components of the magnetic susceptibility of the elements with the diamond structure and of the compounds with the sphalerite structure and with ionic and semiconductor (ionic-covalent) types of bonding.

The results of the separate determination of the dia- and paramagnetic components of the magnetic susceptibility are in good agreement with the experimental data. The working out and development of the method of separating the paramagnetic and diamagnetic components according to the values of the atomic scattering factors are of considerable interest for the problem of the chemical bond, a fact which was previously pointed out by Ya. G. Dorfman.

The magnitude of the paramagnetic Van-Vleck component of the magnetic susceptibility characterizes the anisotropy of the sp^3 covalent-bond bridges. In particular, for the $A^{III}B^{V}$-type compounds, besides the estimate of the magnetic susceptibility, the separation of the dia- and paramagnetic components according to the f-curves enabled us to give a method for the determination of ionic polarizability from x-ray analysis data. The possibility of determining the characteristics of the magnitude of the ionic radii from the electron density distribution charts deserves attention.

Of unquestionable interest is the analysis of the possibilities of determining the elastic constants of the crystallographic lattice and phonon spectra from the electron density distribution functions.

We have considered two methods of estimating the elastic constants: a method based on the statistical model of the atom, and one developed in the molecular orbit theory approximation. Both methods have not as yet led to good quantitative agreement with the experimental data, but the qualitative results obtained are encouraging.

Assuming that the total energy U_{12} of the pair interaction of the atoms in a diamond lattice is made up of a Coulomb U_C, an exchange U_a, and a kinetic U_K energy component and expressing them, within the framework of the statistical theory of atoms, in terms of the electron density, we have

$$U_{12}=\frac{Z_1Z_2}{\delta}-e^2\int\left(\frac{Z_1\rho_2}{r_1}+\frac{Z_2\rho_1}{r_2}\right)dV+\varkappa_k\int[(\rho_1+\rho_2)^{5/3}-\rho_1^{5/3}-\rho_2^{5/3}]\,dV$$
$$-\varkappa_a\int[(\rho_1+\rho_2)^{4/3}-\rho_1^{4/3}-\rho_2^{4/3}]\,dV\ldots,$$

where for the diamond lattice $C_{11}-C_{12}=(1/\Omega)(\partial U_{12}/\partial\delta)\times(\alpha/\sqrt{3})$. By substituting the experimental value for $\rho(x, y, z)$, we found the elastic and force constants for $C_{diamond}$, Si, Ge, and a number of $A^{III}B^{V}$ compounds and computed the phonon spectra.

The magnetic properties of ferro- and ferrimagnetic crystals are due to the electron density distribution for all the electrons and, in particular, for a portion of the 3d-electrons with uncompensated spins. From the experimentally determined x-ray and coherent magnetic neutron scattering form factors we computed the total electron density distribution function and the density distribution function for the electrons with uncompensated spins for nickel, iron, manganese oxide, manganese arsenide, antimonide, and bismuthide, etc. The relations between the total electron density distributions and the density distributions for the electrons with uncompensated spins (a cloud of such electrons is situated inside the total electron cloud) were elucidated. Correlations have been established between the degree of the spin density overlap and the magnetic transition temperature (the exchange energy): the temperature of transition to the phase MnBi – MnSb – MnAs decreases with increase of the degree of the Mn – Mn overlap. Using neutron-diffraction methods, we constructed magnetic phase diagrams for MnAs – MnSb solid solutions and a magnetic P-T phase diagram for MnAs. A connection was established at the same time between the variation of the magnetic and electronic transition ($\alpha_{FM}\rightleftarrows\beta_{PM}$) temperature and the degree of overlap of the 3d-electron orbitals.

A transformation of the $\alpha\rightarrow\beta$ type is accompanied by a redistribution of the electron density and a change in the degree of overlap of the orbitals. This leads us to conjecture the possibility of radiation in $\beta\rightarrow\alpha$ transformations.

On the other hand, it was established jointly with G. A. Govor that excitation by light pumping is accompanied by a magnetic phase transition from the ferromagnetic α_{FM} to the paramagnetic β_{PM} state.

There is a thermodynamic explanation for this effect. The decrease in the equilibrium temperature of the magnetic transition when the ferromagnetic phase is excited, which is accompanied by an increase ΔZ in the free energy, is, for a transition energy Q, determined by the relation $\Delta T = Q\Delta Z/T_K$. In the case of phase transitions in which, besides an insignificant nonradiative transformation, a radiative transition occurs, the frequency of the radiation will be $\nu = (Q - q)/h$, where $q = \gamma Q$ and Q is the transition energy for a nonradiative-like transition.

Since in an electron excitation, induced, for example, by optical pumping, the ions distend—increase in size—and a redistribution of the electron density occurs. This phenomenon is accompanied by an increase in the diamagnetic component of the magnetic susceptibility.

E. M. Gololobov, N. M. Olekhnovich, A. U. Sheleg, G. A. Govor, É. A. Vasil'ev, and G. I. Makovetskiĭ participated in the investigations discussed above.

L. I. Kiselevskiĭ. Problems of Low-Temperature-Plasma Spectroscopy. The sphere of scientific and technological applications of low-temperature plasma (temperatures of up to 10^5 °K) is now steadily expanding. Connected with the plasma is the development of such promising directions as gas-discharge and gas-dynamical lasers, the treatment of materials by means of plasma jets, plasma chemistry, and plasma engines and energy converters. A low-temperature plasma may be produced as a medium accompanying some physical phenomena: a powerful explosion, the motion of bodies with hypersonic velocities in the atmosphere.

The progress made in plasma application is inseparably connected with the development and improvement of investigative and diagnostic methods. Occupying a special place among these methods are the spectroscopic methods which are noncontact methods and enable us to determine the most important plasma parameters with a high time and spatial resolution.

The spectroscopic methods of investigation are based on the utilization of the optical characteristics of atoms, ions, and the simplest molecules both in the absence and presence of interaction with the heavy particles and electrons surrounding them in the plasma. These characteristics include optical transition oscillator strengths, spectral-line contours, absorption and emission cross sections for free-free and free-bound transitions, etc. These same spectroscopic characteristics are necessary for the consideration of the problems of the radiative energy transport in a plasma.

The development of plasma spectroscopy has lately proceeded along the following paths: the creation and development of general theoretical and experimental bases[1,2] and the working out of methods of investigation of specific plasma formations.

We have developed at the BSSR Academy of Sciences Physics Institute experimental plasma equipment with which we intend to carry out diverse spectroscopic measurements in a wide range of thermodynamic parameters (at temperatures of from 3×10^3 to 10^5 °K and pressures from small fractions of a torr to 10^{12} atm), plasma compositions (one-element and many-element plasmas with given percentage compositions), and velocities of the ordered plasma motion (from rest to supersonic with Mach numbers of up to 10).

The main equipment was constructed on the basis of continuous and pulsed electric discharges stabilized by gas flows and solid walls[3,4], as well as on the basis of laser methods of producing plasmas and plasma flows[5].

Conformably to the indicated equipment, methods were worked out for determining the spectroscopic characteristics of the plasma as a whole, as well as of its individual components. For the first time an experimental method has been proposed for determining optical transition probabilities for ions in the intermediate degrees of ionization (up to a degree of ionization of 4—5). The electron transition probabilities for certain diatomic molecules that actively participate in the radiative processes in the plasmas of gases and gas mixtures at temperatures of up to 10^4 °K, as well as the cross sections of processes leading to continuous radiation and absorption in a plasma, have also been determined.

For the case of the nonequilibrium plasma, the processes leading to the population and depopulation of various energy states have been investigated. The results which were obtained became the basis of the development and creation of new spectroscopic methods of low-temperature plasma diagnostics. Special attention has been paid to methods of diagnostics involving the use of the spectral-line contours, the continuous spectrum, the ratio of the intensities of the forbidden lines, as well as the lines beginning from the levels which are subject to auto-ionization[6]. Conditions and limits of applicability of each of the methods considered have been determined with allowance for possible deviations from the feasibility of the conditions of local thermodynamic equilibrium.

In addition to the spectroscopic methods, we have also worked out concrete laser methods of diagnostics based on absorption and scattering measurements and the measurements of diverse interference effects in a plasma. The combination of these methods enabled us to raise considerably the reliability of the measurements and to enlarge the completeness of the measurable parameters.

The application of the developed diagnostic methods for the purpose of controlling the operating conditions of plasma installations also required the construction of a special compact spectral equipment suitable for work under bench and production conditions. We have developed several types of such instruments with photographic and photoelectric spectrum recording.

The scope of the physical parameters in the plasma installations constructed ensured the possibility of a close simulation under laboratory conditions of various sorts of plasma formations—natural or of artificial nature—which are almost inaccessible for direct experimental investigations. To such formations pertains, in particular, a plasma envelope arising around bodies of large dimensions moving in the dense layers of an atmosphere with hypersonic velocities (for example, the flight of a meteorite through the Earth's atmosphere[7]).

We have succeeded in simulating under laboratory conditions the main plasma zones of a complex streamline flow pattern (the region of the compressed layer behind the shock-wave front, the structure of which (region) is determined by the structure of the free stream, the boundary-layer region containing the products of the thermal destruction of the circumfused body, and the region of the high-temperature wake with a low-particle density).

This enabled us to obtain important information about the radiative properties of the plasma shell, which substantially determines the conditions of the body's motion and its thermal condition, as well as to consider the question of the applicability of the spectroscopic methods to the diagnostics of this plasma.

Comparison of the spectra obtained during the observation of a real hypersonic streamline flow pattern with those observable on laboratory installations confirmed the validity and the prospects of model spectroscopic investigations of complex plasma formations, including those like the "fiery trail of a meteorite."

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