gravitational perturbations of the earth and of the ionosphere can hardly be regarded as consistent. The point is that the amplitude and phase of the tide-producing forces, the source of which are the moon and the sun, have only secular variations, owing to the stability of the parameters of the motion of the latter, whereas the results presented in this paper point to the existence of short-period variations both in the radio-wave propagation velocity and in the irregularities of the earth's rotation. The magnitude of the short-period variations is commensurate in a number of cases with the magnitude of the observed effect. It is also necessary to bear in mind that the phase of the semiannual wave in both $\Delta\tau$ and ΔT_S remains practically constant in time, although the phase of the 1.0 and 0.33 year waves, in spite of the common source of their perturbations, indicated by the theory of tides, vary. The results of Brouer[6], Munk and Revelle[7], Vestin[8], and Nunk and MacDonald[9] have shown that it is impossible to attribute the fluctuations of the earth's angular velocity to such potential sources of the perturbations of the regular motions as the displacements of the water and air masses. Nor did the calculations confirm Stoyko's hypothesis[10] that there is a functional connection between the changes of the earth's rotation velocity with the secular variations of the geomagnetic field. For most spectral components of the irregularity in the earth's rotation (with the exception of part of the annual wave) it is apparently necessary to seek an argument that can simultaneously be also the argument of the change of the propagation velocity of ultralong radio waves.

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The results of the paper are contained in the following publications:

1. A. G. Fleer, Mutual Correlation of Seasonal Variations of Radio Wave Propagation and the Irregularity of the Earth's Rotation. Abstracts of Papers at the Plenary Session of the Commission on the Study of the Earth's rotation at the Astronomical Council of the USSR Academy of Sciences, Kiev, Naukova Dumka, 1969.

2. A. G. Fleer, Izmeritel'naya tekhnika, No. 4 (1970).

3. A. G. Fleer, Propagation of Ultralong Radio Waves and the Irregularity of the Earth's Rotation, Sb. trudov SNIIM, No. 11, Novosibirsk, 1970.

4. A. G. Fleer and L. Ya. Vorob'ev, Spectral Analysis of the Maximal Diurnal Phase Variation of Ultralong Waves on Different Routes, ibid.

5. A. G. Fleer, Connection between Changes of the Short-period Irregularity of the Earth's Rotation and the Motion of its Instantaneous Pole, ibid.

G. A. Askar'yan, V. G. Mikhalevich, and G. P. Shipulo, Aureole Refraction and Nonlinear Scattering of Powerful Light by Inhomogeneities in Transparent Media

The presence of absorbing particles in transparent media can produce, following passage of intense light, local changes of the refractive index—"aureoles" around the absorbing particles—and produce nonlinear light scattering that depends on the light intensity and on the time. This new nonlinear-scattering effect is of great practical importance, since real media always contain impurity particles (smoke, dust, droplets in air, suspensions in water, etc.).

Nonlinear scattering by particles in a medium was first considered and investigated experimentally in[1], using as an example liquids with inhomogeneities, around which microscopic bubbles were produced. Such inhomogeneities of the new phase have maximum refractive-index drops. The experiments were performed with a free-running ruby laser. The nonlinear scattering and the appearance of centers of nonlinear scattering were revealed by the scattering of the main or of the diagnostic beam. A subsequent article[2] dealt with the effect of such nonlinear scattering in more general form for arbitrary media (solids, liquids, gases) resulting from the formation of thermal and acoustic disturbances. The decreased transmission of light due to the occurrence of such aureoles was considered. In the case of remote reception for pulsed heating, the cross section radii of the scattering aureoles were $r_{acoust} \approx c_s t$ and $r_{therm} \sim \sqrt{\kappa t}$.

Small dimensions ensure rapid production of aureoles within a time $\tau_{acoust} \sim r/c_s$ and $\tau_{therm} \sim r^2/\kappa$; for example, for $r \sim \lambda\!\!\!^{-}$, the appearance of an aureole is ensured even within times on the order of several nanoseconds for $c_s \approx 10^5$ cm/sec and a temperature conductivity $\kappa \sim 10^{-2}$–10^{-3} cm²/sec.

These investigations stimulated an entire cycle of studies of aureole scattering in both liquids[3,4] (colloidal dye solutions) and solids[5].

We have organized model experiments aimed at the study of aureole refraction by a macroscopic particle in a transparent medium[6]. An infrared beam of a cw YAG-Nd laser with power of several watts was used. The invisible beam was colored red by a low-power He-Ne laser, for ease of observation and registration. An absorbing particle measuring 1–2 mm was introduced into the medium, or else was compressed between two blocks of material, or else was pressed against the surface of the medium. The media employed were various glasses, Plexiglas, water, and others. The absence of nonlinear effects in the absence of the particle was checked. (In particular, in the investigation of media with noticeable absorption, we used low powers and thin layers of the medium). The radius of the intense beam was several times larger than the dimensions of the particle. The profile of the sounding coloring beam could be chosen arbitrarily.

The display was on a screen located 1.5 m from the layer of the medium. Observation was with the aid of IR binoculars, and motion pictures were taken in the red light of the auxiliary laser.

A growth of the overlap area, by up to 30 times and more, was registered. The strongest effects were observed in Plexiglas, which has a large derivative n_T' of the refractive index.

We observed[6] a new type of self-focusing in the region of perturbations of the medium with $n_T' > 0$ near the absorbing particle. A smooth rapid transition from the shadow region to the bright point at the center was observed.

These experiments demonstrated the process of aureole refraction from centers giving thermal aureoles with dimensions exceeding the wavelength of the light. The case of aureoles with dimensions that are small compared with the wavelength also admits of a simple description.

The great abundance of natural and artificial media with inhomogeneities (impregnations, sols, dislocations) make the foregoing effects promising in practice. Cases are possible when the transparency and the scattering ability can depend so strongly on the intensity that even a barely noticeable haze or a slightly scattering cloud may turn out to be opaque to light of high intensity. The pulsed character of the processes makes it possible to use them to produce modulators with variable transmission or reflection. These effects can be the cause of power or energy limitation, for example in such working elements as neodymium glass with small platinum particles or other technological impurities.

This effect can be observed also in intense flashes of incoherent light.

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B. B. Kadomtsev, Matter in a Superstrong Magnetic Field

In fields of 10^{12}–10^{24} Oe, which according to present notions can exist in neutron stars, there should occur a noticeable change of the physical properties of matter. Namely, a complete realignment of the electron shells takes place in an atom with atomic number Z at $B > Z \times 10^9$ Oe. All the electrons are then at the lower Landau levels, their magnetic moments are oriented along the field, and the electrons move in thin crylindrical shells with symmetry axis passing through the nucleus and directed along the field. In the field interval $10^9 Z \ll B \ll 10^9 Z^3$ Oe the ground state of the heavy atom can be described within the framework of the modified Thomas-Fermi approximation, which shows that the atom retains its spherical symmetry, and its volume decreases like $B^{-6/5}$. In a field $B \gg 10^9 Z^3$ Oe the atoms are stretched out along the magnetic field, and since they have a large quadrupole moment they can form molecules with high binding energies.

In a sufficiently strong magnetic field, the ionization energy of the atoms and the dissociation energies of the molecules can be so large that the neutral atoms and molecules can exist even at very high temperatures. If the temperatures are not very high, then the atoms and molecules in the superstrong field can become condensed into a solid phase. A preliminary analysis shows that the solid should apparently be a polymer.

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I. I. Gurevich, Investigation of the Condensed State of Matter with the Aid of Positive Muons

A new method for studying the properties of method and the kinetics of chemical reactions with the aid of muons has been developed recently at the Atomic Energy Institute, the Nuclear Problems Laboratory of the Joint Institute for Nuclear Research, and the Institute of Theoretical and Experimental Physics. The muon method of investigating the properties of matter is based on the fact that muons stopped in matter are "tagged" particles, the polarization and spin direction of which can be traced by means of the asymmetry of the angular distributions of the $\mu \to e$-decay electrons. It uncovers additional possibilities for studying the kinetics of chemical reactions, local magnetic fields in matter, interactions of muonium atoms with matter, etc.

This paper does not consider interactions of negative muons with matter, which are being intensively studied by V. S. Evseev's group at the Nuclear Problems Laboratory of the Joint Institute for Nuclear Research.

All the experiments considered below on muon interaction with matter were performed with the polarized μ^+-meson beam of the same laboratory.

A consistent theory of interaction of positive muons with matter was developed at the Atomic Energy Institute (V. G. Nosov and I. V. Yakovleva, I. G. Ivanter, and V. P. Smilga). According to this theory, when the μ^+ meson slows down in matter to the velocities of the atomic electrons, it captures an electron and forms a