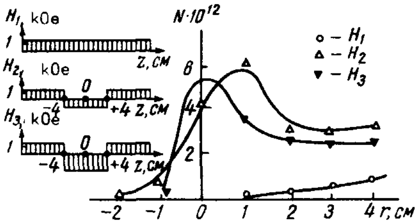

Fig. 3. Radial distribution of integral particle flux N for internal injection of plasma in a spatially-modulated field. The distribution of the magnetic field in the injection region at the corresponding values of H_i is shown schematically. The measurements were made at 135° azimuth.

served (region of zero field), and the configuration of the plasma jet is determined to a much lesser degree by the direction of the injection (external or internal) relative to the direction of the magnetic field gradient.

Thus, the sum total of the experimental results, namely the difference in the spatial distribution of the plasma injected parallel and antiparallel to the gradient of the toroidal magnetic field, as well as the appreciable influence of the spatial modulation of the magnetic field in the injection region on the configuration of the plasma flux, allows us to assert that the model proposed for the resultant drift is correct.

In conclusion, the authors consider it their pleasant duty to thank M. S. Rabinovich and I. S. Shpigel' for useful discussions, and N. V. Perov and V. M. Zykov for help in preparing and performing the experiments.

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GRAVITATIONAL RADIATION OF EXPLOSIVE ORIGIN

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One of the leading trends in modern development of general relativity theory consists in a search for new experiments for its verification. The most promising among such experiments are those involving generation and detection of gravitational waves [1-3]. Under discussion at present is the possibility of observing gravitational waves from the nearest short-period double stars [4] as well as from collapsing masses [5]. In the case of collapsing bodies, their gravitational self-closing greatly reduces the amount of radiated gravitational energy. In the case of expansion from a singular sphere, or in the case of explosion, no such limitation exists. The present note is aimed at estimating the power of gravitational radiation produced by explosively scattered matter during the course of various natural cataclysms.

We shall base our arguments on the following model of asymmetrical scattering: the surface bounding the scattered masses is conical and has a fixed apex angle 2α, while the density of the expanding matter is independent of the coordinates but is a function of the time. When the cone axis is aligned with the $\underline{z}$ axis, the components of the mass quadrupole moment tensor are $D_{xx} = D_{yy} = -(1/2)D_{zz} = (3/10)Mh^2(\tan^2\alpha - 4)$, where M is the mass of the expanding matter and h is the distance to the base of the cone. If we confine ourselves to a crude approximation, assuming the velocity of motion to rise linearly from zero to v_{max} within a time τ, then $h = v_{max}t^2/2\tau$ and the quadrupole moment is of the order of magnitude $D \approx M(v^2_{max}t^4/\tau^2)$. Using the well known formula $v_{max} = (3\gamma - 1)[2E/M(\gamma^2 - 1)]^{1/2}$ to express v_{max} in terms of the explosion energy E, we find that the total gravitational-radiation energy released during the explosion is

$$\mathcal{E}_g = \int \frac{G}{45c^5} \dddot{D}_{ik}^2 \, dt \approx \frac{256G(3\gamma - 1)^4E^2}{15c^5(\gamma^2 - 1)^2\tau}^{1)} \tag{1}$$

and the average gravitational-radiation power in the wave zone is

$$\langle W_g \rangle \approx \frac{256G(3\gamma - 1)^4}{15c^5(\gamma^2 - 1)^2} \frac{E^2}{\tau^2} \approx 3.8 \times 10^{-57} \frac{E^2}{\tau^2} \text{ erg/sec} \tag{2}$$

if the adiabatic exponent is $\gamma = 5/3$. The gravitational energy radiated during the explosion propagates in the form of an isolated wave.

Let us estimate the power of the explosive gravitational radiation produced by various natural sources. It can be noted that the lower limit wich can be registered (in a continuous mode) by modern technical means is 10^{-10} erg/cm^{2}sec [4], or even several orders of magnitude less, depending on the time of observation and on the frequency of the gravitational wave [3].

1. Gravitational radiation from the explosion of quasars. The recently discovered quasars are probably the most powerful sources of gravitational waves in the universe in the explosive stage of evolution. There is no universally accepted point of view concerning the nature of the explosion. The explosive scattering of quasars is related in [6] to processes occurring in the magnetoid (a configuration maintained in equilibrium by the gradient of magneto-turbulent pressure). For a rough estimate of the gravitational-radiation power with the aid of (2), we can estimate, without specifying the explosion concretely, the lower limit of the time scale of the explosion as being equal to the hydrodynamic time $\tau \approx R^{3/2}/(GM)^{1/2}$ necessary to realign the quasar structure. For the 3C273 quasar $\tau \approx 10^8$ sec. Putting $E \approx 10^{59}$ erg [6], we obtain from (2) $\langle W_g \rangle \approx 4 \times 10^{45}$ erg/sec, which is close in order of magnitude to the contemporary optical luminosity of this and similar objects. At the earth's surface the gravitational-radiation flux is $t_{or} \approx 10^{-10}$ erg/cm^{2}sec.

2. Gravitational radiation from the explosion of galaxies. Explosions of galaxies and radiogalaxies are connected with various physical processes. In particular, these explosions play an important role in the thermodynamics of the intergalactic medium [7]. Another consequence of the explosion may be the powerful gravitational radiation, which, like the explosion, is more likely to be of recurrent nature. A characteristic example of an exploding galaxy is M82 (NGC 3034); its explosion-product scattering corresponds schematically to a conical explo-

sion [8]. Such asymmetrical scattering can be due to a magnetic field and to rotation. In the case of M82 we have $E \gtrsim 10^{55}$ erg [8,9] and if τ is of the same order, 10^8 sec. As for quasars (this is based on the possible presence of a compact radio source in M82, cf. the literature cited in [9]), then over the epoch of the explosion we have $\langle W_g \rangle \approx 4 \times 10^{37}$ erg/sec and the flux on earth is $t_{or} \gtrsim 10^{-13}$ erg/cm^{2}sec.

3. Gravitational radiation due to collision of stars in radio-galaxy cores. The concentration of stars in radio galaxies may reach exceedingly large values - more than 10^5 stars per parsec^3. According to estimates [10], frontal collisions between stars in the central region of NGC 4486 occur every several decades or centuries. When stars collide, a shock wave passes through them and results in heating of the stellar matter and in an explosion in which $\sim 10^{51}$ erg is released. The characteristic time is of the order of or smaller than the hydrodynamic time, which amounts to several minutes. Putting $E \sim 10^{51}$ erg and $\tau \sim 3 \times 10^{-2}$ sec we get $\langle W_g \rangle \sim 4 \times 10^{40}$ erg/sec, corresponding at $r \approx 10$ Mparsec to a flux $t_{or} \sim 10^{-11}$ erg/cm^{2}sec on earth. An even greater gravitational-wave flux can be observed, albeit much less frequently, when stars collide in the cores of spherical clusters.

4. Gravitational radiation from explosions of supernovas and novas. It is presently assumed that supernova explosions are spherically symmetrical. It is not excluded, however, that the explosion occurs predominantly in distinct zones of the star. The presence of asymmetry should lead to gravitational radiation. The energy released in the center of a supernova of type II and consumed in the production of a shock wave is $E \approx 10^{52}$ erg. The characteristic time scale of the mechanical instability, caused by exothermal nuclear reactions, is $\lesssim 10^3$ sec [11]. Hence $W_g \gtrsim 4 \times 10^{41}$ erg/sec. Detection of radiation on earth at a level of 10^{-10} erg/cm^{2}sec is feasible in principle, up to distances $r \sim 10$ Mparsec, i.e., for supernova explosions in the nearest galaxies. The explosion of a nova is also accompanied by a gravitational burst, but the latter is difficult to observe, and it is more realistic to record the continuous "background" of gravitational radiation due to the close duality of the novas.

Summarizing, we can note that explosive gravitational radiation in processes (1 - 4) is quite appreciable. It is of interest to analyze cosmic explosive phenomena in greater detail, since the registration of the accompanying gravitational radiation may turn out to be a fundamentally new method of investigating processes occurring in the central regions of exploding cosmic objects.

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OBSERVATION OF SELF-FOCUSING OF LIGHT IN LIQUIDS

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In 1962 G. A. Askar'yan considered one of the important problems involved in the effect of a beam of intense radiation on a medium. He has shown that intense radiation can lead to a differential between the properties of the medium inside and outside the beam. The latter creates conditions suitable for waveguide propagation of the beam, thereby eliminating the geometrical and diffractional divergences. This interesting phenomenon was called by him self-focusing of an electromagnetic beam.

It was shown in [2] that the action of a strong high-frequency field on a plasma causes redistribution of the electron and ion concentrations and therefore gives rise to a waveguide channel that supports the action of the field itself.

Garmire, Townes and Chiao [3] discuss in a recent note the possibility of self-focusing of light beams as a result of the fact that the increment of the refractive index of the medium has an approximate quadratic dependence on the field amplitude:

$$n = n_0 + n_2E^2; \qquad n_2 > 0 \tag{1}$$

This can create conditions under which the radiation becomes self-focused and propagates in the medium within a thin filamentlike channel. Because of the field of the wave itself, the refractive index is larger inside the channel than outside, and the light remains confined to the channel as a result of the total internal reflection.

An interesting result obtained in [3] is that self-focusing can occur only when the light-beam power exceeds a threshold value. The channel diameter depends on the power excess above threshold; it can be quite large when the excess is small, and is of the order of the wavelength when the excess is appreciable.