The first experiments have already demonstrated the successful quantum key distribution from satellite to ground [1]. Today, the usage of small Cubesat modules is considered for laser communications and QKD [2,3]. Rapid growth in the number of small-size satellite for remote sensing and communications, thanks to the availability of low-cost satellites, provides impetus for high capacity laser communication in space. Quantum communication can enhance the overall performance of secure communication. Our concept of using the cubesat for quantum communication involves developing and creating a system of satellite-based laser communication for high-speed information transfer via optical channel protected with the quantum cryptography protocols. The laser modules for the transmitter and the receiver should have a capability of mounting onto ground, aerial and space mobile platforms. The receiver and the transmitter will be equipped with the necessary gear for organizing a complete optical communication channel for both classical high-speed communication and quantum key distribution. The final goal of the project is creating the laser channel between the satellite and the ground station with the transmitting terminal mounted as a payload onto a 6U Cubesat microsatellite and the receiver within the Earth's atmosphere. The communication channel organized in the following way should meet the following requirements:

- Ground-satellite communication distance 450-1200 km with at least 10 km within the atmosphere
- Laser pulse repetition rate 10-300 MHz
- Quantum key rate at least 1 kbit/s
- Quantum cryptography protocol: decoy state, BB84
- Maximum transmitter dimensions 100 mm x 100 mm x 300 mm
- Power consumption no more than 5-10 W; maximum power consumption during 10 min 15-25 W in one rotation
- Supply voltage 5 V
- Communication with controlling electronics via UART, SPI, I2C

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Tu14P-15 (poster)

Calculation of Fluorescence Excitation Spectra to Help Nanoscopy of a Dipole-dipole Coupled Pairs of Light Emitters

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This work is aimed at theoretical investigation of the spatial structure and spectra of light emitted by a single pair of emitters with dipole-dipole interaction for arbitrary geometries of excitation-detection configurations. It is realized to support the experiments with controlled positioning of pairs of quantum light emitters separated by distances smaller than the excitation/emission wavelength driven by a tunable cw laser. We investigate how the arrangement of the incident light against the spatial configuration of the pair can help reveal the strength of dipole-dipole interaction and the distance between the emitters for particular solid angles from which the fluorescence signal is collected for registration. We use the manyparticle quantum-kinetic formalism describing the interaction of optical radiation with an arbitrary number of particles based on the Bogolyubov-Born-Green-Kirkwood-Yvon (BBGKY) hierarchy of equations for reduced density matrices and correlation operators for quantized field and material subsystems. This method includes all possible collective interactions as internal components of the hierarchy. These interactions are expressed through the mean-field potentials and manyparticle correlation operators. We have obtained the two-particle density matrix operator for a coupled emitting pair and calculated the total fluorescence intensity of such a system as a function of laser frequency with respect to the observation and excitation angles. The model and calculation algorithm we developed are adjustable to the real experimental conditions [1]. The criteria for restoring the distance between the emitters and their spatial orientation in the sample from the shape of the measured spectral curve have been formulated. This method was developed to accompany measurements of the distances by means of statistical processing of blinking fluorescence and scanning electron spectroscopy. This study was supported by the Russian Science Foundation (project no. 17-72-20266).

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Tu14P-16 (poster)

Low-temperature study of PLE spectra of GeV centers in CVD diamonds

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In this paper we report the results of low temperature studies of photoluminescence excitation (PLE) spectra of Zero Phonon Line (ZPL) for small ensembles of GeV centers (down to single centers level) in CVD diamond. The diamond film was grown by Chemical Vapor Deposition method in a microwave plasma CVD reactor ARDIS-100 (2,45GHz) [1]. Synthesis conditions were as follows: reaction gas mixture H2/CH4/GeH4 in the ratio of 93,4/6/0,6 % respectively, total

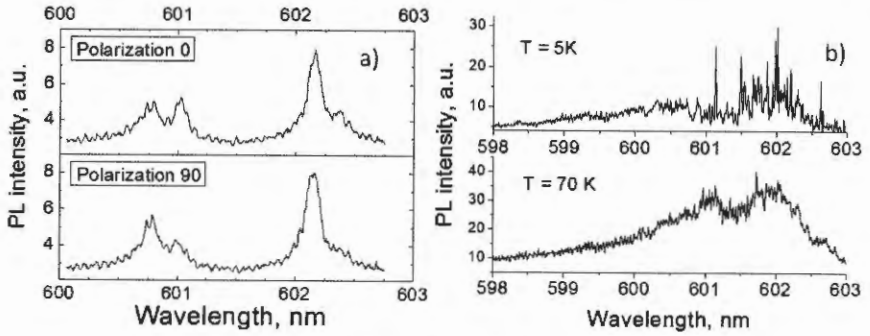

Figure Tu14P-16

PLE spectra from two micro-size (about 1μm3) regions of CVD diamond doped with GeV centers in low concentration. (a) First type of the investigated spectra, which represents four-component ZPL (at 5 K). Different spectra were measured with orthogonal laser emission polarizations. (b) Second type of the investigated spectra: sum of narrow ZPL at 5K, which evolves with temperature increase to the broad inhomogeneous band with two distinct peaks at 70 K.

gas flow rate 500 standard cm3/min, pressure in camera 130 Torr, microwave power 2.7 kW. The polished diamond crystal with sizes 4*4*1mm3 and (100) oriented large face produced via High Pressure High Temperature (HPHT) method was used as the substrate.

PLE spectra of negatively charged GeV centers in CVD diamond were measured in the broad temperature range (4.5-70K) with high spatial (~1μm) and spectral (~8GHz) resolution by applying single molecule cryogenic spectromicroscopy technique [2,3]. Automated laser wavelength tuning synchronous with microscopic fluorescence images capturing allowed us measurement of PLE spectra for different sample points simultaneously.

ZPL of GeV centers from diffraction limited volumes of the sample were found to be grouped in a spectral range of about 2 nm with a center near the wavelength of 601.5 nm (Fig. Tu14P-16). Spectra from different sample points can be divided into two types. The first is a structure consisting of two spectral doublets at the temperature of 5 K (Fig. Tu14P-16a). This type was previously observed in the luminescence spectra of samples containing HPHT micro-diamonds with GeV centers [4]. It should be noted that intensity ratios of these lines vary for the different areas of the sample and it changes under rotation of excitation emission linear polarization. Fig. Tu14P-16a shows examples of spectra measured for the same micro-region with orthogonal excitation laser polarizations. This spatial inhomogeneity and polarization behavior can be explained by the assumption that transitions that represent these four lines have a differently oriented dipole moments.

The second type (Fig. Tu14P-16b) was a sum of narrow spectral lines the number and spectral position of which varies strongly for different parts of the sample. There is currently no answer to the question of whether the obtained narrow lines belong to individual GeV centers or they are spectral sites for small sub-assemblies in which all the centers are in the same conditions. These individual lines broadened with temperature, which led to their overlapping in the temperature range from 40 to 70 K so the broad inhomogeneous band with two distinct peaks was formed (Fig. Tu14P-16b). It can be assumed that these ZPL inhomogeneous spectral distributions are connected to the presence of differences in local environments of individual GeV centers. For example, it can be due to differences in the distance between individual centers and diamond surface.

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Tu14P-17 (poster)

Hyperfine characteristics of quantum registers NV-13C in diamond nanocrystals formed by seeding approach from isotopic aza-adamantane and methyl-aza-adamanthane

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Nanostructured diamonds hosting optically active paramagnetic color centers (NV, SiV, GeV etc.) and quantum memory 13C nuclear spins situated in well-defined sites of diamond lattice are currently in the spotlight of quantum technologies developers. New bottom-up approach to fabricate such systems is to synthesize first chemically appropriate diamond-like organic molecules containing desired constituents in definite positions and then use them as precursors/seeds for CVD or HPHT growth to produce macroscopic diamonds. In particular, diamonds incorporating coupled NV-13C spin systems (quantum registers) with specific mutual arrangements of NV and 13C can thus be obtained from isotopically substituted aza-adamantane or methyl-aza-adamantane [1-3].

Here we are predicting the characteristics of hyperfine interactions (hfi) for a