F_i that the commutator $[H_i H_j] \approx 0$ in the macroscopic regions $e^2_{ij} >> \lambda^2$, i.e., we can replace ϵ^*_{ij} by ϵ_{ij} in all regions $|e^2_{ij}| >> \lambda^2$ and, consequently, the function $\tilde{\Delta}^c_{ij}$ will contain only positive frequencies for $t_i > t_j$. In other words, the S matrix (2), in macroscopic regions of space–time, satisfies the conditions of causality. The unitarity of (2) can be shown in the same way as for the S matrix without the form factor, where the operator P^* can always be replaced by P[3].

We can also determine P^* by the normal product in correspondence with wick's theorem:

$$P^* \{\varphi^*_p(x_1)\varphi_q(x_2)\} = N\{\varphi^*_p(x_1)\varphi_q(x_2)\} + {}^1/_2\tilde{\Delta}^c(x_1 - x_2; p)\delta(p-q).$$

From the viewpoint of computation, such a definition of the operator P^* is much more satisfactory than (4).**

In conclusion, I wish to thank Prof. D.I. Blokhintsev for his interest and discussions.

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*As an example, we consider the simple case of the interaction of the scalar charged and neutral fields φ and A.

**The unitary condition $SS^+ = 1$ in the second approximation of perturbation theory reduces to the requirement that all the matrix elements of the expression $S_2^+ + S_2 + S_1 S_1^+$ vanish. In a theory with a form function, this is impossible. We can establish this fact by considering, for example, the matrix element of the eigenvalue of the energy of the field A or φ[3]

*One can express $\epsilon^*(x)$ in the form of an exponent with dependence only on x, as a consequence of which, calculation of the integrals in the matrix elements presents well known difficulties.[7]

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An Experiment on the Measurement of the Viscosity of an Expanded Liquid

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STUDY of the viscosity of expanded liquids would be of considerable interest for the development of the theory of viscosity. In the literature there is not indication of work in this field. We therefore set ourselves the task of investigating whether such measurements could be carried out. Reported below are some results of experiments we performed.

The substance chosen for investigation was benzene. The sample used had physical constants that agreed fully with handbook values. The benzene was put through an additional distillation just before the experiments for removal of absorbed water and for partial degasification, and the first and last fractions were rejected. Since we did not undertake to attain maximum expansion of the liquid complete degasification of the benzene was not carried out.

The method of Stokes was chosen for making the measurements as being easiest to apply. For manufacture of glass beads of the necessary diameter, we adopted the method of fusion of glass powder granules in the flame of a gas burner. This method was used by Bloomquist and Clark[1]; we modified and simplified their method to some extent. For our task we selected a few beads of 3C-5K molybdenum glass of diameter 0.05 to 0.06 mm, of accurately spherical shape and containing no gas inclusions. Since glass beads in benzene are hard to see, the ones chosen were coated with aluminum by evaporation in a vacuum. The density of the spheres was determined by the method of free flotation and was 2.268 g/cm^3 at 25° C.

The experiments on measurement of the viscosity of the expanded benzene were carried out in cylindrical ampoules, made of 3C-5K molybdenum glass, of inside diameter 6 mm. At the ends of the ampoules were intakes, 150 mm apart. The inside diameter of the intakes was about 1 mm. The ampoule was filled with benzene in such a way that after sealing, a bubble of gas remained in it. The glass bead was inserted into the ampoule

Results of measurements of viscosity (in millipoises) of expanded and unexpanded benzene

Temperature, °C	Unexpanded liquid			Expanded liquid		
	Time of fall, sec	Density	Viscosity	Time of fall	Density	Viscosity
Ampoule No. 1. Solution temperature 32.2 °C Lowest rupture temperature 28.5 °C						
30.00	17.30	0.8680	5.613	17.06	0.8657	5.54
31.00	17.06	0.8670	5.536	16.90	0.8657	5.49
Ampoule No. 2. Solution temperature 34.6°C Lowest rupture temperature 30.8 °V						
32.00	15.65	0.8659	5.462	15.49	0.8631	5.42
33.00	15.44	0.8648	5.389	15.30	0.8631	5.35
34.00	15.23	0.8637	5.318	15.20	0.8631	5.31
Ampoule No. 3. Solution temperature 61.2 °C Lowest rupture temperature 56.3 °C						
58.00	12.74	0.8378	3.979	12.46	0.8343	3.90
60.00	12.44	0.8356	3.892	12.35	0.8343	3.87
60.50	12.37	0.8351	3.871	12.30	0.8343	3.85

filled with benzene; the benzene in the ampoule was frozen, and the ampoule was sealed. Three such ampoules were prepared; they differed from one another in the size of the gas bubbles contained in them. In conducting the experiments, the ampoules were clamped in a stand that permitted rapid inversion of the ampoule, with immediate establishment of accurate verticality of its axis; in addition, it was also possible to set the ampoule in a horizontal position. On the stand were two sights, fastened 100 mm apart. This stand, with the ampoule clamped in it, was set in a water thermostat with transparent walls; the temperature could be varied continuously and could be held constant to within ± 0.02°C.

The experiment was conducted as follows. First the ampoule was set horizontal, and the temperature of the thermostat was very slowly raised until the whole volume of the ampoule appeared full of liquid. Then the temperature ("solution temperature") was recorded, and immediately there began a slow cooling of the thermostat to the point of rupture of the liquid. This procedure was repeated many times, until the solution and rupture temperatures remained constant to within ±0.2 °C. After such a training of the ampoule had been completed, the bead was transferred to one end of the ampoule, the thermostat was heated to the solution temperature, and then – after disappearance of the gas bubble in the ampoule – the temperature of the thermostat was fixed a little below the solution temperature. The ampoule was held at this temperature 20 to 25 minutes; then it was quickly set vertical, with the end containing the bead upward, and the time of fall of the bead from the upper to the lower sight was measured. Such measurements were taken at least 10 to 15 times for each ampoule at each temperature chosen for measurement.

The mean absolute error in the determination of the time of fall of the beads was ±0.04 sec. The density of the expanded liquid was calculated from the density of benzene at the solution temperature and from the coefficient of linear expansion of the molybdenum glass. The calculations gave a value of the density of the expanded liquid that did not differ appreciably from the density of benzene at the solution temperature. The values of the viscosity and density of benzene that were needed for the calculation were calculated with an interpolation formula taken from Ref. 2. The absolute error in the measurement of the viscosity of the expanded benzene was in all cases within ±0.03 millipoise.

Worthington[3] indicates that the presence of a glass bead in an ampoule with an expanded liquid makes the expanded liquid very unstable, and that upon the slightest motion of the bead, the liquid ruptures. However, the data presented in the Table show quite convincingly in our opinion, that mea-

surement of the viscosity of an expanded liquid by the Stokes method is possible. The problem in further investigations is to improve the accuracy of the necessary measurements and to explore methods of extending the temperature interval in which the expanded liquid exists.

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Concerning the Possibility of an Experimental Investigation of the Structure of the Electron

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IN connection with successes in the construction of different electron accelerators, the latter find greater applications as the activating agent in investigations of electric charge distributions in atomic nuclei. In particular, the study of elastic scattering of 100, 188 and 236 mev electrons by protons at rest permitted the determination of the mean square radius of the proton[1].

All these computations and interpretations of experimental results, however, were based on the assumption of a dimensionless electron. The question of charge distribution inside the electron is important not only from the point of view of using this particle for investigations of structures of heavy nuclei, but is also independently of interest in physics. An experimental solution of this question makes it necessary to have a source of ~ 40 bev electrons for the case of the immovable electron target. Besides, in view of the small value of the effective cross section, currents of the order of several amperes are required for a responsible frequency of observation.

The choice of electron energy is determined by experimental capabilities to determine the angular distribution of the differential cross section in elastic scattering of electrons by electrons computed for two extreme cases: 1) the electron is treated as a mathematical point; 2) the electron has the classical radius $r_0 = e^2/mc^2$. The effective cross section for the first case is determined by the known Meller formula[2]. Quantum electrodynamic computations of scattering of extended electrons by electrons was carried out by M. A. Markov and I. V. Polubarinov. Accounting for the extension of the electron consisted of replacing the Hamiltonian of local interaction by the Hamiltonian of interaction with non local current, which formally lead to a change in the propagation function of the virtual photon. The dependence of the differential cross section on the scattering angle in the center-of-mass system is shown graphically in the Figure for the two types of selected form factors. It is seen from the Figure that the ratio of scattering cross sections at these energies $\gamma (= E/mc^2)$ is quite distinguishable experimentally.

At the present time there are no known methods of developing accelerators for obtaining electrons of such high energy (> 40 bev) especially for currents in amperes.

The possibility of conducting an experiment as indicated above is based on utilizing the principle of the ring phasotron, proposed by Kolomenski, Petukhav and Rabinovich[3] back in 1953. In this accelerator the magnetic field remains constant in time, but a small width of the magnetic path is preserved due to high gradients (large n) and the introduction of sectors with reverse direction of the magnetic field. The constancy of the magnetic field permits to apply the principle of charge accumulation in the limiting energy orbit and, in view of the repeated passage of the particles through the same meeting place, permits to circumvent the second difficulty connected with the need for high currents.

As far as the energy phase of the problem is concerned, the operation of two opposing electron beams, i.e., bringing into coincidence the system of center of mass with the laboratory system gives a considerable energy gain for relativistic particles (electrons). Thus, for example, a 100 bev accelerator in its physical effect is equivalent to two opposing electron beams of only ~ 150 mev. An electron accelerator of these energies from the standpoint of dimensions and power, is a relatively modest installation.

The problem of the meeting of two beams can be solved in different ways. For example, Kerst and others[4] considered the possibility of meeting of protons in the case of two adjacent but indepen-