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PERSONALIA

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Vladimir Ivanovich Ritus (on his 90th birthday)

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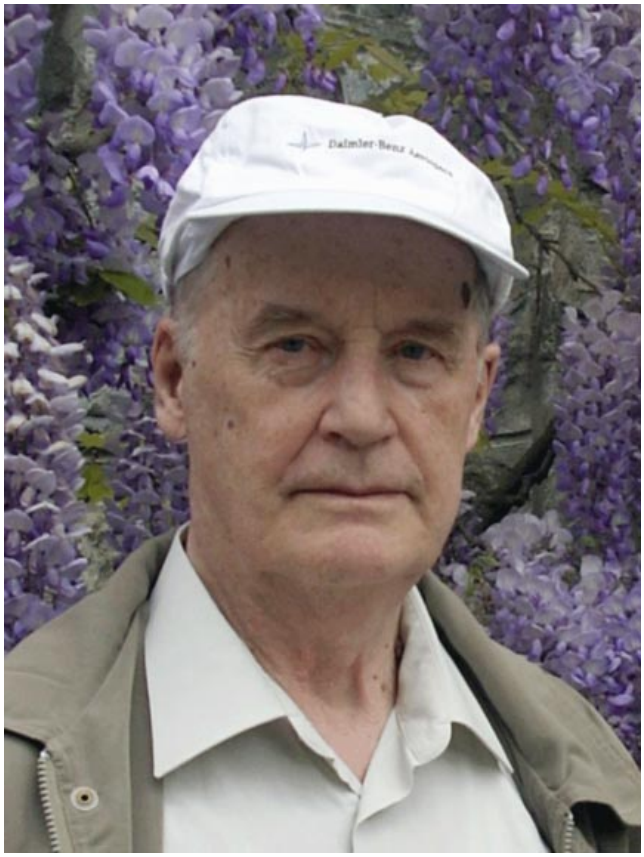
The twenty-third of May 2017 was the 90th birthday of the outstanding Russian physicist and the Corresponding Member of the Russian Academy of Sciences (RAS), Vladimir Ivanovich Ritus.

Vladimir Ivanovich was born in Moscow into the family of research workers of the Timiryazev Academy of Agriculture. Having successfully finished the first year at the Moscow Aviation Institute in 1945, Volodya transferred to the Faculty of Physics of Lomonosov Moscow State University. He did his diploma work at the Lebedev Physical Institute of the USSR Academy of Sciences (FIAN) in the laboratory headed by I M Frank. The coincidence system of scintillation counters designed by him and the measurements of the angular correlation of cascade γ-quanta of nuclei already revealed all the features of the thoroughness and meticulousness inherent in Ritus. Unfortunately, this work was classified as secret and not published, while at the same time a similar work by the well-known American authors E L Brady and M Deutsch appeared in *Phys. Rev.* **78** 558 (1950). The results of these studies for same nuclei coincided. Naturally, when he graduated from the Faculty of Physics, he was recommended to and entered the postgraduate study at FIAN. However, five months later, his postgraduate course was stopped short and Vladimir Ivanovich was sent to the then secret town of Sarov to KB-11. It turned out that, without informing Ritus, M A Markov recommended him to I E Tamm as a candidate to be included in the group organized by Igor' Evgen'evich at the Design Bureau KB-11 for performing the governmental program of creating a thermonuclear weapon.

In about a year of work with I E Tamm and A D Sakharov, at the request of Sakharov and according to his plan Vladimir Ivanovich drew up the mathematical task for L D Landau's and A N Tikhonov's groups for a detailed computation of the physical processes and the energy release in our first thermonuclear bomb 'sloika', code-named RDS-6s. Needed for this purpose were the results of the preliminary studies undertaken by Vladimir Ivanovich and his colleagues of the efficiency of U^{238} fission by neutrons from dd and dt reactions, the calculations of neutron ranges in deuterium and lithium, and the estimations of energy release in the 'sloika' depending on the lithium-6 and tritium concentrations. After the successful test of 'sloika' in August of 1953 V I was awarded the Stalin Prize for the theoretical calculations of RDS-6s.

In March of 1955, not long before his departure from KB-11, V I made a new fundamental proposal concerning the use of ^{6}LiD thermonuclear fuel, namely, a *double implosion* of the main thermonuclear charge by radiation from not only an atomic bomb, but also a small thermonuclear charge. This proposal concerning the physical scheme of thermonuclear charges was realized in the construction of future explosives (see document No. 140 in *Atomic Project in the USSR* Vol. 3, Book 2 (Moscow: Nauka, 2009)).



Vladimir Ivanovich Ritus

In 1955, I E Tamm succeeded in returning V I Ritus to the Theory Department at FIAN headed by him. Here, V I joined on the calculations performed by I E Tamm of pion–nucleon interactions with allowance for isobaric states. He calculated the cross sections of π meson photoproduction and photon scattering by nucleons with allowance for isobaric states. To this end, he elaborated the corresponding angular polynomials-matrices (Ritus polynomials) used efficiently in studies of reactions with polarized particles.

In the 1960s, V I, together with A I Nikishov, found the probabilities of the main quantum-electrodynamic processes in the field of an arbitrarily intense plane electromagnetic wave. The probabilities in any external electromagnetic field were shown to be reduced in the relativistic case to the probabilities in a plane-wave field. Solutions of the Dirac equation with such a field (Volkov's solutions) are rather simple, which paves the way for analytic calculations.

The probabilities of neutrino-pair photoproduction on an electron and the power of photoneutrino radiation in a high-temperature and high-density electron gas found by V I in

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1961 showed the important role of this process in star energy balance and especially in supernova explosions.

Following the classical works by Heisenberg and Euler, Fock, and Schwinger, V I found the two-loop intense-field Lagrangian. He revealed the relation between the asymptotic behavior of this function in the limit of a strong field and the asymptotic behavior of the polarization operator in high-momentum limit and thus established the relation between the intense-field quantum electrodynamics (QED) and quantum electrodynamics at small distances.

Then V I calculated the mass operator of the electron in a constant field of the general form, when both field invariants are nonzero. This turned out to be possible owing to the complete set of matrix eigenfunctions of the Dirac operator with an external field, found by him. The E_p-function method due to Ritus is a standard in the study of problems with a constant electromagnetic field.

V I found the electron-mass shift and splitting (in spin degrees of freedom) and the field-induced electric moment of the electron.

Together with S L Lebedev, he found the radiative corrections to the probability of e^+e^- pair production by the electric (plus magnetic) field.

The dispersion relation for the intense-field Lagrangian derived by Lebedev and Ritus in 1978 was in the context of the relationship between QED in an intense field and that at small distances. It is a certain analogue of the Kallen–Lehmann spectral representation for the photon Green's function.

Together with V O Papanyan, V I Ritus calculated the polarization tensor of three-photon interaction in a crossed field, responsible for the photon splitting in the field into two photons and the inverse process of coalescence of two photons into one. In these calculations, photons are not thought of as located on the mass surface, and so the result can be used in the calculation of more complicated diagrams in higher approximations and processes. The photon splitting effect plays an important role in the models of generation of neutron star (pulsar) radiation.

In a series of studies on elementary particle physics and electrodynamics, V I Ritus established a dual relation between photon emission by a point electric charge accelerated in an ordinary four-dimensional world and scalar quantum pair production by a point mirror accelerated in two-dimensional spacetime. The corresponding spectra of photons and pairs coincide not only functionally but also exactly if, as sources are point-like, the charge is thought of as bare one with the fine-structure constant $\alpha_0 = 1/4\pi$. Thus, the discovered duality can be regarded as a holographic principle of bare charge quantization. The result $\alpha_0 = 1/4\pi$ satisfies all three conditions pointed out by Gell-Mann and Low for a finite bare charge. Moreover, it is owing to the value of $\alpha_0 = 1/4\pi$ that the ratio $\alpha/\alpha_0 \equiv 4\pi\alpha$ of the fine-structure constant α to the bare one, which has the physical meaning of the inverse permittivity of vacuum, finds itself between two geometrical constants: $\alpha_L < \alpha/\alpha_0 \equiv 4\pi\alpha < \alpha_B$, which can be assigned the meaning of approximate values of inverse permittivity measured by the spherical (α_B) and cubic (α_L) cavities.

Indeed, the Poincaré-invariant constants α_B and α_L unambiguously determine the energy shifts of zero-point fluctuations of an electromagnetic field in a vacuum by conducting shells of the sphere and cube. They were calculated in 1968-1978 by a number of well-known authors, first of all Boyer and Lukosh. The values of α_B and α_L differ by less than 0.8%, while $\alpha_0\alpha_L$ and α by less than 0.05%:

$$\alpha_0\alpha_L = \frac{1}{4\pi}\frac{\pi}{16}\left[1 - \frac{1}{\pi^3}\sum_{m_1,m_2,m_3=-\infty}^{\infty\prime}(m_1^2+m_2^2+m_3^2)^{-2}\right]$$

$$= 1/137.101\ldots, \quad \alpha = 1/137.036\ldots$$

(for more details see *Usp. Fiz. Nauk* **183** 591 (2013); *Journal of Russian Laser Research* **36** 101 (2015)).

Importantly, all the constants α_0, α_L, and α_B are of purely geometric origin because they were obtained from solutions of the Maxwell equations and of the equation for a massless quantum spin-zero field, and also the dual relationship between them and geometric boundary conditions. Thus, the studies carried out by V I Ritus substantially confirm Dirac's opinion on the geometric origin of the fine-structure constant and Casimir's idea of a possible relation between this constant and zero-point oscillations of the electromagnetic field in vacuum.

One cannot but notice the reliability and elegance of the results obtained by V I Ritus.

V I Ritus pays considerable attention to scientific organizational work; he is member of several academic councils, an active member of the Editorial Board of the journal *Uspekhi Fizicheskikh Nauk*, a member of the Bureau of the Physical Sciences Division of RAS, and one of the judges for awarding I E Tamm and D V Skobel'tsyn Gold Medals of RAS.

V I Ritus was awarded the USSR State Prize, I E Tamm Prize of the USSR Academy of Sciences, and S I Vavilov Gold Medal of the Russian Academy of Sciences. He is a knight of the Order of Honor.

Many colleagues who are working now and were working earlier with V I nourish a special feeling for him, for he is a deserved representative of the generation of the Russian scientific intelligentsia of the first half of the 20th century, intellectual toilers for whom scientific work was the form of their existence, and the concept of honor was inherent. It is not accidental that his teachers were Igor' Evgen'evich Tamm and Andrey Dmitrievich Sakharov. Although not all of V I's works are always immediately clear and sometimes one may disagree with the interpretation of some of his results, one never doubts that each of V I's studies is sure to be a deep and thorough high-quality study of Nature (which is not always fashionable now).

V I Ritus won general respect for his exclusive goodwill, readiness to help, and his modesty and self-criticism.

We wish Vladimir Ivanovich sound health, well-being, and creative longevity!

B M Bolotovskii, M A Vasiliev, B L Voronov,
A V Gurevich, K P Zybin, N S Kardashev,
A I Nikishov, M A Solov'ev, S M Stishov,
I V Tyutin, V E Fortov, A E Shabad