processes based on the use of wavelet transforms. This method was applied to nucleus–nucleus collisions and made it possible to reveal ring-like structures testifying in favor of Cherenkov-radiation-type effects of a gluon in a chromatic medium.

Problems of experimental diagnostics of a quark–gluon plasma that can be produced at early stages of collisions of ultrarelativistic heavy ions, based on using photon and dilepton signals, were considered by I V Andreev and I I Roĭzen, respectively. According to the standard hydrodynamic description of nucleus–nucleus collisions at high energies, a conversion of the quark–gluon plasma into hadrons in the course of the dynamic expansion must be accompanied by the emission of photons with specific spectral and correlation characteristics. The specific dilepton signal could be a manifestation of the hypothetical 'pion–valon phase', which is intermediate between the phase of the pure quark–gluon plasma and the confinement phase and is characterized by the violation of the chiral symmetry and the formation of constituent quarks (valons). Taking the valon phase into account would probably make it possible to describe the deficiency of dileptons predicted by the standard scenarios, which was observed on the SPS accelerator in CERN.

The effects of quantum electrodynamics (QED) in strong external fields in various media and with the presence of boundaries still remain very interesting in view of the new experimental possibilities.

A review talk by G Soff et al. outlined the modern theoretical and experimental status of QED in the fields of strongly ionized heavy ions. The results of nonperturbative calculations of the Lamb shift of energy levels in a hydrogen-like uranium ion are given. The relative accuracy of calculations of the ground state energy, reached by now, is 10^{-6}, which will allow a more detailed verification of fine QED effects in strong ion fields in the near future.

The study of the electroweak phase transition in a constant electromagnetic field and its relation to baryogenesis in the framework of the Standard Model was reported by V Demchik and V Skalozub. The consideration was performed in terms of the self-consistent effective potential for a scalar and an electromagnetic field at a finite temperature, calculated with allowance for one-loop and ring diagrams. The fundamental-particle masses were assumed to be equal to their experimental values, and the Higgs boson mass was assumed to lie in the range 75–115 GeV. For magnetic field strengths $H = 10^{22} - 10^{23}$ G, a numerical calculation established the presence of a first-order phase transition, but the jump of the order parameter was small. For stronger fields, a crossover was observed. A conclusion was drawn that, in the Standard Model, a hypermagnetic field does not generate a strong phase transition and the conditions for baryogenesis are not met.

K Milton reviewed various aspects of the Casimir effect, as applied to the scalar, electromagnetic, and fermion fields. The dependences of this effect on the geometry and space dimension were analyzed. The most thorough consideration was given to the electromagnetic Casimir effect, in particular, its relation to the Van der Waals forces and its application to dielectrics and semiconductors of various shapes. A possible connection of this effect with sonoluminescence, whose physical origin still remains enigmatic, was also examined. The calculations were performed simultaneously by the traditional method and by the Green function method.

A possible approach to the problem of absorption in quantum mechanics, based on the use of singular attractive potentials, was discussed by J Audretsch and V D Skarzhinskiĭ. Different absorption models were realized by a special choice of exact solutions to the stationary Schrödinger equation. The motion of a charged particle in the Aharonov–Bohm potential and in an axisymmetric potential proportional to the inverse square of the distance to the axis was considered at length.

S Fulling proposed a new scheme of Feynman integral approximation for the particle propagator in an external field. The proposed approximation procedure based on the Wigner–Kirkwood expansion over a short but finite time interval rapidly converges, so that the division of the total time interval even into a small number of sub-intervals provides a good approximation.

The general opinion of the participants was that the conference was well organized and a success.

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About Efim Fradkin [1]

V L Ginzburg

For many years, I have already not been occupied with the problems that are the subject of the present conference. But it was organized in the memory of Efim Fradkin, and therefore I decided to give a talk. The point is that I have known Efim (Fima, as we used to call him) longer than anyone present. I shall tell later how and why I met Fima for the first time. And now I shall begin with his biography [2].

Efim Samoĭlovich Fradkin was born on November 30, 1924, in the provincial Belorussian town of Shchedrin located within the so-called 'Jewish pale'. Not everyone in this audience, especially the foreigners, know what this means. In tsarist Russia, that is, before 1917, Jews had the right to reside only within certain limited territories. Exceptions were only made for christened Jews, rich merchants, and so on, and the Fradkins belonged to none of those groups. Theirs was a poor family with many children. Their life was hard, and the father, a former rabbi, was subjected to repression and died in prison. Fortunately, no racial limitations or, simply speaking, State-encouraged anti-Semitism existed in the USSR in the 1930s, and Fima could enter Minsk University in 1940. He studied there for only a year before the beginning of the Great Patriotic War, that is, before June 22, 1941. Fima managed to leave Belorussia before it was occupied, but his mother, two sisters, and a younger brother were killed by the Nazis. Of all the family, only Fima and his elder brother, who was in the army, could survive. Fima was in evacuation for some time, in Bashkiria, worked as a school teacher, and at the beginning of 1942 voluntarily joined the army as a common soldier. He was badly wounded near Stalingrad, and after the hospital he was sent to an artillery school. Then he took part in combat again,

[1] A talk at the Conference 'Quantization, Gauge Theory and Strings' (dedicated to the memory of Professor Efim Fradkin) held on June 5, 2000.
[2] I shall partly repeat here what I wrote in paper [1] published in the collection [2] devoted to E.S. Fradkin's 60th birthday. See also the obituary [3].

but this time as an officer. He was rewarded for his services in battles. Along with his service in the army, Efim studied by correspondence at the Lvov University from 1945. But only after the demobilization in 1946, he could study normally and he graduated from the university in 1948. He even wrote two diploma theses. One of them, which unfortunately was not published, was devoted to the effects of an electric field upon some transitions in atoms. In his second diploma thesis Efim considered the behavior of a relativistic particle of spin 5/2. He chose this subject himself after he read in a library my paper analyzing spin 3/2 [4]. He wanted to extend my consideration to the case of a higher spin (this paper was later published [5]).

In Lvov, there were apparently no specialists in relativistic quantum theory, and that is why Fima, decided to move to Moscow in 1947, being entitled to do this as an ex-serviceman. I do not remember exactly, but we may have exchanged letters before that. However, I remember well how Fima appeared in FIAN (the P N Lebedev Physical Institute of the USSR Academy of Sciences) in order to speak to me. We met in the old FIAN building in the Miusskaya square, now occupied by the M V Keldysh Institute of Applied Mathematics. I had a tiny office, some walled-off cubbyhall. And there I saw a slender short youth dressed in a greatcoat. I gave him the only chair in the room and sat down myself on the table. Fima told me later that he had been amazed: he thought he would meet a dignified and pompous professor, for in Lvov, which had been a Polish town before 1939, there probably remained such a professorate. I was then 31 years old and was neither dignified nor pompous. None of us at the Theoretical Department of FIAN were dignified nor pompous, and the founder of our department Igor Tamm was not an exception, although he was already 52 at that time. The atmosphere at the department was friendly and democratic. A detached view would of course be more exact, whereas I have worked at the department for 60 years (since 1940). But I would permit myself to express the opinion that our department is not typical, and during all these 60 years there was only one serious conflict caused by the dismissal of one of the research workers. What is typical of our department is respect for youth and the impossibility of putting one's name on another person's paper. In particular, Fima was my post-graduate student and we frequently discussed various issues, but we have no joint publications.

I E Tamm and I appraised Fima's abilities and recommended that he should enter the post-graduate course at FIAN. But this was not at all easy because State anti-Semitism already came to reign in this country. Fima was accepted to the post-graduate course with great difficulty in 1948, and I think only because he was a war veteran and had been wounded. It seems to me, by the way, that Fima first appeared at our department in late 1947. As far as I understand, Fima was happy (he told me about it himself [2]), for after so many years of very hard life he finally had found himself in the right place. And he 'responded' with selfless work; he obviously believed, and not without reason, that much time had been lost. Efim's capacity for work, his devotion to science and work attracted attention, although none of us was idling. In addition, Fima was a bachelor, and it can be said that all his effort was directed to work. He was first of all interested in fundamental questions, and it was not accidental that he had set himself to the spin theory even before he came to FIAN. The young research workers and post-graduate students of the department, including Andreĭ Sakharov (he was three years senior to Fima, having entered the post-graduate course of the department in 1945, and defended his candidate's dissertation in November, 1947), made good company for him.

Unfortunately, or maybe fortunately, because this played a positive role in his fate, Efim was unable to give all his strengths to the solution of fundamental problems for several years. The point was that in 1948 or 1949 he was included in the group headed by I E Tamm and admitted to secret work (the content of this work became known only in 1990 (!) after the death of A D Sakharov; the work was aimed at creating a hydrogen bomb). For several years E Fradkin was engaged in a number of problems, viz., transport processes in hot plasmas [6], hydrodynamics [7], and the theory of turbulent mixing [8] (these studies were published with a delay after their content was declassified). But, as I have already mentioned, in his heart Efim longed for another kind of problem and published not only the above-mentioned paper about spin 5/2 [5], but also a paper about the reaction of radiation in the classical theory of electron [9]. The main thing is that he also found time to follow the current literature on elementary particle physics, as this field was then called. He was also interested in quantum statistics. Beginning with 1953 or 1954, Efim could give almost all his strengths to investigations in these particular fields (quantum field theory and quantum statistics). At that time he also began a 'new life' in another respect — in 1955, Fima got married. This was a very happy marriage. The whole department was present at his wedding, which I described in paper [1], and I would not like to repeat myself here.

From 1955 up to his death (he passed away a year ago, on May 25, 1999), Efim, a person of studious habits, was completely absorbed in his work. The only obstacle in his way was his poor health, which had been badly affected by his hard childhood and youth and the wound. In 1955 or so, I practically stopped working on the above-mentioned problems, which were Efim's prime concern. That is why it would be out of place if I dwelt here on the results of his work on quantum field theory and quantum statistics, the more so as it was done in the collection of papers [2], in the obituary [3], and will certainly be reflected by the present conference.

I would like, however, to make two more remarks.

Here is what A.D. Sakharov wrote in his *Reminiscences* ([10], p. 108): "Of all our company, Fradkin was the only one to have reached the level of a highly professional 'forefront' theoretical physicist, of which we all had dreamed. He has great achievements in almost all basic directions of quantum field theory (the Green function method in renormalization theory, functional integration, gauge fields, unified theories of strong, weak, and electromagnetic interactions, the general theory of quantization of systems with constraints, supergravity, string theory, etc.). He was the first to discover the 'Moscow Zero' independently of Landau and Pomeranchuk. Many of the results obtained by Fradkin are classical. Fradkin has no equal in methodical questions." I think that this is a just appraisal. And, incidentally, during Sakharov's exile in Gor'kiĭ Efim visited him several times and helped him in all possible ways.

Efim Fradkin was a brilliant representative of a whole generation of Soviet physicists, who were involved in science research with great enthusiasm. Meanwhile, the financial conditions of our life were rather bad according to American and European standards. In the Stalin period, particularly during the 'cold war', only the chosen few could go abroad.

Since 1947, the persecution of so-called cosmopolitans began, the remarkable *Journal of Physics USSR* was no longer issued, and our Russian periodicals were not translated into English. I do not even mention the complete lack of freedom of speech under the totalitarian regime. But we worked, I repeat, with great enthusiasm to the amazement of some of our foreign colleagues. It seems to me that it was in 1956 that a large group of such highly qualified theoretical physicists, of whom Sakharov wrote, came to the USSR for the first time after many years. F Dyson was among them. After he returned home, in one of his papers he specially commented on what I have said about (the enthusiasm of Soviet colleagues) and explained it as follows: "They have nothing else" (I quote from memory). In other words, 'everything has gone to science', and in such a way they can forget about their hard life. This is a profound remark (here Efim is a vivid specimen) and for a long time I believed it to be quite correct [3]. But now I no longer consider such an explanation to be exhaustive.

Indeed, after the fall of the villainous bolshevik Lenin – Stalin regime in Russia we now have the freedom of speech and the freedom of migration. Research workers, as all citizens, can go abroad practically unlimitedly and meet their colleagues all over the word or correspond with them through either ordinary or electronic mail. Our main journals are translated into English. Of course, there are still many enthusiasts, who give all their strengths to science. But the tone, the general spirit is now quite different. A lot of young people leave science (say, for business), others go abroad or work reluctantly and do not attend seminars regularly. Elderly people often think that 'everything was better' in the days of their youth. But I am sure that it is not this effect that explains my diagnosis. In my opinion, the explanation is basically as follows: the social status of physicists in Russia has changed. In the USSR, physicists and representatives of some other professions were so-to-say the salt of the earth. To be a physicist was prestigious. And, in addition, the salary of research workers was nearly the largest in the country, except that of higher party and Soviet functionaries. Now the conditions of science in Russia are very hard in any respect. There is not enough money for equipment and literature, and the salary is very low not only according to the international standards, but also compared to all types of clerks and secretaries in banks and firms even in Russia. At the same time, many rich people have appeared, sometimes simply rogues, who earn incomparably more than any first-class physicist. I do not think that our post-graduate students and candidates of science (approximately the Ph D level) live worse financially than they did in the 1950s, to say nothing of the 1930s and 1940s. But they are beggars compared to the so-called 'new Russians', all sorts of swindlers. This cannot but have its effect. But I am still not inclined to exaggerate and hope that Russia and, in particular, physics in Russia will raise their heads in the near future. However, the former students and colleagues of Efim Fradkin do not hang their heads even today and, in many respects, have adopted his anxious attitude and devotion to science. I believe that the present conference is one of the proofs of this. I hope the conference will be successful, and I wish you this success.

[3] It is this particular paper by F. Dyson that is mentioned in my paper [11] dedicated to the memory of D A Kirzhnits.

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E S Fradkin as a person

E L Feĭnberg

I would like to say a few words about Fradkin as a person. His scientific merits and achievements need not be specially described, suffice it to cast a glance at the audience and see how many actively working contemporary theoreticians accepted the invitation to attend this memorial conference.

As a person, he was remarkable in many respects. I shall dwell on only two of his outstanding features. He was a brave and clever man.

He was a courageous soldier and officer at the front during all the years of the Great Patriotic War, and this is confirmed not only by the number of awards he got, but also by another minute detail. Among the orders he received was the Order of the Red Star — not the highest award, but the one that had special significance. It was given for courage shown in the field of battle, face to face with the enemy.

But the usual everyday life in our country often required genuine courage from a man who wanted to remain honest. Fradkin joined the Communist Party at the front. At that time many people joined the party without sharing all its ideals or approving of all of its actions. This was simply the expression of hatred to nazism. The question may arise of why he stayed in the party many years after the war.

This question can only be asked by those who did not live in our country at that time and who do not understand that to withdraw was impossible, for it was fraught with serious penalties. I am aware of only one such case, but they were of course numerous.

In the dark period of persecutions which A D Sakharov was subjected to (as is well known, he worked in our Theoretical Department), the party bosses of our institute and higher ranked ones, from the District and even Central CPSU Committee, pounced upon Fradkin and other Party members of the Theoretical Department because they, as well as all other research workers of the department, refused to participate in the badgering and condemnation of Sakharov. The pressure of the party body was mainly concentrated on Fradkin. He was threatened with various punishments, and