which validates the application of perturbation theory to the problem of the interaction with the meson field. We neglect the interaction with the electromagnetic field because of its weakness in comparison with the meson and χ-inter-over intra-nucleonic distances.

As Werle has shown[3], step by step conversion from Eq. (3) to the nonrelativistic approximation leads to the equation ($V = 0$)

$$i\hbar\, \partial\psi/\partial t = [-(\hbar^2/2m)\nabla^2 + V_v + V_s]\,\psi, \quad (5)$$

$$V_v = aV - a^2V^2/2mc^2, \quad V_s = \gamma\Phi + \gamma^2\Phi^2/2mc^2. \quad (6)$$

As can be seen from Eqs. (6) and (1), the m-particles do not fall on one another unless (see, for example, Ref. 4)

$$a^2/c\hbar < 1/2, \text{ т. е } a < \sqrt{c\hbar/2} \approx 3\cdot 10^{-8}\,\text{CGS}. \quad (7)$$

If we assume that $a \approx 10^{-8}$ cgs units, we can see in Eq. (7) the reason why there is only one type of "(m–χ)-atom" nucleons, since the higher χ-charges contradict the inequality (7). In our problem there are the still undetermined constants λ and m. They are connected with a and $\hbar$ by the relation

$$\lambda a^2 \approx \hbar^2/m, \quad (8)$$

which follows from (see Ref. 5)

$$\int_0^\lambda V(r)\,r\,dr \approx -\frac{2\hbar^2}{M},$$

where M is the mass of the nucleon $\approx 1.6 \times 10^{-24}$ gm. Further, we have the relation[5]

$$2mc^2 - \varepsilon = Mc^2, \quad \hbar\sqrt{2/m\varepsilon} = r_0, \quad (9)$$

where ϵ is the binding energy of the system, r_0 is the radius of the nucleon $\approx 10^{-13}$ cm. We then find $m \approx 1400\, m_e v$ (m_e = mass of the electron), $\epsilon \approx 450$ mev and then $\lambda = \hbar^2/ma^2 \approx 0.8 \times 10^{-14}$ cm, which is a reasonable order of magnitude for the radius of action of the interaction forces. We see that our assumptions (in contrast to the theory of Markov[1]) lead to the possibility of "dissociation" of nucleons for energies ≥ 450 mev, whereupon one ought to look for the m-particles among the heavy mesons with masses $\sim 1400\, m_e$. The dissociation level is higher than the mass of the hyperon Y_2 (mass $\sim 2570\, m_e$, excitation energy ~ 360 mev[6], the highest of the known exicted states of a nucleon.

Calculation of the excited states of the nucleon for our model is possible only in numerical fashion (for large distances, one needs also to take into account the meson interaction of the m-particles). We note that the only possible bound states with $l = 0$ (l is the orbital quantum number)[5] and equal values of n (principal quantum number) are possible. The number of such states will evidently be small (of the order of 3-4). The selection rules connected with the interaction with the meson field may allow the explanation of the comparatively large lifetimes of the hyperons.

A similar but somewhat more complicated discussion can be carried out for consideration of the spin of m-particles [an equation of the Dirac type in place of Eq. (3)] and for interaction with a pseudoscalar meson field.

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* Evidently it must be assumed that the χ-charges (similar to the electric) have two signs, while the meson charges (like gravitational) have only one sign. It follows from this assumption that the nucleon as a whole does not have a χ-charge, but does have a meson charge g.

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Translated by R. T. Beyer
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The Problem of the Interaction of Ultrasonic Waves in Liquids

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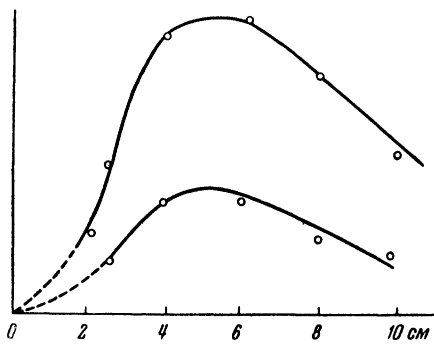
(Submitted to JETP editor June 26, 1955)
J. Exptl. Theoret. Phys. (U.S.S.R.) **30**, 1142 (June, 1956)

If a quartz plate is excited as a resonator at two different frequencies, then combination frequencies can easily be observed in the liquid medium. These suggest the possibility of investigating the phenomenon of interaction between the fundamental waves. Below we give some preliminary data on the variation of the intensity of the combination waves with distance.

Let us give briefly the experimental conditions. In order to put two waves into the medium in one direction, we made use of a combination radiator, which was a quartz plate of 20 mm diameter. To one side of the plate was attached a foil membrane with air padding, and to the other side, foil electrodes in the form of two sectors, each covering half of the radiating face of the crystal. These sectors were separated by a distance of 1 mm. Variable voltages were applied from two independent generators. The foil membrane acted as the ground electrode. The generators developed variable voltages of 250-300 v. The thickness of the quartz plate was so chosen that the radiator was adjusted to resonance at one of the fundamental frequencies (either one). Frequencies of 1 mc and 1.5 mc were used as fundamental frequencies.



A barium titanate plate was used as the pressure receiver. The voltage developed across the receiver was amplified by a two-channel (for the sum and difference frequencies) tuned amplifier. An oscilloscope was used as the output meter. By displacing the receiver relative to the source (maintaining strict parallelism between the two surfaces), it was possible to observe (on the oscilloscope) the change in the intensity of the sum of difference frequency. As these observations showed, the intensity of these waves was spatially modulated by the base frequency . In the Figure the intensity of the modulated vibrations is plotted against distance; the distance from the source in cm is plotted along the abscissa, while the ordinate is a quantity proportional to the intensity of the modulated vibration. The results of the observation refer to the sum wave at 2.5 mc obtained in vaseline oil (at $t = 20^0$). Two curves are shown in the Figure, taken for different intensities of the source (the lower curve was taken for an intensity one-half the higher one). As the curves show, the intensity of the modulated combination waves increases with distance from the source, passes through a maximum and then decreases.

Thus we can draw the following conclusions:

1. The intensity of the modulated vibration has a maximum with respect to distance.
2. The location of the maximum does not depend on the intensity of the fundamental waves.
3. As the data show, the position of the maximum for a given frequency is determined principally by the vicosity of the medium.

Translated by R. T. Beyer
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The Applicability of the Second Law of Thermodynamics for Large Volumes of a Gravitating Gas

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(Submitted to JETP editor October 15, 1955)
J. Exptl. Theoret. Phys. (U.S.S.R.) 30, 1144-1145
(June, 1956)

1. ACCORDING to Terletskii[1-3] the second law of thermodynamics is not applicable to large volumes of a gravitating gas. It is claimed[2] that processes begin to take place in large volumes of a gravitating gas which contradict the second law. Publication of a criticism by the present author[4] was followed by an assertion in discussion form[1] that the earlier conclusions[2,3] were still correct under conditions in which the gravitating gas is enclosed in a thermostatted vessel covered with a piston which works at a fixed force, the pressure being $P > NkT/4V$. We will show that even under these stated conditions, the conclusions[1-3] on the inapplicability of the second law of thermodynamics for large volumes of a gravitating gas cannot be considered correct.

Terletskii[1] assumes that all conditions of the gravitating gas for which $dP/dV < 0$, are entirely stable. Account is not taken of the fact, as we will show below, that the gravitating gas has a metastable region. It is for precisely these same conditions that a greater probability of fluctuations of a cosmic scale is assumed[1].

Let us call the mass of the gravitating ideal gas M, occupying a volume V, situated near the center of the cloud of diffused material, and in a quasistatistical equilibrium. Volume V is much smaller than the volume of the whole diffusion cloud, so that one can assume that the gas is distributed uniformly throughout the volume V. The identical case was considered by Jeans[5],