Digest of Translated Russian Literature

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SOVIET PHYSICS-DOKLADY (*Doklady Akademii Nauk SSSR, Otdel. Fiziki*). Published by American Institute of Physics, New York

Volume 6, number 8, February 1962

Concerning the Structural Stability of a Class of Closed Dynamic Systems, M. V. Meerov, pp. 667–669.

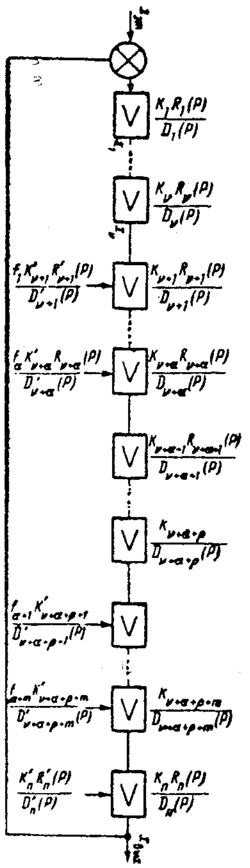

Fig. 1

In this paper we examine a closed dynamic system of which automatic control systems and other negative feedback systems constitute particular cases.

The system consists of N elements having transfer functions $K_iR_i(P)/D_i(P)$. Of these elements, $a + m$ are subject to disturbances. These $a + m$ elements are located at different places in the closed system. For simplicity we will assume that a of the elements are located in one part of the system and m in another part of the system and that β elements which are not subject to the action of the disturbance are located between the a and the m elements. We have chosen this disposition of the elements in the dynamic system in order to simplify the calculations. The conclusions which we will reach can easily be applied to any disposition of the elements in the system. The following is a condition which it would seem to be natural to impose upon the location of the elements. Let us designate as the beginning or the input to the dynamic circuit the place where the useful signal is applied (we assume that there is a useful signal at the input which is not subject to disturbance); we consider that the first ν elements are not subject to disturbance, where ν is any number different from zero. Since the disturbance can be applied not only to the input of an element, we will consider that the transfer function from the output of a given element to the point of application of the disturbance differs from the transfer function of that element and we will designate it by $K_i'R_i'(P)/D_i'(P)$.

In Fig. 1 we present a diagram of the case being discussed.

Theory of Pulse Automatic Systems with Amplitude-Pulse Modulation of the Second Kind, Ya. Z. Tsypkin, pp. 674–677.

The amplitude-pulse automatic systems (APS) can be subdivided into two classes according to the type of the amplitude-pulse modulation. In the APS I, the pulse train has pulses of the same form and such that their heights are proportional to the values of the input (or modulating) quantity at the discrete time moments $t = nT$ (the amplitude-pulse modulation of the first kind). In the APS II, the output quantity from the pulse element is also a pulse train but such that their widths are γT where $0 < \gamma \leq 1$ and T is the repetition period; the tops of these impulses change in the same way as does the input (or modulating quantity into the pulse element (the amplitude-pulse modulation of the second kind). The theory of the APS I was sufficiently expounded elsewhere.

The APS II can be regarded as a continuous system with a switch in its error part which is periodically on for the duration of the time γT and off for the duration of the time $(1 - \gamma)T$. For this reason APS II can be regarded as systems whose parameters can change square-wave-like; their two values correspond to the "on" or "off" state of the continuous system. It should be mentioned that APS II become continuous systems when $\gamma = 1$, and become APS I when $\gamma \ll 1$.

In the few articles dealing with APS II the exact equations describing the systems were derived indirectly. By using any method of solving, the solutions are obtained at first for the closed and open-loop continuous systems which lead to the difference equation between the values of the error (or some other quantity) at different discrete time instants. Subsequently the discrete Laplace transform was applied to the difference equation (or the equivalent Z-transform), and the image was found to correspond to the values of the process at the discrete time instants $t = nT$.

In order to obtain the equations governing the APS II one can apply the theory of systems with periodically varying parameters. This approach, however, leads to a determinant of an infinitely high order and one meets with considerable difficulties in the evaluation of the latter.

In the present article a direct method of obtaining equations for APS II is described in terms of the discrete Laplace transform.

Functional Possibilities and Synthesis of Threshold Elements, V. I. Varshavskii, pp. 678–680.

Main Properties of the Superfluid Model of the Nucleus, V. G. Solov'ev, pp. 707–710.

Elsewhere, a superfluid model of the nucleus has been proposed and calculations made on the one-particle levels of a number of strongly deformed elements in both the rare-earth and the transuranic regions. In another paper an analysis has been made of the effect of pair correlations on the probability of β transitions in strongly deformed nucleii. It has been shown in these papers that the results obtained on the basis of the superfluid model of the nucleus correctly represent many features of the behavior of complex nucleii.

In the present note we shall examine the general properties of the superfluid model of the nucleus, namely: The dependence of the characteristics of the superfluid states and of the behavior of the levels of an even system on the value of the pair-interaction constant G, the superfluid properties of two-quasi-particle excited states of the system, the specific peculiarities of 0+ states, etc.

We shall study the behavior of the ground state and the two-quasi-particle excited states as the pair-interaction constant G is increased, by considering the example of a neutron system with $N = 106$, as in Hf^{178}. From the experimentally found value of the pair energy and with a position of the levels of the average field chosen so that the one-particle levels of adjacent odd nucleii calculated on the basis of the superfluid model agree with the experimental values, we find $G = 0.020\, \hbar^0\omega_0\, (\hbar^0\omega_0 = 41\, A^{-1/3}$ Mev).

Construction of the Scattering Matrix in Nonlocal Theories, V. D. Kukin and A. R. Frenkin, pp. 722–724.

Transverse Refractive Index of a Plasma near the Cyclotron Frequencies and Their Harmonics, V. P. Demidov, pp. 727–728.

The vibrations of a homogeneous unbounded plasma are considered in a constant homogeneous magnetic field H_0 directed along the z axis. The wave vector k is directed along the x axis. The general dispersion equation for this case is well known. However, as yet the behavior of the refractive index near the cyclotron frequencies and their harmonics is uncertain.

Hamiltonian of Averaged Motion, E. L. Burshtein and L. S. Solov'ev, pp. 731–733.

To solve many problems in mechanics, plasma dynamics, the theory of vibration, and so on, approximate methods based on averaging the corresponding equations are widely used. If the averaged equations thus obtained are in canonical Hamiltonian form, then their first integral may be obtained. In the present note a method is expounded for obtaining averaged canonical equations.

Volume 6, number 9, March 1962

Principle of Local Coding and the Realization of Functions in a Certain Class of Networks Composed of Functional Elements, O. B. Lupanov, pp. 750–752.

As we know, almost all functions and systems of functions in logic algebra permit only a very complex network realization and are therefore inaccessible from a practical point of view. Therefore, it is important: a) to isolate classes of functions which can be realized more simply than the majority of functions, and b) to find methods of synthesizing networks for them. The first results in this direction are contained in the fundamental papers by Shannon. Subsequently, still another series of classes was isolated, and more economical methods of synthesis were determined for the classes introduced previously. S. V. Yablonskii formulated and studied a continual family of function classes which are invariant relative to the substitution of constants and the redesignation of arguments.

In this paper we describe one general approach to the synthesis of networks (the principle of local coding) which for many classes of functions permits us to achieve substantially simpler networks than can be achieved in the general case. The idea of using an intermediate parameter which lies at the base of this principle was advanced by A. Sh. Blokh and was used by him in synthesizing contact networks. This principle is especially convenient in synthesizing control systems of the type "formulas with memory" (networks consisting of functional elements) or more powerful types (for example, automata). For a number of function classes, the use of the local coding principle makes it possible to obtain the asymptotics for the Shannon function.

Finite Automata and the Logic of Single-Place Predicates, B. A. Trakhtenbrot, pp. 753–755.

Previously a study was made of the relationship between finite automata and formal languages based on single-place predicate logic. These papers contain the following limitations which are imposed on the logical means that are allowed for the languages that are used: 1) The language developed postulates the ability to control the subject quantors; 2) in the bounded recursive Church arithmetic, there are no predicate quantors; 3) in the Büchi second-order weak arithmetic, there are no limitations either on the subject or predicate quantors; however, predicates proper are interpreted as special predicates which can isolate only finite (and not arbitrary) sets of natural numbers.

In this paper, we establish theorems with respect to the language I in which all of the indicated limitations are removed. Primary attention is devoted to:

1) Clarifying which sets and operators can be described by the language I.

2) Obtaining the criteria for the existence of finite operators (in particular, finite automata) which satisfy the condition expressed in a specified formula.

If such exist:

3) Studying the procedures governing the transition from the formula to the corresponding canonical equations.

In solving these problems, the algorithm for reduction to normal form and the concept of a uniform set play an important part. A convenient (but of course not mandatory) device is the use of a geometric interpretation, which is close to that which has already been used for investigating partially recursive operators by means of Boer space.

Solvability Conditions for a Thermal Conductivity Boundary-Value Problem, E. I. Kim, pp. 760–762.

Find a solution of the thermal conductivity equation

$$\frac{\partial u}{\partial t} = a^2\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right) \qquad [1]$$

in a region $D(0 < x < \infty, -\infty < y < +\infty, 0 < t < T_0)$, satisfying the initial condition

$$u(x, y, 0) = 0 \qquad [2]$$

and the boundary condition

$$\sum_{k=0}^{m}\sum_{j=0}^{k} a_{kj}\frac{\partial^k u}{\partial x^j \partial y^{k-j}}\bigg|_{x=0} = f(y, t) \qquad [3]$$

where the a_{kj} are constants and $f(y, t)$ is a known function which, together with its derivatives in y, satisfies the inequality

$$|f(y, t)|, |f_y'(y, t)| \leqslant Me^{\delta^2 r^2} \qquad [4]$$

We shall seek a solution $u(x, y, t)$, continuous in D together with its derivatives to the mth order in x and y, whence

$$\left|\frac{\partial^k u}{\partial x^j \partial y^{k-j}}\right| \leqslant M_1 e^{\delta^2 y^2}$$

$$(j = 0, 1, \ldots, k;\ k = 0, 1, \ldots, m) \qquad [5]$$

where $r = \sqrt{x^2 + y^2}$; M, M_1, and δ^2 are constants, and T_0 is also a constant satisfying the inequality

$$T_0 < \frac{1}{4a^2\delta^2} \qquad [6]$$

We shall show that the problem presented does not always have a solution, in contrast to the one-dimensional problem, and we shall indicate the conditions for which our problem does have a solution.

Self-Simulating Relativistic Motion in the Case of Point Symmetry, K. P. Stanyukovich, pp. 765–768.

Forces Acting on a Small Particle in an Acoustical Field in an Ideal Fluid, L. P. Gor'kov, pp. 773–775.

When a particle is suspended in the field of a sound wave, the fluid exerts hydrodynamical forces on it. In the linear approximation, these forces are proportional to the velocity of the fluid and, on the average, do not lead to a displacement of the particle. In problems of acoustical coagulation, an important part is played by average forces acting on the particle which arise as the result of second-order effects. These forces are of a nature related to that of the radiation-pressure forces in a sound wave. The magnitude of the forces has been found only for particles which are in an ideal fluid, in a paper by King. A specific method was to solve exactly the problem of the flow around a small sphere in the field of a sound wave. So far as is known to us, no account was taken of effects associated with viscosity and thermal conductivity.

We present here a simple method which allows us to determine the magnitude of the average forces that act on the particle in an arbitrary acoustical field when the size of the particle is much smaller than the wavelength of the sound. In this paper we shall treat the case of an ideal fluid.

Statistical Operator for Nonequilibrium Systems, D. N. Zubarov, pp. 776–778.

For systems in states of statistical equilibrium, there is the well-known Gibbs distribution by means of which one can, in principle, calculate the average value of any dynamical quantity. No such universal distribution has been found for irreversible processess, and, for the solution of problems of statistical mechanics of nonequilibrium systems, resort is made to various approximate methods, for example, to the method of the kinetic equation, to the solution of the Liouville equation with the initial condition of local equilibrium (the method of correlation functions).

We shall show that one can find a probability distribution which for the case of equilibrium systems goes over into the Gibbs distribution and for nonequilibrium systems makes it possible to obtain the macroscopic equations of diffusion, thermal conductivity, and hydrodynamics, generally speaking, of a nonlocal type, in any approximation, and to calculate the kinetic coefficients in terms of the correlation functions. In the linear approximation one obtains from this distribution the results of Mori and of Green.

The usual construction of statistical ensembles for equilibrium systems is based on Liouville's theorem, which states that the time derivative of the statistical operator ρ is equal to zero if the operator is a function of the integrals of the motion, and on the assumption that the integrals in question are the additive integrals of the motion: the Hamilton operator of the system H, and for the grand Gibbs ensemble, in addition, the operator of the total number of particles N, i.e., $\rho = \rho\ (H, N)$. We shall also start from Liouville's theorem, but we require a generalized formulation of theorem.

Entropy of a Distribution of Dynamical Variables, A. S. Rubanov and B I. Stepanov, pp. 779–781.

The concept of the entropy of a random variable has been applied previously to give a characteristic measure of the delocalization of an electron in a stationary state of an atomic or molecular system. In the present paper the concept of the entropy of a state of a quantum system is applied to describe the distribution of probabilities of arbitrary dynamical variables and is illustrated by the example of the harmonic oscillator.

Logarithmic Criterion for Superconductivity, V. V. Tolmachev, pp. 800–803.

On the basis of a detailed analysis of the effects of the Coulomb interaction on superconductivity, N. N. Bogolyubov and the author came to the conclusion that the criterion for superconductivity, $\rho_{ph} - \rho_c > 0$, as proposed by Bardeen, Cooper, and Schrieffer, must be replaced by the more precise logarithmic criterion

$$\rho_{ph} - \rho_c \left(1 - \rho_c \ln\frac{\omega_{ph}}{\omega_c}\right)^{-1} > 0$$

where the dimensionless parameters ρ_{ph} and ρ_c characterize electron interactions from interchange of phonons and the Coulomb interaction of electrons with one another; ω_{ph} and ω_c are associated with the energetic cutoff of these interactions far from the Fermi surface.

The indirect interaction from phonon interchange is naturally cut off at the characteristic Debye phenon energy. The direct Coulomb interaction has of itself no such characteristic cutoff. However, because of the presence of damping of single-electron excitations far from the Fermi surface, there arises a fairly sharp limitation of the effect of the Coulomb interaction at the region close to the Fermi surface, where the damping is still rather small.

A proper calculation of the effects of damping was not given in another paper. The results of an investigation which includes a clear calculation of damping effects is presented here. The investigation is based on the new formulation by Feynman diagram techniques which was proposed by N. N. Bogolyubov. The only approximation used here is the assumption that the effect of superconductivity is small.

Linearization of the Equations of the Plane Problem in the Theory of an Ideally Plastic Body, A. V. Sachenkov, pp. 807–808.

As is well known, the states of plane stress and strain of an ideally plastic body are described with the help of the two equations of equilibrium

$$\frac{\partial X_x}{\partial x} + \frac{\partial X_y}{\partial y} = 0 \qquad \frac{\partial X_y}{\partial x} + \frac{\partial Y_y}{\partial y} = 0 \qquad [1]$$

to which it is necessary to add the plasticity condition being used. In order to solve the problem, we write, respectively, as the original plasticity conditions of Saint-Venant, von Mises

$$(X_x - Y_y)^2 + 4X_y{}^2 = 4k_0{}^2$$
$$X_x{}^2 - X_xY_y + Y_y{}^2 + 3X_y{}^2 = 4k_1{}^2 \qquad [2]$$

and the generalized plasticity condition of von Mises-Schleicher for a state of plane strain

$$(X_x - Y_y)^2 + 4X_y{}^2 = 4k_0{}^2f_0[\tfrac{1}{2}(X_x + Y_y)] \qquad [3]$$

where X_x, Y_y, X_y are the stress components; k_0, k_1 are plasticity constants; f_0 is a positive function of half the sum of the normal stresses.

The usual method of linearization of system [1] with the conditions [2] and [3] is based on satisfying the plasticity conditions identically and a subsequent transformation of system [1]. The method proposed here is based on the use of stress functions introduced into the theory of plasticity by Saint-Venant.

Radiosensitivity of Different Central Nervous System Sectors in Ontogenesis, A. A. Manina, pp. 817–820.

A series of experiments has established the existence of comparatively short periods of high sensitivity of the fetus to the action of harmful agents, critical periods of development in the process of ontogenesis in animals. These periods coincide with the moments of formation of the respective organs and are rather clearly limited in time. In these periods, an increase in sensitivity to the harmful action of certain agents induces injuries not only in the processes of formation of the fetus as a whole but in the development of the individual embryonic organs, systems, and cells.

The present report examines the sensitivity of nerve cells to small doses of radiation and establishes the critical periods for various sectors of the nervous system during ontogenesis.

The work was carried out on embryos, starting on the tenth day of embryogenesis, on newborn, young, and adult rats. The animals were subjected to a single, total irradiation in the RUM-3 apparatus with 0.5-mm Cu and 1-mm Al filters, using a voltage of 180 kv, strength of current 15 ma, focal length 40 cm, intensity of irradiation 30 r/min.

Independence from the "Oxygen Effect" of the Antiradiation Protective Effect of Aminoethylisothiouronium·Br·HBr, É. Ya. Graevskii and M. M. Konstantinova, pp. 825–828.

Effect of Ionizing Radiation on Nucleic Acid Metabolism of Sex Cells of Males in Relation to Development of Males and Females in Their Progeny, V. N. Shreder, pp. 832–833.

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Certain Properties of Code Systems, V. I. Levenshtein, pp. 858–860.

In the present work we investigate effective criteria for the recognition of certain properties of code systems. We obtain algorithms that are simpler than those known at present for determining whether a code system possesses the property of single-value decoding or of bounded delay, and we also obtain an algorithm for the determination of whether a code system possesses the synchronization property.

Equations of Relativistic Radiation Hydrodynamics, V. A. Prokof'ev, pp. 861–864.

The main disagreements about the form of the equations of hydrodynamics with radiation taken into account are due to the fact that in some papers it has not been noted that there is a difference in the definition of the parameters of the radiation field in fixed and moving coordinate systems. The disagreements are about terms that contain the speed of light in the denominator. A complete determination of what sort of terms must be added to the equations of hydrodynamics in order to take into account the interaction of radiation with a moving medium is possible only in the framework of relativistic theory. Published papers have treated, with gravitation neglected, cases of the linear approximation in v/c, cases of small deviation of the radiation from the equilibrium state which satisfies the Kirchhoff law, and a case of one-dimensional motion of a gas; there has also been a treatment in the general theory of relativity of the case of a photon gas satisfying the Stefan-Boltzmann law and the nonrelativistic Schwartzchild equilibrium conditions. In the present paper we consider the radiation field of a moving gas within the framework of the special theory of relativity without the restrictions indicated in the foregoing.

New Analogy in Mechanics, I. M. Belen'kii, pp. 872–873.

An analogy can be established between the plane problem for potential flow of a perfect, incompressible fluid in hydromechanics and the plane problem for trajectories (for conservative fields) in classical mechanics.

Anisotropy of the Mössbauer Effect, Yu. Kagan, pp. 881–882.

Features of Light Absorption in a Heterogeneous Plasma, N. G. Preobrazhenskii, pp. 887–889.

A number of investigations in recent years confirm the possibility of a completely correct description of the complex of phenomena occurring in a heterogeneous high temperature plasma (arc, pulse discharge, hollow cathode, detonation of a wire, etc.) on the basis of models of axially symmetrical radiators of Bartels and Cowan-Dieke. The generality and the interconnection of these models were considered previously. It is natural to try to extend to the case of a heterogeneous absorbing layer the important practical relationships between the equivalent width of the line and the optical density, the graphs of which are called "growth curves."

Radiation Pyrometry in the Blue-Violet and Ultraviolet Regions of the Spectrum, D. Ya. Svet, pp. 907–908.

A Binomial Law of Friction, I. V. Kragel'skii, pp. 909–911.

The Lamb Problem for an Internal Source, E. I. Shemyakin, pp. 930–932.

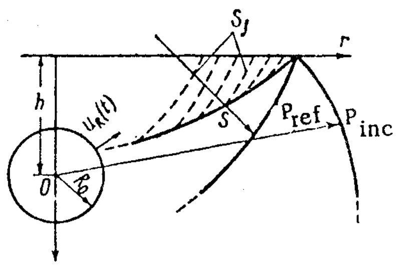

Fig. 1 Geometrical picture of waves in the vertical plane through the epicenter of the source and the observation point. P_{inc} is the wave directly from the source; P_{ref} is that reflected from the free surface; S is the transverse wave arising with the reflection of P_{ref}; h is the depth of the source, and r the cylindrical coordinate

In connection with the study of wave processes in the earth caused by underground explosions, the following problem in the dynamical theory of elasticity is of interest. Suppose a homogeneous isotropic elastic medium has Lamé parameters λ and μ and density ρ and is bounded by a free surface; and on some sphere of radius R_0 with center at 0 (Fig. 1) there is given a signal source. Usually one of the following functions is taken to describe the signal: either $\dot{u}_R(t)$, the velocity of particles along the radius from the point 0, or $\sigma_R(t)$, the normal stress. Also it is assumed that for $t < 0$ the medium is at rest, and the signal occurs at the moment $t = 0$.

The formal construction of the solution of the corresponding unstationary boundary value problem for the equations of the theory of elasticity present no essential difficulty at the present time. There is fundamental interest in the study of oscillograms of motion of the earth at internal points and on the free boundary of an elastic half space at distances comparable to the quantity V_pT—the "wavelength" (V_p is the propagation velocity of longitudinal waves, and T some characteristic time for the signal).

In this note the displacement field $\mathbf{u}(r,z,t)$ on the surface of the half space, with components u_r, u_z, is studied; the signal is described by the function $\dot{u}_R(t) = u_0 f(t)\, \boldsymbol{\varepsilon}(t)$, where $\boldsymbol{\varepsilon}(t)$ is the unit function: $\boldsymbol{\varepsilon}(t) = 0$ for $t < 0$; $\boldsymbol{\varepsilon}(t) = 1$ for $t \geq 0$; $f(t)$ is a continuous function; $f(0) = 0$, and u_0 is a constant with the dimensions of velocity.

Absorption of Light by Solution of Desoxyribonucleic Acid Oriented in an Electric Field, G. A. Dvorkin and V. I. Krinskii, pp. 935–938.

It was shown earlier that when an electric field is applied the anisotropic absorption of light by solutions of nucleic acids can be observed. When monochromatic light is used and the characteristic absorption frequencies are identified the orientation of the chromophore groups of molecules in dilute solutions can be determined.

We shall first examine theoretically the general problem, i.e., the absorption of polarized and natural light in relation to the orientation of the absorbing groups. In this examination we ignore reflection and assume that all the molecules of the dissolved substance are identical, do not interact with one another, and have a common direction of maximum absorption (optic axis of the molecule). When the directions of the electrical vector of the light (henceforth called the light vector for brevity) and the optic axis of the molecule coincide, the light absorption is maximum. If these directions are mutually perpendicular, no absorption occurs. In the intermediate case the absorption is proportional to the square of the cosine of the angle between these directions.

Increased Cariosity of Teeth due to Ionizing Radiation, Yu. A. Fedorov, pp. 942–945.

One of the manifestations of radiation injury in the mouth cavity is damage to the teeth. For instance, many authors have observed injury to the hard dental tissues after radiation exposure in the clinic or in the laboratory. However, the mechanism of these injuries has not received sufficient study.

The aim of the present study was to discover the effect of fractionated total-body exposure on dental cariosity and the combined effect of total-body x-ray exposure and a carbohydrate diet on the hard dental tissues of experimental animals. Sixty-day-old rats were subjected to total-body fractionated x-ray exposure on the RUM-3 apparatus at six-day intervals. The total dose was 300 and 600 r. The exposure conditions were 180 kv, 20 ma, filters 0.5 mm Cu and 0.5 mm Al, skin-focus distance 30 cm, dose rate 90.6 r/min.

Specific Accumulators of Individual Radioisotopes among Freshwater Organisms, E. A. Timofeeva-Resovskaya, N. V. Timofeev-Resovskii, and E. A. Gileva, pp. 949–952.

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Simplest Model of Halos, D. O. Mokhnach, pp. 961–963.

Halos are luminous rings in a comet's head whose centers are practically coincident with the "nucleus" (photometric center). The radius of a halo increases proportionately to time, whereas the surface brightness of a ring is a decreasing function of time. Because of this, halos as objects open to observation exist for only a comparatively short period—in all, a few days.

Let us assume that a halo is formed as the result of an isotropic ejection of particles from a point which we will call the emission center. The rate of emission n (number of particles ejected per second into unit solid angle) we assume to be constant during the time ΔT. The acceleration g due to the repulsive force of the sun can also be assumed to be constant, since during the brief time of existence of a halo its heliocentric distance changes little, while the dimensions of a halo are small by comparison with the distance to the sun. Let v_0 be the initial velocity of the particles.

If the origin of a rectangular system of coordinates is placed at the emission center, the $0x$ axis being directed toward the sun and the $0z$ axis lying along the line of sight, then, as has been shown elsewhere, the particles ejected simultaneously from the emission center, which is motionless with respect to the sun, will lie after time t on the surface of the sphere

$$(x + \tfrac{1}{2}gt^2)^2 + y^2 + z^2 = v_0^2t^2 \quad [1]$$

whose center is at the point $(-\frac{1}{2}\, gt^2, 0, 0)$ and whose radius is v_0t. If the interval between the end of the ejection and the time of observation is T, then the halo is a layer bounded by two spheres whose centers are at the points

$$(-\tfrac{1}{2}gT^2, 0, 0)$$
$$(-\tfrac{1}{2}g(T + \Delta T)^2, 0, 0) \quad [2]$$

and whose radii are

$$R_1 = v_0T \qquad R_2 = v_0(T + \Delta T) \qquad [2']$$

Several halos of varying diameters are usually observed at one time in a comet's head. They are formed at intervals of only a few hours. It is, therefore, convenient to assume that

$$\Delta T \ll T \qquad [a]$$

As a result of condition [a] the small displacement of the halo center relative to the emission center can be taken as

$$\Delta C = -\tfrac{1}{2}gT^2 \qquad [3]$$

Frequently, observations of halos do not show displacement of the center given previously. This has led some investigators to conclude that the molecules in comet halos are not repelled by the sun, whereas the same molecules in the comet's head experience the force of solar radiation pressure. This is the so-called halo paradox.

Interaction of Rotational Discontinuities, V. V. Gogosov, pp. 971–973.

The interaction of shock waves and rarefaction waves in gas dynamics has been investigated previously. The interaction of magnetohydrodynamic shock waves and rarefaction waves between themselves, and also with contact and rotational discontinuities, have been investigated. In the present paper, the interaction of rotational discontinuities (A), which is of particular interest, is investigated. At the moment of collision there appears a discontinuity in which the conservation laws are not fulfilled; therefore, it separates into a certain combination of waves. The goal of this paper is to determine this combination.

Diverging Diagrams in the Formal Perturbation Theory for a Nonideal Fermi-Dirac System, and the Mutual Cancellation of Such Diagrams, V. V. Tolmachev, pp. 976–978.

The formal perturbation-theory series for the energy of the ground state of a nonideal Fermi-Dirac system, the so-called Brueckner-Goldstone expansion, has been repeatedly subjected to careful study. It seems, however, that so far there has not been sufficient attention given to the existence of diverging diagrams in the high orders of this formal expansion, whose divergences arise from the vanishing of energy denominators on the Fermi surface and are not due to the singular nature of the interactions, which will be regarded as regular in what follows. In the present note we shall present the results of a study of these divergences. It will be shown that in the first high orders of perturbation theory these divergences compensate for each other.

Neutrinos and Antineutrinos in Free Space, V. M. Kharitonov, pp. 985–987.

The stars of our world are powerful sources of neutrinos. The stars of "antiworlds," if such things exist, are sources of antineutrinos. Another source of antineutrinos may have been the decay of the neutrons of a primitive neutron cloud, if such a thing ever existed. Neutrinos and antineutrinos interact very weakly with matter.

At the present time, it has been established that neutrinos and antineutrinos are not identical, and the cross section σ_0 of the reaction $p + \bar{\nu} \rightarrow n + e^+$ for slow neutrinos has been found to be $\sigma_0 = 1.1 \cdot 10^{-43}$ cm^2. Because the cross section σ_0 is so small and the neutrino has no charge, the universe is practically transparent for neutrinos and antineutrinos: For a mean density of 10^{-3} to 10^{-4} hydrogen atoms per cubic centimeter the distance required for a single interaction is $\sim 10^{28}$ light years and the time required is correspondingly long, and these values are far beyond the possible maximum estimates of the size and age of the universe. Thus, the fluxes of neutrinos and antineutrinos which exist in free space carry information about the very first stages of their existence and about the universe as a whole.

Steady Flow of a Conducting Liquid in a Rectangular Tube with Two Conducting and Two Nonconducting Walls Placed in an External Magnetic Field, G. A. Grinberg, pp. 992–994.

Shercliff has shown that if the external magnetic field $\mathbf{H}^0$ is homogeneous, and the velocity field and induced electric and magnetic fields do not depend on the coordinate z, whose axis is directed along the axis of the tube, then there exists a solution of the equation of steady motion of a conducting viscous incompressible fluid through the tube such that $\mathbf{v} = v\mathbf{i}_z$ and $H = H^0 + H_z\mathbf{i}_z$.

Choosing the x axis in the direction of the field, setting $-\partial p/\partial z = P =$ const and considering extra volume forces to be absent, we obtain for H_z and v the following equations:

$$\Delta H_z + \frac{4\pi\mu\sigma H^0}{c^2}\frac{\partial v}{\partial x} = 0$$

$$\Delta v + \frac{H^0\mu}{4\pi\eta}\frac{\partial H_z}{\partial x} = -\frac{P}{\eta}$$

where $\Delta = \partial^2/\partial x^2 + \partial^2/\partial y^2$; η is the coefficient of viscosity, and σ and μ its conductivity and permeability. The boundary conditions for H_Z on the walls s of the tube are written as follows: On the nonconducting portions of the wall $\partial H_Z/\partial s|_s = 0$, and on the ideally conducting ones, $-\partial H_Z/\partial n|_s = 0$, where n is the normal to the wall. To these, one adds the obvious condition $v|_s = 0$.

The case of a nonconducting wall was considered previously, as was the case of an ideally conducting wall. In both cases the solution is represented in the form of trigonometric series obtained with the aid of the method of partial solutions. In the same way one could also solve the problem for a rectangular tube whose walls perpendicular to the external magnetic field are ideally conducting, and those parallel to it, nonconducting. Far more complex is the case of a tube whose walls parallel to H^0 are nonconducting. Since an exact solution to this problem is not available in the literature as far as we know, we shall present certain results in this direction in this article.

Circular High Energy Accelerators with a Self-Adaptive Magnetic Field, É. L. Burshtein, A. A. Vasil'ev, A. L. Mints, V. A. Petukhov, and S. M. Rubchinskii, pp. 1001–1003.

At the present time increases in the maximum energy in modern circular accelerators are limited by the achievable accuracies in the construction and adjustment of the magnetic system. The most rigid requirements are imposed by the necessity for maintaining a constant number of betatron oscillations during a turn and the provision of a sufficiently small amplitude of forced betatron oscillations. In this connection methods have recently been discussed for the automatic control of local characteristics of the magnetic field from the information on the behavior of the beam. The use of such methods would make it possible to reduce considerably the cross section of the chamber, which would increase the maximum permissible energy and considerably simplify and cut the cost of the accelerator equipment.

The cross section of an accelerator chamber is determined by the free and forced betatron and synchrotron oscillations of the particles. The amplitudes of free oscillations of the particles are determined by the initial conditions of injection and the nominal parameters of the magnets and the accelerating system. By the appropriate choice of parameters it is possible to make the amplitudes of free oscillations in the high energy accelerators of the order of several millimeters.

The amplitude of forced synchrotron and betatron oscillations is determined by the deviations of the parameters of the accelerator from the nominal values. To reduce these oscillations it is essential to have a system of automatic control. The automatic control of the synchrotron oscillations is already provided by controlling the parameters of the accelerating system. Autocorrection of the betatron oscillations, being the main object of the present work, involves two main problems: controlling the equilibrium orbit and stabilizing the number of oscillations per turn.

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One Mechanism of L_α-Quantum "Splitting" in Gaseous Nebulae, G. A. Gurzadyan, pp. 1031–1033.

According to the theory of radiation emission from gaseous nebulae, of the total number N_c of ultraviolet (L_c) quanta absorbed by the nebula, on the average $2N/3_c$ quanta originate in the L_α line of hydrogen, while the remaining fraction $N_c/3$ goes into two-photon emission. The question of whether L_α quanta can split into two through two-photon emission under conditions existing in nebulae is a separate problem.

Up to now two mechanisms of the "splitting" of L_α quanta have been proposed. The first mechanism, proposed by Spitzer and Greenstein, is the following. A neutral hydrogen atom is transferred from the $1S_{1/2}$ state into the $2P_{1/2,\ 3/2}$ state by the absorption of an L_α quantum. Because of the high density of

L_α radiation in nebulae, the relative occupations of the $2P_{1/2}$ and $2P_{3/2}$ states will not be small. Therefore, there is a finite probability that the atom excited into the $2P_{1/2,\,3/2}$ state will suffer a transition into the $2S_{1/2}$ state as the result of a collison with a free electron. From the $2S_{1/2}$ state the atom can return to the normal state $1S_{1/2}$ by way of two-photon emission. It was later established that collisions with protons are more effective for the transfer of atoms from the $2P_{1/2,\,3/2}$ states into the $2S_{1/2}$ state. The probability for the splitting of L_α quanta by this mechanism (the cycle $1S \rightarrow 2P \rightarrow 2S \rightarrow 1S$) per scattering collision will obviously depend on the electron (proton) density $n_e(= n_p)$. It is given by

$$p_1 = \frac{3.765\cdot 10^{-13} n_e}{1 + 8.58\cdot 10^{-5} n_e} \qquad [1]$$

The quantity p_1 obtained from this formula is of the order of 10^{-9}–10^{-10} for planetary nebulae, 10^{-11}–10^{-12} for diffuse nebulae and *HI* regions around planetary nebulae, and 10^{-17} for the interstellar medium.

The second mechanism of L_α-quantum splitting has been suggested by A. Ya. Kipper and V. M. Tiit. It occurs as follows. The transition $2P \rightarrow 1S$ for hydrogen is an allowed transition with the emission of one L_α quantum. However, this transition can also occur with the emission of two L_α quanta with a much lower probability ($\sim 2\cdot 10^{-5}$ sec^{-1}). In this case (the cycle $1S \rightarrow 2P \rightarrow 1S$), the probability per act of scattering that an L_α quantum splits into two is independent of the physical conditions of the medium and is of the order of

$$p_2 \approx 0.5\ 10^{-13} \qquad [2]$$

The probability of L_α-quantum splitting in either of the two ways is extremely small and a very large number of acts of scattering (of the order of 10^9–10^{13}) are required before an L_α quantum is destroyed and transformed into two quanta. This condition is not satisfied for the usual gaseous nebulae.

A third, more effective mechanism of L_α-quantum splitting in nebulae and interstellar gas can be operative in addition to the two described. This is associated with the fact that the energy gap between the $2P$ and $2S$ hydrogen levels is small and lies within the limits of the thermal spread of the kinetic energy of hydrogen atoms. In frequency units, this gap is equal to $1.092\cdot 10^{10}$ sec^{-1}, which is equivalent to a difference in the velocities of two hydrogen atoms of 1.32 km/sec. Therefore, if the atom absorbing the L_α quantum possesses a negative component of "radial" velocity of 1.32 km/sec relative to the atom emitting the given L_α quantum, then the absorbing atom will be immediately excited to the metastable level $2S$ and will undergo the transition $1S \rightarrow 2S$. Under conditions existing in nebulae, the atom in the $2S$ level has ultimately only one way of returning to the normal level—the transition $2S \rightarrow 1S$ with the emission of two quanta, independently of the probability of this transition with the emission of only one quantum. This is the essential point of the proposed mechanism of L_α-quantum splitting (the cycle $1S \rightarrow 2S \rightarrow 1S$).

Coalition of Systems of Equations of Boolean Algebra and Their Solution, V. N. Grebenshchikov, pp. 1040–1041.

Self-Adaptive Automata for Decoding Messages, V. I. Levenshtein, pp. 1042–1045.

In a previous paper (the definitions and notations cited in that paper are used throughout our present paper) simple algorithms were proposed for recognizing whether a code system has the property of single-valuedness for decoding the property of limited delay, or the property of synchronization. In the present analysis we investigate the possibility of realizing the decoding of messages in an automation with a finite number of states.

Flow of a Gas into a Vacuum with Energy Liberation Obeying a Power Law, V. E. Neuvazhaev, pp. 1055–1057.

The problem of the flow of a gas into a vacuum with energy liberation obeying a power law is investigated. The problem is distinguished by the fact that it reduces to the solution of a system of two ordinary differential equations rather than one, as is usually the case in problems of one-dimensional motion. The integral curve sought passes through two nonisolated singular points. From each point there proceeds an infinite set of integral curves. When numerical integration from point to point is attempted, the roundoff error grows exponentially, so the usual methods of numerical integration are unsuitable here. The solution is found by an iteration method, after suitable variables are chosen.

Shift of the Branch Point in the Mass Operator of Formal Perturbation Theory for a Nonideal Fermi-Dirac System, V. V. Tolmachev, pp. 1062–1065.

It was shown previously that beginning with the fifth order in the formal perturbation-theory series for the energy of the ground state there are diverging diagrams, and that in the first high orders these divergences from the different diagrams compensate each other. A legitimate question arises whether in such a case it makes sense to study such divergences. Moreover, as has been shown, irreducible diagrams without proper-energy parts in general never diverge, and we can always carry out a so-called mass summation by leaving out of consideration all of the reducible diagrams with proper-energy insertions.

The point is, however, that when we make such a formal reconstruction of the perturbation-theory series there remains a complicated nonlinear integral equation for the new one-particle propagator, which is itself formulated as a series of irreducible diagrams. The study of the divergent reducible diagrams provides a way of studying this equation. In the present note we shall show that the divergences which are studied are due to a shift of the branch point in the mass operator, i.e., to an effect of a sort which obviously cannot be obtained in the formal perturbation theory.

Method of Solving the Many-Body Problem for Charged Particles by Using High Speed Computers, S. P. Lomnev, pp. 1066–1068.

Point Interaction for a Three-Particle System in Quantum Mechanics, R. A. Minlos and L. D. Faddeev, pp. 1072–1074.

A mathematically correct description of the point interaction in quantum mechanics was proposed in a recent note by F. A. Berezin and one of the authors. The method was illustrated by the example of the interaction of two nonrelativistic scalar particles, and led to formulas which have been obtained repeatedly in the physical literature by means of procedures which cannot be given a unique mathematical meaning. In the present paper this approach is applied to study a system of three particles which interact in pairs with a point interaction.

New Information on Initial Stages of a Spark, I. S. Stekol'nikov, pp. 1085–1087.

In discharge gaps with a very uneven field the development of the spark passes through several stages: a pulse corona, leader, main and final stages. Over the long period of time in which these stages have been studied much information has been collected on them. New possibilities for studying spark development were provided by the introduction of an image converter (eopograph) with amplification of the luminous flux. The results given here were obtained with the eopograph designed in the High Voltage Gaseous Discharge Laboratory in the G. M. Krzhizhanovskii Energy Institute.

Regenerative Processes in Bone Tissue in Case of Local X-Ray Exposure, S. A. Ivanova, pp. 1105–1108.

It is known from the literature that in acute radiation sickness bone is subject to massive necrosis, its growth in length is retarded, the osteoblasts and osteoclasts disappear and then reappear, the healing of fractures is slow, and regeneration is distinctly inhibited. Irradiation suppresses not only regeneration due to injury, but also physiological regeneration.

Local x-ray exposure (1000–2000 r) injures vessels, reduces the thickness of the bone trabeculae, and intensifies the development of connective tissue in the growth zone of bone tissue. Owing to these changes the development of the bone is retarded. In young mammals x rays cause an arrest of growth of the tubular bones and modification of the cellular structures in the metaphyses close to the cartilage growth plate and in the epiphyseal cells. Small doses (75, 150, and 250 r) accelerate callus formation.

In our previous investigations, in which rat limbs (before subperiosteal resection of the tibia) were exposed to 500 r of x rays, regenerative processes were not inhibited. With a dose of 1000 r there was a considerable inhibition of all the main stages of bone formation. With a dose of 2000 r there was an even more pronounced inhibition of regeneration. In this work the effect of local x-ray exposure on regenerative processes in bone tissue at the main stages of bone formation was investigated.

Choice of Accelerating Voltage in Electron Microscope for Investigation of Processes in Living Cells, I. G. Stoyanova and A. N. Pilyankevich, pp. 1112–1114.

It was shown elsewhere that the electron microscope could be used to observe changes in living cells not only at the level of cell components (membranes, protoplasm), but also at the level of smaller structural elements, of dimensions 100 A or less, which are probably largely representative of molecular processes occurring in cells during their development. The visualization of these changes requires optimal conditions of investigation, which are determined with reference to the least possible radiation injury to the object, and with reference to the adequate resolution and contrast of the electron-microscope image, which depend on the scattering of electrons in the object and the electron-optical parameters of the system. While the reduction of the injurious effect of electrons on the object and the improvement of resolution of the electron-microscope image require an increase in the accelerating voltage, the attainment of the necessary contrast in objects which are close to the limit of resolution requires a reduction in the accelerating voltage.

The aim of the present study was to estimate the optimal accelerating voltage, which would permit the study of processes at the submicroscopic level (20–50 A) in living cells.

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Transition Radiation and the Cerenkov Effect, I. M. Frank, pp. 740–746.

The discovery of the Cerenkov effect and its subsequent theoretical analysis stimulated research into many problems related to this phenomenon. Various aspects of the Cerenkov effect besides those treated in the original theory have been analyzed, for example, the radiation of a fast particle in a plasma in a magnetic field, the Cerenkov effect in crystals, etc. In addition, much work has been published in which phenomena less directly connected with the Cerenkov effect have been treated. A characteristic feature of all this work is the fact that it is almost all theoretical. Many of these predicted effects have now been studied in greater or lesser detail and a large number of them should be amenable to experimental observation.

Except for the development of the Cerenkov counter, which is really an application of the Cerenkov effect, it may be said that in the last 20 years very little on the Cerenkov effect itself has been added to the original results of Cerenkov.

The situation is very much the same for problems related to the Cerenkov effect. Thus, it is only very recently that the phenomenon known as transition radiation has been investigated experimentally. This phenomenon will be considered in detail in the present communication.

Transition radiation is produced when a fast charged particle passes through the interface between two media possessing different optical properties. The theory of transition radiation was published as far back as 1944 by Ginzburg and the present author. It was at that time that the predicted effect received its now generally accepted name. Various aspects of the theory of transition radiation were considered later in a large number of publications. The number of papers concerned with transition radiation has increased markedly in recent years. However, it has been only recently that the validity of certain of the basic theoretical predictions has been established by experiment.

Theory of Cerenkov Radiation (III),*– B. M. Bolotovskii, pp. 781–811.

Introduction
Cerenkov Radiation in the Presence of Boundaries
1 Boundary Conditions
2 Radiation Produced by a Charge Moving Along the Axis of a Cylindrical Dielectric-Filled Channel
3 Motion of a Point Charge Parallel to the Axis of a Channel in a Dielectric
4 Radiation Produced by a Dipole Moving Along the Axis of a Cylindrical Channel
5 Cerenkov Radiation in Linear Periodic Structures
a) General Theory
b) Radiation of a Charge in an Iris-Loaded Wave-Guide
6 Cerenkov Radiation in Wave-Guides
a) Wave-Guide Filled With an Isotropic Dielectric
b) Wave-Guide Partially Filled With an Isotropic Dielectric
c) Wave-Guide Filled With an Anisotopic Dielectric
7 Field Produced by a Charged Particle Moving Parallel to the Boundary Between Two Media
Literature References

* "The Cerenkov effect in infinite media and in crystals" (Parts I and II) appeared in Usp. Fiz. Nauk 62, 201 (1957).

Ultraviolet Radiation and Soft X-Rays of the Sun, I. S. Shklovskii, pp. 812–834.

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The Microtron, A. P. Grinberg, pp. 857–879.

Introduction
1 Conditions for resonance acceleration of electrons. Different modes of operation of the microtron
2 Injection of electrons into the microtron
3 Phase focusing in the microtron
4 Focusing of electrons
5 Fundamental information concerning construction of microtrons
6 Conclusion
Literature references

Introduction: The microtron is a cyclic resonance accelerator of electrons with a guiding magnetic field that is constant in time. The electrons are accelerated by a high frequency electric field produced in a cavity resonator, in which one uses a special type of resonance acceleration—"resonance with variable harmonic number."

Paramagnetic Absorption of Sound, S. A. Al'tshuler, B. I. Kochelaev, and A. M. Leushin, pp. 880–903.

1 Introduction
2 Resonant paramagnetic absorption of sound
3 Crystals containing ions of the iron group
4 Ions with an effective spin $S' > \frac{1}{2}$
5 Effect on Ni^{2+} ions in an MgO crystal
6 Ions with effective spin $S' = \frac{1}{2}$
7 Crystals containing ions of the rare earth elements
8 Crystals containing paramagnetic ions in S-states
9 The Waller mechanism
10 Acoustic paramagnetic resonance and spin-lattice relaxation in ionic crystals
11 Metals
12 Experimental investigations of electronic acoustic paramagnetic resonance
13 Acoustic paramagnetic resonance on nuclei
14 Experimental investigations of acoustic paramagnetic resonance on nuclei
15 Shape of the acoustic paramagnetic resonance line
16 Pulse methods for investigating acoustic paramagnetic resonance
17 Double resonance. Possible applications of acoustic paramagnetic resonance
18 Nonresonant paramagnetic absorption of sound
19 Conclusion
Literature references

Acoustic paramagnetic resonance appears to have interesting applications. Kastler has proposed to use the acoustical effect for polarization of nuclei. Townes et al. have established the conditions for the appearance of an acoustical "maser effect," the achievement of which would make possible the development of generators and amplifiers of supersonics.

Some Results of IGY and IGC Research on the Aurora and Night Glow, V. I. Krasovskii, pp. 904–918.

The International Geophysical Year (IGY) was organized from July 1957 through December 1958 for the purpose of extensive and varied scientific investigations; these investigations were continued through 1959, the so-called year of International