CONFERENCE ON THE THEORY OF ELEMENTARY PARTICLES

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THE fifth conference on the theory of elementary particles, organized by the chair of theoretical physics at the Uzhgorod University, like all the previous ones, acquired an all-Union character, although formally it was called by the Ministry of higher and medium specialized education of the Ukrainian S.S.R. as a local one. As in previous years (1958, 1960, 1961, 1962) there were approximately a hundred participants in the conference, predominantly young theorists from Moscow, Dubna, Kiev, Minsk, Tbilisi, Novosibirsk, Baku, Dniepropetrovsk, Uzhgorod, and other scientific centers. Following the pattern of the previous conference (November 1962) the work of the first days proceeded in the framework of seminars of the "Autumn School" in the form of review reports accompanied by discussion; the second half of the conference was devoted to original reports. The well known popularity of the Uzhgorod conferences is connected, probably, both with the indubitable need for a regular relatively wide discussion of actual problems of quantum field theory and elementary particle theory with some excursion into related aspects of the atomic nucleus and gravitation, and with the possibility for the participation in such conferences of wide circles of young the-

orists. Apparently the hospitable setup of a small Carpathian town with ample possibilities for excursions to neighboring historically memorable cities and vineyards also contributes to the amicable atmosphere at the now already traditional Uzhgorod conferences.

I. REVIEW PAPERS AT THE AUTUMN SCHOOL

Ya. B. Zel'dovich (AN SSSR) outlined the history of the discovery of the neutrino and the study of its properties. Experiment showed that the neutrino mass is less than 0.001 times the electron mass. The modern theory of a spiral neutrino is a theory of a particle whose mass is precisely zero. The neutrino and antineutrino differ from each other in their spirality as well as in the nuclear reactions that they can induce. It has been shown recently that there exist two types of neutrino—the electron neutrino and the muon neutrino. Weak interactions combine reactions involving the neutrino and decays of strange particles. The common properties of weak interactions are: a) nonconservation of parity, approximate equality of probabilities of processes referred to the same state. The theoretical physicists are now again inclined to believe that the weak interactions proceed through intermediate particles—charged bosons of spin 1; in that respect there is a similarity between the weak and electromagnetic interactions.

Preliminary information from CERN (Geneva) indicates the recent discovery of such particles—intermediate bosons with a mass of about 1400 MeV. It was noted in the discussion that these bosons are, probably, not ordinary resonances since, in contrast to the latter, they live comparatively long: 10^{-18}—10^{-19} sec. The lecturer touched on the question of a third, kaon neutrino, for the existence of which there is no particular basis.

The theory predicts so far unobserved processes: neutrino-electron scattering, and also the possibility of emission of neutrino-antineutrino pairs, a phenomenon significant for astrophysics. It was noted that there does not as yet exist a theory explaining the electron and muon mass. Sometimes the muon mass is considered anomalous and it is supposed that it is connected to some additional interaction. The point of view is attractive that in some approximation the electron has no mass. The existence of heavier particles of the electron-muon type is not excluded.

D. Ivanenko (MGU) has considered, on the basis of work carried out by him in collaboration with **A. M. Brodskiĭ, G. A. Sokolik, V. I. Rodichev, Yu. S. Vladimirov,** and **D. F. Kurdgelaidze,** the possibility of a "maximally" unified picture of the world. After outlining the main facts on the structure of ordinary matter out of particles and resonons (the name "resonon" is proposed for the excited states or quasiparticles, usually described by the term "resonance"), and also the basic cosmological facts, it was indicated that the following is likely: 1) construction of a unique theory of ordinary matter with the help of nonlinear spinor theory, 2) the unification of the isotopic and ordinary Minkowski spaces, 3) a closer unification of gravitation and ordinary matter with the predicted mutual transmutations taken into account, 4) a uniform group and "compensational" (in the Yang-Mills sense) treatment of gravitation along with other fields, 5) the admission of a special connection between cosmological circumstances and the conventional local theory of matter. The latter is suggested both by the mutual transmutations of the gravitational field and ordinary matter, and by the empirical relations between the constants of particle theory and the Hubble constant, as well as by the possible relation between the expansion of the Universe and the predominant concentration of particles rather than antiparticles.

N. N. Neĭman [ITEF (Inst. Theor. Expt. Phys.) AN SSSR] talked about the proofs of asymptotic equality of total and differential cross sections for particle and antiparticle scattering, which follow from certain natural assumptions about the scattering amplitude. The proof is based on crossing symmetry and the Lindelöf theorem, which states that it is impossible for a bounded function to approach two different limits at its boundary point.

D. Ya. Petrina (Mathematics Institute, Ukrainian Acad. Sci.) considered the Landau curves and complex singular points of Feynman diagram contributions. A method was proposed for deciding at what points of the Landau surface are the Feynman diagram contributions holomorphic functions. The Mandelstam representation was proved for the diagrams described as the "envelope" diagram, Kim's diagram and the "tetrahedron" or "open envelope" diagram.

S. G. Matinyan (Physics Institute, Georgian Acad. Sci.) considered in a long review the particle production processes at super high energies from the point of view of singularities in the angular momentum plane, on the basis of the results obtained by the K. A. Ter-Martirosyan group on the behavior of inelastic interaction cross sections. It was shown that the idea of a single dominant moving Regge pole is in contradiction with the unitarity requirement for the elastic scattering amplitude, expressed in terms of the contributions from the inelastic processes.

É. M. Lipmanov (Volgograd Pedag. Inst.) gave a survey of the theory of weak interactions with two types of neutrino (the electron type and the muon type). The Schwinger, Nishijima, and Kawakami schemes with two leptonic charges, and the Lipmanov scheme based on γ_5 invariance, were discussed in detail.

N. V. Mickiewicz (P. Lumumba University of Friendship among Nations, Moscow) surveyed the studies of the problem of energy in the gravitational field, giving special attention to the formulation of Noether's theorem and the work of Moller. A funda-

mental role is played by the latest n-tuple treatment of gravitation (Moller, Rodichev, Ivanenko, Sokolik, Brodskiĭ, Treder, Plebanski), needed for the description of spinor fields. Auxiliary components are also introduced in the two-metric formulation of Rosen. The necessity of the introduction of additional components for the description of the gravitational field is underscored. The Mach principle is analyzed in the given connection.

V. A. Filimonov and **A. M. Kol'chuzhkin** (Tomsk Polytechnical Institute) reviewed the discovery and the development of the theory of hypernuclei and analyzed the experimental data on the binding energies of hypernuclei aiming at obtaining information on the ΛN interaction. The spins of the hypernuclei are deduced from their decay characteristics. The problem of hypernucleus isomerism is discussed. Special attention was given to the recently discovered $\Lambda\Lambda B^{10}$ hypernucleus with two hyperons. It follows from the analysis of the binding energy of this hypernucleus that the forces between the two ΛΛ particles are attractive.

A. S. Zhukarev (MGU) reported the basic empirical data on all known particles and resonons. They are systematized by means of Regge trajectories and isotopic and unitary multiplets (SU_3 and others). A new approach (Glashow and Rosenfeld) is noted, according to which 4 baryon and 3 meson unitary multiplets are the basis of the corresponding Regge trajectories.

It should be noted that a number of the newest resonons was predicted both by the analytic Reggeized approach (Chew et al.) and by the vector gauge treatment of the type of Yang-Mills fields (Sakurai).

As a rule all reports gave rise to fruitful discussions.

II. ORIGINAL CONTRIBUTIONS TO THE CONFERENCE

1. Dispersion Approach

V. I. Mal'chenko (University of Dnepropetrovsk) considered elastic scattering of spinless relativistic particles by a potential. It was shown that in the absence of bound states the process is fully determined by the conditions of analyticity and unitarity of the scattering amplitude.

V. A. Kaminskiĭ and **Yu. V. Orlov** [NIIYaF (Inst. of Nuc. Phys.) MGU] used the dispersion method to take into account the interactions in the initial and final states in direct nuclear reactions. Finite nuclear size effects and the existence of bound states of the "particle + nucleus" system were taken into account. The analytic properties of the matrix elements were studied in the distorted wave method making it possible to compare with the dispersion method and evaluate the approximations used. The report gave rise to a lively discussion.

A. F. Plish (Mathematics Institute, Ukrainian Acad. Sci.) obtained an integral representation for vertex functions, starting from the axioms of quantum field theory and making use of the integral representation for the vacuum expectation value of the double commutator found by Streater. The singularity equations for these functions coincide with the singularity equations for the vertex function corresponding to third order perturbation theory diagram.

In the discussion the relation between the axiomatic approach to field theory of Wightman et al. and other methods was touched upon.

V. I. Lend'el and **B. M. Érnst** (University of Uzhgorod) attempted to eliminate the ambiguity in the phase shift analysis of pp scattering at energies below 40 MeV by bringing in additional quantum field theoretic information. By taking into account the analytic structure of the singlet S scattering phase shift it is possible to somewhat reduce the ambiguity in the $^1S_0$ and $^3P_0$ phase shifts. This communication, making use of a variety of theoretical methods, also led to a lively discussion.

A. S. Zhukarev and **Yu. G. Pavlenko** (Physics Dept., MGU) combined the pole approximation and the isobar model, i.e., made use of resonons, by writing a Muskhelishvili-Omnes type of equation for the partial wave helicity amplitude for the reaction $\pi + N \to \pi + \pi + N$, with restriction to two-particle unitarity relation and with the pole term in the t channel taken into account.

Ya. I. Granovskiĭ (Inst. Nuc. Phys., Kazakh Acad. Sci.) worked out on the basis of the Jacob-Wick method useful in practice expansions in partial waves and considered the processes $\pi N \to \pi N$, $\pi\pi \to N\tilde{N}$, $NN \to NN$, $N\tilde{N} \to N\tilde{N}$.

Yu. M. Lomsadze, S. S. Tokar', and **I. M. Shuba** (University of Uzhgorod) studied the character of the motion of the poles of the Bethe-Salpeter partial amplitude in the complex plane of the coupling constant, which turned out to be analogous to the previously studied (Yu. Lomsadze, I. Khimich, I. Shuba) motion of the poles of the quantum-mechanical partial amplitude in the complex plane of the interaction "intensity." The assumption is quite likely that an analogous situation would occur in field theory, making possible an effective calculation of the field partial amplitude $f_g(l, s)$, and hence the total amplitude $T_g(s, t)$, to an arbitrary prespecified degree of accuracy. At that use is made of information contained in the coefficients of a finite number of terms in a formal perturbation theory series, with the help of a Mittag-Leffler expansion, also in the case of strong interactions. In the lively discussion following this long report interesting analogies with the theory of Regge poles were underscored.

2. Strong Interactions

Yu. M. Kazarinov and **V. S. Kiselev** (OIYaI, Dubna) obtained at 210 and 147 MeV a set of phase shifts corresponding to, when extrapolated, a set obtained by

Stapp et al. at 310 MeV. The energy dependence of the set of type I was studied at other energies (from 23 to 310 MeV). A simultaneous phase shift analysis of np and pp data was performed at 630 MeV. Three sets of phase shifts were obtained.

Yu. P. Kumekin, M. G. Meshcheryakov, S. B. Nurushev, and **G. D. Stoletov** (OIYaI, Dubna), continuing with the program of investigating the pp interaction at 660 MeV, measured the Wolfenstein triple scattering parameters D, R and A at angles of 54, 72, 90, 108 and 126° in the c.m.s. of the colliding protons. The values obtained for these parameters, as well as data from other experiments, are used to directly reconstruct the scattering matrix, and also to compare with the results of the phase shift analysis. Attention is attracted by the increase in the contribution of the tensor and then spin-orbit terms, which play a dominant role at high energies.

This fundamental study, which used approximately 2000 working hours of the synchrocyclotron, created great interest also in connection with the theory of nuclear forces.

L. S. Azhgireĭ (OIYaI, Dubna) carried out a phase shift analysis of the data on pp scattering at 660 MeV and 435 MeV. He found that all of the experimental information at 660 MeV can be described, in a statistically reliable fashion, by a single set of real parts of the phase shifts and absorption coefficients. A substantial contribution to the production of pions at 660 MeV comes from the ^{3}F state. The analysis of the data at the intermediate energy of 435 MeV showed that they can be satisfactorily described with the help of phase shifts which agree with the corresponding smooth curves connecting the solutions below the production threshold with those at 660 MeV.

V. A. Yarba (OIYaI, Dubna) reviewed the experimental data on the $\pi\pi$ interaction at low energies. It has become clear that: 1) the S-wave $\pi\pi$ interaction in the isospin zero state is dominant, 2) the difference of the S-wave $\pi\pi$ scattering lengths $a_0 - a_2 > 0$, 3) the cross section for the elastic scattering $\pi^+\pi^- \to \pi^+\pi^-$ in the energy interval $\omega^2 = 4-5.5$, obtained by linear extrapolation, amounts to ~ 20 mb, 4) the cross section for elastic $\pi^+\pi^-$ scattering at $\omega^2 = 4-6$ does not, apparently, exceed 10 mb.

K. D. Tolstov (OIYaI, Dubna) explained on the basis of the uncertainty principle the independence of the transverse momentum of the nucleons in inelastic collisions of fast particles on their energy by the constancy of the dispersion of the interaction region. The emission of the baryons in πN collisions preferentially in the direction of their original motion in the c.m.s. is related to the decrease in the difference between the dispersions of the interaction region in the longitudinal and transverse directions.

L. G. Moroz and **V. N. Tret'yakov** (Physics Institute, Beloruss. Acad. Sci.) have calculated the electric (α) and magnetic (β) polarizability of the neutron on the basis of dispersion relations for six independent Compton scattering amplitudes. The imaginary parts of the Compton scattering amplitudes are expressed in terms of the coefficients of the angular distribution for π photoproduction on neutrons, and the values of these coefficients are taken from experimental data on π photoproduction on protons and deuterons under the assumption of charge independence. The following values are obtained:

$$\alpha = 0.43 \cdot 10^{-42} \text{ cm}^3, \qquad \beta = 0.6 \cdot 10^{-44} \text{ cm}^3.$$

A. S. Zhukarev and **Yu. G. Pavlenko** (MGU) computed the reaction $\pi N \to N K \tilde{K}$ in the pole approximation and with the resonant $\pi\pi$ interaction taken into account at the $\pi\pi \to K\tilde{K}$ vertex. The ρ resonon and K meson coupling constant is determined by comparison with the experimental differential cross sections and turns out to be equal to $g^2/4\pi \approx 0.15$.

V. I. Kushtan (Physics Dept., MGU) applied the modified Chew method to the determination of the quantum numbers of resonons. If the mass of the intermediate particle in the pole diagram is taken as a variable parameter then the product of the coupling constants will be a function of this parameter. The natural requirement that the coupling constants be independent of the energy and mass of the particles makes possible the determination of the magnitude of the coupling constant and the mass of the intermediate particle as the common point of this family of functions.

I. A. Kuchin and **P. A. Usik** (Inst. Nuc. Phys. Kazakh Acad. Sci.) in a well illustrated report considered the inelastic NN interaction in terms of the one-meson exchange. It was shown that the one-stream process is the only process not in contradiction with the unitarity condition. The necessary and sufficient conditions for the dominance of the one meson exchange were obtained. Values for the total cross sections for the processes NN, πN, $\pi\pi$ were found at energies tending to infinity.

V. V. Balashov, G. Ya. Korenman, and **T. S. Macharadze** (NIIYaF, MGU) gave a classification of the partial transitions in the photoproduction of charged pions on light nuclei in the framework of the impulse approximation with the many-particle aspects of the nuclear structure taken into account. Concrete calculations were performed for the reactions $He(\gamma\pi^+)H^3$ and $Li^6(\gamma\pi^+)$, $He^6(O, H^3)$. An approximation is discussed in which the cross section for the photoproduction of π^+ on He^3, π^- on H^3 can be obtained with the help of the amplitude for photoproduction on the proton, neutron and the He^3 formfactor without the use of special nuclear models.

V. A. Filippov (Tomsk Polytechnic Institute) studied the possibility of producing $\Sigma^+ p$ hypernuclei in pp collisions. He calculates the ratio of the cross sections for the reaction

$$p + p \to \Sigma^+ + p + K^0 \qquad (1)$$

and

$$p+p \to \Sigma^+ p + K^0 \qquad (2)$$

as a function of the spin and binding energy of $\Sigma^+ p$. The calculation is performed in the framework of the impulse approximation. If $\Sigma^+ p$ has spin $J = 1$ then the cross section for reaction (1) may be comparable with the cross section for reaction (2); for spin $J = 0$ reaction (1) is strongly suppressed.

3. Weak and Electromagnetic Interactions

V. A. Petrun'kin (FIAN) considered all quadratic in the frequency terms in the expansion of the amplitude for the scattering of a photon by a spinless particle in the framework of local field theory. It is shown that it is necessary for their description to introduce two additional parameters $\bar{\alpha} = \alpha + \Delta\alpha$ and $\bar{\beta} = \beta + \Delta\beta$ along with the charge and mass, i.e., add to the α and β coefficients of electric and magnetic polarizability corrections having to do with the particle charge form factor. An analogous result is obtained when one considers scattering of a photon by a bound system described by a nonrelativistic equation. The possibility is discussed of experimental determination of the upper bound of the electric polarizability of the neutron in photon-helium scattering experiments.

A. A. Sokolov, I. M. Ternov, V. G. Bagrov and **R. A. Rzaev** (MGU) showed that it is possible to polarize an electron beam in a magnetic field, with approximately 96% of the electrons in the beam oriented so that their spin is opposite to the direction of the field and only 4% having their spin in the direction of the field. The effective polarization time at an energy of ~ 1 BeV in magnetic fields $\sim 10^4$—1.5×10^4 Oe amounts to 60—20 minutes, which may be relevant for the motion of electrons in storage rings. As was pointed out in the discussion by Yu. S. Loskutov, these predictions were found to be interesting by the Frascati (Italy) laboratory and others.

A. A. Bogush and **A. I. Bolsun** (Physics Institute, Beloruss. Acad. Sci.) presented a compact matrix representation for the wave functions of polarized vector particles. With it it is possible to explicitly obtain a set of matrix elements encompassing arbitrary forms of electromagnetic interactions of similar mesons. On the basis of the proposed method the differential cross section for the scattering of a polarized vector particle by a scalar particle is calculated.

A. I. Mukhtarov (University of Azerbaĭdzhan) used the method of A. A. Sokolov to study the elastic scattering of electrons and positrons on electrons taking into account arbitrary polarization in both initial and final states. Special cases were discussed when all particles are polarized either longitudinally or transversely, and also the case of partially longitudinal, partially transverse polarization.

I. M. Nadzhafov, N. Tenyakov, and **A. I. Mukhtarov** (University of Azerbaĭdzhan) studied the angular and energy distributions of electron-positron pairs and of scattered photons in the reaction $\gamma + (Ze) \to (Ze)' + \gamma' + e_+ + e_-$ with the polarization of all particles taken into account.

V. S. Vanyashin (University of Dnepropetrovsk) showed that the "catastrophic" electromagnetic interaction of bosons, due to the e^2 term in the Lagrangian, can be taken into account without explicit consideration of multiple vertices, and namely by a redefinition of the T-product of derivatives of the field operators.

L. M. Tomil'chik (Physics Institute, Beloruss. Acad. Sci.) studied the consistency problem of the conventional electrodynamic scheme, connected with the field equations and the equations of motion in the case of simultaneous presence of electric and magnetic (monopole) currents. It is shown that the prescription of the interaction in the usual form "current-field" is not possible in this case, since the potentials should then satisfy the homogeneous D'Alembert equation. It is also shown that the electrodynamics with monopoles developed by Dirac is not logically closed.

L. D. Palgi (Inst. Phys. and Astron. Est. Acad. Sci.) considered the effect of a charged vector intermediate boson on the decay of the free and bound muon and on the muon capture process. The results were compared with presently available experimental data.

A. I. Bolsun and **I. S. Satsunkevich** (Physics Institute, Beloruss. Acad. Sci.) obtained differential and total cross sections for the photoproduction of the intermediate vector boson on a proton for certain values of the mass and anomalous magnetic moment of the boson.

I. B. Bobodzhanov, V. M. Ivanenko, L. L. Kashkarov, and **V. V. Cherdyntsev** (Tadzhik University) studied the neutron asymmetry in μn reactions on lead, iron and copper making use of cosmic ray muons. The meson asymmetry and polarization coefficients obtained were of a magnitude in agreement with the assumption of a dominant V and A weak interaction in the indicated reactions.

É. M. Lipmanov (Volgograd Pedag. Inst.) considered the differences in weak interaction schemes with one and two leptonic charges and indicated a possible experimental test of this difference in the muon decay.

V. V. Balashov, N. M. Kabachnik, and **R. A. Éramzhyan** (NIIYaF, MGU) calculated the probability for muon capture by the Ca^{40} nucleus in the framework of the shell model with intermediate coupling. The spectrum of the neutrons emitted in such a capture was obtained. It was shown that the neutron spectrum below 10 MeV is substantially affected by resonance effects.

R. A. Éramzhyan (NIIYaF, MGU) studied the dependence of the partial probabilities, the polarizations of the various levels and the angular distributions of the recoil nuclei on the choice of the nuclear wave functions, the induced pseudoscalar coupling constant and "weak magnetism."

G. Ya. Korenman and **R. A. Éramzhyan** (NIIYaF, MGU) showed that the asymmetry coefficient in the angular distribution of tritium nuclei and the ratio of the probabilities for capture from the triplet and singlet states of the mesonic atom do not depend on the choice of the He^3 wave function, if the small admixture of the D state is neglected. The dependence of the ratio of the probabilities and of the asymmetry coefficient with the hyperfine structure taken into account on the coupling constant of the induced pseudoscalar interaction was studied.

4. Theory of Gravitation

Ya. I. Granovskiĭ (Inst. Nuc. Phys. Kazakh Acad. Sci.) showed that corrections to the Newtonian theory of gravitation of order v^2/c^2 are uniquely determined by a) Lorentz invariance, b) the equivalence principle, c) the tensor dimensionality of the gravitational field. The coincidence of the gravitational potentials with the metric tensor, the effect of which becomes felt in next order, is a hypothesis which has not been so far, in the opinion of the speaker, verified experimentally.

It was emphasized in the discussion that the Einstein theory of gravitation continues to be the basis of our understanding of gravitation. Birkhoff type adjustment schemes cannot be guaranteed in higher order approximations. On the other hand Einstein's theory, no doubt, must be generalized since fermions do not interact with a potential in the form of a metric tensor, but with a tetradic potential (Fock-Ivanenko, Weyl, Moller).

Yu. S. Vladimirov (MGU) considered the cross section for the scattering of fermions by the Schwarzschild field in the first approximation on the basis of a Lagrangian, more accurate in comparison with the work of Gupta, for the interaction of the spinor and gravitational fields.

N. V. Mickiewicz (P. Lumumba University of Friendship among Nations, Moscow) solved the Dirac equation with respect to the electromagnetic potential and, having substituted the latter into the Maxwell equations, showed the possibility of obtaining a nonlinear spinor theory of the type of the unified field theory of Reinich-Wheeler.

M. P. Korkina and **M. A. Pevzner** (University of Dnepropetrovsk) calculated gravitational corrections to the electric and magnetic moments of the electron on the basis of a phenomenological inclusion of the gravitational field in electrodynamics.

V. S. Brezhnev (MGU) formulated, with the help of a certain scalar quantity, a theory analogous to the canonical formalism of classical mechanics, and developed a method of canonical transformations. In the case of the n-tuple formalism in gravitation theory this approach leads to a reasonable definition of the gravitational energy.

5. General Problems

A. A. Borgardt (University of Dnepropetrovsk) developed on the basis of covariant projection operators a general computation technique for the quantum theory of boson fields. As an example the construction of the scattering matrix for the scattering of bosons of given spin on spinless particles was discussed.

Yu. A. Rylov (MGU) introduced in place of the four-dimensional space a universal six-dimensional events space. It is shown that the conservation laws of electric and baryonic charge and the existence of an elementary electric and baryonic charge may be viewed as properties of the new space. The motion of a charged particle in a gravitational and electromagnetic field is described as the motion of a free particle in 6-space.

M. I. Shirokov (OIYaI) considered the quantum dynamics of a scalar particle with the proper time treated as a parameter. A formal difficulty arises in the proper time formalism: the momentum does not commute with $\hat{x}^2 = -\tau^2$, so that it is not possible to prescribe a state with definite momentum on the spacelike surface $-x^2 = \tau^2$. This difficulty is overcome by the introduction of new momentum operators, such that $[p'_\mu, x^2] = 0$. The equations of motion are obtained accurate to first order in τ and a number of problems in the τ-formalism are discussed.

A. I. Naumov (MGU) considered the possibility of degeneracy in helicity of the vacuum of the self-interacting spinor field, described by a nonlinear equation of the Heisenberg–Ivanenko–Brodskiĭ type. At that one obtains for the mass of the primary fermion an expression different from zero, which agrees up to a numerical factor with the result obtained by a different more complicated method by Nambu and Jona-Lasinio. Upon choosing a reasonable value for the cut-off momentum one finds for the dimensionless combination ml (where l is the nonlinearity constant) a result very close to the relation derived by the Heisenberg group, although in the present context one uses the conventional Hilbert space for state vectors with a positive definite metric.

A. D. Sukhanov (Karpov Physicochem. Inst.) discussed certain fine points in the S-operator formalism, related to the difference between the T-product of Dyson and Bogolyubov.

Translated by A. M. Bincer
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