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PULSED LASERS AND LASER APPLICATIONS

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ABSTRACTS

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In this work, we investigated the photophysical and electroluminescent properties of molecules consisting of electron donor and electron acceptor fragments, in which the RISC process is possible. Electronic spectra of absorption, fluorescence and phosphorescence, the quantum yield of fluorescence in solutions and films obtained by thermal vacuum deposition are investigated. OLED devices have been created, their light and electrical characteristics have been studied.

B-11

STEADY STATE AND TIME RESOLVED FLUORESCENCE STUDY OF EXCITED STATE PROTON TRANSFER IN FLUORESCEIN

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Fluorescein and fluorescein based derivatives are very sensitive indicators of changes in pH, viscosity, pressure, and ionic composition of the local environment. Due to the high absorbance and quantum yield, fluorescein is used for marking and visualizing colorless systems (for example, living cells, proteins, carbon nanotubes) as a fluorescent probe.

It is known that in the ground state, fluorescein in very alkaline conditions at pH > 10–11 exists as dianion in aqueous solution, at pH 5–5.5 – mainly as anion, at pH 3–3.5 the neutral form predominates and in very acidic conditions at pH < 0, the dye is presented as cation. Upon transition to the excited state, the situation changes significantly, especially with the increase in the ion concentration. For example, the neutral form predominates at lower pH 1–2. This is due to the appearance of the proton transfer (nonradiative transition to the other protolytic form with subsequent emission from it) competing with fluorescence. Excited state proton transfer together with the presence of a strong overlap of the emission spectra of individual forms complicates the interpretation of fluorescence so much that there is still no consensus on the number of fluorescent forms and the shape of their contours. This leads to a large scatter in the values of the fluorescence quantum yields and lifetimes of individual protolytic forms. Solving this problem requires the creation of new approaches and research methods.

The work discusses the advantages, limitations and disadvantages of using steady state and time resolved fluorescence methods separately, as well as their combination for study photoinduced proton transfer in the excited state of fluorescein in the presence of a strong spectral overlap of individual protolytic forms.

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B-12

ORGANIC THIN FILM LASERS AND SOME OF THEIR APPLICATIONS

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Recently, there has been an increase in interest in the creation of photoexcited organic thin film lasers, including those based on polymers with semiconducting properties, since intensive work is currently underway to create injection organic lasers and the first results have been obtained. Unlike solid-state lasers based on inorganic materials, organic lasers use a thin layer of organic molecules to amplify light. One of the main advantages of organic lasers is that they can cover the entire visible wavelength range.

When creating thin-film structures, a number of problems arise that must be solved: the search for a highly efficient laser dye with good photostability; the dye must be combined with a solid state matrix; the matrix must have good optical properties; be sufficiently photostable and have good adhesion to the substrate. In addition to the above conditions, for the successful implementation of efficiently emitting thin-film structures, it is necessary to ensure their good waveguide properties.

Due to their unique characteristics, organic film lasers find applications in sensorics, optics, optogenetics, and spectroscopy.

B-13

LASER SPECTROSCOPY OF LIGHT POLARIZATION FLUCTUATIONS

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The physical basis of a new experimental method for studying the spin dynamics of paramagnetic ensembles was laid by the work of E.B. Aleksandrov and V.S. Zapassky in 1981 [1]. The basis of the technique of laser *spectroscopy of polarization fluctuations* (SPF), also known as *spin noise spectroscopy* (SNS), is the registration of RF spectra (usually in the range up to 1 GHz) of Faraday rotation or ellipticity noise of light probing a system. In this case, information on the spectral composition of radiation in the optical frequency range is not retained; however, modulations at the recording frequencies make it possible to observe extremely small splittings of optical lines. This technique can not only be used to study EPR in low and zero magnetic fields, but also provide a number of other fundamental knowledge on the spin subsystem of the medium under study.

The key element of a modern SPF setup is a laser radiation source thanks to its extremely high spectral brightness, monochromaticity, and the possibility of smooth tuning. The report discusses the fundamentals of laser polarimetry and the features of application in technology of cw and mode-locked titanium-sapphire lasers, diode with an external and built-in resonator, as well as the use of different types of optical modulation to increase the sensitivity and information deepness of the response. The main experimental results of the SPbGU spin noise spectroscopy group over the past decade are presented.

1. *Alexandrov E.B. and Zapasskii V.S.* Magnetic resonance in the noise spectrum of Faraday rotation // JETP. 1981. V. 81, No. 7. P. 132–138.

B-14

PHOTODEGRADATION OF AQUEOUS SOLUTIONS OF PHENOXYACETIC ACIDS UNDER EXCILAMPS RADIATION

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Every year thousands of organic substances are synthesized for subsequent use as insecticides, herbicides, detergents, etc. They remain in the environment for a long time, and when they get into the atmosphere or into water sources they can lead to serious ecological consequences. The application of herbicides plays an important role in a productivity increase in agriculture. It should be noted that production, application, and assortment of pesticides, including herbicides, increases in the world every year. A study of transformations of stable toxic compounds in nature and a choice of optimal methods of herbicide utilization are important problems of environmental protection and rational use of natural resources. UV radiation can be used not only for disinfection of water and air, that is, for removal of pathogenic microorganisms, but also for decomposition of complex organic compounds. For study of photodegradation, an excilamp on working molecules KrCl with λ_{rad} = 222 nm, developed at the Institute of High Current Electronics of the SB RAS, was used as source of UV radiation. The results of direct photolysis of phenoxyacetic acids herbicides in aqueous solutions are discussed. The phototransformation occurs more slowly when the herbicides concentration increases. The use of the flow through reactor is more effective than operation in the stationary conditions. The prospect of using a wide range of excilamps with different characteristics for solving environmental problems is highlighted.