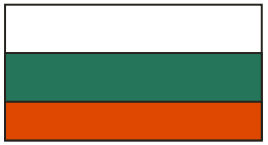
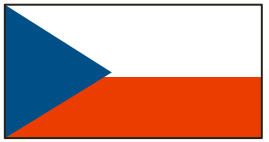
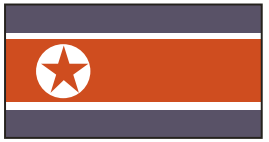
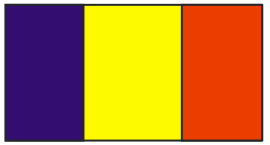
BOGOLIUBOV LABORATORY OF THEORETICAL PHYSICS









The agreement on the establishment of JINR was signed on 26 March 1956 in Moscow

Laboratory of Theoretical Physics, JINR

May 25, 1956

ПРИКАЗ

ПО ЛИЧНОМУ СОСТАВУ ОБ"ЕДИНЕННОГО ИНСТИТУТА

№ 5

"25" мая 1956 года.

До утверждения новой структуры Института возложить на академика БОГОЛЮБОВА Николая Николаевича /начальника сектора № 3 Теоретической лаборатории/ исполнение обязанностей директора Теоретической лаборатории об"единенного Института.

ДИРЕКТОР
ОБ"ЕДИНЕННОГО ИНСТИТУТА ЯДЕРНЫХ ИССЛЕДОВАНИЙ

Д.И. БЛОХИНЦЕВ

ПО ЛИЧНОМУ СОСТАВУ ОБ"ЕДИНЕННОГО ИНСТИТУТА

№ 6

"25" мая 1956 г.

ЗАЧИСЛИТЬ: 1. БОГОЛЮБОВА Николая Николаевича временно начальником сектора № 3 Теоретической лаборатории с окладом 6000 руб. в месяц, с 1 июня с.г.

2. ШИРКОВА Дмитрия Васильевича старшим научным сотрудником сектора № 3 Теоретической лаборатории с окладом 1500 руб. в месяц по совместительству, с 1 июня с.г.

3. МЕДВЕДЕВА Бориса Валентиновича старшим научным сотрудником сектора № 3 Теоретической лаборатории с окладом 1500 руб. в месяц по совместительству, с 1 июня с.г.

4. ПОЛИВАНОВА Михаила Константиновича научным сотрудником сектора № 3 Теоретической лаборатории с окладом 1000 руб. в месяц по совместительству, с 1 июня с.г.

ДИРЕКТОР
Б"ЕДИНЕННОГО ИНСТИТУТА ЯДЕРНЫХ ИССЛЕДОВАНИЙ

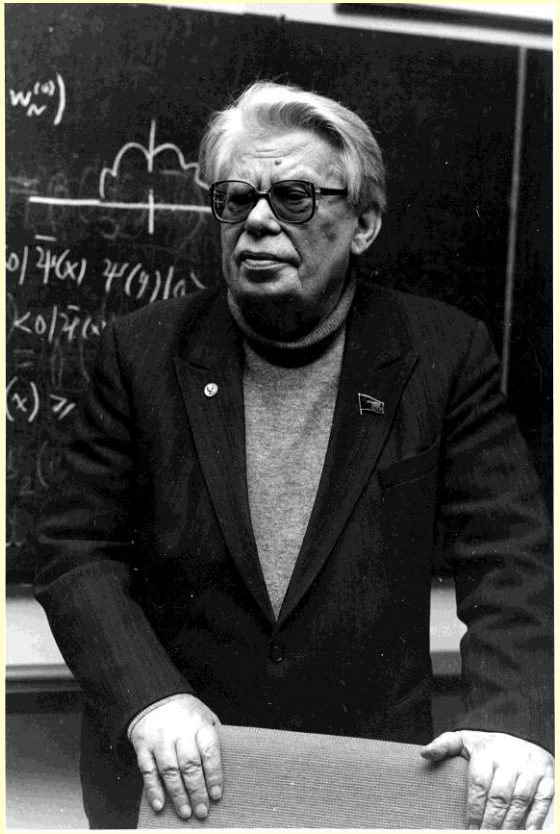
Д.И. БЛОХИНЦЕВ

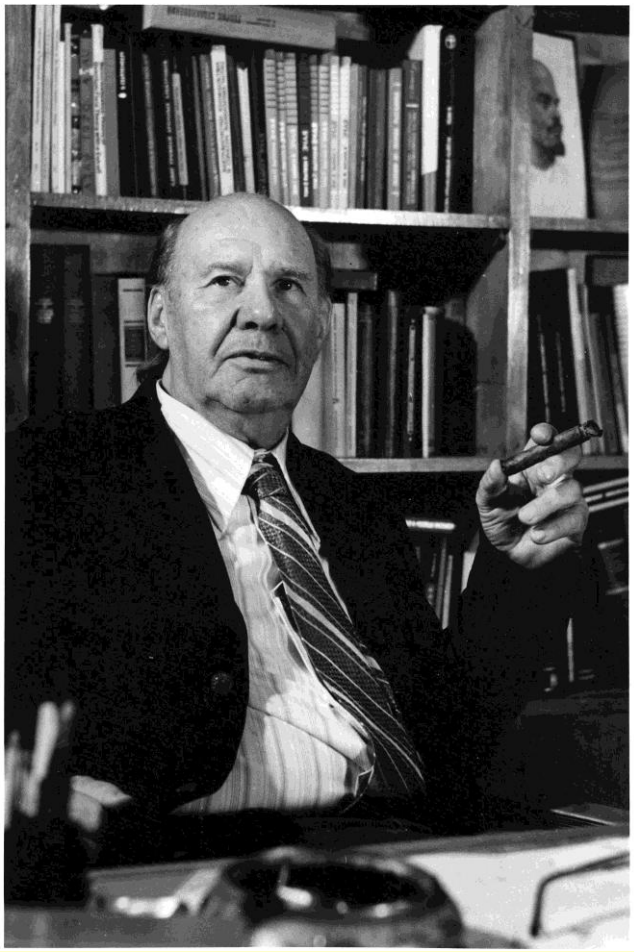
Nikolai Nikolaevich Bogoliubov (1909–1992) is a distinguished scientist in the field of physics and mathematics. His scientific activity began in Kyiv (1923–1947) and then continued in Moscow (since 1949) and Dubna (since 1956). Main scientific results in the fields:

- Nonlinear mechanics: asymptotic methods, stability theory ;
- Statistical physics: kinetic equations, quasiaverages for systems with spontaneously broken symmetries;
- Quantum statistics: microscopic theory of Bose-gas superfluidity, microscopic theory of superconductivity ;
- Quantum field theory: axiomatic scattering matrix, general renormalization theory, renormalization group theory, proof of dispersion relations;
- Elementary Particle Theory: "quark bag" model, quantum number "colour".

N.N. Bogoliubov's scientific activity began at the age of 14 –15. His major independent results were obtained when he was 20–25.

N.N. Bogoliubov's scientific activity is specified by considerable mathematical culture and directness to solution of concrete problems of natural science.





Dmitrii Ivanovich Blokhintsev (11.01. 1908 – 27.01.1979), one of the pioneers of atomic science and technology in USSR, the organizer and the first director of the JINR.

Main scientific results in the fields:

•Quantum mechanics

•Acoustics of an inhomogeneous moving medium

•Neutron physics

•Quantum field theory

•Paricle physics

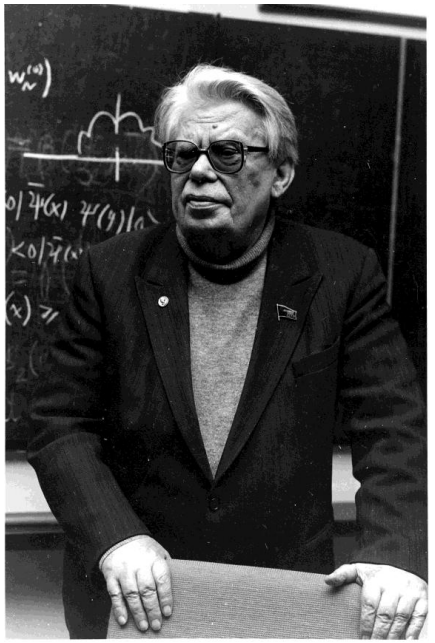
1954 – the scientific supervisor of creation and putting into operation of the world first atomic power station.

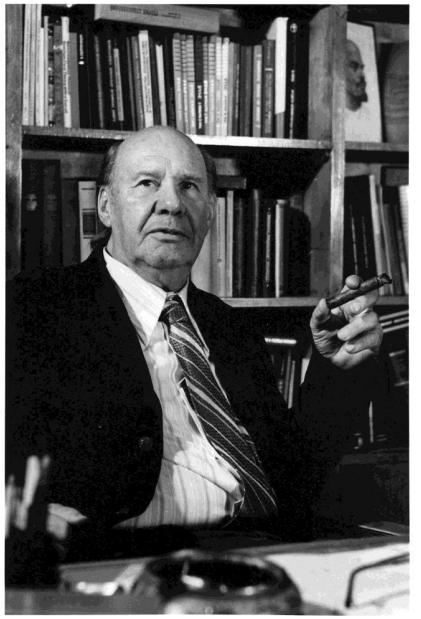
Initiated work on the creation of a nuclear rocket engine for space flights with S. P. Korolev

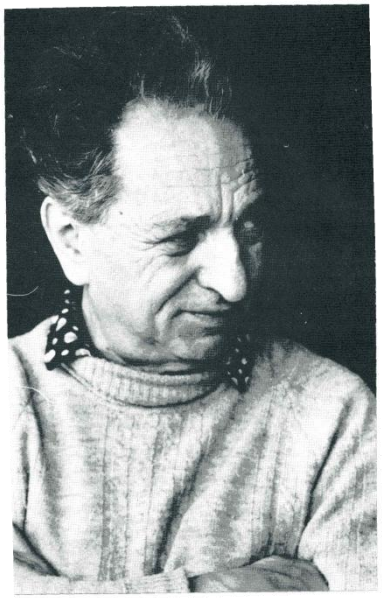
1960 – first pulsed reactor on fast neutrons

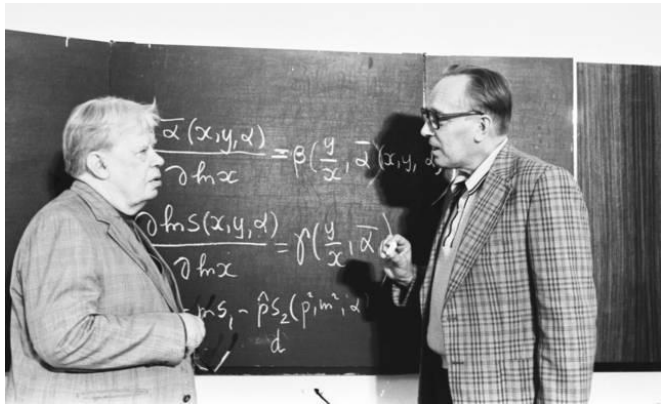
1956- 1965 – the JINR Director

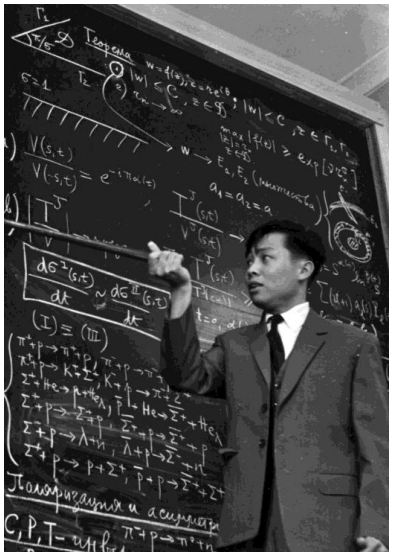
1965 – 1979 – Director of Lab of Theoretical Physics

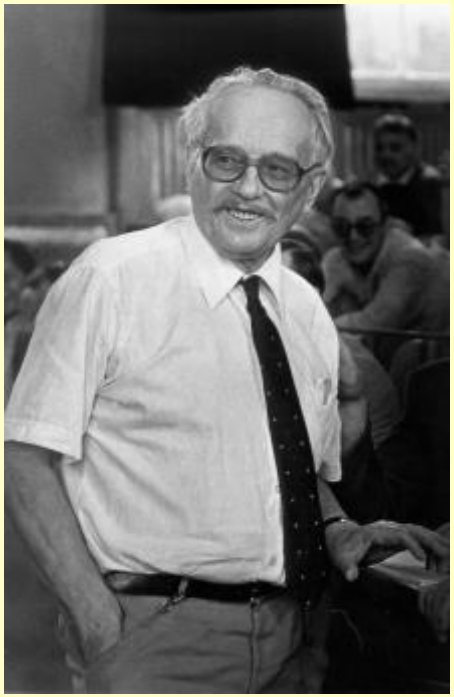


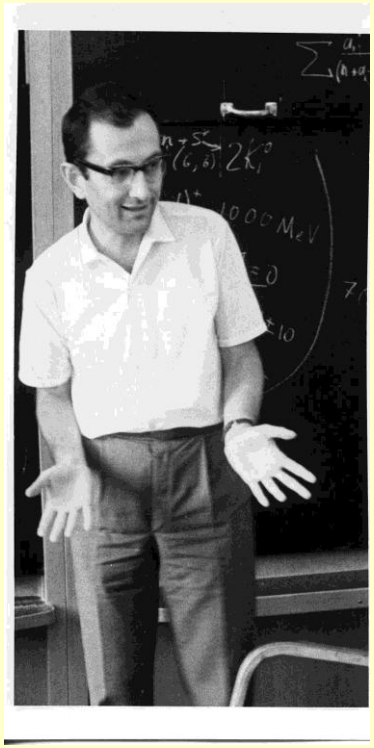


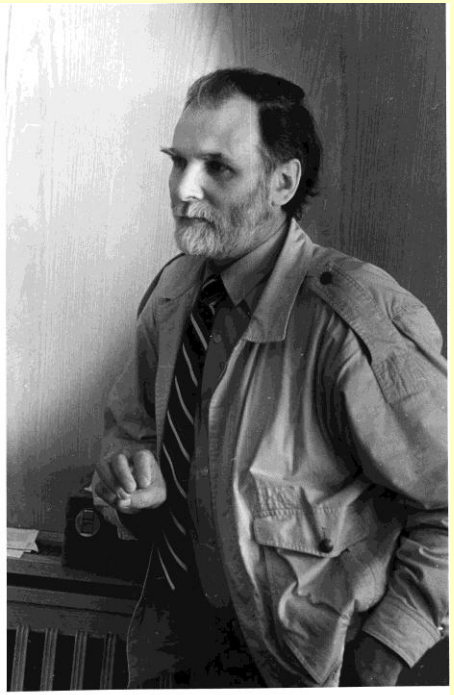


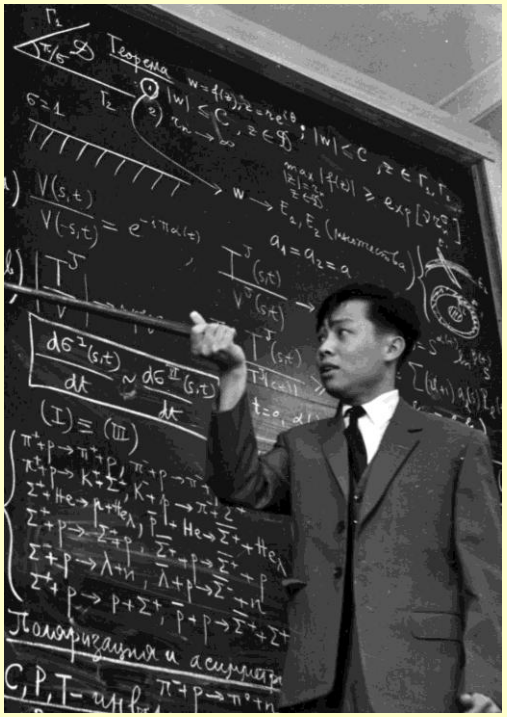


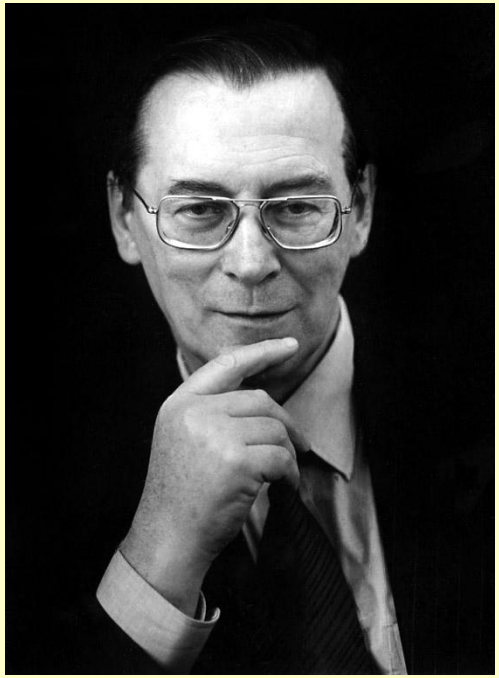


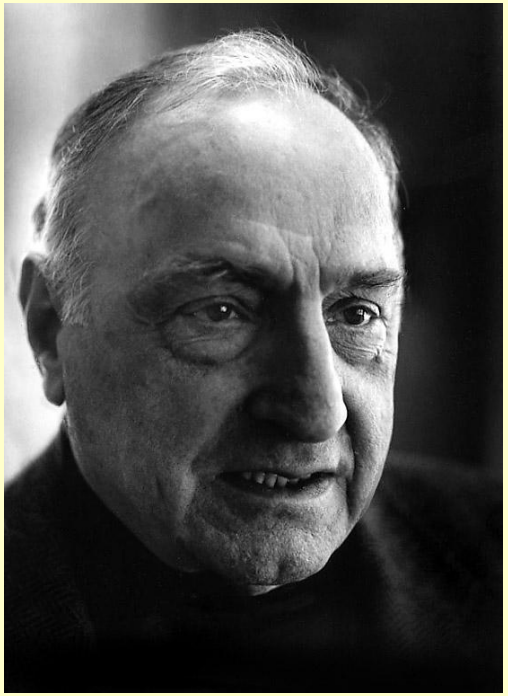


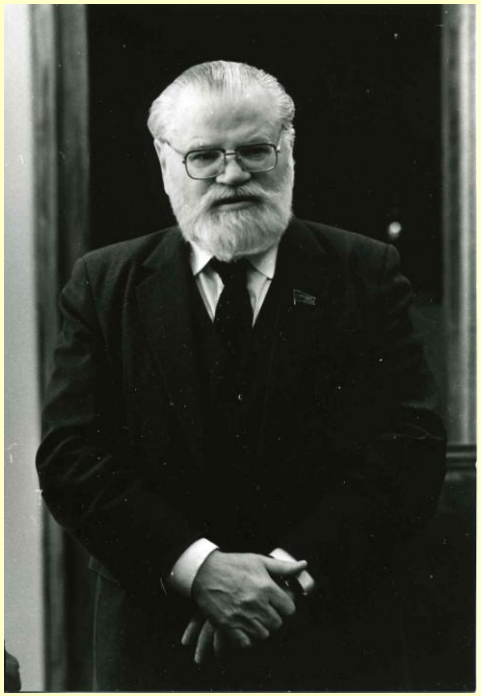




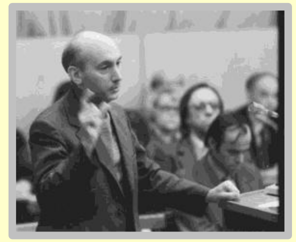


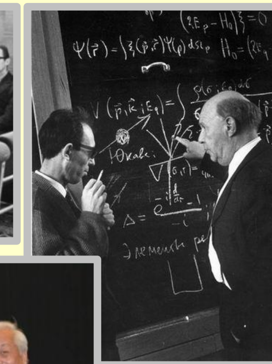














BLTP:
Fundamental Science
International Cooperation,
Education

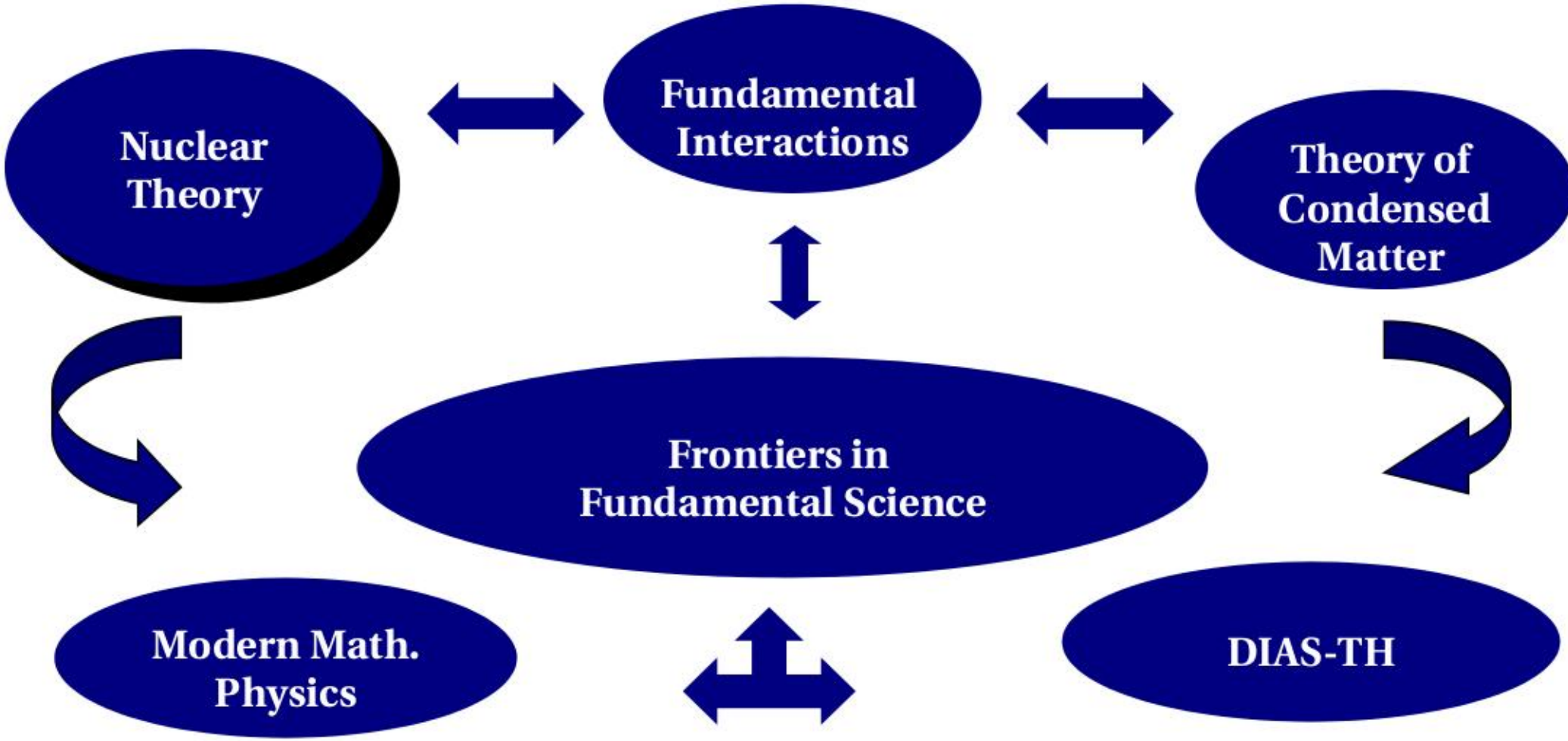




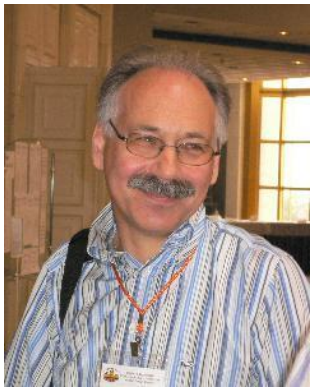



Scientific Policy:
Multidisciplinary research,
theoretical physics on the basis of advanced mathematics,
support of the JINR experimental programme,
strengthening of the efficiency of scientific staff through
the interplay of research and education.

Научная политика ЛТФ:
Междисциплинарные исследования,
Теоретическая физика на основе
современной математики,
поддержка экспериментальных программ ОИЯИ,
укрепление научного потенциала
через взаимодействие
науки и образования.



BLTP Directorate

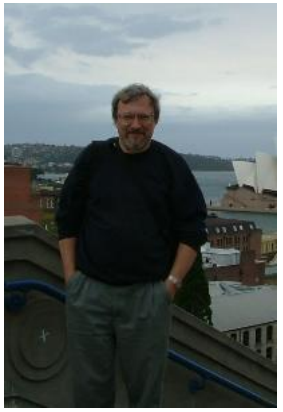


Director

Kazakov D.I.

Antonenko N.V.

Deputy director



Isaev A. P.

Deputy director

Hnatic M.

Deputy director

Andreev A. V.

Scientific secretary

Scientific Personnel

	D	C	O	Total
Fundamental Interactions	37	37	20	94
Nuclear Physics	27	29	7	63
Condensed Matter	15	16	5	36
Mathematical Physics	15	17	4	36
Total	94	99	36	229

+ 11 Aspirants (PhD students)

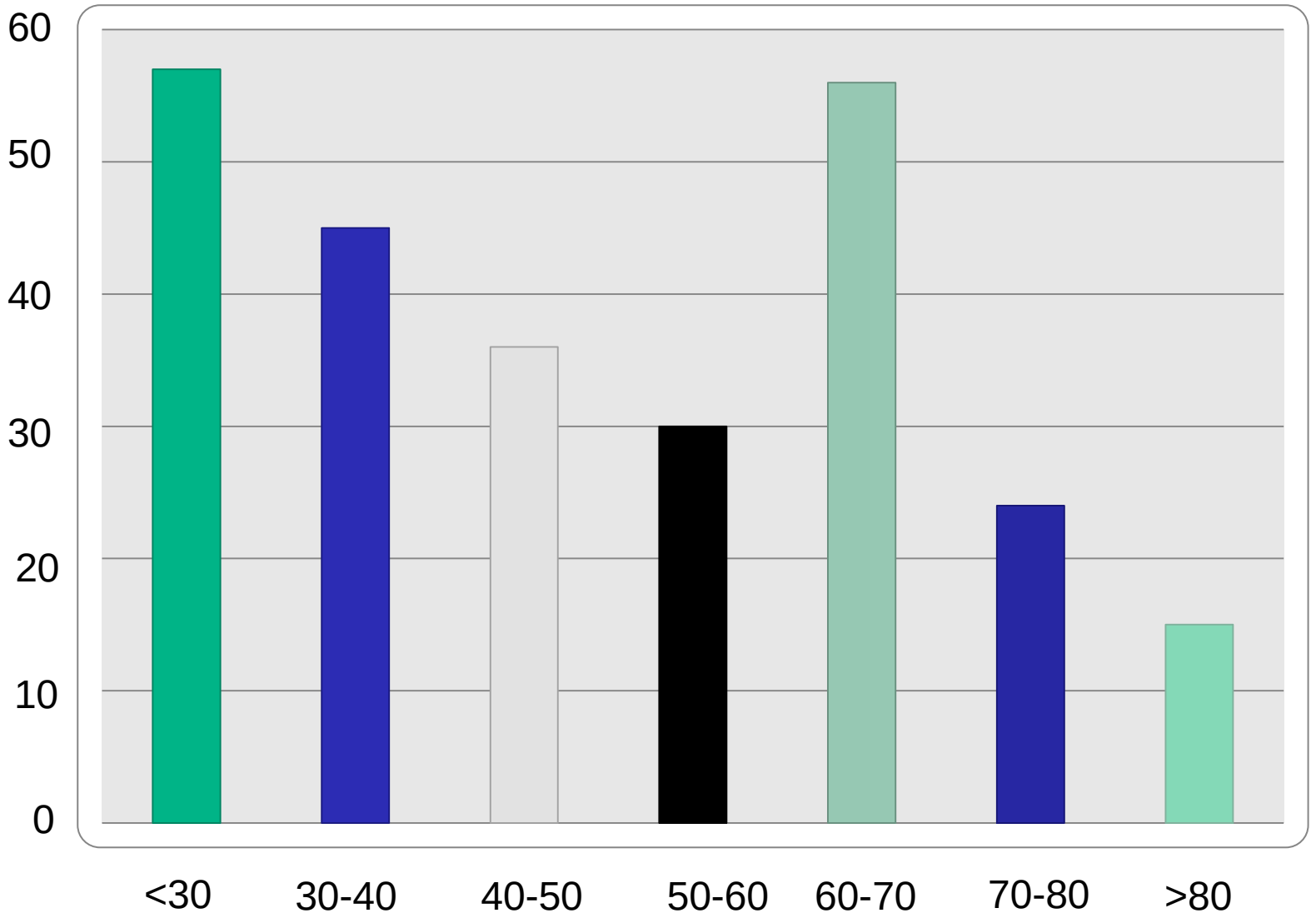
+ 15 Students

D – Doctor of Science (2nd degree)

C – Candidate of Science (PhD)

O – Other (no degree)

Scientific Personnel by Age



1/3 are young scientists (below 35)

Scientific Personnel by Country

Country	Total
Russia	169
Kazakhstan	17
Slovakia	11
Armenia	6
Ukraine	6
Belarus	5
Czech Republic	5
India	5
Poland	5
Vietnam	4
Bulgaria	3
Germany	3

Country	Total
Romania	3
Iran	2
Mongolia	2
Uzbekistan	2
Azerbaijan	1
China	1
Egypt	1
Japan	1
Mexico	1
Moldova	1
Tajikistan	1

Total 255 including students (169 from Russia and 86 from other countries)

Web of Science®

JINR publication statistics	
2012 – 2018	**2018**
Total number of publications: 8 873 Total number of citations: 109 733 Excluding self-citations: 81 960 Average citations per article: 12,37 h-index: 117	Total number of publications: 1 408 Total number of citations: 1 662 Excluding self-citations: 1 272 Average citations per article: 1,18 h-index: 16

2018: JINR in comparison with CERN	
JINR	**CERN**
Total number of publications: 1 408 Total number of citations: 1 662 Excluding self-citations: 1 272 Average citations per article: 1,18 h-index: 16	Total number of publications: 1 262 Total number of citations: 2 486 Excluding self-citations: 1 960 Average citations per article: 1,97 h-index: 17

BLTP PUBLICATIONS (2014-2018)

	2014	2015	2016	2017	2018	Total
Journal publications	331	327	313	334	345	**1650**
Conference proceedings	193	232	275	242	172	**1114**
Total	524	559	588	576	517	**2764**

2019-2023: Themes and projects

Fundamental Interactions of Fields and Particles

Projects:

- Quantum field theory and physics beyond the Standard Model
- QCD Parton Distributions for Modern and Future Colliders
- Strong interactions phenomenology and precision physics
- Theoty of hadronic matter under extreme conditions

Theory of Nuclear Systems

Projects:

- Microscopic models for exotic nuclei and nuclear astrophysics
- Low-energy nuclear dynamics and properties of nuclear systems
- Quantum few-body systems
- Relativistic nuclear dynamics and nonlinear quantum processes

Theory of Complex Systems and Advanced Materials

Projects:

- Complex materials and nanostructures
- Contemporary problems of statistical physics

Modern Mathematical Physics: Gravity, Supersymmetry and Strings

Projects:

- Quantum groups and integrable systems
- Supersymmetry
- Quantum gravity, cosmology and strings

Research and Education Project "Dubna International School of Theoretical Physics (DIAS-TH)"

Fundamental Interactions of Fields and Particles

Leaders: D.I. Kazakov, O.V. Teryaev

Further development of the **quantum field theory** approach in the framework of the Standard Model of fundamental interactions and its extensions. **Lattice simulations** for obtaining nonperturbative results in gauge theories. Elaboration of **multiloop calculations** in **QCD, Electroweak theory, and Minimal Supersymmetric Standard Model**. Theoretical predictions concerning the experimental observation of **supersymmetry**, the **Higgs boson,** investigation of the **spin structure of the nucleon**, T-odd spin effects, jet handedness, **heavy flavor physics**, **vacuum structure in QCD**, and **hadron properties in dense and hot media**. Elaboration of new **phenomenological models to describe the hadron dynamics** in the framework of general principles of quantum field theory incorporating basic experimental patterns. **Theoretical support** of current and future **experiments at JINR, CERN, GSI, DESY, IHEP and other physics centers**.

Theory of Nuclear Systems

Leaders: N.V. Antonenko, S.N. Ershov, A.A. Dzhioev

The main goals are to predict and analyze **properties of atomic nuclei beyond the stability valley** and investigate structure peculiarities of **superheavy and exotic nuclei;** to study dynamics of **nuclear collisions at low and intermediate energies** accompanied by production of stable as well as radioactive nuclides; to investigate fundamental properties of various **few-body systems** and develop **rigorous** and effective **mathematical methods** of calculations of their properties; to explore the dynamics of **particle-nucleus and nucleus-nucleus collisions at relativistic energies** and **nuclear matter properties** and its phase transitions **at extreme values of temperature and density**.

Theory of Complex Systems and Advanced Materials

Leaders: V.A. Osipov, A.M. Povolotskii

Multiparticle models of solids taking into consideration **strong electron correlations**, electron-lattice, and **spin interactions to describe spectra of quasiparticle excitations, phase transitions and kinetic phenomena in solids.** In **equilibrium and nonequilibrium media** with strong correlations, the processes of **multifragmentation, clusterization in phase transitions and the influence of surface effects** on properties of clusters. In the **theory of superconductivity, nonstandard mechanisms of pairing in metal-oxides,** the problem of bipolaron stability in a polaron gas environment, the influence of **strong electric fields and temperature gradients** on elastic, magnetic, and thermal properties of granular superconductors. For a study of mechanisms of phase transitions caused by charge, orbital, and **magnetic ordering in magnetic semiconductors and in metals with a large magnetoresistance**, experimental data obtained at the **Frank Laboratory of Neutron Physics**, JINR.

Nonlinear problems in multiparticle theory will be studied by using modern methods of the renormalization group theory, the **inverse scattering problem, fractal geometry, and the conformal field theory**. The main subjects of the study are integrable systems, equilibrium systems of the statistical mechanics, and **dissipative systems far from the thermodynamic equilibrium.**

The **microstructure of amorphous state** will be studied in the framework of the theoretical model where topological disorder is introduced via **arrays of disclination dipoles and loops**. The thermal properties of disclinated media are of primary interest. The electronic spectrum of **carbon materials, fullerenes and nanotubes,** will be examined within the field-theory models adapted to account for nontrivial geometry of these nanostructures. The model of **random Josephson junction arrays** will be studied and applied to describe **high-temperature granular superconductors.**

Modern Mathematical Physics: Gravity, Supersymmetry, and Strings

A.P. Isaev, S.O. Krivonos, A.S. Sorin, A.T. Filippov

Superstring Theory is the most serious and worldwide pursued candidate for a unified theory of all fundamental interactions including **Quantum Gravity** and thus it is the principal source of the problems which are the subject of modern mathematical physics. The development of the theory involves the study of its surprisingly wide spectrum of possible regimes, vacua and exact classical and quantum solutions. Furthermore, the theory has **applications in many directions including the nonperturbative regime of supersymmetric gauge theories, the mechanics and thermodynamics of black holes and cosmological models of the universe expansion.** These are unique laboratories to check general ideas from unified theories. In particular, in order to accommodate and develop the new ideas in these sectors inspired by String Theory, it is crucial to use the powerful mathematical methods provided by the **theory of Integrable Systems, Quantum Groups and Non-Commutative Geometry.** The goals of the present new theme precisely belong to the bridging between these fields and further development of suitable schemes to be applied in this context.

Dubna International Advanced School of Theoretical Physics (DIAS-TH)

V.V. Voronov, A.S. Sorin, A.T. Filippov

The Bogoliubov Laboratory of Theoretical Physics has a good record of organizing international workshops and schools in Dubna. **DIAS-TH organizes and supervises all educational programs for students, postgraduates, and young scientists at BLTP**. It should function continuously an**d the standard short schools (about 3-4 a year) should be organized coherently**. Other educational programs in Dubna such as the **JINR University Center correlate with DIAS-TH** (common programs on modern theoretical physics, workshops for students and young scientists, etc.).

“Govorun” Supercomputer is a project developed by the Bogoliubov Laboratory of Theoretical Physics and Laboratory of Information Technologies.

This project is aimed at sufficient acceleration of complex theoretical and experimental researches in the field of nuclear physics and condensed matter physics held at JINR **including NICA project**.

AGREEMENTS

- **BLTP – ICTP** (since ’88)
- **BLTP – Germany** (since ’91)

  Heisenberg-Landau Program
- **BLTP – INFN** (since XII ’95)

  6 month visits to Italy
- **BLTP – CERN-TH** (since XII ’95)

  3 month visits to CERN
- **BLTP – Poland** (since XII ’98)

  Bogoliubov-Infeld Program
- **BLTP – Czech Republic** (since XII ’99)

  Blokhintsev-Votruba Program
- **BLTP – Romania** (since XII ’03)

  Titeica-Markov Program
- **BLTP – APCTP, Pohang** (since ’07)
- **BLTP – Bulgaria** (since ’09)

  Soloviev-Khristov Program
- **BLTP – ITP CAS, China** (since VII ’10)
- **BLTP – IOP VAST, Vietnam** (since VIII ’11)
- **BLTP – Physical Inst., NAS, Armenia** (since ’09)

  Smorodinsky - Ter-Antonyan Program
- **BLTP- IMSc India** (since 2016)

Meetings in BLTP 2019

January 28 - February 1
XV Winter School on Theoretical Physics
Complex Systems and Advanced Materials

March 20 - 22
International Workshop
Infinite and finite nuclear matter

June 2 - 8
XIV International Workshop
Particle Correlations and Femtoscopy (WPCF2019)

July 14 - 20
BLTP/JINR - APCTP/Korea Joint Workshop
Modern problems in nuclear and elementary particle physics

July 8 - 12, Prague, Czech Republic
The XXVIth International Conference on
Integrable Systems and Quantum Symmetries

July 22 - August 2
Helmholtz International Summer School
Quantum Field Theory at the Limits: from Strong Fields to Heavy Quarks

July 28 - August 2
International School
Advanced Methods of Modern Theoretical Physics: Integrable and Stochatic Systems

August 4 - 17
Helmholtz International Summer School
Cosmology, Strings, New Physics

August 26 - 31, Yerevan, Armenia
International Workshop
Supersymmetries and Quantum Symmetries (SQS19)

September 1 - 10, Sinaia, Romania
VIIIth International Pontecorvo
Neutrino Physics School

September 2 - 7
XVIIIth International Workshop on
High Energy Spin Physics (DSPIN-19)

September 9 - 13
International Bogolyubov Conference
Problems of Theoretical and Mathematical Physics
(dedicated to the 110th anniversary of the birth of N.N. Bogolyubov (1909-1992))

September 16 - 19
II International workshop
Theory of Hadronic Matter under Extreme Conditions

September 22 – 28, Varna, Bulgaria
XXIII International School on
Nuclear Physics, Neutron Physics and Applications

October 27 - November 1, Guangzhou, China
BLTP/JINR - KLTP/CAS Joint Workshop
Physics of Strong Interacting Systems

Conferences and Schools, 2014-2018

Total - **93 (> 5000 participants)**

DIAS-TH and Helmholtz Schools - **23**

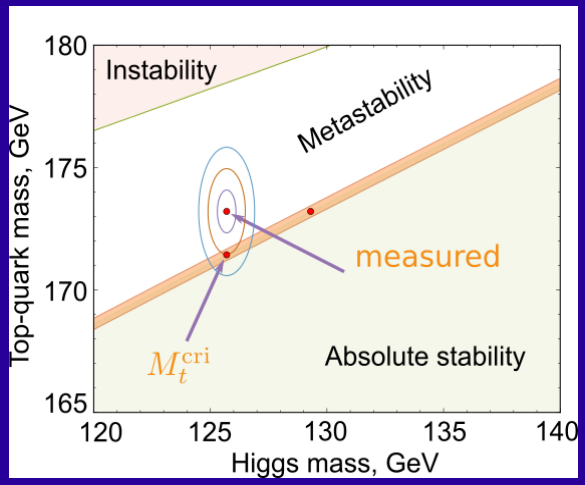
Educational Activities

More than **250 lecture courses**
at JINR University Centre,
DIAS-TH, Moscow U.,
Dubna U., MIPT, etc.

Helmholtz School "Quantum Field Theory at the Limits: from Strong Fields to Heavy Quarks"

22 July to 2 August 2019

THEORY OF FUNDAMENTAL INTERACTIONS



The state of art analysis of the Stability of the Standard Model vacuum

Based on record 3-loop order calculations it was shown that for a fixed value of M_h=125.7 GeV absolute SM stability leads to a bound on the top mass

$$M_t < M_t^{crit} = 171.54 \text{ GeV}$$

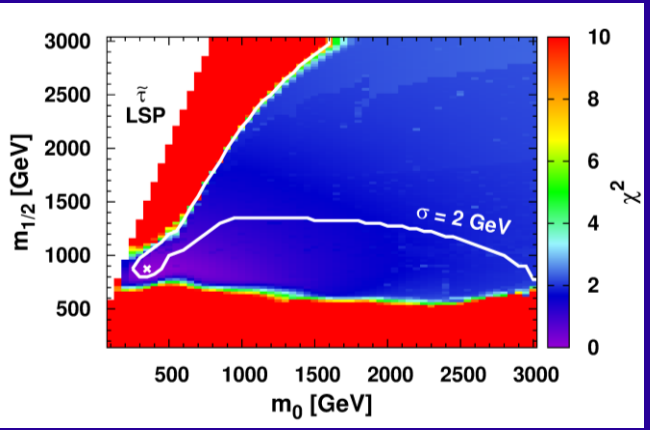
compartible with measured $M_t^{expt} = 173.21(87)$ GeV at the 1.3 sigma level. Previously made conclusion that the SM vacuum is metastable may be premature.

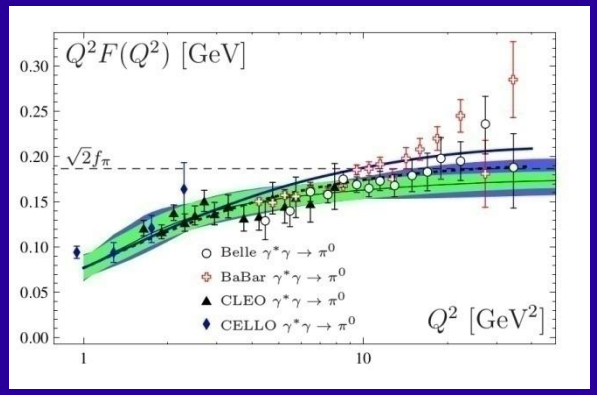
A. Bednyakov *et al, Phys. Rev. Lett. 115, 201802 (2015); JHEP 1301 (2013) ; Phys.Lett. B722 (2013); Nucl. Phys. B875 (2013).*

Constraints on Supersymmetry from LHC data combined with cosmology and direct dark matter searches

A combined LHC data (LHCb experiment), the relic density (WMAP and other cosmological data) and upper limits on the dark matter scattering cross sections on nuclei (XENON100 data) indicate that gluinos below 1 TeV and the lightest supersymmetric particle with the mass below 160 GeV are excluded.

C. Beskidt, W. de Boer, D.I. Kazakov, F. Ratnikov**,** *Eur. Phys. J. C (2012); JHEP (2012)*





BaBaR puzzle

BaBaR puzzle for pion transition form factor was systematically and comprehensively analyzed using the various QCD-motivated approaches. It is concluded that the current experimental accuracy (BaBar and Belle experiments) is not sufficient to discriminate between QCD factorization and its violation.

A.P. Bakulev, S.V. Mikhailov, A.V. Pimikov, N.G. Stefanis, Phys. Rev. D 86 (2012);
Few Body Syst. 55 (2014); A. Dorokhov, E.Kuraev, *Phys. Rev. D88 (2013);*
Ya. Klopot, A.Oganesian, O.Teryaev, *Phys. Rev. D 87 (2013).*

Determination of the electron-to-proton mass ratio

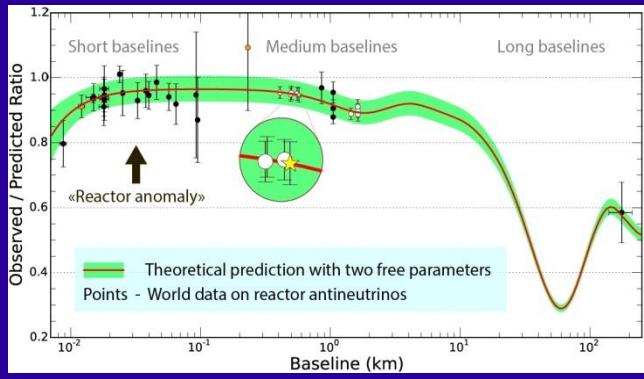
The record 10-fold improvement for the transition energies of the hydrogen molecular ion and the antiprotonic helium was obtained. This allows one to achieve a fractional precision of $1.5 \cdot 10^{-11}$ in determination of the electron-to-proton mass ratio. This progress may have serious impact on the fundamental physical constants.

V.Korobov, et al, Phys.Rev.Lett. 112 (2014).

Explanation of the "reactor anomaly"

Within the field theoretical approaches to neutrino flavor oscillations It is shown that for relatively short but macroscopic baselines, there must be a small violation of the classical inverse-square law for the neutrino flux. Numerical results provide an explanation of the long-standing "reactor anomaly".

V.A. Naumov, D.S. Shkirmanov, *Mod. Phys. Lett. A**30** (2015); Eur. Phys. J. C73 (2013).*

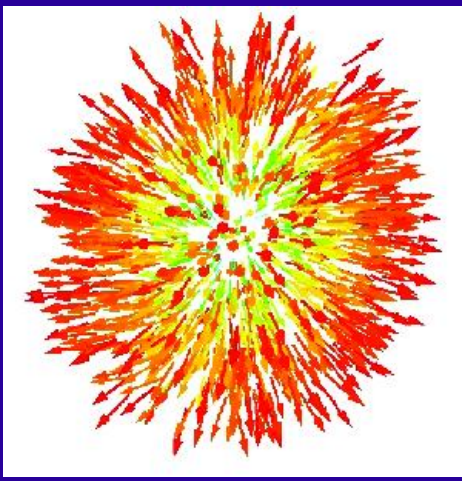


HADRONIC MATTER UNDER EXTREME CONDITIONS

Helicity separation in heavy-ion collisions

The P-odd effects related to the vorticity of the medium formed in noncentral heavy-ion collisions are studied. The noticeable hydrodynamical helicity was observed to manifest specific mirror behavior with respect to the reaction plane. The effect is maximal at the NICA and FAIR energy range.

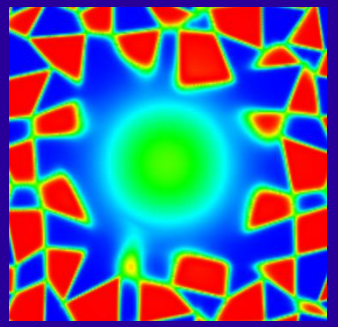
M. Baznat, K. Gudima , A. Sorin, O. Teryaev, *Phys.Rev. C88 (2013).*

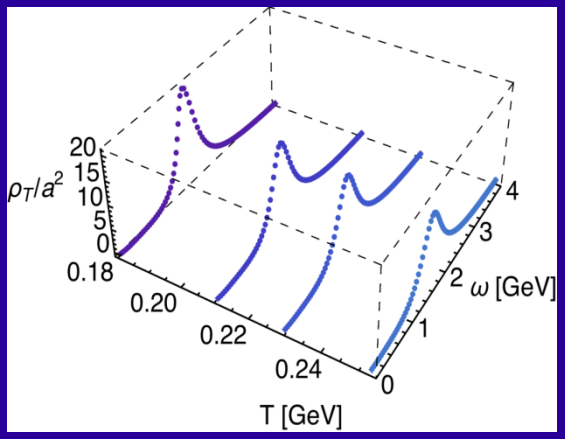


Polarization of the QCD vacuum by the strong electromagnetic fields

The quark interaction with both confining vacuum gluon fields and external strong electromagnetic field created in HIC leads to specific polarization of the vacuum gluon fields, and EM field may trigger deconfinement in HIC. This polarization effect was confirmed later in Lattice QCD calculations (LQCD - *JHEP 1304 (2013); Phys. Rev. Lett. 110 (2013)*).

B. Galilo, S. Nedelko, *Phys.Rev.D 84 (2011)* ; S. Nedelko, V.Voronin, *Eur.Phys. J. A (2015).*





Finite temperature gluon spectral functions from N_f=2+1+1 lattice QCD

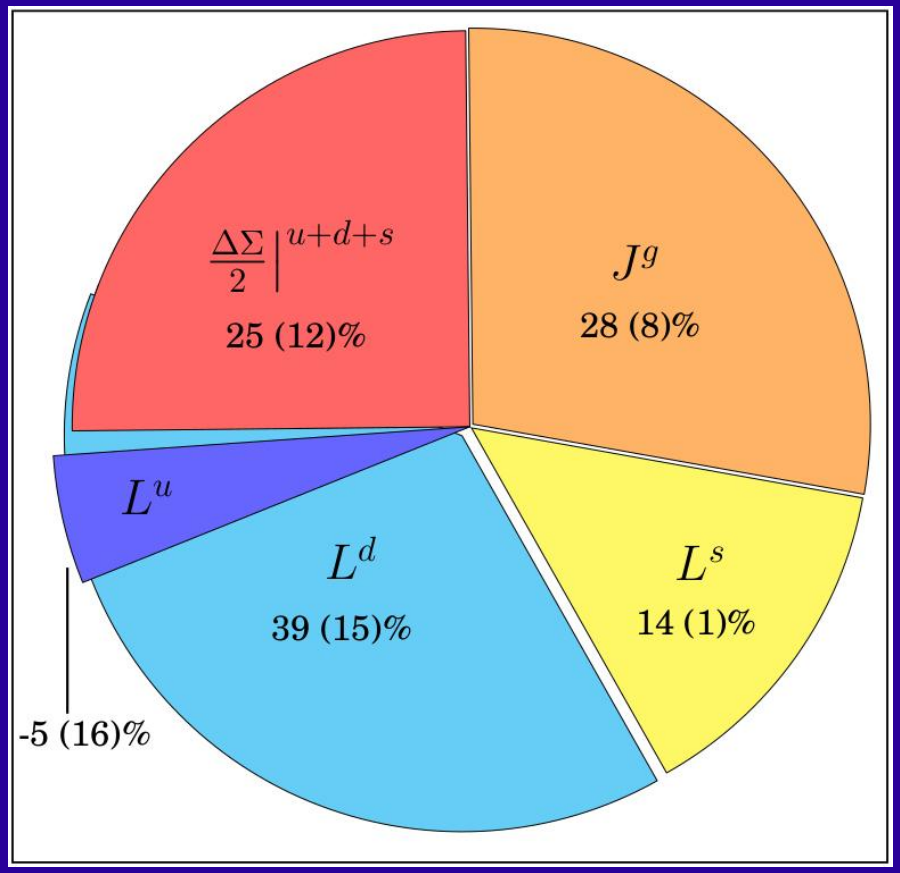
For the first time gluon spectral functions at finite temperature in Landau gauge were calculated based on lattice QCD with N_f=2+1+1 dynamical quark flavors combined with a novel Bayesian approach for the extraction of non-positive definite spectral functions. Gluon quasi-particle peaks in the spectral function were found. The obtained gluon dispersion relation reveals different in-medium masses for longitudinal and transversal gluons. This methodological advances allows one to perform ab initio QCD studying of the transport properties of quark-gluon matter, which is highly important for theoretical description of the relativistic heavy ion physics.

E.-M. Ilgenfritz, J. M. Pawlowski, A. Rothkopf, A. Trunin, *ArXiv:1701.08610[hep-lat]*

Proton spin calculation within Lattice QCD

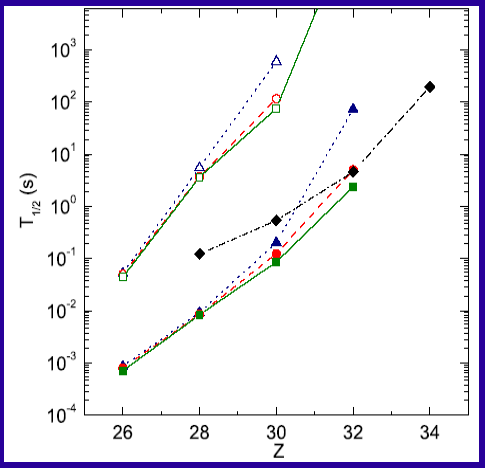
For the first time the contribution of orbital angular momenta of up, down and strange quarks and gluon angular momenta to proton spin were computed using LQCD. It have been found that they contribute ~47% (sum of individual quark contribution) and ~28%, respectively, and thus accounting for all of missing proton spin. The other quantity, quark spin contrubution, has been known for a long time to be ~25% both experimentally and in Lattice QCD.

M. Deka et al [χQCD collaboration] Phys. Rev. D 91 (2015)



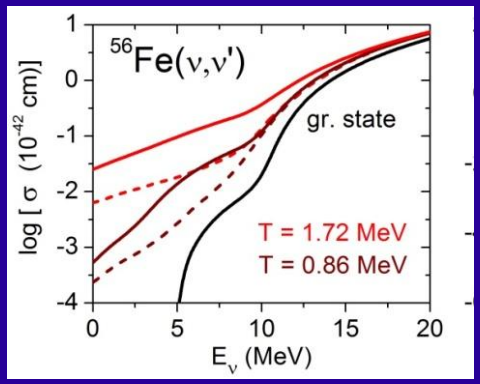
THEORY OF NUCLEAR STRUCTURE AND NUCLEAR REACTIONS

β^--decay half-lives of the neutron-rich $N = 50$ isotones



It was shown that tensor interactions and 2p-2h configuration result in decreasing of beta-decay half lives of the neutron-rich N = 50 isotones significantly. Results of the calculations without the tensor interaction (open triangles, circles, squares) and **with the tensor interaction (filled triangles, circles, squares)** are shown.
Experimental data - filled diamonds.

Severiukhin A ., Voronov V., Borzov I., Arseniev N., Nguen Van Giai, *Phys. Rev. C90 (2014).*

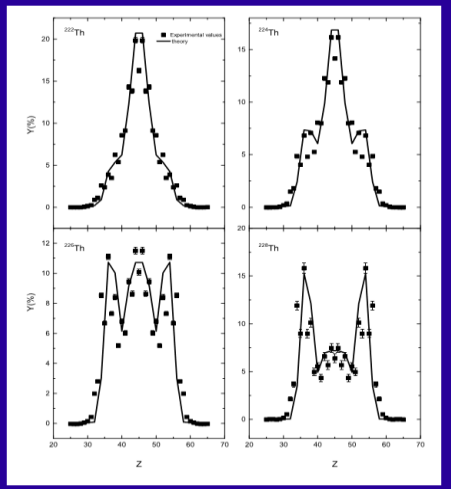


Nuclear weak interaction processes in supernova

A new method to compute rates and cross sections for nuclear weak interaction processes in supernova environments was developed. For iron isotopes the results demonstrate that temperature shifts the Gamow-Teller (GT) strength function to lower energies, thereby leading to a significantly larger rate increase than expected from the shell model calculations. The method was also applied to study supernova neutrino nucleus reactions.

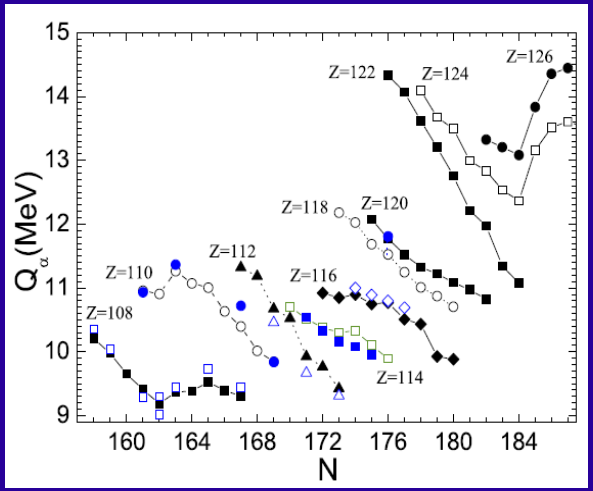
A.A. Dzhioev, *et al,, Phys. Rev. C81 (2010); Phys. Rev. C89 (2014); Phys. Rev. C92(2015)*

Cluster approach for describing nuclear fission



The model is developed suited for the description of the symmetric and asymmetric charge yields, as well as the transition between them. Unexpectedly large asymmetric mode for the fission of Th and Ra isotopes was observed at high excitation energy. Triple-peak charge distributions are predicted for fissioning N~136 nuclei.

Pasca H., Andreev A.V., Adamian G.G., Antonenko N.V., ***PRC*** *93, 034620 and 054602 (2016); 94, 064614 (2016);* ***PLB*** *760, 800 (2016);* ***EPJA*** *52, 369 (2016)*



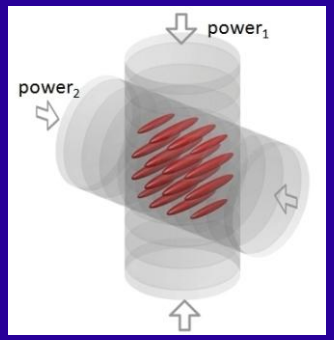
Predictions of shell closures in the region of unknown nuclei

It is shown that the two-center shell model indicates the magic nucleus next to ^{208}Pb has the charge **Z ≥ 120** and the half-life **1,7ms – 0,16s** (for Z=120, N=175-179)

Calculated (symbols connected by lines) and experimental energies of α decay of the nuclides with even Z from the range 108 ≤ Z ≤ 126 are shown in figure.

G.G.Adamian, N.V.Antonenko, R.V.Jolos, A.K.Nasirov, V.G.Kartavenko, L.A.Malov, T.M.Shneidman, A.Sushkov, A.N.Bezbakh, *Eur. Phys. J. A45 (2010); Eur. Phys. J. A47 (2011); Phys. Rev. C 84 (2011); Phys. Rev. C 85 (2012); Phys. Rev. C 91 (2015)*.

Discovery of confinement-induced resonances



A splitting of the confinement-induced resonance in ultracold gases was predicted and then discoveredf in experiment . The developed theory has allowed to describe quantitatively the resonance effects: width and shifts of the s-wave CIR in an atomic trap and its splitting caused by the trap anisotropy. Predictions of the theory – the widths and shifts of the p-wave CIRs and the found conditions for appearance of dipole CIRs - are extremely relevant to the ongoing research of cold atoms and molecules.

V.S. Melezhik, et al, *Phys. Rev. Lett. 104 (2010); Phys. Rev. A 84, 042712 (2011); Phys. Rev. A 86, 062713 (2012); Phys. Rev. Lett. 111, 183201 (2013); J. Phys. B 48, 155301 (2015).*

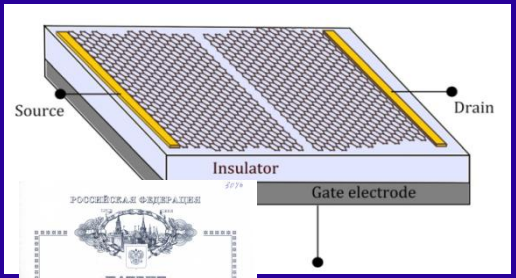
The electron-positon pair emission in interaction of the photon with laser pulses

For the first time it has been found that the short laser pulses “generate” high momentum components which produce a great amplifier effect for the multi-photon, sub-threshold events. Enhancement may reach many orders of magnitude depending on field intensity and the beam shape. The probability of the electron-positon pair emission in interaction of the probe photon with the short and intensive laser pulses is enhanced(by several orders of magnitudes.

A. Titov, *et al, Phys.Rev. A* ***87*** *(2013); Phys. Rev. Lett. 108, (2012); Eur. Phys. J. D* ***68*** *(2014).*

$$Laser + \gamma \rightarrow e^+ + e^-$$

CONDENSED MATTER THEORY



Graphene tunnel field-effect transistor

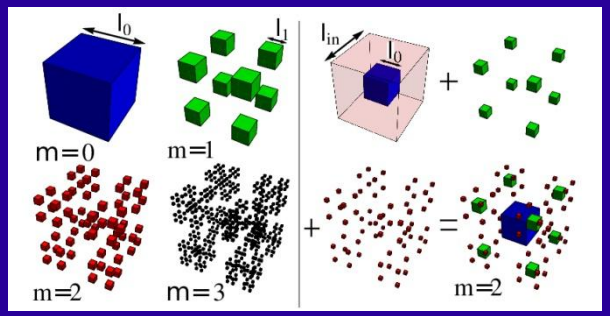
A new concept for a graphene tunnel field-effect transistor was proposed. The main idea is based on the use of two graphene electrodes with zigzag termination divided by a narrow gap under the influence of the common gate. It was shown that the device will have a pronounced switching effect at low gate voltage and high on/off current ratio at room temperature.

V. Osipov, V. Katkov *// Applied Phys. Lett. 104 (2014) 053102; JETP Lett. 98 (2013) 782;* ***Patent No 2554694 [01.06.2015].***

Surface fractals and the small-angle neutron scattering

New general properties of fractals have been predicted . Particularly important result is that a surface fractal can be realized as a sum of mass fractals, and thus the small-angle neutron scattering amplitude of the surface fractal can be calculated as a sum of the mass fractal amplitudes.

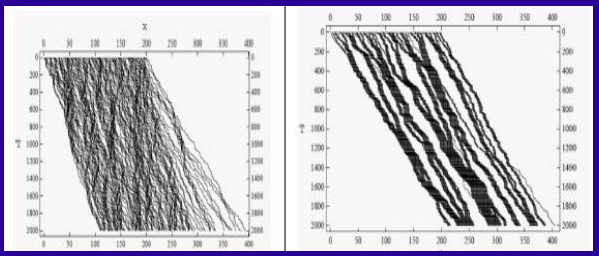
E. M. Anitas *et al*, *Rom. Journ. Phys.* 60, 658 (2015); *J. Appl. Cryst*. 47, 198 (2014); *Phys. Rev. E* 84, 036203 (2011).



Microscopic theory of metals with strong electron correlations

A microscopic theory of metals with strong electron correlations was developed. The theory is based on a consistent consideration of kinematic interaction of electrons with spin and charge fluctuations. Within this approach, a microscopic description of high temperature superconductivity in cuprates without fitting coupling constant, a theory of magnetic excitations in the normal and superconducting states, and a theory of electrical conductivity and optical absorption have been created.

N. M. Plakida, *High-Temperature Cuprate Superconductors, Springer, 2010;* N. M. Plakida, V. S. Oudovenko, *Eur. Phys. J. B 86 (2013)*; N. M. Plakida, V. S. Oudovenko, *JETP 146 (2014);* A. A. Vladimirov, D. Ihle, N. M. Plakida, *Phys. Rev. B 83 (2011);* A. A. Vladimirov, D. Ihle, N. M. Plakida, *Phys. Rev. B 85 (2012).*



Emergence of jams in ASEP

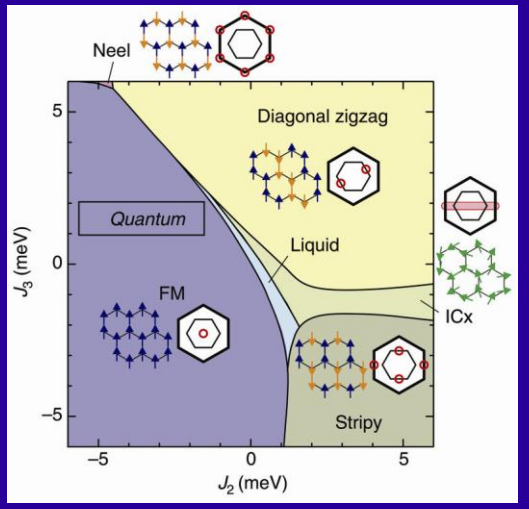
An integrable generalization of totally asymmetric simple exclusion process (ASEP) with extra interaction was constructed . The distribution of particle current shows two types of universal scaling behaviourdepending on the value of the interaction strength. Either, when the density of particle clusters is finite, the distribution has the form specific for Kardar–Parisi–Zhang universality class, or all particle form single cluster, characterize by the Gauss distribution. Unification the two universal regimes and describtion of the transition between them were obtained.

A.E. Derbyshev, A.M. Povolotsky, V.B. Priezzhev, *Phys. Rev. E 91 (2015).*

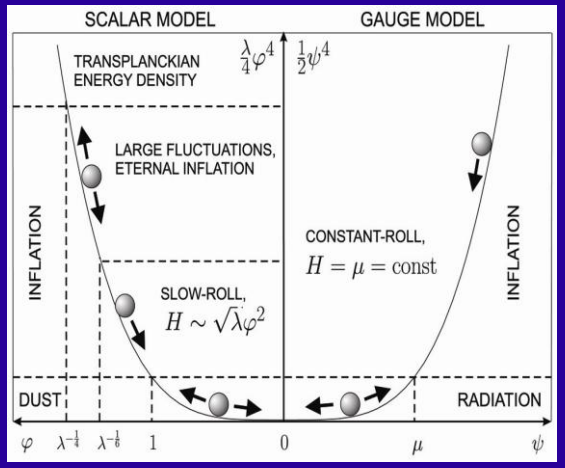
Strongly frustrated triangular spin lattice emerging from triplet dimer formation in honeycomb Li_2IrO_3

Iridium oxides with a honeycomb lattice have been identified as platforms for the much anticipated Kitaev topological spin liquid. A new type of magnetic ground state that was called “the structure of triplet dimers on an effective triangle lattice” has been predicted. The prediction can be verified by means of neutron diffraction and neutron magnetic spectroscopy.

S. Nishimoto, V. Katukuri, V. Yushankhai, H. Stoll, U. Roessler, L. Hozoi, I. Rousochatzakis, and J. van den Brink, ***NATURE Comm.*** *7, 10273 (2016)*



MODERN MATHEMATICAL PHYSICS



HYM-flation: Yang–Mills cosmology with Horndeski coupling

It is discovered that the effective gravity theory with non-minimal (Horndeski) coupling of gauge fields to gravity gives rise to robust Planck-scale inflation with graceful exit. This solves the initial conditions problem for the observed GUT-scale inflation. Considering both gauge and Higgs fields one obtains a consistent description of the early Universe based solely on the fields of Standard Model.

E. Davydov, D. Gal'tsov, ***Phys. Lett. B*** *753, 622 (2016)*

New proof of the Atiyah-Singer theorem

The full description of the geometries of the most general N=2 supersymmetric quantum mechanical models was done and a new simple physical proof of the Atiyah-Singer theorem was given. A new example of N=2 supersymmetric quantum mechanical sigma models was studied. A special class of quasicomplex sigma models was derived. These results are important for understanding of the properties of quantum states in the field theories with anomalies and supersymmetric theories in diverse dimensions.

S. Fedoruk, E. Ivanov, A. Smilga, *Int. J. Mod. Phys.* ***A27****(2012)1230024,* ***A27****(2012)1250146; SIGMA* ***9****(2013)069; J. Math. Phys.* ***55****(2014)052302; J. Phys.* ***A48****(2015)215401.*

Elliptic hypergeometry of supersymmetric dualities

Seiberg type dualities were constructed for supersymmetric field theories outside the conformal window. Explicit forms of the superconformal indices were derived in terms of the elliptic hypergeometric integrals and systematically studied for a number of supersymmetric theories.

V.P. Spiridonov, G.S. Vartanov, *Phys. Rev. Lett. 105 (2010), Comm. Math. Phys. 304 (2011); Comm. Math. Phys. 325 (2014); JHEP 06 (2012) 016; JHEP 06 (2014), 062; Contemp. Math. 563 (2012), 181-211.*

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Welcome!