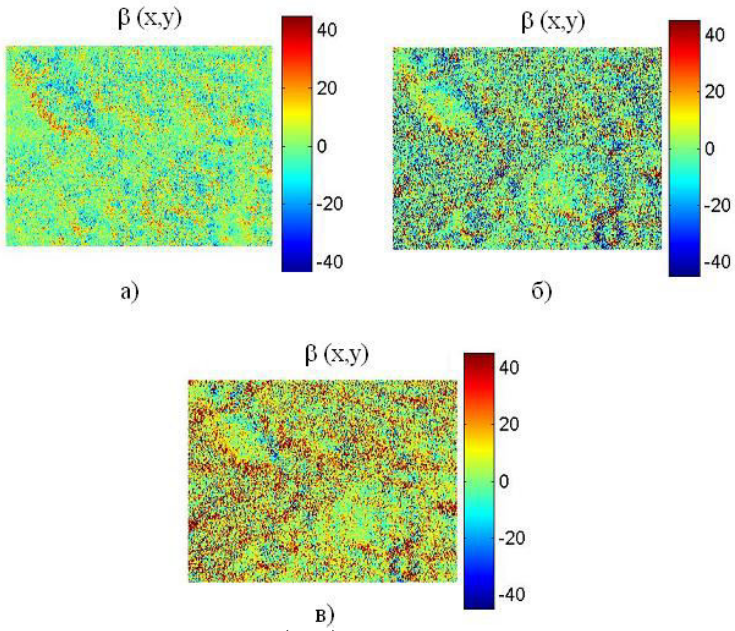

Fig. 1. Coordinate distribution of elliptic polarization $\beta(x, y)$ of laser images for $\lambda_1 = 0{,}632 \mu m$ punctate samples of patients of groups I ("c"), II ("b") and III ("a").

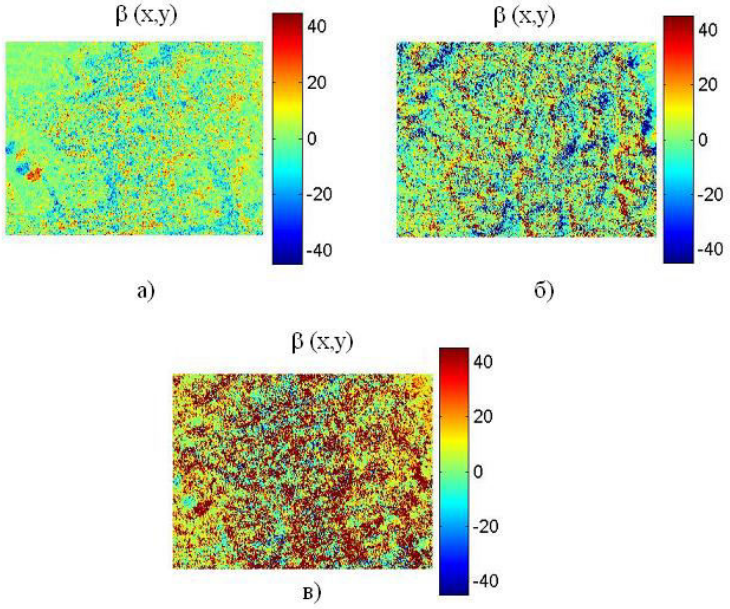

Fig. 2. Coordinate distribution of elliptic polarization $\beta(x, y)$ of laser images for $\lambda_2 = 0{,}414 \mu m$ punctate samples of patients of groups I ("c"), II ("b") and III ("a").

A comparative analysis of the coordinate distribution structure of polarization ellipticity recorded for different wavelengths, laser images of punctate samples of cancer patients of various groups found:

- all the studied punctate samples have optical anisotropy, which is indicated by the coordinate-inhomogeneous distribution of the ellipticity of polarization images of all I ("c"), II ("b") and III ("a") groups of laser images for $\lambda_1 = 0{,}632 \mu m$ (fig. 1) and $\lambda_2 = 0{,}414 \mu m$ (fig. 2);

- an increase in the overall level of polarization ellipticity $\beta(x, y)$ in the coordinate distributions of laser images of all wavelengths of puncture samples of unoperated patients ("c") compared with the operated ("b") and the groups of patients operated on with chemotherapy ("a"),
- with decreasing wavelength ($\lambda_2 = 0{,}414 \mu m$), both the general level of polarization ellipticity and the coordinate heterogeneity of polarization states in the "blue" laser images of punctate samples of all groups of patients increase in comparison with the series of corresponding polarizing "red" images ($\lambda_1 = 0{,}632 \mu m$) - Fig. 3 and fig. 4, respectively.

Comparison of a series of scalable (100pix x 100px) samples of two-dimensional and three-dimensional distributions of ellipticities of polarization of laser images of both wavelengths for all groups of patients:

- confirms the great sensitivity of polarization states in the short-wavelength range (where large phase shifts and, accordingly, large ellipticities are realized) to changes in the physiological state of the patient, which is manifested in the corresponding changes in the polymerization of the liquid fraction of punctate;
- necessitates the use of a comprehensive statistical and spatial-frequency analysis of distributions $\beta(x, y)$ to identify objective criteria for the differentiation of cancer patients A, B, C groups.

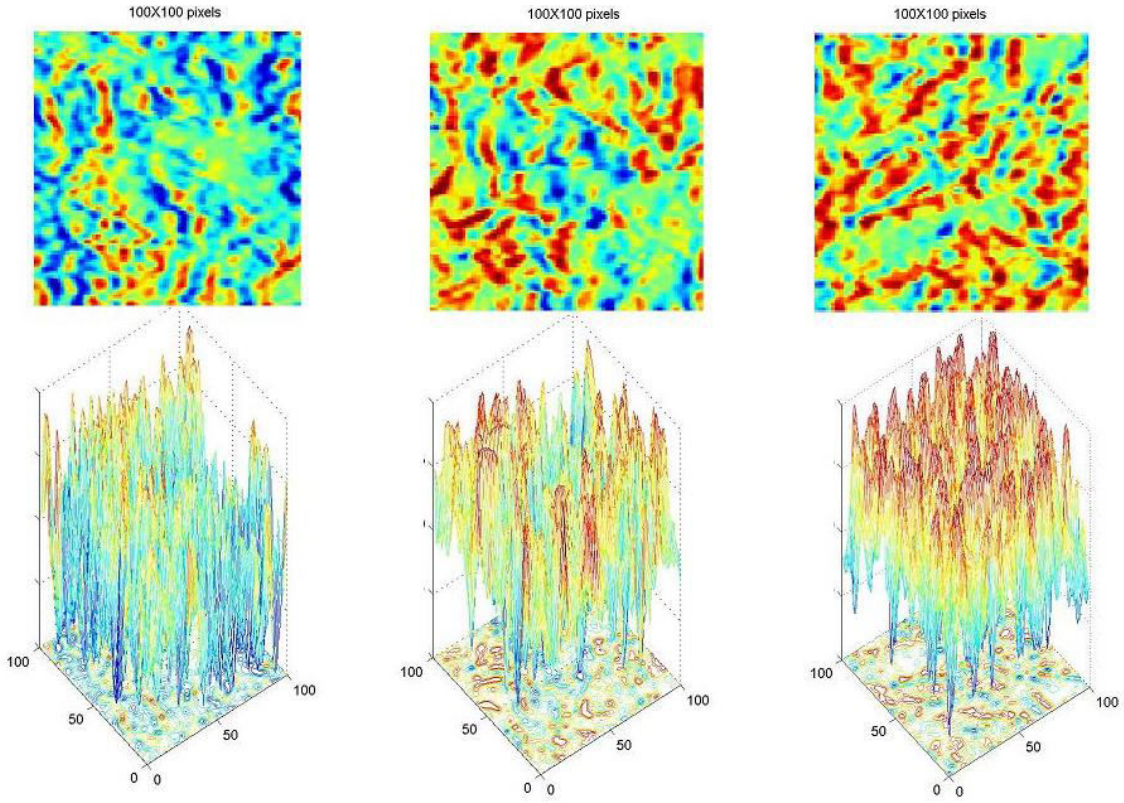

Fig. 3. A sample (100pix x 100px) of coordinate (upper row) and three-dimensional (lower row) patterns of distribution of ellipticity of polarization of laser images for $\lambda_1 = 0{,}632 \mu m$ samples of punctate patients (from left to right) of groups I, II and III.

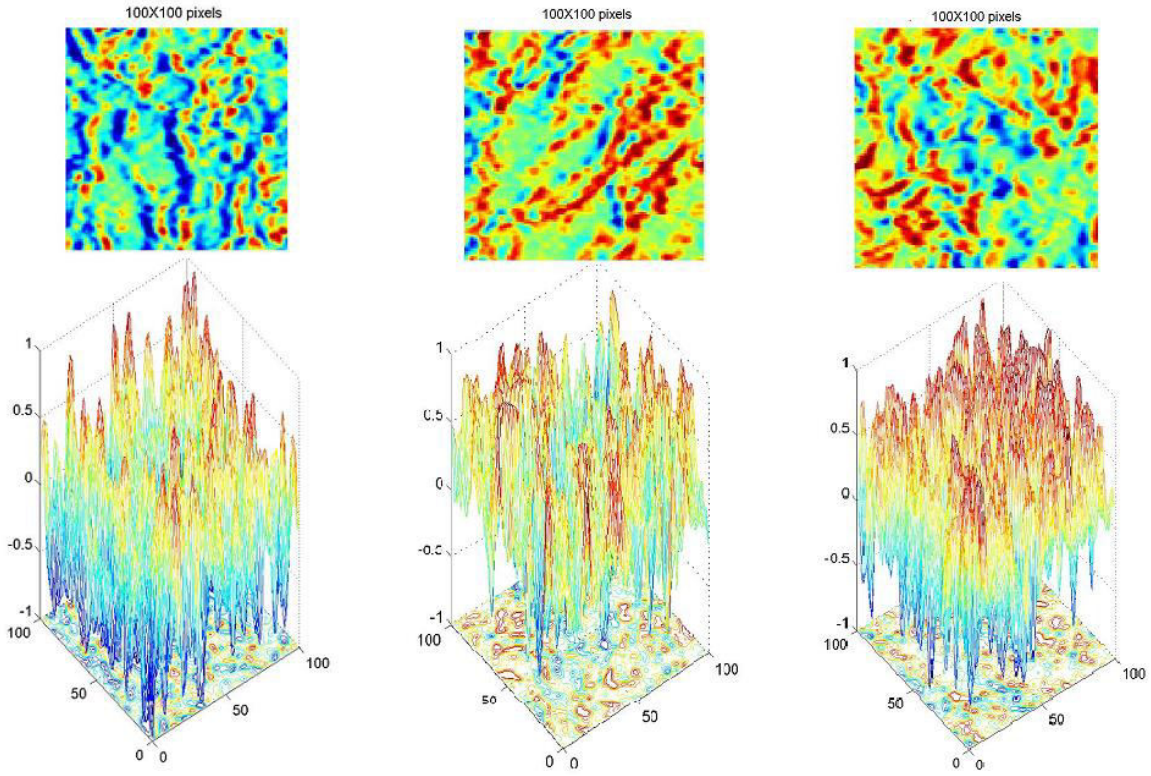

Fig. 4. A sample (100pix x 100px) of coordinate (upper row) and three-dimensional (lower row) patterns of distribution of ellipticity of polarization of laser images for $\lambda_2 = 0{,}414\mu m$ samples of punctate patients (from left to right) of groups I, II and III.

2. Analysis of statistics of coordinate intensity distributions of laser images of punctate samples of groups I, II and III cancer patients

Tables 1-6 show the results of a study of values (averaged within statistically significant groups of cancer patients I (15 samples), II (15 samples), III (15 samples) average, dispersion, asymmetry and excess of coordinate distributions of samples of polarization ellipticity $\beta(x, y) = const$ at different levels ($\beta(x, y) = 5^0$; $\beta(x, y) = 15^0$ and $\beta(x, y) = 30^0$) laser imaging ($\lambda_1 = 0{,}632\mu m$ and $\lambda_2 = 0{,}414\mu m$) of punctate specimens[13-19].

The value of statistical moments $Z_{i=1,2,3,4}$ was calculated according to the algorithms by substituting the number of points of a particular level of ellipticity of polarization of the dependences $N(\beta)$ of laser images of punctate samples of oncological patients of different groups.

Table1. Statistical moments of the 1st - 4th orders of coordinate distributions of ellipticity of polarization $\beta(x, y) = const$ of images of punctate samples of patients of group III for $\lambda_1 = 0{,}632\mu m$

Z	$\beta(x, y) = 5^0$	$\beta(x, y) = 15^0$	$\beta(x, y) = 30^0$
Z_1	$0{,}34 \pm 0{,}038$	$0{,}23 \pm 0{,}027$	$0{,}13 \pm 0{,}014$
Z_2	$0{,}16 \pm 0{,}014$	$0{,}19 \pm 0{,}024$	$0{,}23 \pm 0{,}024$
Z_3	$1{,}14 \pm 0{,}11$	$1{,}42 \pm 0{,}26$	$2{,}28 \pm 0{,}37$
Z_4	$1{,}28 \pm 0{,}13$	$1{,}67 \pm 0{,}18$	$2{,}27 \pm 0{,}25$

Table2. Statistical moments of the 1st - 4th orders of coordinate distributions of ellipticity of polarization $\beta(x,y)=const$ of images of punctate samples of patients of group III for $\lambda_2 = 0{,}414\mu m$

Z	$\beta(x,y)=5^0$	$\beta(x,y)=15^0$	$\beta(x,y)=30^0$
Z_1	$0{,}43 \pm 0{,}045$	$0{,}32 \pm 0{,}037$	$0{,}21 \pm 0{,}023$
Z_2	$0{,}12 \pm 0{,}014$	$0{,}15 \pm 0{,}019$	$0{,}19 \pm 0{,}024$
Z_3	$1{,}44 \pm 0{,}14$	$1{,}71 \pm 0{,}36$	$2{,}52 \pm 0{,}47$
Z_4	$1{,}29 \pm 0{,}21$	$1{,}86 \pm 0{,}24$	$2{,}39 \pm 0{,}35$

Table3. Statistical moments of the 1st - 4th orders of coordinate distributions of ellipticity of polarization $\beta(x,y)=const$ of images of punctate samples of patients of group IIfor $\lambda_1 = 0{,}632\mu m$

Z	$\beta(x,y)=5^0$	$\beta(x,y)=15^0$	$\beta(x,y)=30^0$
Z_1	$0{,}39 \pm 0{,}035$	$0{,}31 \pm 0{,}034$	$0{,}25 \pm 0{,}023$
Z_2	$0{,}14 \pm 0{,}013$	$0{,}16 \pm 0{,}014$	$0{,}21 \pm 0{,}022$
Z_3	$1{,}57 \pm 0{,}19$	$2{,}09 \pm 0{,}26$	$2{,}82 \pm 0{,}37$
Z_4	$0{,}72 \pm 0{,}13$	$1{,}26 \pm 0{,}14$	$1{,}85 \pm 0{,}27$

Table 4. Statistical moments of the 1st - 4th orders of coordinate distributions of ellipticity of polarization $\beta(x,y)=const$ of images of punctate samples of patients of group II for $\lambda_2 = 0{,}414\mu m$

Z	$\beta(x,y)=5^0$	$\beta(x,y)=15^0$	$\beta(x,y)=30^0$
Z_1	$0{,}43 \pm 0{,}048$	$0{,}34 \pm 0{,}037$	$0{,}29 \pm 0{,}031$
Z_2	$0{,}13 \pm 0{,}014$	$0{,}18 \pm 0{,}019$	$0{,}25 \pm 0{,}024$
Z_3	$0{,}27 \pm 0{,}034$	$0{,}79 \pm 0{,}16$	$1{,}18 \pm 0{,}28$
Z_4	$0{,}67 \pm 0{,}093$	$1{,}41 \pm 0{,}21$	$2{,}25 \pm 0{,}37$

Table 5. Statistical moments of the 1st - 4th orders of coordinate distributions of ellipticity of polarization $\beta(x,y)=const$ of images of punctate samples of patients of group I for $\lambda_1 = 0{,}632\mu m$

Z	$\beta(x,y)=5^0$	$\beta(x,y)=15^0$	$\beta(x,y)=30^0$
Z_1	$0{,}34 \pm 0{,}038$	$0{,}28 \pm 0{,}027$	$0{,}23 \pm 0{,}024$
Z_2	$0{,}18 \pm 0{,}021$	$0{,}21 \pm 0{,}024$	$0{,}27 \pm 0{,}032$
Z_3	$1{,}08 \pm 0{,}11$	$1{,}79 \pm 0{,}13$	$2{,}28 \pm 0{,}22$
Z_4	$0{,}97 \pm 0{,}093$	$1{,}41 \pm 0{,}14$	$2{,}17 \pm 0{,}34$

Table 6. Statistical moments of the 1st - 4th orders of coordinate distributions of ellipticity of polarization $\beta(x, y) = const$ of images of punctate samples of patients of group I $\lambda_2 = 0{,}414 \mu m$

Z	$\beta(x, y) = 5^0$	$\beta(x, y) = 15^0$	$\beta(x, y) = 30^0$
Z_1	$0{,}44 \pm 0{,}051$	$0{,}34 \pm 0{,}037$	$0{,}25 \pm 0{,}023$
Z_2	$0{,}11 \pm 0{,}011$	$0{,}14 \pm 0{,}019$	$0{,}19 \pm 0{,}022$
Z_3	$1{,}47 \pm 0{,}19$	$1{,}93 \pm 0{,}31$	$2{,}26 \pm 0{,}37$
Z_4	$1{,}19 \pm 0{,}13$	$2{,}05 \pm 0{,}24$	$2{,}77 \pm 0{,}45$

A comparative analysis of the data on the significance of the statistical moments[20-25] $Z_{i=1,2,3,4}$ of the distribution $N(\beta)$ of polarization states of laser images of punctate samples of cancer patients of various groups revealed:

- polarization statistical moments of the 1st – 4th orders are characterized by a wide change in eigenvalues both within the framework of a series of laser images of one group of punctate samples for different levels of their polarization ellipticity, and for the aggregate of polarization parameters of laser images of punctate samples of other groups of cancer patients registered in various spectral ranges $\lambda_1 = 0{,}632 \mu m$ and $\lambda_2 = 0{,}414 \mu m$;
- the smallest changes in eigenvalues within one group of patients are experienced by the average and variance of the distribution of samples of polarization ellipticity $\beta(x, y) = const$ of a series of laser images of the corresponding punctate samples - the differences between them do not exceed 10% - 20% in both spectral ranges;
- asymmetry and excess of dependences $N(\beta)$ change most dynamically within 2 to 6 times for different levels of sampling of ellipticities of polarization $\beta(x, y) = const$ of laser images of a collection of punctate samples of cancer patients of groups I, II and III;
- diagnostically relevant changes for various groups of cancer patients experience statistical moments Z_3 and Z_4, determined for the distributions of all levels of polarization ellipticity $\beta(x, y) = const$, in the corresponding series of laser images of punctate samples.

Some Legal Aspects of Cancer Diagnosis for Adaptation of Cancer Patients to Labor Collectives

The early diagnosis of various diseases of workers is a preliminary assessment of their health status and will be the initial promising stage of diagnosis, which will be included in the content of collective agreements and agreements at all levels of legal regulation of labor relations.

Early diagnosis of various diseases will be aimed at identifying the degree of compliance of a person as a potential employee with the requirements of a particular profession (professional suitability). As part of such a diagnosis, a candidate for a vacancy identifies psychological properties, psychophysiological qualities and reveals medical contraindications for the performance of a particular work or activity, readiness to occupy a particular position. It is at the stage of early diagnosis of various kinds of diseases that a person's suitability for a certain type of activity can be determined by comparing his individual characteristics with the requirements of the profession, which directly affect the success of any professional activity and the effectiveness of its implementation, identifies the general and special shortcomings of the employee, which can to be, in the future, an obstacle to a certain position or performance of work. Early diagnosis of diseases will help to identify and evaluate the difficulties in mastering the profession of a person and to develop at the enterprise, by adopting a collective agreement, a system of measures aimed at adapting a person to the conditions of a particular workplace, production as a whole, to take appropriate recommendations in order to increase labor efficiency such persons. Detection of various diseases of workers by early diagnosis will stop staff turnover at enterprises, institutions, and organizations, since excess turnover leads to significant economic costs caused by the dismissal of employees who do not correspond to the profession or work performed due to disability; losses caused by downtime, the corresponding costs of finding new employees, their training.

The ultimate goal of the early diagnosis of various kinds of diseases of people, as potential workers and workers, is aimed at the professional orientation of building up the "quality" of the labor subject even at the stage of choosing a profession or in the process of changing activity, is an important step towards achieving professionalism, that is, such

qualities and properties that will allow him to achieve high productivity, to achieve high, stable results in the labor process.

The results of early diagnosis of various kinds of diseases of people being hired and workers must be taken into account by employers of enterprises, institutions, organizations, in order to maximize the use of their labor potential, increase their productivity and labor activity in the labor process. The aforementioned confirms the need to use an integrated approach in the development and practical implementation of modern motivation systems at enterprises, institutions, organizations, one of the components of which is the identification of early diagnosis of various diseases in people employed and workers directly related to the performance of their labor functions. This approach is based on the individual needs and characteristics of workers and will ensure the effective innovative development of the entire national economic system based on increased labor productivity.

CONCLUSION

As a result of the study of the statistical polarization structure of laser images of punctate samples of cancer patients of different groups, the following conclusions can be drawn:

1. Distributions of polarization ellipticity and their stationary samples in laser images of punctate samples of groups of unoperated patients (I), operated patients (II) and operated on with a course of chemotherapy for patients (III) in all cases are complex spatiallyheterogeneous structures.
2. Diagnostic sensitivity to differentiation of groups of patients of types I, II and III of asymmetry and excesses of coordinate distributions of the values of the level polarization ellipticity in a series of spectral laser images of the corresponding punctate samples was found. The most diagnostically sensitive changes in the physiological state of various groups of cancer patients are the 3rd and 4th statistical moments of the coordinate distributions of polarization states in laser images recorded in the blue $\lambda_2 = 0{,}414 \mu m$ region of the spectrum.
3. Some legal aspects of labor adaptation of identified cancer patients are considered.

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