



Ivan Todorov

Scientist, teacher, personality

Mathematical QFT

Sofia 2026



Family and Early Education

Born on October 26, 1933, in Sofia, Ivan grew up in a family of distinguished literary scholars.



His father, **Todor Borov**, was an eminent bibliographer and professor who pioneered Bulgarian library science. Before the war, he belonged to an intellectual circle of writers, poets, and academics. This home environment established a lifelong standard of broad culture, critical thinking, and intellectual freedom.

His younger brother, Tzvetan Todorov, became a prominent intellectual figure in France - a renowned linguist, philosopher, and literary critic. The ongoing intellectual dialogue between the two brothers maintained a constant bridge between Ivan's exact sciences and Tzvetan's humanitarian disciplines.



University Years (1951–1956)



Ivan Todorov was a student at the **Natural-Mathematical Faculty** (until 1944 - Faculty of Physics and Mathematics).

While his official specialization was Physics, the faculty was unified at the time, meaning the curriculum for theoretical physicists was heavily saturated with advanced mathematics. Ivan demonstrated a profound affinity for mathematics. He was part of a cohort of brilliant young students who participated in the legendary '**Tagamlitski circle (seminar)**'. **Yaroslav Tagamlitski** was a functional analyst who deeply influenced Todorov's later preference for using rigorous mathematical approach to solve physical problems.



ITT: Tagamlitsky introduced his students to new then concept of "generalized function", long before the monographs of Gelfand and Shilov made it popular. I am happy that as a student, I had the opportunity to experience the strong influence of a scientist who was not content with anything below the stars.

He graduated with a M.Sc. in Physics in **1956** with a thesis under the supervision of Tagamlitski:

“Spaces of Pseudofunctions and Application to the Theory of Linear Differential Operators”

Then he was appointed to the **Physics Institute** of the Bulgarian Academy of Sciences (**BAS**), where he joined the tiny at that time **Section on Theoretical Physics**.



Christo Christov, Bruno Pontecorvo

It was founded by the mathematical physicist **Christo Ya. Christov** (elected academician in 1961), the director of the Physics Institute and a head of the Department of Atomic Physics at the Sofia University; long-time professor at the University

During (1968-1970) Christov was a deputy director of the **Joint Institute for Nuclear Research (JINR)** in Dubna.

In May 1957 Todorov submitted to the Soviet Mathematical Journal (Uspehi Matematicheskikh Nauk) his first independent paper:

On One Uniqueness Theorem for the Wave Equation

(to the discussion V. A. Fok - F. I. Frankl)

Russian Mathematical Surveys XIII, 2 (80) (1958) p. 211-213.

The aim of the note : *"to show that it is possible to refine the formulation of V. A. Fock's hypothesis so that it is not refuted by the example given by Frankl"*.

In an article of (1956) F.I. Frankl gives an example that contradicts the statement formulated by V. A. Fok, a discussion between them followed. Later Frankl agreed that Todorov's reformulation saved the theorem.

ITT: Already from my student years, Professor Hristov paid attention to me and I owe a lot to him. Not everyone who showed talents and abilities was given a chance.

In 1958 by the recommendation and decision of Christov his brilliant young associate was sent to Dubna - initially for 2 years.

The "Dubna" Era 1958-1968 - Transition to Theoretical Physics



Todorov joined the Laboratory of Theoretical Physics (LTP) at the newly founded (1956) JINR in Dubna, the first international scientific research center for nuclear physics among the socialist countries, of which Bulgaria was a founding member. JINR's first director was Dmitry I. Blokhintsev, and the LTP was led by the great mathematician and theoretical physicist **Nikolay N. Bogolyubov**.

ITT: In January 1958 I arrived in the small town of the Volga river. Thus started my long term collaboration with the theoretical school of N.N. Bogolyubov

This period was presumably the “golden era” of JINR, Dubna and in particular for LTP. At the time, the Laboratory of Theoretical Physics was one of the most vibrant centers for theoretical physics in the USSR.

Due to his strong mathematical background Todorov very quickly became an active member of Bogolyubov’s theory group.



1960: Candidate of Sciences degree (PhD)
“Analytic Properties of Feynman Diagrams in Quantum Field Theory”

1962: his **son Todor** (Toshko) was born in Sofia

1963: Doctor of Sciences (DSci.) degree
“Problems of the Theory of Analytic Properties of Feynman Amplitudes” (in Russian)

1967: Corresponding member of the Bulgarian Academy of Sciences

Rigorous mathematical treatment of the analytic properties of scattering amplitudes.

ITT: In the 1960s, which I remember with fondness, there was talk of physicists and lyricists. I think there has always been a kinship at some deep level. Both mathematics and music, and physics and fine arts, and even religion.

The **House of Culture “Mir”** provided a stage for poetry recitals, theater plays, bards performances and classical music concerts. Avant-garde poets and writers, who faced censorship or political pressure elsewhere were regularly invited to perform.

V. Vysotsky, B. Okudzhava, A. Galich

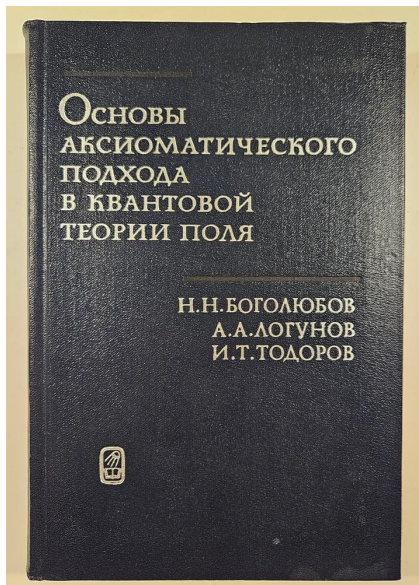
A. Voznesenski, theatre “na Taganke”, I. Smoktunovsky

S. Richter, M. Rostropovich, D. Oistrakh

Legendary chess champions visited Dubna, e.g. M. Botvinnik, D. Bronstein, V. Smyslov, M. Tal, T. Petrossyan, P. Keres



Boris Spassky 1962



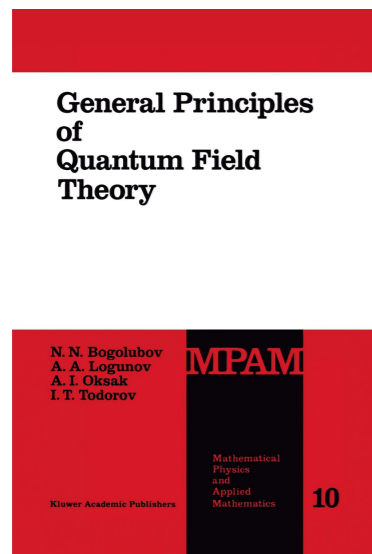
N.N. Bogolyubov, A.A. Logunov, I.T. Todorov,

Osnovy aksiomaticheskogo podkhoda v kvantovoy teorii polya,
Nauka (1969)

English edition:

Axiomatic Quantum Field Theory, W. A. Benjamin (1975)

This monograph is his most influential joint work. Along with other axiomatic approaches, it provides a comprehensive and rigorous mathematical foundation for QFT, moving away from the heuristic methods of earlier Lagrangian approaches to a set of formal axioms.



N.N. Bogolyubov, A.A. Logunov, A.A Oksak, I.T.
Todorov,

Obshchie printsipy kvantovoy teorii polya
(1987)

English edition:

General Principles of Quantum Field Theory
(1990)

Group-theoretical approach

He attended I.M. Gelfand's famous Monday seminar at Moscow University. After hearing Todorov lecture on "dynamical symmetries" in Yalta in 1966, Gelfand invited him to co-author a book on group representations and their applications in physics, alongside himself and M.I. Graev.

Visiting scientist at the **International Centre for Theoretical Physics (ICTP)**, Trieste, **Institut des Hautes Etudes Scientifiques (IHES)**, Bures-sur-Yvette, **Institute of Advance Studies (IAS)**, Princeton

Collaboration with **Gerhard Mack**



I. T., Todorov, **Discrete Series of Hermitian Representations of the Lie Algebra of $U(p,q)$** , ICTP, Trieste, preprint IC/66/71

G. Mack and I. T. Todorov, **Irreducibility of the Ladder Representations of $U(2,2)$ When Restricted to Its Poincaré Subgroup**, *J. Math. Phys* (1969)

1967 : Corresponding Member of the Bulgarian Academy of Sciences

Princeton 1968-1970

Collaboration with **Claude Itzykson, Vladimir G. Kadyshevsky**

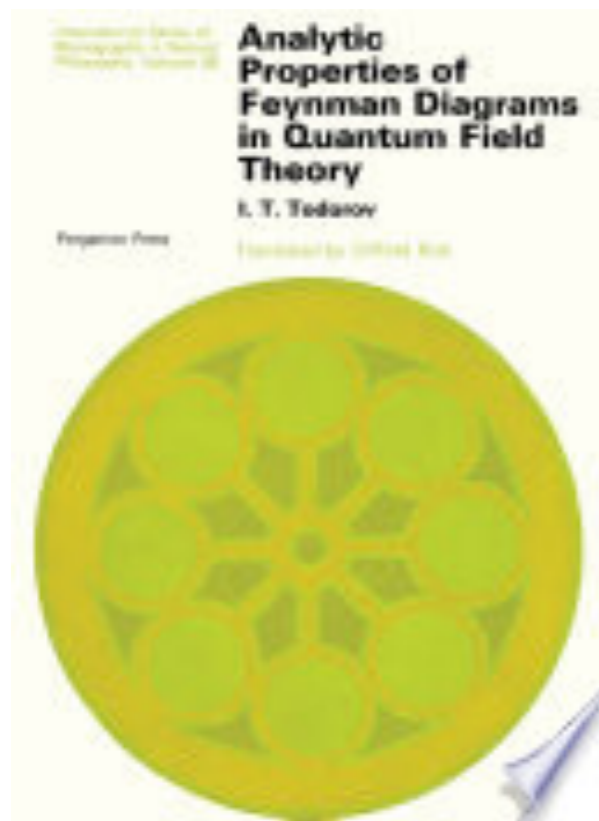


Quasipotential approach: A relativistic generalization of the nonrelativistic integral Lippmann–Schwinger equation applied to two-body problems, originally initiated by Logunov and Tavkhelidze

C. Itzykson, V.G. Kadyshevsky, IT Todorov, **Three-dimensional formulation of the relativistic two-body problem and infinite-component wave equations**", *Phys. Rev. D* (1970)

I.T.Todorov, **"Quasipotential Equation Corresponding to the Relativistic Eikonal Approximation"**, *Phys.Rev. D* (71) (completed in Princeton)

Todorov derived a remarkably clean, local, three-dimensional relativistic wave equation for two interacting particles (known historically as the "**Todorov Equation**"). It significantly simplified the notoriously complex 4D Bethe-Salpeter equation.



I.T. Todorov, **Analytic properties of Feynman Diagrams in Quantum Field Theory (1971)**, Pergamon Press (Princeton 1970)

(Extended edition of the book in Russian (1966, Sofia, BAS))

The monograph is one of the world's first original, rigorous, and comprehensive studies in this "classical" field of perturbative quantum field theory, including the proposed method for proving the analyticity of Feynman diagrams of arbitrary order in perturbation theory across broad regions in momentum space. At the time, these results attracted the immediate interest of one of the "patriarchs" of 20th-century elementary particle physics T. Regge.

Sofia 1971- 1989

1972: Institute for Nuclear Research and Nuclear Energy (INRNE)

Founded by Academician Ch. Christov - its first director until 1988

“Theory of elementary particles” (TEP). Nearly two-thirds of the members were under 30 years old

Todorov returned to Sofia in the spring of 1971, choosing not to build his career abroad. With an enthusiasm that deeply inspired the younger generation of physicists at the time, he founded a workshop on Quantum Field Theory (which remains active to this day under a new name). It was initially launched as an adjunct workshop to the regular seminar led by Academician Ch. Christov.

It stands as the only seminar at the INRNE to have been held weekly and consistently for nearly fifty years. To this day, its schedule and location remain constant: **Thursdays at 1:15 PM in Room 300** of the main INRNE building.



The seminar's **aim** was to focus on concrete problems, work in progress, and reviews of important results, alongside sharing information on new preprints or recent conference talks. The title itself remained tentative, allowing it to cover a broad spectrum of areas across theoretical and mathematical physics.

Participants: broad circle of physicists and and mathematicians, including undergraduate and PhD students, who participate in the seminar as both listeners and presenters. Foreign speakers at this seminar number over 130 from nearly 30 countries.

From 1072 as an extension of the seminar TEP started organising **international conferences/schools** - Gyulechitsa (Rila mountain) , Primorsko, Varna

ITT: *About the seminar - I think, I have a feeling, that it is my most significant work.*

interview October 2023

1974: Full Member of the Bulgarian Academy of Sciences (Academician)

This famous seminar laid the foundation for the creation of the internationally recognized Bulgarian school of mathematical physics, many of whose members work both in Bulgaria and at a number of prestigious scientific institutes and universities around the world.

He brought back not only a vibrant, inspiring working atmosphere—fueled by a curiosity for new ideas and developments in modern theoretical physics—but also a clear sense of direction regarding which problems were truly worth pursuing. Furthermore, he introduced the high standards of research quality accepted in global science."

Ivan Todorov profoundly shaped the lives of an entire generation of young physicists, inspiring their purpose and helping them achieve world-class excellence. He celebrated the achievements of his students and took genuine delight in every success of a Bulgarian physicist or mathematician, whether at home or abroad.

For many years, **he** delivered lectures to undergraduate and graduate students on various topics in theoretical physics at the Faculty of Physics of Sofia University 'St. Kliment Ohridski,' and supervised numerous Master's and PhD theses

ITT: The connection with the University was also established by Prof Christov. It was supported by the optional courses that I taught for many years at the faculty. The lectures touched on the topics on which we worked, and were attended by active participants of the seminar.

Ivan Todorov worked at numerous scientific institutes around the world, including the Institute for Advanced Study in Princeton, New Jersey (1968–1970 and 1974–1975); the Massachusetts Institute of Technology (**MIT**); the Joint Institute for Nuclear Research in Dubna, Russia; the Institut des Hautes Études Scientifiques (IHÉS) in Bures-sur-Yvette near **Paris**; and the Erwin Schrödinger International Institute for Mathematics and Physics in **Vienna**, as well as giving talks and lectures at numerous international conferences

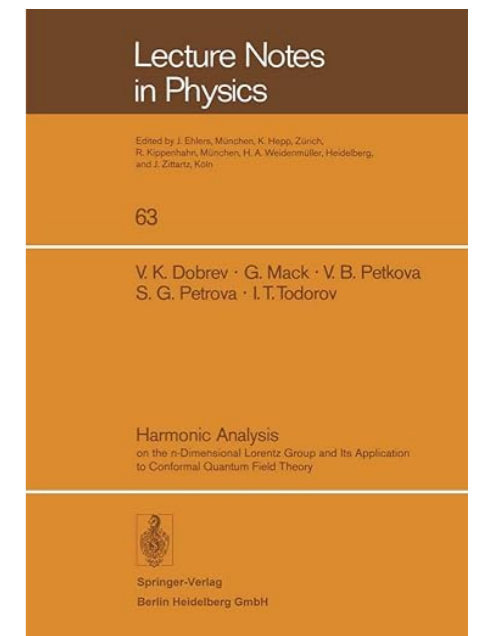
- I. Todorov, V. Rizov, “**The two-body problem in quantum theory**”, Nauka i Izkustvo (1974) (in Bulgarian, English summary; A modern textbook on relativistic quantum theory for advanced undergraduate and PhD students in Bulgarian academic and scientific literature.
- Conformal field theory

ITT: *While at the ICTP I learned from Mack about the extinguisher new work of Polyakov and Migdal in Moscow: 2- and 3-point functions are determined by the conformal invariance alone; combined with the Schwinger-Dyson equations they may serve as a starting point of a non-perturbative approach to conformal QFT.*

G. Mack, G. and I.T. Todorov, “**Conformal-Invariant Green Functions Without Ultraviolet Divergences**”, Phys. Rev. D (1973)

“**Harmonic Analysis of the n-Dimensional Lorentz Group and Its Application to Conformal Quantum Field Theory**”,

V.K. Dobrev, G. Mack, S.G. Petrova, V.B. Petkova and I.T. Todorov,
Lecture Notes in Physics (63) (1977)



The monograph later received renewed attention following the development of the gauge-gravity duality

- V. Bargmann and I.T. Todorov, ***Spaces of analytic functions on a complex cone and symmetric tensor representations of $SO(n)$*** , J. Math. Phys. (1977)
- Two-dimensional CFT

ITT: *The years 1984-1986 have been, perhaps, the most productive in my life.*

Teaching a class in MIT (where the best students were Asians), I realised that we had no reason to be shy about the quality of our pupils (and of the quality of our education) at the University of Sofia.

V.G. Kac, I.T. Todorov, ***Superconformal current algebras and their unitary representations***, Comm. Math. Phys. (1985)

Detlev Buchholz, Gerhard Mack, Ivan Todorov, ***The current algebra on the circle as a germ of local field theories***, Nucl. Phys. B, Proceed. Supplements (1988)

P. Furlan, G. Sotkov, I. Todorov, ***Two-Dimensional Conformal Quantum Field Theory***, La Rivista del Nuovo Cimento, vol.12, no.6 (1989)

1985: his daughter Haritina (**Tincheto**) (1985-2000) was born in Boston

Popularizer of science

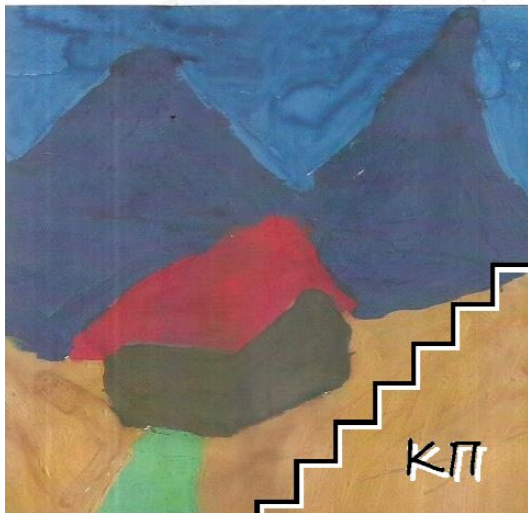
ITT: My interest in science has always been intertwined with my interest in scientists.

Numerous popular essays presenting an original, deep and instructive read of the life and work of great scientists - physicists and mathematicians - some published regularly in the magazine “World of Physics”, publication of the Bulgarian Union of Physicists, some - as arXiv preprints.

Some collected in his last book **"Science, personalities, experienced"**, 2014

Наука, личности,
преживяно

ИВАН ТОДОРОВ



*ITT: Not every popularization is a blessing. Some create a false image of science. How can one - at a time when school science education has declined - talk about the subject without misrepresenting it? My choice was to talk about the people behind the science. To do this right, if you don't know the person you are writing about, you must delve so deeply into their writings, life, and letters that you feel you know them personally. Everything you write must be **truly experienced** for it to come alive on the page.*

The poet and lecturer at Sofia University **Ani Ilkov**: This is a book about the stoically sustained wisdom, both in science and in everyday life”.

Sofia 1990-2025

Immediately after 1989, BAS faced severe pressure to reform. With the adoption of the new Law on BAS, the Academy gained autonomy, but its budget and staff were drastically slashed.

Ivan Todorov lived a long life. He remembered the wartime bombings of Sofia. He had also absorbed the spirit of the restless Russian intelligentsia during his stay in Dubna, and his social circle in Bulgaria was much the same. He was a dissenter all his life. He welcomed the democratic changes of 1989 with great enthusiasm, even bringing his old typewriter to the editorial office of the opposition newspaper *Demokratiya* (*Democracy*). Yet, with his independent and critical mind, the initial optimism of the years following November 10 faded. He became disillusioned, finding himself once again in opposition to the new authorities and their newly imposed doctrines.



In 2010 Ivan Todorov played a very active role in the campaign to save the Academy as a research center, reaching out to colleagues abroad to gather support for the international petition organized by his laboratory.

There is a **Postscript** in his 2014 book after a text, written **1980** and broadcasted then on BNR radio, criticizing excessive ill-considered education reforms.

*ITT: Alas, over the more than three decades since this article was written, schools have not become any better. Political privileges have been replaced by corruption and by the now-mandatory 'private tutoring' required to pass entrance exams for elite high schools. ... Idealistic teachers are a dying breed, and consequently, so are their pupils—young people ready to dedicate themselves to science and learning. We are beginning to look back at the school system of 30 years ago with nostalgia. The words of the Polish public figure and dissident **Adam Michnik** come to mind: 'The worst thing about communism is what comes after it.'*"

in his last interview -13.10.2023:

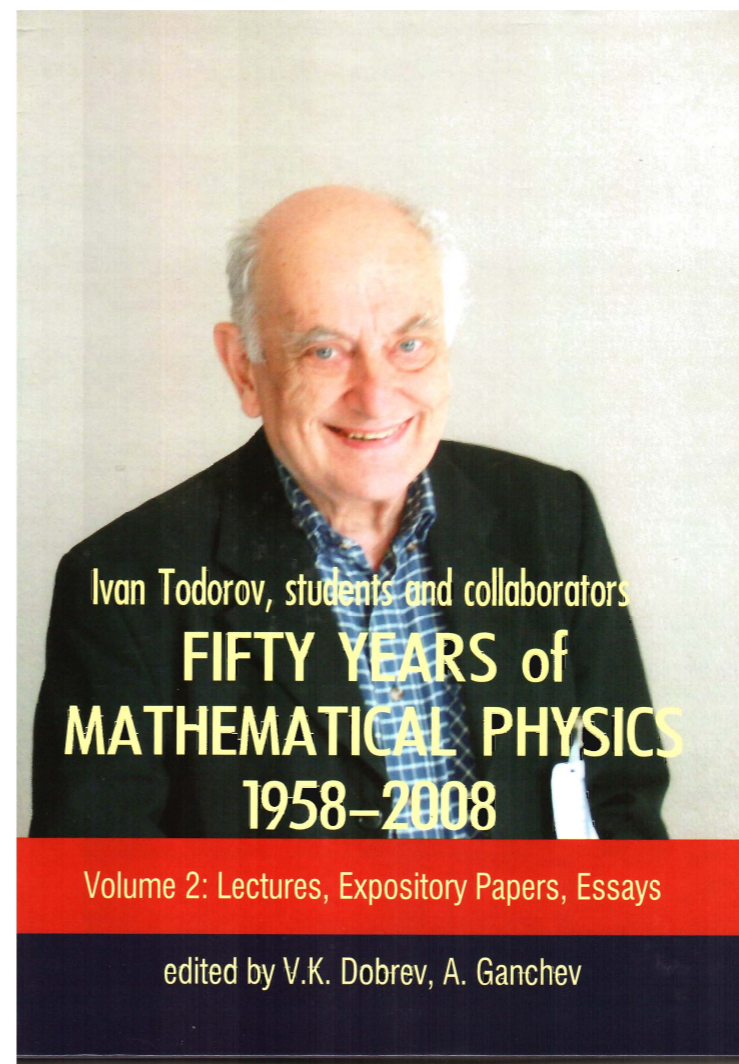
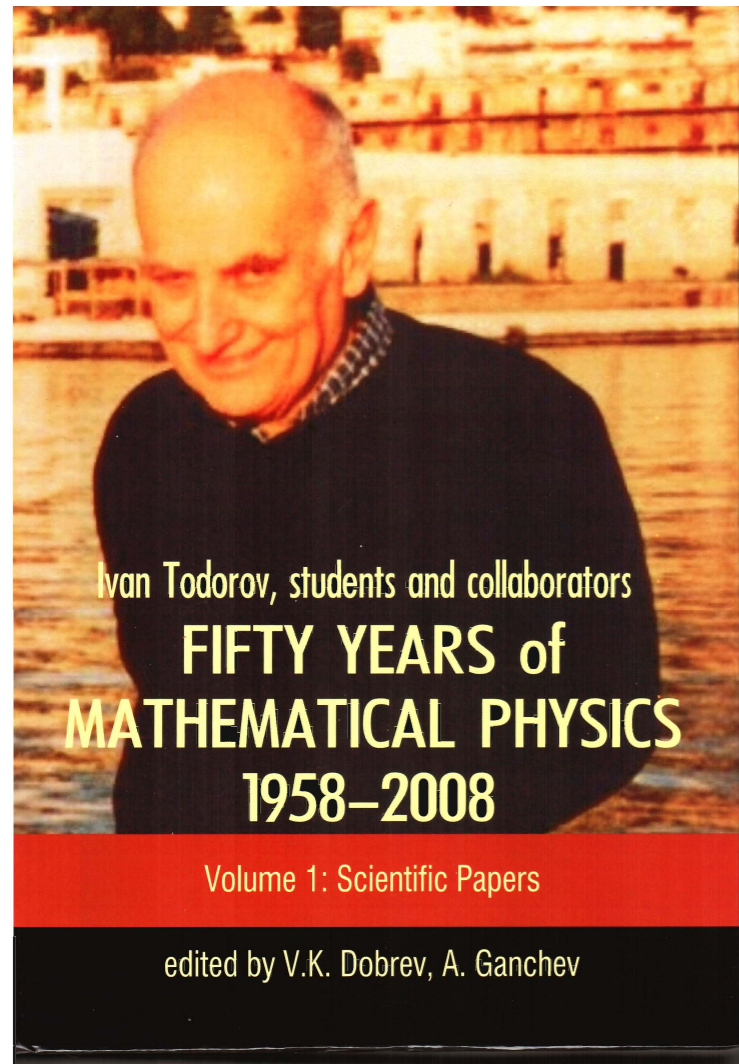
ITT: Bulgaria still has been taking one of the first places in mathematical Olympiads for students, for years. But these boys and girls, after their last year of high school, don't even enrol, they just go straight to American educational institutions.. ... And they disappear...

Main developments in the period

- New approach to CFT (N.M. Nikolov, K-H Rehren, B. Bakalov)
- CFT applied to quantum Hall states (A. Cappelli , L. S. Georgiev)
- Orbifolds (Bojko Bakalov, Jason Elstinger, Victor G Kac)
- Quantum groups (LK Hadjiivanov, A.P. Isaev, O.V. Ogievetsky, P.N. Pyatov, P. Furlan)
-
- Symmetry of the standard model (M Dubois-Violette, S. Drenska)

Ivan Todorov possessed an impressive scientific vitality; at the age of 85, he launched into an entirely new field of research, quickly achieving results that earned him invitations to seminars and conferences at the most prestigious institutes and universities.

On the occasion of his 75th anniversary, a two-volume edition was published, containing selected works of Academician Ivan Todorov as well as papers by his students.



“Over the past years, I have always admired the wonderful contributions—both your own and those of your collaborators so the idea of publishing them in the form of a two-volume collection is very fine. The volume of work you have accomplished as the leader of the remarkable School of Mathematical Physics you created is also impressive,” wrote the renowned Italian scientist **Franco Strocchi** from the Scuola Normale Superiore in Pisa.

Ivan Todorov was a gentle, polite man who would recoil in the face of rudeness, insolence, and aggression. At the same time, he defended his views calmly but firmly. For all his restraint, moderation, and gentleness, he did have rare emotional outbursts. He possessed an innate nobility, without a single drop of arrogance or snobbery.

He deeply felt and was pained by the problems in the Institute and the Academy - and escaped to poetry

ITT: Don't be upset!

I'm sending you the end of the poem 'Contemplation' (Stargazing) by Rilke (in Russian) translated by Pasternak:

In full awareness, at the peak of his strength,
He will no longer search for victories.
He waits to be defeated, more and more,
By something greater,
So that he may grow to meet it.

(В сознании и расцвете сил.
Не станет он искать побед.
Он ждет, чтоб высшее начало
Его все чаще побеждало,
Чтобы расти ему в ответ.)

Poetry, Osip Mandelstam

Ivan Todorov possessed a phenomenal memory; he could reproduce a complex mathematical theorem on the spot, or would quote a verse perfectly suited to the moment, often of his favourite poet Osip Mandelstam.

ITT: I am intentionally sending you Mandelstam's poem once again - give it another read. It is wonderful. The transition from "Leningrad" to the twice-repeated "Petersburg!", and not only that...

His reaction to the congratulations of his 1991 birthday:

ITT: For me, 9×10 is far more banal than 7×13 . And Mandelstam's eight-line poems are what free me from gloomy thoughts about academic affairs:

The vast universe in the cradle
sleeps near the tiny eternity.

(Большая вселенная в люльке
у маленькой вечности спит.)

ITT: We are fortunate to know Russian well so can enjoy the originals.

*ITT: Get well and **read poetry** (September 2024)*

The mountain



He loved the mountains endlessly and was grateful for every opportunity to go up to Vitosha




Boeritsa hut, Vitosha

He worked, quite literally, without pause. He would bring his notebook of 'calculations' - and later, his laptop—**even to the mountain**, filling the time by working at the Vitosha **mountain hut** while waiting for his younger colleagues to complete the hiking loop for which he no longer had the physical strength. Though exhausted, he worked until his very last day."

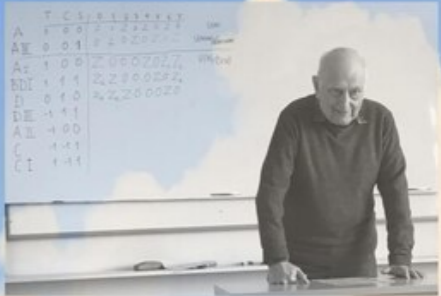
The second day of the celebration for the seminar's 50th anniversary (which in fact marked his **90th birthday**) was held at the **Boeritsa hut**. A copy of the poster still hangs on the wall of the hut today.”

50+ YEARS QFT SEMINAR at INRNE  

7-8 September, 2023, Sofia, Bulgaria



The Seminar "Quantum Field Theory" (Квантова теория на полето) at the Institute of Nuclear Research and Nuclear Energy has been started about half a century from now by Professor Ivan Todorov as a working weekly seminar. A commemorative event dedicated to the seminar will take place on 7th & 8th of September 2023.




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A ₁	1	0	0	1	1	1	1	1	1
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B	0	1	0	1	1	1	1	1	1
DE	1	1	1	1	1	1	1	1	1
AE	1	1	1	1	1	1	1	1	1
C	1	1	1	1	1	1	1	1	1
CI	1	1	1	1	1	1	1	1	1

Speakers:

Ivan Kostov
Kiril Hristov
Petko Nikolov
Serguey Petcov

On September 7th there will be talks and discussions at Hall 300 of INRNE starting at 13:15 – the standard place and time of the seminar each Thursday for many years.

On September 8th there will be a short excursion to Mountain Hotel "Boeritsa" (Vitosha) where the participants may have lunch together.



ITT: *I have been asked (and still hear) the question what has motivated me for years to lead a seminar and give lectures in Sofia (with sub-question: Could I not find a job abroad?). The truth is that **I like to share interesting news, it gives me pleasure to tell what I have learned.** The incentive to return, after having accumulated impressions and news from visited countries and institutions, was the belief that my story would be welcomed with interest in our country, that there were colleagues for whom my presence was necessary, communication with whom brought joy.*

*ITT: I had heart operations, two, and I had the experience of lying in a hospital, when one **can only console oneself with thoughts.** And when I found out that Gerhard Mack was in a serious condition and lying in a hospital, I wrote to him that even at 80 years old **we still have the pleasure of thinking.** And he wrote me an answer: “**Yes, the pleasure of thinking...!**”*

The pleasure of thinking!