ABSTRACT


The results of complex investigations of crystal and magnetic structures, electric and magnetic properties of quasibinary systems based on 3d-transition element monochalcogenide compounds – chromium, manganese and cobalt tellurides, chromium and manganese selenides, chromium, nickel and manganese sulfides – are given. According to researches of systems properties in large range of temperatures and magnetic fields phase diagrams of its magnetic state are built.


At a present time the emphasis of the investigations in almost all the branches of science, including magnetism, is shifted towards the study of nanosized structures. In this review the main classes of magnetic materials – films with columner type of crystal structure, multilayed films, granular alloys and nanowires are discussed. Mechanism of their formation, structure, magnetic and magnetoresistive properties are anylized.

I.O. Troyanchuk, S.V. Trukhanov, D.D. Khalyavin. Phase transformations and magnetoresistance in perovskites LnBaMn$_2$O$_{5+\gamma}$ (Ln = lanthanide, M = Mn, Co).

Crystal structure, magnetic and magnetotransport properties of new class oxide magnetic semiconductors LnBaMn$_2$O$_{6-\gamma}$ and LnBaCo$_2$O$_{6-\gamma}$ (Ln – lanthanide) have been studied. Large variety of magnetic and crystal structure phase transformations accompanied by electrotransport anomalies are found in these
compounds. Some compounds demonstrate CMR-effect near the room temperature.

V.G. Shadrov, A.V. Boltushkin. Intergranular magnetic interaction and magnetization reversal processes in Co based thin film structures.
The analysis of the intergranular magnetic interaction and magnetization reversal processes in Co-W based films with columnar structure and Co deposited alumite films has been made on the basis of the remanent magnetization, $\delta M$ curves and time dependence of magnetization and angular variations of coercivity.

S.S. Grabchikov. Amorphous electrodeposited alloys their structure, magnetic and mechanical properties.
In results of investigations of amorphous electrodeposited films on the basis of iron group metals with phosphorus and tungsten are presented. Their structure on the micro- and submicro level are studied by of scanning and transmission electron microscopes. In all the investigated samples the existence of universal structural defect – cellular net of the density materials is observed. It is shown, the form, a kind and character structural inhomogenenitis are dependent from the chemical composition and conditions of films preparation.
The static magnetic (coercive force, permeability, an induction of saturation) and mechanical (elastic and strength properties) properties are discussed. The conclusion about the perspectivity of the amorphous CoFeP and CoNiP films as the soft magnetic materials, and amorphous NiW films as protective films has been done. The interrelation of magnetic and mechanical properties with a microstructure of the films is discussed.

V.M. Ryzhkovskii. The manganese pnictides – $\text{Mn}_2\text{Sb}$, $\text{Mn}_2\text{As}$ and alloys on their basis: crystallostructural and magnetic properties.
The comprehensive study of structural and magnetic properties of pnictides Mn$_2$Sb, Mn$_2$As and solid solutions on their basis Mn$_{2-x}A_x$Sb(As)$_{1-y}B_y$ (A – Zn, Fe, Cu, Ni; B – Sn) with the tetragonal crystal structure of the type Cu$_2$Sb (P4/nmm, C38) has been performed. The conditions of their formation and structural characteristics have been determined. The character of magnetic state, phase transitions and manifestations of magnetic properties depending on the peculiarities of their crystal structure, composition temperature and pressure has been established. The magnetic phase diagram “composition - temperature” has been constructed. The model-theoretical approaches have been refined for describing changes of effective exchange interactions as well as order to order magnetic phase transitions caused by them.


It is shown, that increase or decrease of charge carriers concentration on a surface of semiconducting metal oxide at a chemosorption of gas-reducer or oxidizer leads to the same electrical conductivity change, as at the temperature change. In this connection it is necessary to expect, that chemosorption of a gas – reducer or oxidizer on a surface of metal oxide possessing phase transition metal-semiconductor, will result in the considerable change of electrical conductivity which in such oxides changes by some orders at phase transition temperatures. It will allow to use the given metals oxides as chemical sensors of gases working at temperatures of metal – semiconductor phase transition.
V.V. Pankov. **Nano-sized Ba-hexaferrite powders and heterostructures on its basis.**

Ba-hexaferrite particles have been prepared by modified coprecipitation and the aerosol synthesis technique. The phase composition of the intermediate products and the crystallization process were investigated by DTA, electron microscopy, vibrating sample magnetometry and Mössbauer spectroscopy. The transition into the superparamagnetic state for particles about 10 nm in size is investigated. Thin films of BaFe$_{12}$O$_{19}$ have been grown on (00l) oriented α-Fe$_2$O$_3$ single crystal substrates. The initial stages of the reaction between BaFe$_2$O$_4$ thin films and hematite single crystals have been investigated using AFM and SEM.

N.M. Olekhnovich. **The interaction in the perovskite type crystals: strain of bonds, multiwell local potential, ordered distortions.**

The method of estimation of interatomic bonds strain characteristics in the perovskite type crystals ABX$_3$ was developed. The strain energy of bonds has been found to cause ordered distortions of crystal lattices related to the octahedron tiltings or (and) collective displacement of cations in all unit cells. Interatomic interaction energy of the crystals with the strain bonds as a function of ordered distortion has been shown to be multiwell potential.

A.U. Sheleg, T.I. Dekola, N.P. Tekhanovich, A.Y. Yachkovski. **Effect of γ- and electron irradiation on the characteristics of phase transitions in the hydrogen-containing and A$_2$BX$_4$ ferroelectrics.**

The heat capacity, electroconductivity, dielectric and elastic investigations of some ferroelectric crystals of the A$_2$BX$_4$ group and ferroelectrics with the hydrogen bonds also, both nonirradiated and γ-irradiated with various dozes and electrons are presented. The distinguishing feature of many investigated crystals is presence of the complicated sequence of phase transitions depending on
temperature, in particular paraphase - incommensurate - ferroelectric phase. As a result of study both laws of influence of defects, induced by irradiation, on crystal lattice are established on physical properties of the ferroelectric crystals, and on sequences of phase transitions in these crystals. It is shown, that γ- and electron irradiation results in decreasing of peaks and smearing of anomalies in temperature dependence curves of the investigated properties in the vicinity of phase transition temperatures. It is established, that phase transition temperatures with increasing fluence may both be increased and decreased. It depends on the type of the phase from which the transition to the ferroelectric phase is realised. It is shown, that the ferroelectric phase transition temperature $T_c$ with γ- irradiation fluence decreases at transition from the paraphase to the ferroelectric phase. In the case that transition to the ferroelectric phase occurs from the intermediate incommensurate phase the $T_c$ temperature under γ- irradiation is increased, that is connected to presence of soliton structure in the vicinity of the transition temperature to the incommensurate phase. The analysis of obtained results is performed in the framework of Landau theory of second-order phase transitions.

A.I. Akimov, T.M. Akimova, G.K. Savchuk **Physics of kinetics of magnification density of ceramic powders at high pressures.**
The densification kinetics of ceramic powder medium at high pressures of 1 to 10 GPa has been investigated for the first time. The model for the rate of the densification of ceramic powders is proposed taking into account linear dependence of viscosity coefficient on the pressure. Good agreement between calculated and experimental density data in depending on the pressure in process of the densification is revealed for piezoelectric and superconducting ceramic powders.
A.K. Soika. Production of unipolar pulsed magnetic field up to 100 T and their Application for magnetooptical and galvanomagnetic phenomena research.

This paper describes the development of a three-coil pulsed magnet for production of non-destructive unipolar pulsed magnetic fields in the region above 50 T. The case in point is a new efficient technique for implementing the crowbar discharges of a several capacitor banks through coils of multi-coil magnet. This technique is reliable and can be implemented easily.

The Faraday effect is experimentally studied for concentrated ruby \((n_{Cr^{3+}} \sim 3.5 \times 10^{20} \text{ cm}^{-3})\) at room temperature and magnetic field strength up to 740 Koe. It is found that under these conditions the angle of rotation for the plane of light polarization \((\lambda = 632.8 \text{ nm})\) is a nonlinear function of the magnetic field strength beginning from \(\sim 200 \text{ Koe}\).

The Hall effect is experimentally studied for \(\text{InAs}\) at room temperature and unipolar high pulsed magnetic field up to 56 T. It is found that the Hall constant to stay put.

It has been observed that the polarized luminescence of ruby is complete quenched by an applied strong magnetic field. This experiment was done at room temperature. The optical axis of ruby and polarized plane of the light is perpendicular to the field. The observation line of the emission from ruby coincided with the magnetic field.


The physical basis and practical results of penetrating radiation usage in technology of nuclear transmutation of semiconductor materials (Si, GaAs), and
also in production of semiconductor devices, including power silicon diodes, thyristors and transistors, have considered. The high efficiency of application of radiation technology for increase of speed of electronic products, elimination of the operation of gold or platinum diffusion, improvement of the quality, cost reduction and rise of suitable devices output have been shown. Designed in the Institute of Solid State and Semiconductor Physics of NAS of Belarus methods of radiation technology are widely used in electronic industry.

L.I. Murin, V.P. Markevich, J.L. Lindstrom. **Formation mechanism and properties of the oxygen dimer in silicon.**

Oxygen dimer (O$_2$) is the first step of oxygen aggregation in silicon. For a long time it has been suggested that O$_2$ plays a very important role in processes of oxygen clustering at elevated temperatures due to its expected high mobility in the Si lattice. However, only in our recent studies, which are reviewed in the present paper, the oxygen dimer was detected and identified. We discuss here also some characteristic features of the O$_2$ formation kinetics in Si&lt;O&gt; and Si&lt;O,H&gt; crystals. A recently developed special method of enhanced dimer generation by electron irradiation at about 650 K is described. The results of FTIR and DLTS studies of the interaction between Si self-interstitials and the oxygen dimer are presented as well.

A.V. Mydryi, T.P. Larionova, I.A. Shakin, G.A. Gusakov, G.A. Dubrov, V.V. Tichonov. **Growth and optical spectroscopy of synthetic diamond.**

High-quality single crystals of diamond were grown by the high-pressure high-temperature (HPHT) method using nickel (iron) – containing metals as the solvent catalyst. Photoluminescence, photoluminescence excitation and absorption measurements were employed out to study the nature of impurity-related defects
in as-grown and HPHT treated diamonds. The different optical absorption and luminescence bands in both as grown and annealed diamonds have been attributed to nitrogen or nitrogen-nickel-related defect centers.

V.I. Levchenko, V.N. Yakimovich, L.I. Postnova, V.I. Konstantinov V.G. Shcherbitsky, V.E. Kisel, N.V. Kuleshov. **New laser materials on the basis of transition metals doped A\(^2\)B\(^6\) semiconductors.**

Laws of crystallization are investigated, growth methods are developed and undoped crystals ZnSe, CdSe, ZnS, and Cd\(_{1-x}\)Mn\(_x\)Te are grown. The technique of diffusion doping is developed and Cr:ZnSe, Cr: CdSe, Cr:ZnS, Cr: Cd\(_{1-x}\)Mn\(_x\)Te, Co:ZnSe, Fe:ZnSe crystals are obtained. Optical and laser properties of the obtained crystals are investigated.


In this paper results are presented for the growth and characterization of polycrystalline CuIn\(_{1-x}\)Ga\(_x\)Se\(_2\) thin films. The samples were prepared by an infrared (Nd:YAG laser) pulsed laser deposition (PLD) of prereacted material onto glass substrates with and without Mo back contact at temperatures between 790 - 810 K. The crystal structure, microstructure and chemical composition of the as-grown films were investigated by XRD method, scanning electron microscopy and EDX measurements. Electrical characteristics were analyzed by 4-point probe method system and Hall effect measurement apparatus. Using the laser deposited absorber layers thin film solar cells of type glass/Mo/Cu(In,Ga)Se\(_2\)/CdS/ZnO:Al/Al-Ni were fabricated as a preliminary step. We have obtained a conversion efficiency of 5.5%. These results have shown that
PLD could be used as a technique for the fabrication of complex semiconductor films for solar cells.

N.S. Orlova. The lattice dynamics and the peculiarities of the interatomic interactions in the AgGaS\textsubscript{2} and AgGaSe\textsubscript{2} compounds with chalcopyrite structure from the X-ray inelastic scattering data.

Measurements of the diffuse X–ray scattering intensity are performed from the (100) and (001) planes in the AgGaS\textsubscript{2} and AgGaSe\textsubscript{2} ternary compounds with the tetragonal chalcopyrite–type structure. The obtained data were analyzed and the phonon frequencies of acoustic and optic modes in the [001] and [100] symmetry directions, the polarization vectors of these phonons as well as the elastic constants C\textsubscript{ik} were found. These data were used to model the lattice dynamics, to determine the force constants, to calculate the phonon energies and other dynamical characteristics, to analyse the dispersion curves. The results indicate that for both compounds the force constants \(\alpha_{AC}\) for the Ag-S(Se) bonds are approximately half of the force constants \(\alpha_{BC}\) for the Ga-S(Se) bonds and are close to the parameters of the nearest-neighbours interaction in binary analogues ZnS (ZnSe). The large \(\alpha_{GaS(Se)}\) values are mainly responsible for the high-energy optical modes while the energy of acoustic phonons is determined by the low constant \(\alpha_{AC}\) of the Ag-S(Se) bond. The characteristic features of the lattice dynamics of AgGaS\textsubscript{2} and AgGaSe\textsubscript{2} are that the TA phonon mode frequencies have a very flat dispersion at large wave vectors.

The comparative analysis of the phonon dispersion curves and the character of the elastic anisotropy for the ternary compounds AgGaSe\textsubscript{2} and AgGaS\textsubscript{2} with the chalcopyrite structure and the binary analogs \(A^2B^6\) with the sphalerite structure was carried out. It is established that the relations between the force parameters, between the elastic constants, the character of elastic anisotropy, the structure of
phonon spectra are closely connected with the crystal structure feature and tetragonal distortion in the ternary compounds $A^1B^3C^6$.

B.V. Korzun. **Phase equilibriums in systems on the basis of semiconducting compounds** $CuAlX_2$ (where $X$ is S, Se, Te).

T-x phase diagram of the $Cu_2S-Al_2S_3$ system is established using XRD, DTA, and EPMA at the first time. Two ternary compounds ($CuAlS_2$ and $CuAl_5S_8$) are crystallizing in this system. $CuAlS_2$ melts congruently, and $CuAl_5S_8$ – on a peritectic. The alloys in the $CuAlSe_2$ - $CuAlTe_2$ system are investigated and is shown, that the continuous series of solid solutions with the chalcopyrite structure are formed. The composition dependence of melting heat of solid solutions in this system has additive character.

V.M. Trukhan, T.V. Haliakevich. **Compounds and solid solutions in system Cd-Zn-P-As.**

The analysis of the phase diagram of quasi-binary sections on compounds $A^{II}B^{V}$ ($A$ – Zn, Cd; $B$ – P, As) is carried out, the domains of existence of the three- and four-component solid solutions in system Cd-Zn-As-P are considered. The physical properties and the practical application fields of compounds and solid solutions of group $A^{II}B^{V}$ are examined.

E.M. Shishonok. **Photoluminescence dates about defect formation in irradiated by electrons cubic boron nitride.**

Results of photoluminescence (PhL) investigations of cubic boron nitride irradiated by near shreshold electrons of 150-300 keV in energy and comparative analysis to cathodoluminescence (CL) dates received by the material irradiation by high energy electrons of 4.5 MeV are presented. It is established that near shreshold and high energy electrons irradiation of cBN single crystals lead to
different changes in optically-active defects systems of the material. The differences concern a preferable formation of different radiation damage-induced optical centres and their zero phonon lines (ZPL) parameters. A fine structure of RC centres ZPLs is firstly discovered which changes since irradiation electrons reach the threshold energy. The phonon sideband of RC ZPLs is found to be complicated and performed by interconnection of electronic transitions on the centres with lattice phonons of 0.1-0.125 eV in energy.

A.I. Akimov, G.K.Savchuk, S.A.Lebedev. High-\textit{T}_c \textit{Tl-based superconductors: structure, properties.}

The formation behavior and physical characteristics of high –\textit{T}_c \textit{Tl-based superconductors are investigated. Low temperature x-ray diffraction studies revealed anomalies in the c cell parameter and c – axis thermal expansion coefficient near the superconducting transition. The temperature dependencies of lattice parameter and thermal expansion coefficients for Tl-ceramics annealed under different conditions demonstrate that the superconducting transition is accompanied by sharp changes in thermal vibration parameters, suggesting that changes in the phonon spectrum play a significant part in this phase transition.

S.N. Barilo, V.I. Gatalskaya, S.V. Shiryaev, H. Szymczak, R. Szymczak, M. Baran. Magnetic properties of the superconducting single crystals and films of BKBO.

Magnetic properties of BKBO superconducting single crystals and films grown by electrodeposition technique are studied by VSM and SQUID- magnetometry in range of 4.2-\textit{Tc for fields up to 6T. The peak-effect was first observed in this system. The investigation of the temperature dependence of the reversible magnetization near \textit{Tc in order to the determination of the critical fields, penetration depth and the specific-heat jump displays that the BKBO are}
superconductors with the intermediate electron-phonon coupling. The pinning mechanism of the flux lattice was also studied. It is shown that the field dependences of the critical currents for 5-20K are well described in the frame of the theory of small bundle collective pinning regime.

V.I. Gatalskaya, S.V. Shiryaev, S.N. Barilo, G.L. Bychkov, L.A. Kurochkin, S.N. Ustinovich, R. Szymczak, M. Baran. The single crystals of \( \text{LaMnO}_{3+\delta} \): the growth and study on the magnetic ordering.

The single crystals of \( \text{LaMnO}_{3+\delta} \) (0.01 \( \leq \delta \leq 0.085 \)) are grown by the electrodeposition technique. The magnetic ordering in the single crystals is investigated using the temperature and field dependences of the magnetization in the range from 4.2K to 300K at the fields up to 5T for the different directions of magnetic field. The data analysis is performed in the frame of the two-phase model of the magnetic state of the crystal.

A.P. Saiko, V.E. Gusakov, S.A. Markevich. Correlated bistable sublattice and the temperature hysteresis of elastic and thermal characteristics of cuprate oxides and lanthanum manganites.

A model for the bistable lattice to be incorporated into crystal lattice with a complex basis has been developed and the temperature dependence of it’s statistical and thermal parameters determined. A physical interpretation of temperature hysteretic behavior of the elastic and thermal properties of high temperature superconducting cuprate oxides and lanthanum manganites in the frame of the bistable sublattice is given.

N.N. Sirota. Magnetoresistivity of metals, the law of Kapitsa.
Quantitative formulation of the rules of magnetoresistivity variation as magnetic field is represented, which gives a new viewpoint on the problem of the grant magnetoresistivity effects.

S.E. Demyanov. **Fermi surface sheets transformation and electron transfer in metals under strong magnetic field conditions.**

In some pure metals geometry of Fermi surface sheets has been studied by the method of quantum thermopower oscillations in magnetic fields up to 15T. New type of oscillations observed in Al was due to multiple coherent scattering of electrons by magnetic breakdown regions. The oscillation frequencies in Zn and Cd associated with classical and magnetic breakdown orbits are observed and the trajectories on the Fermi surface under total breakdown conditions are analysed. A new type of oscillation frequencies in Ag and Au does not correlate with any extreme cross-section of the Fermi surface and deals with the oscillations of d-states. Galvanomagnetic measurements have shown that relative transverse magnetoresistance of Al during deformation increases due to small angle electron scattering on extended lattice defects. Two kinds of electron small angle scattering on phonons and dislocations are compared. The effective small angle scattering was observed on plastically deformed single crystals of Cu. The dislocations changed the magnetoresistance field dependence both for open and closed electron orbits.

V.R. Sobol, O.N. Mazurenko. **Magnetic pinch of current lines in metals.**

The materials of long-term researches by authors of a problem of influence of a strong stationary magnetic field on electric properties of pure metals at low temperatures are generalized in this article. The basic attention is concentrated on experimental and analytical studying of processes of a current distribution in conditions of inhomogeneity of conductivity, when the volumetric characteristics
are non-local as they can't be described by simple summation of conductivity in each single point of environment.

V.B. Shipilo, N.A. ShIshonok, A.G. Duto. Superhard materials: deriving, properties and application. The representation about origin and propagation are stated at catalytic synthesis of diamond and cubic boron nitride, shaping of their substantial structure depending on parameters of synthesis, aspect and impurity concentration. Have considered regularities, feature of shaping of structure both properties of superhard polycrystals and composites.

V.S. Urbanovich. Effect of high pressures and temperatures on the structure and properties of ceramics based on high-melting point compounds. The process of densification and sintering of titanium diboride is studied at pressures up to 4 GPa. Influence of high pressure and temperatures on physical and mechanical properties of solid solutions based on titanium and tantalum diborides is investigated. The structure and physical and mechanical properties of silicon nitride sintered at high pressure are studied. Highly dense pure $\alpha$-Si$_3$N$_4$ ceramics with high corrosion resistance and two-phase silicon nitride ceramics with high microhardness (34.8-38.4 GPa) are obtained. The possibility of obtaining of highly dense nanostructured ceramics with high hardness by high-pressure sintering nanopowders of high-melting point compounds is shown. Their structure and physical and mechanical properties are studied depending on sintering regimes and dispersibility of initial powder.

A new approach to electrochemical synthesis of different forms of carbon including micro- and nanocrystallinediamond, amorphous diamondlike carbon and carbon nanotubes are proposed. As several studies have underline the role of \( \text{CH}_3^* \), \( \text{C}_2\text{H}_2^* \), \( \text{H}^* \), \( \text{OH}^* \) radicals for CVD diamond growth, the basic idea of present was to look for the electrochemical production of these radicals.

A.P. Ges’, P.V. Molchan, A.A. Klimza. Growing of dielectric single crystals \( \text{BaO}–\text{R}_2\text{O}_3–\text{TiO}_2 \) systems (\( \text{R}=\text{Sm, Pr, Gd} \)) for microwaves.
Single crystals of \( \text{BaR}_2\text{Ti}_4\text{O}_{12} \) oxides were synthesized of binary melt of \( \text{BaO}–\text{TiO}_2 \). This melt is eutectic and surplus of \( \text{TiO}_2 \) to 5 mol\% in which 16 mol\% \( \text{Sm}_2\text{O}_3 \) was introduced. Crystals size was 1.5\( \times \)1.5\( \times \)15 (mm\(^3\)). Crystals ware investigated by X-ray diffraction. Crystals’ composition was in control by X-ray-fluorescence analysis.

In the article a comparison of growth imperfections, impurity content, and surface morphology of grown emerald and alexandrite single crystals are carried out. Raman light scattering spectra, and data of visual inspection by optical microscope and X-ray fluorescent analysis are presented. The emerald single crystals were grown from \( \text{PbO}–\text{V}_2\text{O}_5 \) as solvent and alexandrite growth from \( \text{Bi}_2\text{O}_3–\text{MoO}_3 \) flux was done. Both the growth sculptures onto the crystals surface and defect character differ essentially depending on a seed crystallographic orientation. At increased PbO content in the flux a new type of orientated defects of higher optical activity was detected in the emerald crystals, grown with a seed of (10\( \overline{1} \)0) hexagonal prism orientation.
V.V. Fedotova, A.P. Ges, G.L. Bychkov. **Epitaxial Growth of Ferromagnetic Oxides Films.**

A complex study of LPE film growth conditions and physical properties of \((\text{BiGdLu})_3(\text{FeGa})_5\text{O}_{12}\) system was carried out. Optimal technological conditions of growth for the films with 160 \(\mu\)m thickness and peculiarities of elemental content distribution by the film depth (including transition film-substrate sublayer) were determined. It was established that the Faraday rotation 2000 deg/cm at \(\lambda = 1.3\) \(\mu\)m is reached at maximal possible content of Bi\(^{3+}\) ions.

O.K. Khasanov, T.V. Smirnova, O.M. Fedotova, A.P. Sukhorukov, D. von der Linde. **Processes under interaction of powerful femtosecond pulses with Kerr dielectrics.**

Non-stationary interaction between terrawatt femtosecond light pulses and dielectric materials resulting in large values of free electron density in the bulk of a sample is considered. Dynamics of processes under consideration is analyzed when longitudinal gradient of the refraction index is involved, which results in partial reflection of propagating wave from non-linear focus.

A.P. Saiko. **Quantum cooperative phenomena in the optics of fluctuating media.**

The peculiarities of forming a series of cooperative nonlinear optical phenomena with regard for the non-markovian dephasing caused by strong adiabatic interaction of electron states with fluctuation excitations of the condensed media are established.

Stochastic and microscopic models of the non-markovian dephasing have been worked out as applied to four photon space parametric effect. A modified system
of the Bloch—Maxwell equations for describing the optical bistability phenomena with a glance to the non-markovian dephasing effects has been derived.

Two - and three-pulse photon echoes in rigorous consideration of the strong electron-phonon interaction (without resort to the perturbation theory) have been examined.

Peculiarities of realizing the echo phenomena with the use of prolonged exciting pulses of low intensity in the limiting case of non-markovian relaxation corresponding to inhomogeneous broadening of resonance transition have been investigated.

The influence of temperature and crystal parameters on the characteristics of cooperative nonlinear optic phenomena with regard for elastic interaction of light in impurity crystals has been explored.

A theory of the Dicke superradiation and laser generation with a glance to the vibronic structure of optical spectrum in impurity crystals has been created.