where

R_0 = disk radius
$H(x)$ = step function
V_0 = velocity of disk

then the proper solution for f in the region $z < 0$ is

$$f = n_{m_0}\left(\frac{M}{2\pi kT}\right)^{3/2} \times H\left(\sqrt{\left(x - \frac{V_x z}{V_z}\right)^2 + \left(y - \frac{V_y z}{V_z}\right)^2} - R_0\right) \times e^{-(M/2kT)[V_x^2 + V_y^2 + (V_z + V_0)^2]}$$

(It is more convenient to work in a Cartesian system, because the solution is not simplified by the use of cylindrical coordinates.)

The number density n is expressed as an integral over velocity space:

$$n = n_{m_0}\left(\frac{M}{2\pi kT}\right)^{3/2} \iiint H\left(\sqrt{\left(x - \frac{V_x z}{V_z}\right)^2 + \left(y - \frac{V_y z}{V_z}\right)^2} - R_0\right) e^{-(M/2kT)[V_x^2 + V_y^2 + (V_z + V_0)^2]}\, dV_x dV_y dV_z$$

The integration can be done easily for $r/z = 0$, but an approximate technique was used to obtain simple expressions for the number density near the axis of symmetry. The results are shown in Fig. 2 for a value of V_0 equal to $8\sqrt{2kT/M}$. Here r and z are normalized by the disc radius and n_{m0} is the number density in the plane $z = 0$. The dotted portions of the curves represent regions where calculations were not made. However, by using the known initial conditions and the exact solution along the axis of symmetry, the dotted portions can be sketched with reasonable accuracy.

The reasonably close agreement between the results represented in Fig. 2 and those presented in Ref. 1 is difficult to explain. It appears that other errors have been made in the evaluation of the number density in Ref. 1 which discourage any logical comparison of similarities.

Reference

[1] Gurevich, A. V., "Perturbations in the ionosphere caused by a moving body," ARS J. 32, 1161–1167 (1962).

Digest of Translated Russian Literature

The following abstracts have been selected by the Editor from translated Russian journals supplied by the indicated societies and organizations, whose cooperation is gratefully acknowledged. Information concerning subscriptions to the publications may be obtained from these societies and organizations. Note: Volumes and numbers given are those of the English translations, not of the original Russian.

Soviet Physics—Technical Physics
(Zhurnal Tekhnicheskoi Fiziki).
Published by American Institute of Physics, New York

Volume 6, Number 5, November 1961

Production of Negative Hydrogen Ions in the Passage of Protons through Gas Targets, Yu. M. Khirnyi, pp. 427–432.

Results are given of an investigation of the content of H_1^-, H_1^+, and H_1^0 in equilibrium beams obtained in the passage of protons through gas targets of H_2, He, Ne, Ar, CO_2, and C_3H_8; data on the scattering of hydrogen beams on these targets are also given.

In sources of negative hydrogen ions one usually makes use of charge exchange in the passage of positive hydrogen ions through matter. The usual charge-exchange target is either a point hydrogen target or a supersonic mercury jet. Since the H_1^-

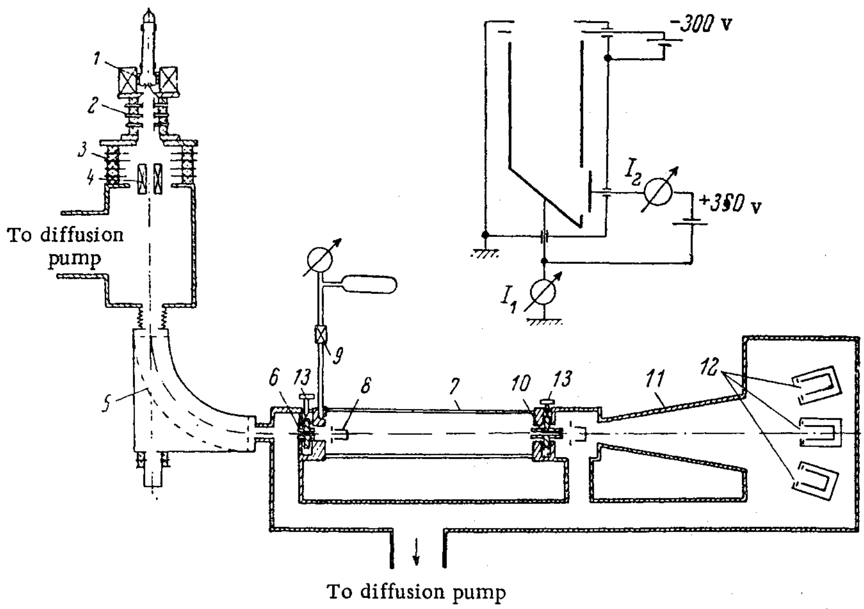

Fig. 1.

yield from these sources depends on the composition of the beam passing through the target and on beam scattering in the target, in order to obtain optimum design of a charge-exchange target all these characteristics must be known.

The efficiency of hydrogen charge exchange in vapor jet targets has been well studied. The equilibrium composition of hydrogen beams passing through gas targets has also been studied in other papers. In another study an investigation was made of the ratio H_1^-/H_1^+ in a beam passing through hydrogen as a function of proton energy in the range 4–70 kev. In this work the neutral component was not measured; the data from this work therefore does not allow us to evaluate the negative-ion content in the beam emerging from the target. Fogel' and Mitin have determined this ratio in charge exchange of protons on H_2, He, N_2 O_2, Ne and Ar at energies of 9–30 kev. The neutral component was not measured in this work either. In another study the ratio $H_1^0/(H_1^0 + H_1^+ + H_1^-)$ has been studied for gas targets of H_2, He, N_2 O_2, Ne, Ar, and air at ion energies of 20–200 kev.

It is apparent from this survey that the investigation of the negative hydrogen ion content of beams which pass through gas targets is incomplete, especially in the energy range 4–20 kev, which is the optimum for charge exchange. An investigation of the composition of equilibrium beams formed in the passage of hydrogen and deuterium ions through different gas targets, and the scattering of ion beams on these targets, has been carried out in the present work with the apparatus shown schematically in Fig. 1.

Apparatus: The beam, emerging from rf ion source 1, is focused on lens 2 and enters a small accelerating tube 3, inside of which there is an electrostatic hyperbolic lens 4, which provides additional beam focusing. The focused beam passes through a diaphragm (aperture ϕ 5 mm) into a magnetic analyzer 5 and, after being deflected through an angle of 90°, enters a channel 6 (width ϕ 3 mm and length 26 mm) in the target chamber 7. Inside the chamber the beam current can be measured by means of a movable Faraday cylinder 8. Gas is admitted into the chamber through a bimetallic valve or a palladium thimble 9. The effect is measured with an LT-2 thermocouple. The effective length of the chamber $l_{\text{eff}} = 30$ cm. From the chamber the beam moves through a tube (width ϕ 7 mm and length 70 mm) with a diaphragm 10 at the end of the magnetic analyzer 11, where it is divided into neutral and charged components which are measured by the Faraday cylinders 12. The construction of the center cylinder (shown in the upper right portion of Fig. 1) makes it possible to measure both the neutral and charged components. The system is pumped by two oil diffusion pumps. One is used for pumping gas from the source while the other is used for pumping gas which comes from channels of the gas target. The channels 6 and 10 are centered along the beam axis by means of the set screws 13; these can be used to displace the channels in planes perpendicular to the beam without disturbing the vacuum.

Volume 6, number 6, December 1961

Relativistic Radiation of a Circular Current, V. N. Tsytovich, pp. 481–487.

Veksler has proposed the principle of coherent acceleration of charged and quasi-neutral plasma bunches. It is well known that dissipation of energy, in particular, radiation loss, is one of the mechanisms that tend to limit the energy which can be achieved in various acceleration devices. However, up to the present time, this problem has not been considered in connection with coherent acceleration techniques.

Two modes of coherent acceleration can be distinguished: 1) radiation acceleration, due to the effect of a radiation flux on the plasma; and 2) collision acceleration, produced by the collision of a heavy relativistic plasma bunch with a lighter bunch. Because the radiation force due to a radiation flux and the resulting acceleration are relatively small, the basic problem in radiation acceleration is one of stability: a relatively long time interval is required to achieve the energy which is required. On the other hand, we may assume that the collision acceleration mechanism is effective in relatively short time intervals, so that instabilities do not have a chance to develop. In collision acceleration, however, radiation can be extremely important.

In the present paper we consider the question of radiation for a specific bunch shape, i.e., a current ring; the condition for small radiation is determined, and it is found that the radiation can always be made small if the number of particles in the heavy bunch is made to increase in some appropriate fashion as the energy increases. This result seems to be independent of the shape of the bunch and is a general one for coherent collision acceleration.

The choice of bunch shape is dictated by the need for adequate stability during the high acceleration caused by collisions. This stability can be provided by the strong focusing forces due to magnetic attraction effects, which compensate the electric repulsion of electrons. In general, this does not mean that the initial current in the light bunch before the collision must be the limiting value, i.e., corresponding to electron velocities approaching the velocity of light. From simple energy considerations it can be shown that at the turning point in the center-of-mass system the electrons in the light bunch are relativistic if the initial translational velocity of the bunch as a whole is relativistic.

We shall first consider the radiation from a circular current of radius a which varies in time in accordance with $I = I(t)$ and which obeys a given law of motion $z = z(t)$. It is assumed that the velocity of the ring remains perpendicular to the plane of the ring throughout the entire acceleration process. In what follows we shall compute the energy loss due to radiation for an actual example.

Observation of Hydromagnetic Plasma Waves in a Pulsed Electrodeless Discharge, M. D. Gabovich and I. M. Mitropan, pp. 488–490.

Radial plasma oscillations associated with circular currents produced in a pulsed electrodeless discharge have been reported in other papers and investigated in detail in one of these papers. In the present short note we describe the results of several experiments which establish the existence of these oscillations under certain conditions.

Ionization of Argon by Nitrogen and Oxygen Ions, R. N. Il'in and E. S. Solov'ev, pp. 491–495.

Measurements have been made of the total ionization cross sections (σ_-), the total electron-capture cross sections (σ_0), and the cross sections for the formation of secondary argon ions (σ_{0n}) for the ions N^+, O^+, N_2^+, O_2^+, NO^+, and NO_2^+ with energies of 15–180 kev in argon. It is found that the total ionization cross section σ_- and the cross sections for the formation of doubly, triply, and quadruply charged argon ions (σ_{02}, σ_{03}, and σ_{04}) increase with the number of atoms in the primary ion. A connection has been established between the process in which two electrons are captured, leading to the transition $O^+ \rightarrow O^-$ and the formation of multiply charged ions.

Approximate Method for Calculating Natural Frequencies of Irregular Critical Resonators, V. M. Dmitriev, A. F. Zorkin, N. V. Lyapunov, and V. M. Sedykh, pp. 512–515.

It is known that when energy is transferred along a waveguide, the cross section of which changes from large to small, resonance effects appear at certain frequencies. This is because in the guide, waves are produced for which the narrowing section of the guide has a critical cross section, i.e., a cross section in which the operating frequency is critical. Quite complex and awkward theory of these phenomena from the point of view of energy transfer along waveguides is given in other papers, where these phenomena are considered undesirable.

However, sections of irregular waveguides may find independent application as resonators. It could be expected that such resonators would find application in cases when molecular or electronic beams must be passed through a resonator. In a number of uses of resonators for measurement purposes it is more convenient to use resonators without the end wall. It must be noted that by changing the geometry of an irregular critical resonator we can control the distribution of critical frequencies of the resonator.

To use irregular critical resonators in physics and technology of microwave frequencies, we require simple relationships suitable for practical calculations. Since there are no such relationships in the literature, we present a method of approximate calculations of quite simple and accurate formulas for determining resonance wavelengths of irregular critical resonators.

X-Ray Investigation of the Compressibility of Light Materials under the Action of Shock-Wave Impacts, L. V. Al'tshuler and A. P. Petrunin, pp. 516–522.

We describe an x-ray method of studying regular regimes of oblique reflection and oblique impact of shock waves on solids and liquids. The method is intended for the determination of the pressure and density in the gradual "double" compression behind the fronts of the reflected shock waves. The objects of the experiment were light metals—aluminum and compounds with light atoms transparent to x rays such as water, paraffin, and plexiglas. For all the materials investigated, high pressures and densities of from 600,000 to 900,000 atm were maintained in the reflection region, and these were several times as great as the pressure due to the shock wave before the impact.

Nonequilibrium Dissociation of a Mixture of Gases behind a Shock Wave, Yu. P. Lun'kin and F. D. Popov, pp. 523–526.

The nonequilibrium dissociation of a two-component mixture of gases behind a direct shock wave is investigated.

The passage of a gas through a shock wave is accompanied by a disturbance in its internal degrees of freedom. The different times of relaxation of rotations, oscillations, and dissociation of the molecules significantly facilitate the study of the nonequilibrium processes in a real gas.

Elsewhere an approximate method was proposed for the solution of the system of equations that describes the nonequilibrium dissociation of a pure, diatomic gas behind a shock wave. In the present work, this method is made more precise and is generalized to the case of a two-component mixture consisting of diatomic or of monatomic and diatomic gases. If both components are diatomic, we restrict ourselves to the case where there dissociation energies differ considerably and we can consider the dissociation of each component separately.

Refraction of Detonation Waves Incident on the Boundary between Two Gas Mixtures, L. G. Gvozdeva, pp. 527–533.

We discuss one of the phenomena characteristic of detonation waves—the refraction of such a wave when it passes from one explosive mixture to another.

By using a high speed movie camera, photographs have been obtained of the phenomenon that occurs when a detonation wave moving through a medium capable of reaction passes through a boundary dividing this medium from an explosive or inert medium.

SOVIET PHYSICS—USPEKHI (*Uspekhi Fizicheskikh Nauk*). Published by American Institute of Physics, New York

Volume 5, Number 2, September–October 1962

Present State of the Theory of Liquids, I. Z. Fisher, pp. 239–250.

The present stage in the development of the theory of the liquid state originated for the most part in the numerous researches of Jacob Il'ich Frenkel, which he summarized in his classical book *Kinetic Theory of Liquids.* He was one of the first to point out that the approximately equal particle density in solid and fused crystals, and the consequent approximate equality of their intermolecular interaction intensity, is bound to make the structure and the character of thermal motion of the atoms and molecules nearly the same in both phases. This gives rise to the known parallelism between the physical properties of solids and liquids, and creates a real basis for the theory of the processes that relate both phases. The views developed by Frenkel proved equally fruitful for both the theory of crystals and the theory of liquids. These views presupposed the increasing *disorder* in real crystals with rising temperature, and the presence of elements of *order* in liquids. The notion of defects (in the broad sense) in crystals and of their role in thermodynamic, electric, kinetic, and optical properties of real solids was a most important step in the development of solid state theory. On the other hand, the ideas of short-range order and strong interaction between the particles of a liquid, and their specific influence on its physical properties, has given rise to a new branch of physics—the statistical theory of liquids.

We shall attempt to review briefly the present status of statistical theory of simple liquids, confining ourselves to nonquantum theory. Except for liquid helium and to some extent liquid neon, all monatomic liquids can be described satisfactorily by classical methods.

The lack of a simple and readily visualized model for liquids, one capable of serving as the "zeroth approximation" in the building of a theory of liquids (in contrast with the perfect-gas and ideal-crystal models in the theory of gases and solids) makes the development of the theory extremely difficult. The mathematical difficulties encountered on the path toward the development of the theory of the liquid state of matter are so great that only a statistical theory of simple monatomic liquids is feasible at present. Liquefied inert gases and fused metals are real examples of simple liquids. We can also include, with some degree of approximation, certain monatomic liquids with molecules and force fields that have some measure of specific symmetry.

Many problems in the statistical theory of liquids recently have been discussed in detail in reviews and books. Therefore we have attempted to pay more attention here to questions that are relatively new or insufficiently explained in the review literature. Many problems in the theory of liquids have not been touched upon at all.

Physical Theory of Plasticity and Strength, V. L. Indenbom and A. N. Orlov, pp. 272–291.

During the 50 years that have elapsed since the discovery (in 1912) of diffraction of x rays by crystals and the development of the dynamic theory of the crystal lattice (1915), the physics of plasticity and strength has turned from a descriptive science with only formal premises into a major division of solid state physics, based on reliable experimental researches and on fully developed theoretical notions. The development of the physical theory of plastic deformation and failure is closely connected with the work of J. I. Frenkel, whose varied interests included basic problems in the theory of mechanical properties of both crystalline and noncrystalline solids. The present development of theoretical ideas and experimental methods of research on the real structure of solids has prepared the ground for the decisive stage in the development of the physics of plasticity and strength, namely, the direct investigation of the atomic mechanism of plastic deformation and failure. This is most clearly pronounced in the case of crystalline bodies.

Present State of Research on Atmospheric Electricity, I. M. Imyanitov and K. S. Shifrin, pp. 292–322.

Introduction
1. Basic information
2. Two theories
3. Vertical structure of field, conductivity, and current in "good weather"
4. Distribution of space charge in the atmosphere
5. Time variation of field and potential at high altitudes
6. Description of electric processes in regions of good weather
7. Electricity of stratified clouds
8. Electricity of cumulus and cumulus congestus clouds
9. Structure of shower and thunderstorm clouds
10. Accumulation of charges in thunderstorm clouds

References

Present State and Lines of Development of Optical Flame Pyrometry, A. E. Kadyshevich, pp. 347–363.

TELECOMMUNICATIONS AND RADIO ENGINEERING. PART 1. TELECOMMUNICATIONS (*Elektrosviaz'*). Published by American Institute of Electrical Engineers in conjunction with Scripta Technica, Inc., New York

Number 1, January 1962

Frequency Modulation of a Crystal Oscillator by Means of a Controlled Capacitance of a *p-n* Junction, Ye. G. Servinsky, pp. 25–35.

In this article the possibility of applying a controlled capacitance of a *p-n* junction to frequency modulation of a crystal oscillator by means of a series control circuit is discussed. Analytical expressions are developed from which it is possible to determine the limits of frequency deviation, the coefficients of nonlinear distortion, and frequency stability. The characteristics of several types of *p-n* junctions are also included.

The application of a controlled capacitance of a *p-n* junction to frequency modulation (FM) of oscillators has already found wide use. We shall discuss certain problems associated with the application of a *p-n* junction capacitance to FM modulation of a