Gold nanoparticles (10-40 nm) that are conjugated with proteins are used for labelling of the histological sections with the subsequent acquisition of images in the transmission electronic microscopy, and also for identification of pathogens of infectious diseases and their surface antigens by means of a transmission electronic, scanning and fluorescence microscopy. In recent years, while using GNPs in medical and biological research, optical microscopy and in particular a confocal laser one is used. With the aid of two-photon luminescent microscopy, an image of localization of individual golden nanoparticles attached to the oncocells, or those that circulate in the blood is obtained. One of the most popular methods of obtaining images using GNPs is microscopy of the dark field, which is widely used in the diagnostics of cancer. The method is based on the binding specific GNPs conjugates with the surface of cancer cells. During this process it is possible to make "tumor maps" with the accuracy of several cells with the help of dark field microscopy of resonance scattering. GNPs are also used for photo-acoustic monitoring of inflammation in tissues (a technology is based on transforming of light into acoustic signals).

Using gold particles, kits for early diagnostics of pregnancy were developed, as well as for determination of rheumatoid factor and streptolysin, for quantitative analysis of immunoglobulins, for the determination of thrombin and glucose, for direct detection of cancer and leptospore cells in urine, for determination of the markers of Alzheimer's disease and protease activity. The method of colorimetric detection of DNA of mycobacteria, staphylococci, streptococci and chlamydia in clinical specimens is also proposed.

Different types of biosensors with using GNPs have been developed for immunodiagnostics of tick-borne encephalitis, papilloma viruses and human immunodeficiency, the definition of pesticides, antibiotics, allergens, cytokines, carbohydrates, immunoglobulins, detection of cancer and bacterial cells. GNPs methods are also used in the dot-blot analysis (express method of laboratory detection of DNA in which a DNA sample is directly applied to the membrane). Biosensors based on GNPs are also used to detect nucleotide sequences in DNA. And the detection of resonance scattering spectra from individual GNPs opened the way for the registration of intermolecular interactions at the level of individual molecules.

Nanotechnology has become an integral part of modern diagnostic methods that emphasizes the importance of developing nanomedicine as a separate area of medicine. Further development of diagnostic methods in medicine on the basis of golden nanoparticles is a perspective direction of research.

Galushko K.S.

A NEW METHOD OF SIMULATING AN IRREGULAR POLARIZED OPTICAL FIELD CELL

Department of Biological Physics and Medical Informatics
Higher state educational establishment of Ukraine
"Bukovinian State Medical University"

A new approach to the modeling of elementary cells of an inhomogeneously polarized field with a controlled number of polarization singularities is proposed. The cells can be obtained by superposition of specially formed orthogonally linearly polarized waves.

Keywords: polarization singularities, C-point.

The development of new methods for modeling fields containing a limited number of singularities with easily controllable parameters is relevant. This kind of structures are known to be obtained by means of computer-synthesized holograms. Using this technique vortex structures can be formed as well as elementary polarization singularities. The main disadvantage of such a technique is the loss of energy (may be substantial) due to the diffraction of beams on computer-synthesized holograms.

Creation of vortex chains is known to be possible due to interference of two practically flat waves, if there is a small gradient of intensity between them. A similar technique is developed for the simulation of optical field cells, where a limited number of polarization singularities appears.

The superposition of two orthogonally linearly polarized waves U_1 and U_2 along X and Y axes correspondingly is considered. The phases of these waves Φ_1, Φ_2 and the amplitudes A_1, A_2 satisfy the approximation of the wave front. In other words, it can be argued that waves U_1 and U_2 are propagate without diffraction. The intensity of waves is practically the same, and the field U_2 has some intensity gradient (for example, along the Y axis). In this case in the plane of observation x, y, the modulus of the field amplitudes is small and there is a solution of the equation $A_1 = A_2$ in the form of a line of equal intensity (modulus of amplitude) of the components.

The conditions for the emergence of one C-point at the points x_i, y_i are as follows:

$$\begin{cases} \Phi_1(x_i, y_i) = \Phi_2(x_i, y_i) \pm \pi/2 \\ A_1(x_i, y_i) = A_2(x_i, y_i) \end{cases} \quad (1)$$

The index of one C-point is shown to depend on two parameters: the direction of increasing the intensity of the wave and the sign of the phase difference between Φ_1 and Φ_2 in the position of the C-point correspondingly to the following rules:

Table

Dependence sign of C-point on two parameters

Phase difference between U_1 and U_2	Direction of intensity increasing in the wave U_2	Sign of C-point
$+\pi/2$	–Y	–
$-\pi/2$	+Y	+

Thus, on the basis of the obtained results, the following conclusions can be formulated: C-points can be obtained due to the superposition of two orthogonally linearly polarized waves; the sign of the topological indices C-points alternate in the transition from one to the adjacent period of superposition; the sign of topological index of C-point is defined by direction of increasing of intensity changes of one of the waves and the phase difference between interfering beams.

Ivanchuk M.A.

NON-LINEAR CLASSIFICATION PROBLEM SOLVING

Department of Biological Physics and Medical Informatics
Higher State Educational Establishment of Ukraine
"Bukovinian State Medical University"

There are many algorithms for solving linear classification problems, the most well-known of which are the linear discriminant analysis and the Bayesian classifier. The tasks of the nonlinear classification are more difficult to solve, since each specific task requires its approach. For example, using the Support Vector Machine, the quality of classification depends on the correctly selected kernel. We offer our own approach to nonlinear classification problems solving.

Let the training sets of points A, B are given in the Euclidean space R^d. The task is to create a classifier that divides the sets A and B with a predetermined significant level ε. Consider the case when the sets A and B do not intersect, but the convex hull of the set A lies inside the convex hull of the set B.

Let $k = 2$. We conduct a cluster analysis by the k-means algorithm for the sets A and B. Let's separate each of the sets A and B into k clusters. Consider all possible k^2 pairs of subsets A_i, B_j, $i = 1,..., k$, $j = 1,.., k$. For each pair of subsets, we find separating hyperplanes by the method of convex hulls linear separation, which is described by us previously. If the number of errors does not correspond to the given significant level, we increase the number of clusters by 1. If the number of clusters is very large according to the volume of samples, we are talking about the impossibility of classifying sets at a predetermined significant level of errors. If the significant level ε is satisfied, then the solution of the classification problem is a set of optimal separable hyperplanes of all pairs of subsets.

The algorithm complexity of the proposed method is $O(n)$, which is less than the complexity of the nonlinear Support Vector Machine algorithm.

Makhrova Ye.G.

CALIBRATION OF THERMOELECTRIC RECEPTORS WITH A FLAT RECEIVING PLANE

Department of Biological Physics and Medical Informatics
Higher State Educational Establishment of Ukraine
"Bukovinian State Medical University"

Receivers based on anisotropic thermoelements are used in industrial sanitation in energy radiometers, in medical diagnostic instruments by the method of dynamic heat-metering, namely:

- in diagnostics of functional state of the kidneys, for detection of pyelonephritis or glomerular nephritis (Kalugin V.O., Pishak V.P. Dynamic Radiation Thermometry, Opportunities and Perspectives.-Chernivtsi, - Prut-2009.-244);
- in diagnosis of the thyroid gland to determine its functional state (Gozhenko A.I., Berezovskaya M.E., Vetoshnikov B.C., etc. Method and device for temperature monitoring of the functional state of the thyroid gland in radiation damage - Radiation damage and development perspectives of personal protective equipment from ionizing radiation - M., 1992.- S. 101-107);
- in gynecology for detection of inflammatory processes, the function of the placenta, (Gozhenko A.I., Dikusarov V.V., Orenchuk B.C. Relationship between the level of radiation heat loss from the placenta and its function in EHR gestosis - Actual issues in morphogenesis: Mater. Conf.-Chernivtsi, 1996. pp. 87-88), (Gozhenko A.I., Dikusarov V.V., Orenchuk B.C. Usage of the test with the change of position of the body of a pregnant woman in the diagnosis of disorders of the placenta function - Actual problems of morphogenesis: 20 Mater. Sci., Conf. - Chernivtsi, 1996. - P. 88-89). Etc.

Calibration, that is, verification of the instrument parameters by comparing them with the indicators of exemplary devices, are widely used in modern instrument making, and is one of the last operations in the manufacture of devices. This method relates to the calibration of devices for contactless diagnostics on human radiation, and can be used to calibrate radiation receivers with heat-sensitive elements based on anisotropic thermocouples, i.e., heat receivers with a flat receiving plane. The calibration of thermoelectric receivers with a flat receiving plane is as follows. For calibration, a heat measuring cell consisting of a thermostat block is used, inside which, symmetrically with respect to the side walls, a flat metal core (0.2 mm thick plate) with a heater inside, on both sides of which two identical thermoelectric receivers with a flat receiving plane installed closely, are fixed.

The electric heater has the shape and size that coincide with the shape and size of the receiving plane of the thermoelectric receiver; and grading thermoelectric receivers with a flat receiving plane by stepwise change in the power of the heater, measuring the thermoelectric force, plotting the dependence of the signal of thermoelectric receivers with a flat receiving plane on the density of the heat flux for a given thermostatically controlled temperature unit.

The whole procedure for different temperature levels of the thermostated unit is repeated and nomogram of the dependence of the thermo-driving force of thermoelectric receivers with a flat receiving plane for the desired operating temperature interval is obtained.