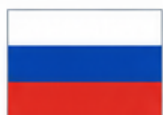


Book of Abstracts

Advanced functional materials
for digital and quantum electronics



14–18 September 2026

Moscow Institute of Physics and Technology · Dolgoprudny, Russia



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14–18 SEPTEMBER 2026

Conference programme

At a glance

Monday, 14 September

p. 6

Superconducting functional materials

Concert hall

M1: Prof. Alexander GOLUBOV (proposed); M2: Prof. Alexander GOLUBOV (listed); M3: Prof. Alexei VAGOV (listed).

Tuesday, 15 September

p. 8

Quantum technology

Hall to be confirmed by organisers the day before

T1: Prof. Walter POGOSOV (proposed); T2: Prof. Daniel DOMINGUEZ (listed); T3: Prof. Oleg ASTAFIEV (proposed); T4: Dr. Gleb FEDOROV (proposed); T5: Prof. Walter POGOSOV (proposed); T6: Dr. Evgeniy KIKTENKO (proposed).

Wednesday, 16 September

p. 11

Devices based on superconducting functional materials

Hall to be confirmed by organisers the day before

W1: Prof. Alexei VAGOV (proposed); W2: Prof. Rafael ZADOROSNY (proposed); W3: Prof. Mauro DORIA (proposed).

Thursday, 17 September

p. 13

Functional materials and quantum technology

Hall to be confirmed by organisers the day before

Th1: Dr. Alexander FROLOV (proposed); Th2: Prof. Boris GORSHUNOV (proposed); Th3: Prof. Denis VYALIKH (proposed); Th4: Prof. Vadim GRINENKO (proposed).

Friday, 18 September

p. 15

Spintronics and photonics

Hall to be confirmed by organisers the day before

F1: Prof. Irina BOBKOVA (proposed); F2: Prof. Vladimir BELOTELOV (proposed); F3: Prof. Alexey BOLSHAKOV (proposed); F4: Prof. Wei JIANG (proposed).

Conference hall: The conference hall for Tuesday–Friday, 15–18 September, will be confirmed by the organisers the day before.

Welcome concert / Приветственный концерт: Monday, 14 September, 11:10–11:40, Concert hall; repertoire and performers on p. 19. **Conference group photo:** Monday, 14 September, 12:10, immediately after Prof. Vasily STOLYAROV's talk, during lunch (12:10–13:10). **Poster session:** Wednesday, 16 September, 16:30–18:00; poster index on p. 122. The poster-room assignment is not specified. Free time follows the final Tuesday and Thursday talks and the Wednesday poster session.

CONFERENCE PROGRAMME / DAY 1

Monday, 14 September

Superconducting functional materials

MIPT, Dolgoprudny · Concert hall

Time	Monday, 14 September · Concert hall	Ref.
Opening Registration and welcome programme		
09:00–10:00	Registration Main Building, ground floor	
10:00–10:05	Welcome remarks · Prof. Vasily STOLYAROV Director of CMN MIPT	
10:05–10:10	Welcome remarks · Prof. Alexander GOLUBOV Head of Laboratory of Topological Quantum Phenomena in Superconducting Systems	
10:10–10:20	Welcome remarks · Prof. Irina KUKLINA Executive Director of the International Center for Innovations in Science, Technology and Education (ICISTE)	
10:20–10:30	Welcome remarks · Marcelo LARABURU Head of the Science, Technology and Innovation Sector at the Brazilian Embassy in Moscow	
10:30–10:40	Welcome remarks · Prof. Rafael ZADOROSNY Universidade Estadual Paulista	
10:40–10:50	Welcome remarks · ZHOU Yu Minister Counselor of the Embassy of the People's Republic of China in the Russian Federation · To be confirmed	
10:50–11:00	Welcome remarks · Prof. Wei JIANG Associate Professor, School of Physics, Beijing Institute of Technology (BIT)	
11:00–11:10	Welcome remarks · Dmitriy LIVANOV Rector of Moscow Institute of Physics and Technology	
11:10–11:40	Welcome concert / Приветственный концерт Spirit of Russia / «Дух России» · Vocals and bayan / Вокал и баян · p. / с. 19.	
M1 Opening scientific session		
Proposed chair: Prof. Alexander GOLUBOV		
11:40–12:10	Prof. Vasily STOLYAROV Microscopic structure of the vortex cores in granular niobium: a coherent quantum puzzle Moscow Institute of Physics and Technology; LPEM, ESPCI Paris, PSL, CNRS, Sorbonne University	O-01 p. 21
12:10–13:10	Lunch and conference group photo Group photo at 12:10, immediately after Prof. Vasily STOLYAROV's talk, at the start of the lunch break.	
M2 Superconducting materials and quantum states		
Chair: Prof. Alexander GOLUBOV		
13:10–13:40	Prof. Yutao XING Applications of high-resolution electron microscopy: from fundamental physics to materials engineering Institute of Physics, Fluminense Federal University	O-02 p. 22
13:40–14:10	Prof. Alexander KUNTSEVICH Van der Waals bond in 2D-materials-based structures: rigidity, friction, quantification and control P.N. Lebedev Physical Institute of the Russian Academy of Sciences	O-03 p. 23

Programme continues on the next page

Time	Monday, 14 September · Concert hall (continued)	Ref.
14:10–14:40	Prof. Shyam SUNDAR Unified picture of time-reversal-symmetry breaking two-band superconductivity in noncentrosymmetric LaNiC_2 and centrosymmetric LaNiGa_2 via μSR studies Instituto de Física, Universidade Federal do Rio de Janeiro	O-04 p. 24
14:40–14:55	Coffee break	
14:55–15:25	Prof. Igor BURMISTROV Majorana bound states in chiral ferromagnet–superconductor heterostructures revisited L. D. Landau Institute for Theoretical Physics, Chernogolovka, Russia	O-05 p. 25
15:25–15:45	Dr. Jingyi DUAN Crystal flat band in a triangular lattice Beijing Institute of Technology	O-06 p. 26
15:45–16:15	Prof. Alexei VAGOV Correlated disorder as the microscopic mechanism of subgap absorption in superconductors HSE University	O-07 p. 27
16:15–16:35	Coffee break	
M3 Surfaces, disorder, and superconducting devices Chair: Prof. Alexei VAGOV		
16:35–16:55	Prof. Alexey ALADYSHKIN Atomically precise triple-step staircase on a vicinal silicon surface: how to distinguish $\text{Si}(5 \times 5)$, $\text{Si}(7 \times 7)$, and $\text{Si}(8 \times 8)$? Moscow Institute of Physics and Technology; Institute for Physics of Microstructures RAS; Lobachevsky State University of Nizhny Novgorod	O-08 p. 28
16:55–17:15	Dr. Vyacheslav NEVEROV Majorana zero mode edgetronics in topological superconductors Moscow Institute of Physics and Technology; HSE University	O-09 p. 29
17:15–17:35	Dr. Natalia MALEEVA Granular aluminum: new life for an old friend National University of Science and Technology MISIS	O-10 p. 30
17:35–17:55	Dr. Grigoriy BOBKOV Intrinsic coexistence of magnetism and superconductivity in magnetic misfit compounds $\text{Mn}_x\text{Bi}_{1-x}\text{Se}/\text{NbSe}_2$ Moscow Institute of Physics and Technology	O-11 p. 32
17:55–18:10	Coffee break	
18:10–18:30	Dr. Alexander MELENTEV Compact mechanically robust high-Q superconducting resonator for terahertz optics Moscow Institute of Physics and Technology	O-12 p. 32
18:30–18:45	PhD Konstantin POLEVOY Multiterminal quasi-ballistic Josephson effect in monocrystalline gold: experiment and theory Moscow Institute of Physics and Technology; Dukhov Research Institute of Automatics (VNIIA)	O-13 p. 33
18:45–19:00	PhD Mark NAUMOV Superconductivity in thin $\text{Pb}_{0.7}\text{In}_{0.3}\text{Bi}_2\text{Te}_4$ with Nb contacts Moscow Institute of Physics and Technology; Dukhov Research Institute of Automatics (VNIIA)	O-14 p. 34
Time not specified	Reception	

CONFERENCE PROGRAMME / DAY 2

Tuesday, 15 September

Quantum technology

MIPT, Dolgoprudny · Hall to be confirmed by organisers the day before

Time	Tuesday, 15 September · Hall to be confirmed	Ref.
T1 Quantum systems and control Proposed chair: Prof. Walter POGOSOV		
09:00–09:30	Prof. Oleg ASTAFIEV Lasing with superconducting quantum systems Skolkovo Institute of Science and Technology; Moscow Institute of Physics and Technology	O-15 p. 37
09:30–10:00	Prof. Ling-Jun KONG Quantum holography and its application in image encryption Beijing Institute of Technology	O-16 p. 38
10:00–10:30	Prof. Daniel DOMINGUEZ Efficient strong driving protocols for fast quantum gates in superconducting qubits Centro Atomico Bariloche and Instituto Balseiro Bariloche, Argentina	O-17 p. 39
10:30–10:50	Coffee break	
T2 Artificial atoms and quantum optics Chair: Prof. Daniel DOMINGUEZ		
10:50–11:10	Prof. Walter POGOSOV Photon-statistics analysis via quantum wave mixing in superconducting qubits Dukhov Research Institute of Automatics; National Research University Higher School of Economics; Institute of Theoretical and Applied Electrodynamics, Russian Academy of Sciences	O-18 p. 40
11:10–11:30	Dr. Gleb FEDOROV Josephson artificial atoms: quantum optics and algorithms Moscow Institute of Physics and Technology	O-19 p. 41
11:30–12:00	Prof. Olga TIKHONOVA Resonance fluorescence of a two-level atom driven by quantum electromagnetic field Lomonosov Moscow State University; Russian Quantum Center	O-20 p. 41
12:00–13:30	Lunch	

Programme continues on the next page

Time	Tuesday, 15 September · Hall to be confirmed (continued)	Ref.
T3 Quantum computing: control, algorithms, and machine learning		
Proposed chair: Prof. Oleg ASTAFIEV		
13:30–14:00	Dr. Aleksey FEDOROV Complexity classes of quantum states Russian Quantum Center (RQC); National University of Science and Technology MISIS	O-21 p. 42
14:00–14:20	Dr. Marina BASTRAKOVA High-speed control of a fluxonium qubit via picosecond pulses from Josephson digital circuits Lobachevsky State University of Nizhny Novgorod; Russian Quantum Center	O-22 p. 43
14:20–14:40	Dr. Alexander ZENCHUK Matrix encoding method in measurement-based algorithms of matrix manipulations Federal Research Center of Problems of Chemical Physics and Medicinal Chemistry RAS	O-23 p. 44
14:40–15:00	Dr. Evgeniy KIKTENKO Quantum machine learning for quantum states processing Russian Quantum Center; Steklov Mathematical Institute of the Russian Academy of Sciences	O-24 p. 45
15:00–15:20	Coffee break	
T4 Superconducting qubits: fabrication, control, and noise		
Proposed chair: Dr. Gleb FEDOROV		
15:20–15:35	Dr. Yulia ZOTOVA Transmon in the straddling regimes across cavity photon number Moscow Institute of Physics and Technology	O-25 p. 46
15:35–15:50	Dr. Ivan FILIPPOV Superconducting niobium TSV contacts for cryoelectronic devices: effect of supercycle etching on sidewall quality and qubit fabrication prospects Institute of Nanotechnology of Microelectronics of the Russian Academy of Sciences	O-26 p. 47
15:50–16:05	Dr. Sergey GUNIN Revealing sensitivity of superconducting artificial atoms to photon statistics of scattered field Moscow Institute of Physics and Technology	O-27 p. 48
16:05–16:20	Dr. Danila BABUKHIN Runtime-efficient zero-noise extrapolation from mixed physical and logical data Dukhov Research Institute of Automatics (VNIIA)	O-28 p. 49
16:20–16:35	Dr. Daria KALACHEVA Kinemon artificial atom for high-fidelity superconducting quantum operations Moscow Institute of Physics and Technology; Skolkovo Institute of Science and Technology	O-29 p. 50
16:35–16:50	PhD Igor TROFIMOV Reducing TLS defects using the air-qubit fabrication approach Institute of Nanotechnology of Microelectronics of the Russian Academy of Sciences	O-30 p. 51
16:50–17:10	Coffee break	

Programme continues on the next page

Time	Tuesday, 15 September · Hall to be confirmed (continued)	Ref.
T5 Quantum devices: error detection, sensing, and simulation		
Proposed chair: Prof. Walter POGOSOV		
17:10–17:25	Dr. Ilia SIMAKOV Demonstration of quantum error detection on a fluxonium–transmon–fluxonium processor National University of Science and Technology MISIS; Russian Quantum Center	O-31 p. 52
17:25–17:40	PhD Minna ZHANG Towards lasing-enhanced quantum sensing with organic spintronics Beijing Institute of Technology	O-32 p. 52
17:40–17:55	PhD Daria MOSKALEVA Broadband impedance-matched parametric amplifiers with accurately predicted central frequency, gain and bandwidth Shukhov Labs, Quantum Park, Bauman Moscow State Technical University; Dukhov Automatics Research Institute (VNIIA)	O-33 p. 53
17:55–18:10	PhD Boris BANTYSH Analysis of the classical simulability of quantum circuits for approximate optimization Russian Quantum Center	O-34 p. 54
18:10–18:25	PhD Aleksei MATANIN Superconducting integrated on-demand quantum memory with microwave pulse preservation Shukhov Labs, Quantum Park, Bauman Moscow State Technical University; Dukhov Automatics Research Institute (VNIIA)	O-35 p. 55
18:25–18:40	Dr. Andrey ZHUKOV Trotterization on NISQ processors: capabilities, limitations, and future directions Dukhov All-Russia Research Institute of Automatics	O-36 p. 56
18:40–19:00	Coffee break	
T6 Quantum processors: gates and compilation		
Proposed chair: Dr. Evgeniy KIKTENKO		
19:00–19:15	PhD Nikita SMIRNOV High-fidelity gates in superconducting quantum coprocessor Snowdrop 8Q Dukhov Research Institute of Automatics (VNIIA); FMN Laboratory, Bauman Moscow State Technical University	O-37 p. 57
19:15–19:30	D. I. DROZHZHIN Qudit transpilation techniques for trapped ions Russian Quantum Center; National University of Science and Technology MISIS	O-38 p. 58
19:30–19:45	Dr. Grigoriy MAZHORIN Experimental three-qubit processor unit with a native CCZ gate University of Science and Technology MISIS	O-39 p. 58

CONFERENCE PROGRAMME / DAY 3

Wednesday, 16 September

Devices based on superconducting functional materials

MIPT, Dolgoprudny · Hall to be confirmed by organisers the day before

Time	Wednesday, 16 September · Hall to be confirmed	Ref.
W1 Superconducting and magnetic materials		
Proposed chair: Prof. Alexei VAGOV		
09:00–09:30	Prof. Mauro DORIA Commensurate resonances and the increase of the gap in superconducting films by non-superconducting layers Universidade Federal do Rio de Janeiro	O-40 p. 61
09:30–10:00	Prof. Vladimir PUDALOV Emergence of ferromagnetism at the nanoscale in antiferromagnetic crystals V.L. Ginzburg Research Center, P.N. Lebedev Physical Institute	O-41 p. 62
10:00–10:30	Prof. Rafael ZADOROSNY Engineering microstructure in superconducting ceramics: from powder to fiber routes for enhanced functional performance Universidade Estadual Paulista	O-42 p. 63
10:30–10:50	Coffee break	
W2 Vortices and collective phenomena		
Proposed chair: Prof. Rafael ZADOROSNY		
10:50–11:20	Prof. Alexander MELNIKOV Vortex matter in superconducting structures with intrinsic diode effect Moscow Institute of Physics and Technology; Institute for Physics of Microstructures, RAS	O-43 p. 64
11:20–11:40	Prof. Si-Li WU Gate-tunable Josephson diode effect mediated by topological surface states in BiSbTeSe ₂ (BSTS) Josephson junctions Beijing Institute of Technology	O-44 p. 65
11:40–12:00	Prof. Dmitri EFREMOV Unusual low-energy collective charge excitations in high-T _c cuprate superconductors IFW Dresden	O-45 p. 67
12:00–13:30	Lunch	
W3 Superconducting hybrid devices		
Proposed chair: Prof. Mauro DORIA		
13:30–13:50	Prof. Denis VODOLAZOV Giant nonlinearity of kinetic inductance in superconducting hybrid strip Institute of Nanotechnology of Microelectronics of the Russian Academy of Sciences; Institute for Physics of Microstructures, Russian Academy of Sciences	O-46 p. 67
13:50–14:10	Dr. Tatiana GOLIKOVA Recovery of superconductivity in the applied magnetic field in Nb/Pt microbridges fabricated on YIG Institute of Solid State Physics RAS	O-47 p. 68
14:10–14:30	Prof. Yuriy SHUKRINOV Locking phenomena and magnetization dynamics in anomalous Josephson structures Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research; Dubna State University	O-48 p. 69

Programme continues on the next page

Time	Wednesday, 16 September · Hall to be confirmed (continued)	Ref.
14:30–14:50	Dr. Sergey BAKURSKIY Role of Josephson SN-N-NS bridges in superconductor electronics Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University	O-49 p. 70
14:50–15:05	Coffee break	
15:05–15:20	PhD Alexey NEILO Current transport in a spin valve with two ferromagnets Moscow State Research Institute of Nuclear Physics, Moscow, Russia	O-50 p. 71
15:20–15:40	Dr. Vitaliy BOLGINOV Implementation of adiabatic neurons for superconducting neural networks Osipyan Institute of Solid State Physics, Russian Academy of Sciences	O-51 p. 72
15:40–15:55	PhD Anna ELISTRATOVA Compact two-junction Josephson neuron based on nanoscale Nb/Au weak links Dukhov Research Institute of Automatics (VNIIA); Moscow Institute of Physics and Technology; Institute of Nanotechnology of Microelectronics of RAS	O-52 p. 73
15:55–16:10	PhD Dmitriy KALASHNIKOV Equidistant resonance jumps in superconducting coplanar resonators driven by Abrikosov vortices Moscow Institute of Physics and Technology	O-53 p. 74
16:30–18:00	Poster session for young scientists Best poster award. Proposed chairs: Prof. Irina BOBKOVA and Prof. Alexey ALADYSHKIN. Index: p. 122.	

CONFERENCE PROGRAMME / DAY 4

Thursday, 17 September

Functional materials and quantum technology

MIPT, Dolgoprudny · Hall to be confirmed by organisers the day before

Time	Thursday, 17 September · Hall to be confirmed	Ref.
Th1 Magnetism and functional materials		
Proposed chair: Dr. Alexander FROLOV		
09:00–09:30	Prof. Vadim GRINENKO Origin of spontaneous magnetic fields in Sr_2RuO_4 Tsung-Dao Lee Institute & School of Physics and Astronomy, Shanghai Jiao Tong University	O-54 p. 77
09:30–10:00	Dr. Caihua WAN High-performance magnetic tunnel junctions and their applications in artificial intelligence and probabilistic computing Institute of Physics, Chinese Academy of Sciences; Center of Materials Science and Optoelectronics Engineering, University of Chinese Academy of Sciences	O-55 p. 78
10:00–10:30	Prof. Denis VYALIKH 4f-driven surface effects in lanthanide-based materials: reorientation of 4f moments, 2D ferromagnetism, Kondo and Rashba effects Donostia International Physics Center; IKERBASQUE, Basque Foundation for Science	O-56 p. 79
10:30–10:50	Coffee break	
Th2 Superconducting films and spectroscopy		
Proposed chair: Prof. Boris GORSHUNOV		
10:50–11:20	Prof. Alexander KORNEEV Critical currents and nonlinearity of kinetic inductance in NbN/Mo bilayer structures Institute of Nanotechnology of Microelectronics of Russian Academy of Science; Higher School of Economics - National Research University	O-57 p. 81
11:20–11:40	Dr. Yulia KORNEEVA Superconducting properties of thin NbN films on ScN buffer layer Institute of Nanotechnology of Microelectronics of the Russian Academy of Science	O-58 p. 82
11:40–12:00	Dr. Ilya SHIPULIN Lattice softening and hidden charge order dynamics in CsV_3Sb_5 kagome superconductors Tsung-Dao Lee Institute & School of Physics and Astronomy, Shanghai Jiao Tong University	O-59 p. 83
12:00–13:30	Lunch	
Th3 Functional materials and light-matter interaction		
Proposed chair: Prof. Denis VYALIKH		
13:30–13:50	Dr. Alexander FROLOV Atomic disorder as an overlooked control parameter in topological insulators Centre for Advanced Mesoscience and Nanotechnology, Moscow Institute of Physics and Technology; Lomonosov Moscow State University	O-60 p. 83
13:50–14:10	Dr. Victor SEMIN Characterization of ferrimagnetic Fe-Gd coatings formed by magnetron sputtering Moscow Institute of Physics and Technology	O-61 p. 85

Programme continues on the next page

Time	Thursday, 17 September · Hall to be confirmed (continued)	Ref.
14:10–14:25	PhD Haojie SUN Lattice-driven magnetic and topological phase transitions in monolayer 1T-CrTe ₂ : role of structural dimerization Beijing Institute of Technology	O-62 p. 86
14:25–14:45	Dr. Olga PERMIAKOVA Low-variability hafnia-based memristors enabled by thermal exchange layer incorporation Moscow Institute of Physics and Technology	O-63 p. 87
14:45–15:10	Coffee break	
Th4 Quantum and nanoscale devices Proposed chair: Prof. Vadim GRINENKO		
15:10–15:30	Dr. Mikhail DRYAZGOV Single-photon spectroscopy of SiN _x using an integrated superconducting single-photon detector Institute of Nanotechnology of Microelectronics of the Russian Academy of Sciences	O-64 p. 88
15:30–15:45	Dr. Yaroslav RODIONOV Nesting-driven ferromagnetism of itinerant electrons Dukhov Research Institute of Automatics (VNIIA)	O-65 p. 89
15:45–16:00	PhD Anastasia SALOMATINA Sensitivity analysis of changes in the curvature parameter in spin dynamics Udmurt Federal Research Center, Ural Division, RAS	O-66 p. 90
16:00–16:15	PhD Elizaveta KRIVKO KITWPA based on NbN/Mo superconducting thin film structure Institute of Nanotechnology of Microelectronics (INME RAS)	O-67 p. 91
16:15–16:30	PhD Deng HU Vortex dynamics and anisotropy evolution in the double-dome kagome superconductor CsV ₃ Sb _{5-x} Sn _x Beijing Institute of Technology	O-68 p. 92
16:30–16:45	Coffee break	
16:45–17:00	PhD Artem MINAEV Surface properties of the layered compounds CeCo ₂ P ₂ , LaCo ₂ P ₂ and TbCo ₂ B ₂ investigated by scanning tunneling microscopy Moscow Institute of Physics and Technology	O-69 p. 94
17:00–17:15	PhD Xue-Tao DI Anomalous magnetoresistance hysteresis in the two-dimensional superconducting state of PtBi ₂ nanoflakes Beijing Institute of Technology	O-70 p. 95
17:15–17:30	PhD Radik TYUMENEV Magnetically memorable inductance in superconducting multilayer resonators Moscow Institute of Physics and Technology	O-71 p. 96
17:30–17:45	PhD Semen LARIONOV Peculiarities of the vortex dynamics in a granular niobium superconducting bridge Moscow Institute of Physics and Technology; VNIIA n.a. N.L. Dukhov	O-72 p. 97
17:45–18:00	PhD Yuqi ZHANG Controllable physical vapor deposition synthesis and one-dimensional hinge state transport of higher-order topological insulator α -Bi ₄ Br ₄ nanostructures Beijing Institute of Technology, Beijing; Institute of Physics, Chinese Academy of Sciences, Beijing	O-73 p. 98
18:00–18:15	PhD Polina KUZNETSOVA Stray-field-controlled Josephson switching in segmented Au/Ni/Au nanowire junctions Moscow Institute of Physics and Technology	O-74 p. 100

CONFERENCE PROGRAMME / DAY 5

Friday, 18 September

Spintronics and photonics

MIPT, Dolgoprudny · Hall to be confirmed by organisers the day before

Time	Friday, 18 September · Hall to be confirmed	Ref.
F1 Institutional cooperation and spintronics		
Proposed chair: Prof. Irina BOBKOVA		
09:00–09:30	Marcia Christina Bernardes BARBOSA UFRGS review and proposal for future cooperation · Universidade Federal do Rio Grande do Sul (UFRGS)	
09:30–10:00	Prof. Sergey NIKITOV Antiferromagnet-Cyclotron Hybridization in a Back-Gated 2D Electron System on an Antiferromagnetic Film Kotelnikov Institute of Radioengineering and Electronics of Russian Academy of Sciences; Moscow Institute of Physics and Technology; Laboratory of Magnetic Metamaterials, Saratov State University	O-75 p. 102
10:00–10:30	Prof. Vladimir BELOTELOV Spin-photonics at optical and THz frequencies Lomonosov Moscow State University; Russian Quantum Center	O-76 p. 102
10:30–10:50	Coffee break	
F2 Spin, light, and hybrid systems		
Proposed chair: Prof. Vladimir BELOTELOV		
10:50–11:20	Prof. Wei JIANG Quantized spin Hall effect in 3D nodal-ring semimetal: geometric scaling and symmetry-engineered spin response Beijing Institute of Technology, Beijing; International Center for Quantum Materials, Beijing Institute of Technology, Zhuhai	O-77 p. 103
11:20–11:40	Prof. Alexey BOLSHAKOV Resonant photonics, optical routing and hybrid photonic sources based on 2D materials and nanowires Center for Photonics and 2D Materials, Moscow Institute of Physics and Technology	O-78 p. 104
11:40–12:00	Prof. Irina BOBKOVA Ultrastrong light–matter coupling in superconductor/(anti)ferromagnet and superconductor/ferroelectric nanostructures Moscow Institute of Physics and Technology	O-79 p. 105
12:00–13:30	Lunch	
F3 Materials, photonics, and energy conversion		
Proposed chair: Prof. Alexey BOLSHAKOV		
13:30–13:50	Prof. Lada YASHINA Crystal growth for advanced studies and applications Lomonosov Moscow State University; Moscow Institute of Physics and Technology	O-80 p. 106
13:50–14:10	Dr. Yu-Hui CHEN On-chip optical memory enabled by bound states in the continuum – a silicon-erbium hybrid platform Beijing Institute of Technology	O-81 p. 107
14:10–14:30	Prof. Irina ROMANOVA Solid-phase synthesis, properties, and ab initio investigation of $\text{Gd}_{1-x}\text{Re}_x\text{TiO}_3$ titanates Kazan Federal University	O-82 p. 108
14:30–14:45	Coffee break	

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Time	Friday, 18 September · Hall to be confirmed (continued)	Ref.
14:45–15:05	Prof. Vyacheslav STORCHAK Novel 2D magnetic materials for spintronic applications National Research Center “Kurchatov Institute”	O-83 p. 109
15:05–15:25	Prof. Carlos GRAEFF Efficient and stable perovskite solar cells: new materials and modeling São Paulo State University (Unesp), School of Sciences	O-84 p. 110
15:25–15:45	Coffee break	
F4 Correlated materials and hybrid quantum devices Proposed chair: Prof. Wei JIANG		
15:45–16:05	Prof. Wei KU Fractionalization of ionic spin and orbital dimerization in $\text{La}_3\text{Ni}_2\text{O}_7$ high- T_c superconductors School of Physics and Astronomy, Shanghai Jiao Tong University, China	O-85 p. 111
16:05–16:25	Dr. Artem TARASOV Magnetot-spin-orbit graphene: Chern topology and photoinduced Hall response Saint Petersburg State University, Saint Petersburg, Russia	O-86 p. 112
16:25–16:40	PhD Daniil KONKOV Selective ultrafast optical excitation of high-k spin dynamics in a magnetophotonic nanostructure Lomonosov Moscow State University; Russian Quantum Center	O-87 p. 113
16:40–16:55	Dr. Majed NASHAAT Unveiling phase-magnetization dynamics in anomalous Josephson junctions Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research; Department of Physics, Faculty of Science, Cairo University	O-88 p. 114
16:55–17:10	PhD Maxim VASIAKIN Knight shift anisotropy in dirty superconductor-altermagnet hybrids Moscow Institute of Physics and Technology; L. D. Landau Institute for Theoretical Physics RAS	O-89 p. 115
17:10–17:25	Coffee break	
17:25–17:40	PhD Fuhong CHEN Synergistic modulation of electro-phonon transport in AgSbTe_2 via Pb-doping for enhanced thermoelectric performance Beijing Institute of Technology	O-90 p. 116
17:40–17:55	PhD Ruslan KINZIBAEV High-frequency vortex dynamics and kinetic inductance: the role of charge-imbalance potential relaxation Moscow Institute of Physics and Technology; Dukhov Research Institute of Automatics (VNIIA)	O-91 p. 117
17:55–18:10	PhD Minjun WANG Enhancement of the anomalous Nernst and thermal Hall effects in topological flat-band systems Beijing Institute of Technology	O-92 p. 118
18:10–18:25	PhD Valeria GORDEEVA Temperature-dependent exceptional points in S/AF/S heterostructures Moscow Institute of Physics and Technology	O-93 p. 119
18:25–18:40	PhD Qiuhong LUO Paramagnetic spin-based chiral cavity quantum electrodynamics at ambient conditions Beijing Institute of Technology	O-94 p. 120
18:40–18:50	PhD Nikita DUBITSKIY Superconducting heterostructures based on spin-orbit-coupled strontium iridate thin films National Research University “Higher School of Economics”, Faculty of Physics; Kotelnikov Institute of Radio Engineering and Electronics of RAS	O-95 p. 121
Time not specified	Closing ceremony and dinner	

Conference Information

The II International Scientific Conference *Advanced functional materials for digital and quantum electronics 2026* takes place at the Moscow Institute of Physics and Technology, Dolgoprudny, Russia, on **14–18 September 2026**. The conference language is English.

Conference hall. The conference hall for Tuesday–Friday, 15–18 September, will be confirmed by the organisers the day before.

Megagrant support

The conference is being held for the second time with the support of the **Megagrant Programme of the Ministry of Science and Higher Education of the Russian Federation**, through the project *Advanced functional materials for digital and quantum electronics*. The project is implemented in 2024–2028 at MIPT by the Laboratory of Topological Quantum Phenomena in Superconducting Systems of the Center for Advanced Mesoscience and Nanotechnology, under the scientific leadership of Prof. Alexander Golubov and Prof. Vasily Stolyarov.

Main topics

Superconductivity
Functional materials
Digital and quantum technologies
Spintronics

Topological quantum phenomena in superconducting systems
Quantum computing and simulation
Quantum optics and metrology
Nanophotonics

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Key dates and contact

Conference: 14–18 September 2026. **Abstract submissions:** 1 March–10 May 2026.

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Conference Secretariat: Ekaterina Dobrovolskaya

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FROM THE CHAIR OF THE CONFERENCE

Welcome Address

Dear Colleagues, Guests, and Participants,

On behalf of the Program and Organizing Committees, it is my great pleasure to welcome you to the **Second International Scientific Conference on Advanced Functional Materials for Digital and Quantum Electronics 2026**, held at the Moscow Institute of Physics and Technology.

We are delighted to host this gathering of brilliant minds from across the globe, bringing together leading scientists, researchers, and students to discuss the latest breakthroughs and future directions in quantum materials, superconductivity, spintronics, topological phenomena, nanophotonics, quantum optics, and digital and quantum technologies. The interdisciplinary nature of this conference reflects the collaborative spirit essential for tackling the complex challenges at the forefront of modern technology.

This Book of Abstracts showcases the diverse and high-quality research that will be presented during the conference. It is a testament to the vibrant activity and significant progress being made in the field. We are confident that the exchange of ideas and discussions that will take place here will foster new collaborations and inspire innovative research pathways.

We extend our sincere gratitude to all authors for their valuable contributions, to the members of the Program Committee for their diligent work in reviewing the submissions, and to the Organizing Committee for their tremendous efforts in preparing this event.

We wish you all a productive, stimulating, and enjoyable conference at MIPT.

Sincerely,

Prof. Vasily Stolyarov

Director, Center for Advanced Mesoscience and Nanotechnology
Moscow Institute of Physics and Technology (MIPT)
Chairman of the Program and Organizing Committees

MONDAY, 14 SEPTEMBER 2026 · 11:10–11:40 · CONCERT HALL

Welcome concert

Приветственный концерт

ПОНЕДЕЛЬНИК, 14 СЕНТЯБРЯ 2026 · 11:10–11:40 · КОНЦЕРТНЫЙ ЗАЛ

Дух России / Spirit of Russia

Лауреаты Всероссийских и
международных конкурсов

Елизавета Алексеевна Янина
Вокал

Андрей Леонидович Новиков
Баян

Laureates of All-Russian and
international competitions

Elizaveta Alekseevna Yanina
Vocals

Andrey Leonidovich Novikov
Bayan (Russian button accordion)

Программа концерта

01 «Катюша»

Слова — Михаил Исаковский.
Музыка — Матвей Блантер.

02 «Лучший город Земли»

Слова — Леонид Дербенёв.
Музыка — Арно Бабаджанян.

03 «Смуглянка»

Слова — Яков Шведов.
Музыка — Анатолий Новиков.

04 «Валенки»

Народная песня
в обработке Лидии Руслановой.

05 «Где-то на белом свете»

Слова — Леонид Дербенёв.
Музыка — Александр Зацепин.

06 «Подмосковные вечера»

Слова — Михаил Матусовский.
Музыка — Василий Соловьёв-Седой.

07 Частушки

08 «При лужку»

Русская народная песня.

Concert programme

01 Katyusha

Lyrics — Mikhail Isakovsky.
Music — Matvey Blanter.

02 The Best City on Earth

Lyrics — Leonid Derbenyov.
Music — Arno Babajanian.

03 Smuglyanka (The Dark Maiden)

Lyrics — Yakov Shvedov.
Music — Anatoly Novikov.

04 Valenki (Felt Boots)

Folk song
arranged by Lidia Ruslanova.

05 Somewhere in the World

Lyrics — Leonid Derbenyov.
Music — Alexander Zatsepin.

06 Moscow Nights

Lyrics — Mikhail Matusovsky.
Music — Vasily Solovyov-Sedoy.

07 Chastushki (Folk Ditties)

08 Pri luzhku (By the Meadow)

Russian folk song.

ORAL PRESENTATIONS / SECTION 1

Superconducting functional materials

Monday, 14 September 2026

Concert hall · O-01–O-14

M1 · Opening scientific session

Proposed chair: Alexander GOLUBOV

M2 · Superconducting materials and quantum states

Chair: Alexander GOLUBOV

M3 · Surfaces, disorder, and superconducting devices

Chair: Alexei VAGOV

O-01 | 14 September 2026 · 11:40–12:10 · M1

Microscopic structure of the vortex cores in granular niobium: a coherent quantum puzzle

V. S. Stolyarov^{1,2,*}, V. D. Neverov¹, A. V. Krasavin^{1,3,4}, D. I. Kasatonov¹, D. K. Panov¹, D. S. Baranov¹, O. V. Skryabina¹, A. S. Mel'nikov^{1,5,6}, A. A. Golubov¹, M. Yu. Kupriyanov^{1,7}, A. A. Shanenkov^{1,3}, T. Cren⁸, A. Yu. Aladyshkin^{1,5,6}, A. Vagov^{1,3}, D. Roditchev²

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Keywords: granular superconductors, Abrikosov vortices, vortex-core bound states, STM/STS, Bogoliubov–de Gennes theory

In homogeneous type-II superconductors, the order parameter decreases smoothly over the coherence length ξ and vortex cores host low-energy Caroli-de Gennes-Matricon (CdGM) states [1,2]. Granular niobium films form a different regime: 3–10 nm grains are smaller than the effective coherence length $\xi \approx 12$ nm and are coupled through disordered boundaries [5].

Scanning tunneling microscopy and spectroscopy at $T = 1.1$ K showed homogeneous spectra with $\Delta_0 = 1.35$ meV in zero field. After field cooling at 0.25 T, gap maps revealed a disordered vortex lattice. Each core formed an irregular “quantum puzzle”: the spectral gap changed by discrete jumps at grain boundaries but remained nearly constant inside grains. In several vortices, a finite 0.2–0.8 meV excitation gap persisted at the apparent center, although the pair potential must vanish at the 2π phase singularity.

Bogoliubov–de Gennes calculations based on the measured grain geometry reproduced the maps and showed that the singularity lies close to, but not necessarily on, a boundary. Intergrain scattering disrupts the destructive interference responsible for a zero-energy core state and opens a soft minigap [3]. Confinement also shifts bound states to high energies and groups them into grain-correlated bunches; the lowest bunch can reach $E_0 \approx 0.8\Delta_0$, far above the conventional CdGM scale Δ_0^2/E_F . The core therefore remains phase coherent across many grains, while its local density of states is assembled from grain-sized elements.

After increasing the field from 0.25 to 0.5 T, vortex displacements initially reached $\sim \xi$ and then slowed to local rearrangements over 23.5 h. This ultra-slow dynamics links the puzzle-like core structure to a heterogeneous pinning landscape relevant to granular Nb devices [4].

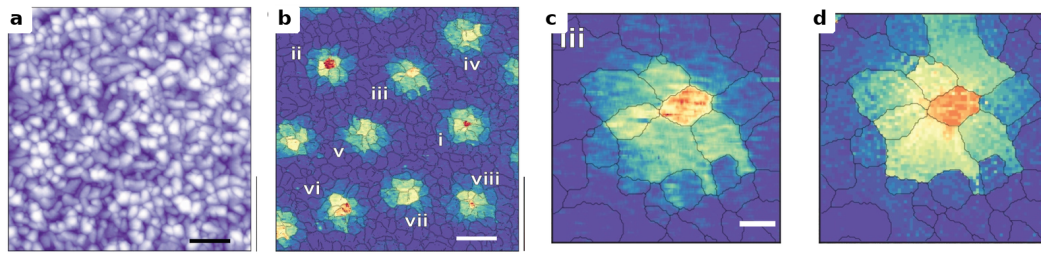


Fig. 1. (a) Nb topography; (b) superconducting-gap map; (c,d) measured and BdG-calculated core "iii".

Acknowledgments. This work is supported by a grant from the Ministry of Science and Higher Education of the Russian Federation No 075-15-2025-010, dated 28.02.2025.

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- [2] C. Caroli, P. G. de Gennes, J. Matricon, Phys. Lett. 9, 307 (1964).
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- [5] V. S. Stolyarov et al., Microscopic structure of the vortex cores in granular niobium: A coherent quantum puzzle, [arXiv:2601.20486](https://arxiv.org/abs/2601.20486) (2026). doi:10.48550/arXiv.2601.20486.

O-02 | 14 September 2026 · 13:10–13:40 · M2

Applications of high-resolution electron microscopy: from fundamental physics to materials engineering

Yutao Xing

Institute of Physics, Fluminense Federal University

In this work, I will provide a brief introduction to the High-Resolution Electron Microscopy Laboratory (LaMAR) of UFF. Subsequently, selected research topics developed at LaMAR are discussed. One focus is superconductivity in the Ni–Bi system. Although neither pure Ni nor Bi is intrinsically superconducting, Ni/Bi bilayers grown at room temperature and at 80 K exhibit a superconducting transition with a critical temperature (T_c) of approximately 4 K. Detailed microstructural investigations of the Ni/Bi interface reveal that superconductivity arises from the spontaneous formation of the intermetallic compounds NiBi_3 and NiBi during sample preparation. An oscillatory behavior of T_c as a function of bilayer thickness was observed. This oscillation occurs in samples that simultaneously satisfy the quantum size limit (QSL) and the coherence size limit (CSL). Owing to the low density of states near the Fermi level, the electron mean free path exceeds the thickness of the bismuth thin films, enabling the observation of T_c oscillations in the Ni–Bi system. Additional research topics include advanced materials for energy storage applications. It includes manganese oxide nanofoams for high-performance supercapacitors and hard carbon materials for sodium-ion batteries.

O-03 | 14 September 2026 · 13:40–14:10 · M2

Van der Waals bond in 2D-materials-based structures: rigidity, friction, quantification and control

A. Yu. Kuntsevich, * A. Yu. Klovov, V. A. Ievleva, N. Yu. Frolov, A. I. Sharkov, M. V. Pugachev

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Keywords: 2D materials, van der Waals heterostructures, topological insulators, hexagonal boron nitride, graphene, picoacoustics, surface acoustic wave, thermal cycling

Layered materials attract researchers due to their novel properties originating from the 2D limit, an almost infinite parameter space, and the ability to mechanically assemble heterostructures. Although many 2D materials-based devices have been demonstrated, much remains unknown about the van der Waals (vdW) bond between layers or between a layer and a substrate.

In the linear Hookean regime, this bond can be approximated by distributed springs with certain lateral and longitudinal rigidities. We measured these rigidities for several van der Waals interfaces. The method involves optical femtosecond excitation of a sound pulse and measurements of reflectivity with spatial and temporal resolution. The optical response can be modeled by a multi-layer acousto-optic model with rigidity as an adjustable parameter. Whereas for 3D materials and 3D epitaxial heterostructures this rigidity is unmeasurably high, for van der Waals bonds it appears to be an order of magnitude weaker than interlayer bonds in crystals [1]. The pump–probe setup also triggers a surface acoustic wave, whose profile can be obtained by scanning the probe pulse along the sample. A surface acoustic wave would be dispersionless on an infinite substrate; however, due to adjacent layers (hBN in our case), the pulse profile changes over time. This effect is a consequence of dispersion and allows us to calculate interlayer rigidity [2].

The interface is often not smooth enough, and the strength of the van der Waals bond may be reduced. For example, when two surfaces of 3D topological insulators from the Bi_2Se_3 family are assembled in the standard mechanical way, the expected annihilation of topological surface states does not occur.

Outside the small-deformation regime, the van der Waals bond can be broken. For instance, in the lateral direction, the van der Waals bond leads to static friction, which can be rather small in the absence of defects and grain boundaries. We found a way to controllably break the van der Waals bond for flakes placed on a textured substrate by thermal cycling, utilizing strain caused by thermal expansion [3].

Thus, the van der Waals bond is comparatively weak. Its rigidity is measurable, and substrate structuring allows tuning of the bond. This work is supported by the Russian Science Foundation, Grant No. 25-42-01036.

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O-04 | 14 September 2026 · 14:10–14:40 · M2

Unified picture of time-reversal-symmetry breaking two-band superconductivity in noncentrosymmetric LaNiC_2 and centrosymmetric LaNiGa_2 via μSR studies

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Keywords: TRSB, multiband superconductivity, muon spin relaxation, penetration depth

Superconductors lacking inversion symmetry in their crystal structure are known as noncentrosymmetric superconductors. The absence of inversion symmetry in these materials allows for the possibility of mixed spin-singlet and spin-triplet pairing states. LaNiC_2 is a noncentrosymmetric superconductor that has previously been reported to exhibit time-reversal-symmetry-breaking superconductivity in polycrystalline samples. In addition, the compositionally similar compound LaNiGa_2 crystallizes in a centrosymmetric, nonsymmorphic structure and has also been shown to host nontrivial topological states. Time-reversal symmetry breaking has likewise been observed in LaNiGa_2 . However, most previous studies on these materials have been performed on polycrystalline samples, leading to ambiguity regarding their superconducting gap structure.

We performed detailed μSR investigations of noncentrosymmetric LaNiC_2 and nonsymmorphic LaNiGa_2 in single-crystal form [1, 2]. In contrast to earlier μSR studies on polycrystalline and powder samples, the well-defined orientation of single crystals enables a simultaneous determination of the absolute value of the magnetic penetration depth and the vortex core size through measurements of the magnetic field distribution in the vortex state. The temperature dependence of the superfluid density in both compounds is well described by a two-band model. While the interband coupling in LaNiC_2 is found to be moderate, LaNiGa_2 exhibits unusually strong interband coupling. In LaNiC_2 , the magnetic-field dependence of the penetration depth and vortex core size unambiguously shows the presence of two nodeless superconducting energy gaps. In contrast, for LaNiGa_2 , the field dependence of the vortex core size resembles that of a single-band superconductor, consistent with strong coupling between superconducting condensates in different bands. Our results suggest that Cooper pairing in these compounds is characterized by an interorbital equal-spin pairing model, originally proposed to unify the pairing states of LaNiC_2 and the centrosymmetric superconductor LaNiGa_2 .

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O-05 | 14 September 2026 · 14:55–15:25 · M2

Majorana bound states in chiral ferromagnet–superconductor heterostructures revisited

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Keywords: superconductors, Majorana states, skyrmions

Majorana zero modes are central to the pursuit of fault-tolerant topological quantum computation. While traditionally sought in one-dimensional hybrid nanowires, a robust alternative platform involves heterostructures combining superconductors with noncollinear magnets. This work focuses on a particularly promising system: a chiral ferromagnet hosting a magnetic skyrmion coupled to a superconducting film containing a superconducting vortex. Such skyrmion-vortex pairs have recently been realized experimentally and are theorized to harbor localized Majorana states, offering a potential pathway for braiding operations. We present a comprehensive theoretical analysis of the low-energy quasiparticle bound states in these heterostructures. Extending previous studies, we develop an analytical framework for the Majorana wavefunctions as well as the wavefunctions and spectrum of other low-lying states within a Bogoliubov–de Gennes approach. Our analytical results explicitly demonstrate the critical role of spin–orbit coupling for the stabilization of Majorana modes and provides approximate analytical expressions for low-lying states localized at the vortex, both with and without an accompanying skyrmion. The derived analytical results show excellent agreement with numerical simulations. We further elucidate the role of realistic effects, including vector potentials and texture perturbations from stray magnetic fields, to assess their impact. The results are reported in [1].

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O-06 | 14 September 2026 · 15:25-15:45 · M2

Crystal flat band in a triangular lattice

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Keywords: Flat band, Symmetry, Tight-binding model, First-principles calculations

Flat bands provide an ideal platform for exploring correlation-driven quantum phenomena, yet their experimental realization remains challenging. The identification of simple and experimentally accessible lattice models, exemplified by kagome and honeycomb lattices, is therefore essential for guiding the discovery of new flat-band materials. Here, we propose an orbital-dependent triangular-lattice model that hosts an emergent flat band through the incorporation of multiple orbital degrees of freedom. We show that the orbital configuration imposes nontrivial symmetry constraints, prohibiting certain inversion operations that would otherwise be allowed in a conventional triangular lattice. Based on this model, we identify a family of phosphorus-sulfur compounds as promising material candidates for realizing the proposed flat-band physics. These compounds also exhibit additional desirable physical properties, further broadening their potential for investigating correlated electronic states. Our work establishes a direct connection between orbital-lattice engineering and realistic flat-band materials, providing a versatile platform for exploring exotic quantum phases driven by strong electronic correlations.

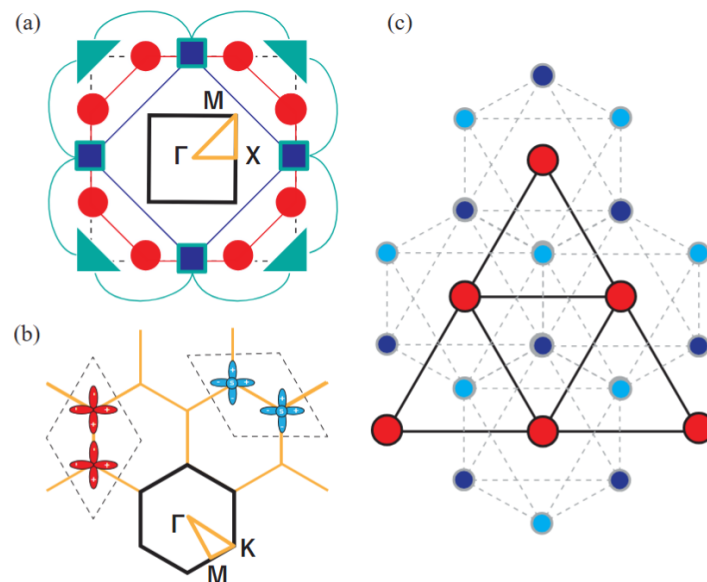


Fig. 1. Three strategies for the flat zone lattice model. (a) increase number of sites: checkerboard - Lieb - S4. (b) consider orbital degrees of freedom $p_x p_y$ and sp^2 honeycomb lattice. (c) The triangular lattice after considering auxiliary atoms.

O-07 | 14 September 2026 · 15:45–16:15 · M2

Correlated disorder as the microscopic mechanism of subgap absorption in superconductors

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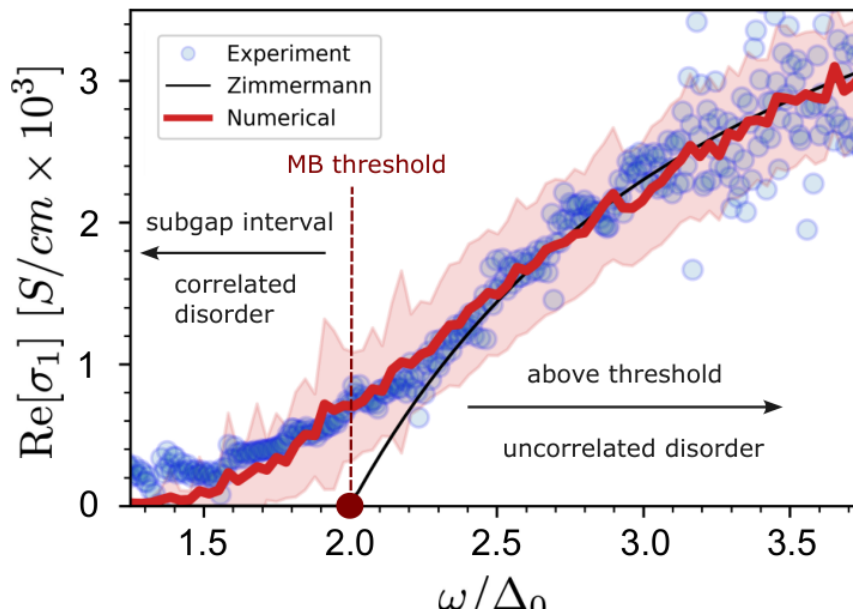
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Subgap optical absorption is widely observed in disordered conventional s-wave superconductors, although its microscopic origin remains debated. We show that superconducting inhomogeneity by itself is insufficient to produce absorption below the Mattis-Bardeen (MB) threshold and identify spatial correlations of disorder as the decisive microscopic ingredient. Using self-consistent Bogoliubov–de Gennes calculations, we compare strong uncorrelated and spatially correlated disorder with similar distributions of the local pairing amplitude. Uncorrelated disorder preserves a sharp absorption threshold near 2Δ , whereas correlated disorder organizes pairing inhomogeneity into extended regions of suppressed superconductivity. These regions host low-energy quasiparticle states, reduce the spectral gap below the average pairing amplitude, and enable optical transitions in the subgap interval. We apply this mechanism to terahertz measurements of strongly disordered NbN films. A model containing correlated and uncorrelated disorder quantitatively reproduces the measured optical conductivity, including the gradually decaying subgap tail, while retaining the conventional high-frequency response. The fitted disorder correlation length $\xi_V = 2\xi_0 \approx 10$ nm agrees with the characteristic size of twin domains independently observed by transmission electron microscopy. The results establish the disorder correlation length relative to the superconducting coherence length as a key parameter governing subgap electrodynamics and demonstrate that THz spectroscopy can serve as a quantitative probe of mesoscopic disorder correlations.

Figure: Measured (circles) and calculated (red line) real part of the optical conductivity of NbN films at $T = 2.5$ K. The black line is the Zimmermann result. Spatially correlated disorder accounts for the finite absorption below the MB threshold, while uncorrelated disorder controls the response above the threshold.



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O-08 | 14 September 2026 · 16:35–16:55 · M3

Atomically precise triple-step staircase on a vicinal silicon surface: how to distinguish Si(5 5 7), Si(7 7 10), and Si(8 8 11)?

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Keywords: High-index-Miller surfaces, 7×7 reconstruction, 5×5 reconstruction, triple steps

Scanning tunneling microscopy studies of periodic arrays of triple steps fabricated on single-crystalline Si(5 5 7) wafers demonstrate several possible atomic structures of consecutive steps and flat Si(1 1 1) terraces that maintain the same periodicity on micrometer-sized surface areas. Detailed analysis of the atomically resolved data reveals the formation of a Si(8 8 11) triple-step staircase with a period of $18b \approx 5.99$ nm in projection onto the terrace plane [1,2], where $b=0.333$ nm is the distance between atomic rows on the Si(1 1 1)1×1 surface. Schematic models for several possible configurations of either 7×7- or 5×5-reconstructed terraces and triple steps are proposed and shown in Fig. 1.

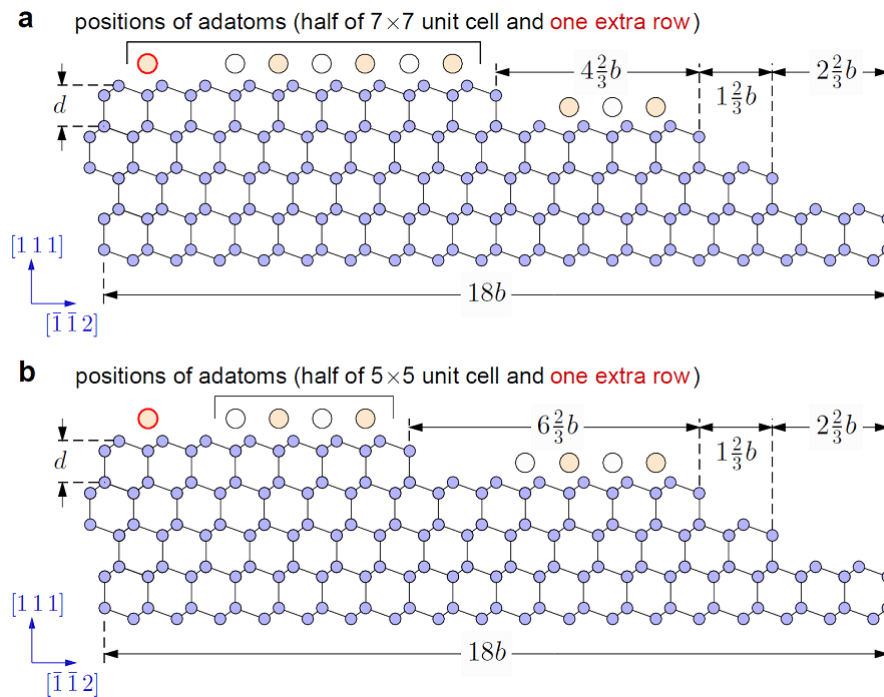


Fig. 1. a, b – Schematic models of possible terrace and triple step structures responsible for the periodic Si(8 8 11) staircases with 7×7 or 5×5 -reconstructed terraces in accordance with the STM images.

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O-09 | 14 September 2026 · 16:55–17:15 · M3

Majorana zero mode edgetronics in topological superconductors

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Keywords: topology, superconductivity, Majorana, vortex

Majorana zero modes (MZMs) have evolved from a purely theoretical concept [1] to a central topic in contemporary condensed matter physics, driven in part by their potential applications in topological quantum computation. A key advantage of MZMs lies in the nonlocal encoding of quantum information, whereby topological properties provide intrinsic protection against local sources of decoherence. In topological superconductors, MZMs can emerge both in the cores of Abrikosov vortices and at system boundaries. However, implementing the braiding operations required for quantum logic by adiabatically moving vortices remains experimentally challenging [2].

In this work, we propose a conceptually distinct approach to manipulating vortex- and edge-bound MZMs that avoids both vortex motion and the need for switchable Josephson junctions. The central idea is to exploit the nonlocal nature of Majorana states by controlling the topological phase of the system via an electrostatic gate potential. As a result, a system initially hosting vortex-bound MZMs can be transformed into a configuration supporting additional edge-bound MZMs localized at the gate-defined interfaces. This voltage-induced topological segmentation of the system provides a purely electrostatic mechanism for the controlled creation, annihilation, and spatial redistribution of Majorana modes, enabling their use in braiding protocols and quantum logic operations.

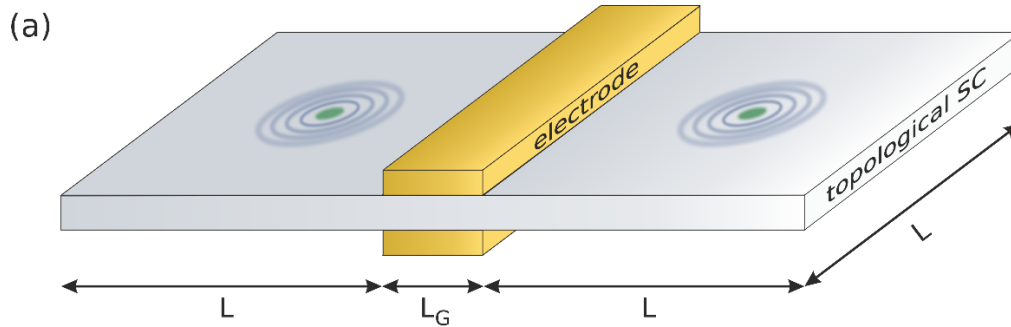


Fig. 1. Schematic of the proposed setup: a top gate is applied to the central region of a two-dimensional topological superconductor with two well-separated Abrikosov vortices.

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O-10 | 14 September 2026 · 17:15–17:35 · M3

Granular aluminum: new life for an old friend

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Keywords: granular Aluminum, qubit, parametric amplifier, MKID

Granular aluminum [1, 2] (grAl), consisting of remarkably uniform grains connected by Josephson contacts [3], has attracted interest since the sixties thanks to their rich phase diagram [4, 5] and practical advantages, like increased critical temperature [2, 6], critical field [7, 8], and kinetic inductance [9]. According to the strength of the nonlinearity, one could use thin film structures from grAl as superinductors [11–14] and microwave kinetic inductance detectors [15–22], the lowest possible Kerr nonlinearity; as parametric amplifiers [23–26] and frequency converters, the self-Kerr nonlinearity is in kHz range; and as nonlinear element of qubits [27], the highest possible self-Kerr.

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O-11 | 14 September 2026 · 17:35–17:55 · M3

Intrinsic coexistence of magnetism and superconductivity in magnetic misfit compounds $\text{Mn}_x\text{Bi}_{1-x}\text{Se}/\text{NbSe}_2$

G. A. Bobkov^{1,*}, I. A. Shvets¹, I. V. Bobkova¹¹ Moscow Institute of Physics and Technology, Dolgoprudny, RussiaContact: gabobkov@mail.ru**Keywords:** superconducting heterostructures, proximity effect, van der Waals materials

Misfit compounds are naturally grown crystalline structures composed of alternating trigonal and tetragonal layers. Spatial separation of the superconducting trigonal layers makes it possible to realize the properties of two-dimensional materials—in this report, superconducting monolayer NbSe_2 —with additional functionalities induced by the tetragonal layers.

We predict that the misfit compound $\text{Mn}_x\text{Bi}_{1-x}\text{Se}/\text{NbSe}_2$, in which magnetism originates from the tetragonal layer and superconductivity from trigonal NbSe_2 , exhibits nontrivial superconducting behavior: increasing the fraction of the superconducting constituent leads to stronger suppression of superconductivity. Furthermore, the superconducting state can be tuned by varying the composition of the misfit compound, including the possibility of artificially isolating or connecting the superconducting NbSe_2 layers both to the Mn-containing magnetic layers and to one another.

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O-12 | 14 September 2026 · 18:10–18:30 · M3

Compact mechanically robust high-Q superconducting resonator for terahertz optics

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The absorption of terahertz radiation in a superconductor is strongly suppressed, and its permittivity attains large negative values, resulting in enhanced reflectivity [1]. We leverage these effects to construct a high-Q terahertz Fabry-Perot resonator, comprising a plane-parallel plate of high-resistivity silicon coated on both sides with thin $\text{Mo}_{0.6}\text{Re}_{0.4}$ superconducting films serving as reflectors. Using terahertz spectrometers, we measure the transmission coefficient spectra of resonators with 10, 20, and 30 nm thick films across the frequency range $\nu = 3\text{--}50\text{ cm}^{-1}$ at temperatures $T = 2.5\text{--}300\text{ K}$. As the films become superconducting below $T_c = 7\text{--}8\text{ K}$, the interferometric resonances exhibit a dramatic increase in quality factor Q , finesse F , and peak transmittance Tr_{max} , and a reduction in FWHM $\Delta\nu$ [2,3]. The best values are achieved for a 30 nm resonator at $T = 2.5\text{ K}$: $Q = 830$ (peak at $\approx 6\text{ cm}^{-1}$) and FWHM $\Delta\nu = 0.005\text{ cm}^{-1}$ ($\Delta f = 150\text{ MHz}$, peak at $\approx 3\text{ cm}^{-1}$); the values of Tr_{max} are in the range of 40–55%. We thoroughly analyze the dependence of resonance parameters on temperature, frequency, and film thickness and propose strategies for further improving resonator performance. The described compact, portable, and mechanically robust resonators are promising for applications with stringent

weight and size constraints, such as astronomy and atmospheric science, as well as in portable and integrated terahertz systems, e.g., for stabilization of the frequency of terahertz lasers, narrow-band filters, frequency calibration of terahertz sources, high-resolution spectral analyzers, elements of millimeter and submillimeter wave circuits, etc.

Acknowledgments. This work was supported by the Ministry of Science and Higher Education of the Russian Federation grant No. 075-15-2025-010 and Russian Science Foundation grant 26-12-00493.

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O-13 | 14 September 2026 · 18:30–18:45 · M3

Multiterminal quasi-ballistic Josephson effect in monocry- talline gold: experiment and theory

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Keywords: multiterminal Josephson effect, quasi-ballistic transport, proximity effect

We investigate a planar eight-terminal Josephson device with Al electrodes on an 80 nm thick monocrystalline Au flake [1,2]. The low-temperature electron mean free path is 680 nm; the four opposing electrode pairs have weak-link lengths of 94, 258, 614 and 1008 nm. All leads are coupled through the common Au region.

Three observations establish the multiterminal response. At 0.2 K, the zero-field critical currents depend nonmonotonically on weak-link length: the two inner pairs carry larger currents than the outer pairs, with an outer-to-inner ratio of approximately 7/8. At 0.7 K, simultaneous current injection through two electrode pairs produces superconducting-domain boundaries with slopes near -1.7, rather than -1 expected for three independent junctions in series. Perpendicular-field interference is governed by the larger areas between neighbouring same-side electrodes, with a crossover near 0.2 mT towards nearly independent opposing junctions.

Eilenberger-based theory [2] considers three limiting models: single bulk-impurity scattering, multiple specular reflections and single diffuse surface reflection. All eight leads form a 28-link network, with phases of unbiased leads set by current conservation. Surface-reflection models reproduce the low-temperature critical-current ratios without pair-specific fitting; interface transparency fixes the overall current scale. Diffuse reflection better describes the temperature dependence, although intermediate-temperature deviations remain. The results establish a metallic platform for nonlocal Josephson transport.

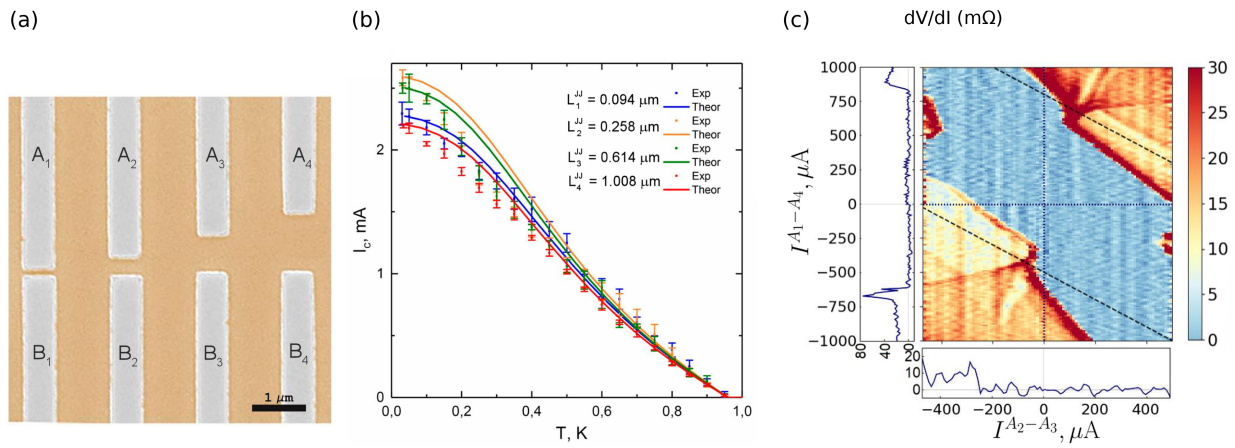


Fig. 1. (a) Device micrograph [2]. (b) Critical currents: experiment (points) and theory (lines) [1]. (c) Two-current differential resistance at 0.7 K [1]; colour scale in $\text{m}\Omega$.

Acknowledgments. Supported by RSF grants No. 23-72-30004 (experiment) and No. 25-72-10127 (theory).

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O-14 | 14 September 2026 · 18:45–19:00 · M3

Superconductivity in thin $\text{Pb}_{0.7}\text{In}_{0.3}\text{Bi}_2\text{Te}_4$ with Nb contacts

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Keywords: Topological insulators; superconductivity

PbBi_2Te_4 is a three-dimensional topological insulator with a small band gap [1]. The material has a layered structure with weak van der Waals interlayer coupling. When PbBi_2Te_4 is doped with indium, it becomes a type-II superconductor [2]. Such materials have long attracted attention because of the predicted transition to a topological superconducting state [3].

In this work, electronic transport properties were measured for both a bulk $\text{Pb}_{0.7}\text{In}_{0.3}\text{Bi}_2\text{Te}_4$ crystal and thin exfoliated samples in four-point and quasi-four-point geometries. The temperature dependence of the resistance of the bulk sample is nonmetallic, indicating a short mean free path in this compound. The resistivity approaches $1 \text{ m}\Omega \text{ cm}$, suggesting proximity to the Ioffe–Regel limit for metals. The superconducting transition temperature of the bulk crystal is 1.015 K. For thin samples, the transition temperatures lie in the range 0.9–1.1 K, which may indicate that superconducting Nb contacts affect the transport properties depending on the contact geometry. The temperature dependence of the critical current will be discussed, with emphasis on an intriguing feature near T_c and its possible origins. In a perpendicular magnetic field, Fraunhofer oscillations of the critical current observed for samples with wide contacts will also be analyzed.

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ORAL PRESENTATIONS / SECTION 2

Quantum technology

Tuesday, 15 September 2026

Hall to be confirmed by organisers the day before · O-15–O-39

T1 · Quantum systems and control

Proposed chair: Walter POGOSOV

T2 · Artificial atoms and quantum optics

Chair: Daniel DOMINGUEZ

T3 · Quantum computing: control, algorithms, and machine learning

Proposed chair: Oleg ASTAFIEV

T4 · Superconducting qubits: fabrication, control, and noise

Proposed chair: Gleb FEDOROV

T5 · Quantum devices: error detection, sensing, and simulation

Proposed chair: Walter POGOSOV

T6 · Quantum processors: gates and compilation

Proposed chair: Evgeniy KIKTENKO

O-15 | 15 September 2026 · 09:00–09:30 · T1

Lasing with superconducting quantum systems

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Keywords: superconducting quantum technologies, quantum optics, quantum acoustics

Superconducting quantum systems are key elements for a new field of physics – quantum optics with artificial atoms in the microwave range. These artificial atoms have quantized energy levels and thus behave like natural ones, enabling demonstrations of cavity quantum electrodynamics, quantum state control, single-photon emission, and more. Such an “atom” possesses properties that allow fundamental quantum optics effects to be realized on a chip and previously unattainable phenomena to be observed. For example, it easily achieves strong coupling with other circuit elements, such as resonators, open transmission lines, and other atoms. This, in particular, enables fundamental effects using just a single quantum system. We present a series of works on lasing in a single artificial atom: a current-pumped system – the first experimental realization of lasing in an artificial atom [1]; lasing via Landau–Zener tunneling pumping [2]; lasing in an atom with a specially designed electromagnetic environment [3]; and lasing in an acoustic system, where photons are replaced by phonons. The latest experiment is a breakthrough in superconducting quantum technologies and one of the first results in the emerging field of quantum acoustics [4].

In this experiment, the artificial atom is coupled to a surface acoustic wave (SAW) resonator with resonant frequency $f_r = 3.15$ GHz. The SAW resonator is formed by Bragg mirrors made of metallic stripes, and the electric field is converted to acoustic waves by interdigitated transducers – sets of submicron metallic stripes on a quartz surface. The base temperature in our refrigerator is $T = 10$ mK, so $\hbar f_r \gg k_B T$. By implementing population inversion in a three-level atom via microwave excitation to the third level and relaxation to the first excited state, and under near-resonant conditions, radiation emission is observed. Importantly, the emission linewidth narrows by one order of magnitude. The estimated number of phonons in the resonator is about one hundred.

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O-16 | 15 September 2026 · 09:30–10:00 · T1

Quantum holography and its application in image encryption

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Keywords: holography, quantum entanglement, encryption

As an important imaging technique, holography has been realized with different physical dimensions of light, including polarization, wavelength, and time. Recently, quantum holography has been demonstrated using a polarization-entangled state with the advantages of high robustness and enhanced spatial resolution, compared with classical holography. However, the polarization is only a two-dimensional degree of freedom, which greatly limits the capacity of quantum holography. Here, we propose a method to realize high-dimensional quantum holography by using high-dimensional orbital angular momentum (OAM) entanglement. A high-capacity OAM-encoded quantum holographic system can be obtained by multiplexing a wide range of OAM-dependent holographic images. Proof-of-principle experiments with four- and six-dimensional OAM entangled states have been implemented and verify the feasibility of our idea. Our experimental results also demonstrate that the high-dimensional quantum holography shows high robustness to classical noise. Moreover, the level of security of the holographic imaging encryption system can be greatly improved in our high-dimensional quantum holography.

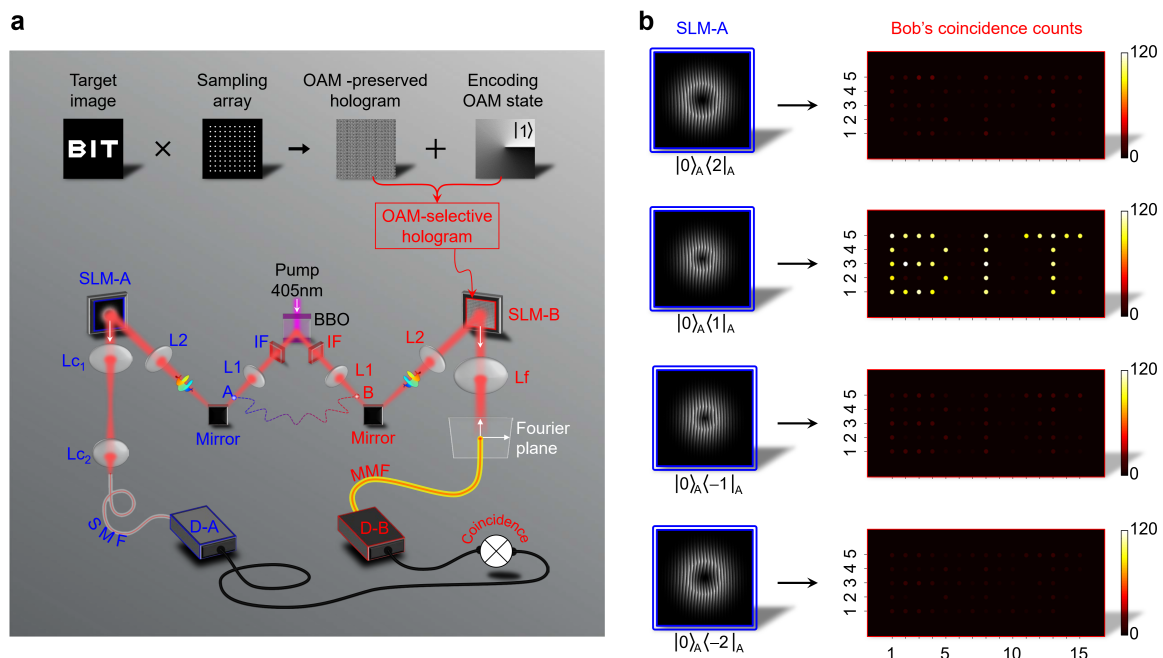


Fig. 1. OAM entanglement-enabled quantum holography.

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O-17 | 15 September 2026 · 10:00–10:30 · T1

Efficient strong driving protocols for fast quantum gates in superconducting qubits

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In recent years, significant progress has been made in the design of quantum processors using superconducting qubits, which have become one of the most promising platforms due to their scalability, long coherence times, and potential for fast high-fidelity operations. The standard protocols for the implementation of quantum gates are based on resonant Rabi driving. However, quantum gates based on resonant Rabi oscillations are inherently slow for small-frequency qubits like the fluxonium device, and are also prone to errors due to counter-rotating terms. In the fluxonium architecture, alternative manipulation protocols can outperform standard resonant driving. I will present our theoretical work on the implementation of fast, high-fidelity quantum gates based on a one-period Landau–Zener–Stückelberg–Majorana (LZSM) driving protocol. We derive analytical expressions that simplify the exploration of the parameter space while accounting for the multi-level structure of the circuit. Furthermore, we analyze the role of leakage, discussing strategies to mitigate it and identifying regimes in which it becomes the dominant source of error. Finally, to evaluate the impact of dissipation on gate fidelity, we develop a robust formalism suitable for analyzing the open-system performance of quantum gates in the strong driving regime.

Work in collaboration with Santiago Ferreyra, Valentin Reparaz, Maria Jose Sanchez and Leandro Tosi

O-18 | 15 September 2026 · 10:50–11:10 · T2

Photon-statistics analysis via quantum wave mixing in superconducting qubits

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Keywords: quantum optics, superconducting qubits, photons

This work discusses theoretical and partly experimental approaches to nonlinear quantum optics with superconducting two-level systems and to the detection of nonclassical photon statistics through wave-mixing spectra.

In the first approach, a degenerate parametric amplifier is considered as a source of squeezed vacuum generated by a strong classical pump in a nonlinear medium. This squeezed field contains correlated photon pairs and therefore exhibits nonclassical photon statistics. Its interaction with a superconducting qubit is described theoretically within a white-noise framework. Under simultaneous action of the pump and probe fields, nonlinear wave mixing produces characteristic sidebands in the qubit emission spectrum. The positions and relative amplitudes of these spectral components, including the appearance of missing lines, provide direct fingerprints of the quantum correlations in the squeezed field. The second approach considers a continuously driven qubit as a source of antibunched microwave photons. The radiation emitted by this source is mixed with a classical signal on another qubit, which acts as a nonlinear detector. The resulting wave-mixing spectrum contains clear signatures of nonclassical statistics: high-order classical mixing lines are suppressed, while processes involving a single quantum photon become dominant. In this regime, the second qubit effectively operates as a photon-statistics sensor.

Taken together, these results show that superconducting qubits can be used not only as nonlinear quantum emitters, but also as sensitive probes of photon statistics. Wave-mixing spectroscopy of artificial two-level systems therefore offers a practical route toward detecting squeezed, paired, and antibunched microwave radiation without relying solely on conventional correlation-function measurements.

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O-19 | 15 September 2026 · 11:10–11:30 · T2

Josephson artificial atoms: quantum optics and algorithms

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Keywords: superconducting qubits, quantum simulation, quantum AI

Quantum simulation is a promising approach to studying large quantum systems in regimes where corresponding classical calculations are infeasible. Josephson circuits are among the tools that have recently emerged for this purpose: studies over the last decade have demonstrated notable progress in both the quality and complexity of experiments with arrays of coupled superconducting artificial atoms (SAAs). Such systems are expected to reach scales at which they behave like artificial materials with unique properties, offering an interesting direction for fundamental research [1, 2].

Acknowledgments. This work was supported by Russian Science Foundation, project No. 25-22-00280

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O-20 | 15 September 2026 · 11:30–12:00 · T2

Resonance fluorescence of a two-level atom driven by quantum electromagnetic field

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Keywords: quantum optics, nonclassical states of light, atom-field interaction, resonance fluorescence, photon correlations

The interaction of quantum systems with nonclassical electromagnetic fields is an active area of quantum optics, quantum information, and nanophotonics. It underpins coherent control, quantum-information storage and transfer, and fully quantum photon-matter interfaces. Experimentally accessible few-photon states, biphoton pairs, and multiphoton squeezed states offer opportunities for applications and for observing new light-matter effects.

A central, less-explored question is how an atom emits radiation when driven by quantum light. Under resonant classical excitation, resonance fluorescence [1] can produce the well-studied Mollow triplet [1, 2]. Quantum excitation poses a more difficult theoretical problem because the atom and driving field influence each other, particularly for few-photon or fragile squeezed states. Strongly nonstationary

dynamics can introduce additional features. These effects, including correlations and entanglement of the emitted photons under quantum pumping, require detailed investigation.

We develop a fully quantum, first-principles approach to the emission of a two-level atom driven by a quantum electromagnetic field. The emitted radiation is described by a set of dissipative field modes that interact with the atom and can consequently influence one another. We calculate the emission spectrum and its formation in time, identify features arising from the nonclassical driving field, and analyze correlations between emitted photons and their time evolution. The correspondence with the classical limit of Mollow-triplet formation is discussed. We also study the interaction of the emitted radiation with a second probe atom and compare the resulting effects with experimental observations [3, 4]. The results are relevant to quantum-information technologies, atom–field interfaces, and the generation of nonclassical states with correlated photons.

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O-21 | 15 September 2026 · 13:30–14:00 · T3

Complexity classes of quantum states

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Keywords: quantum states, quantum computing

Significant advances in the development of computing devices based on quantum effects [1] and the demonstration of their use to solve various problems have rekindled interest in the nature of the “quantum computational advantage” [2]. Although various attempts to quantify and characterize the nature of the quantum computational advantage have previously been made, this question largely remains open. Indeed, there is no universal approach that allows determining the scope of problems whose solution can be accelerated by quantum computers, in theory or in practice. We consider an approach to this question based on the concept of complexity and reachability of quantum states [3]. On the one hand, the class of quantum states that are of interest for quantum computing must be complex, i.e., not amenable to simulation by classical computers with less than exponential resources. On the other hand, such quantum states must be reachable on a practically feasible quantum computer. This means that the unitary operation that transforms the initial quantum state into the desired one must be decomposable into a sequence of one- and two-qubit gates of a length that is at most polynomial in the number of qubits. By formulating several statements and conjectures, we discuss the question of describing a class of problems whose solution can be accelerated by a quantum computer. We also review new results on concrete examples of sets of quantum states with “complexity transitions” and new ways to describe quantum states.

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O-22 | 15 September 2026 · 14:00–14:20 · T3

High-speed control of a fluxonium qubit via picosecond pulses from Josephson digital circuits

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Keywords: fluxonium qubit, single-flux-quantum (SFQ) pulses, digital control, superconducting circuits, high-fidelity gates

In this work, we develop and analyze two digital control protocols for a fluxonium qubit using picosecond SFQ pulses generated by superconducting digital electronics [1, 2]. We first show that naive single-channel SFQ trains (either flux-only or charge-only) are ineffective: flux driving is too slow (X-gate duration > 140 ns), while charge driving induces severe leakage to noncomputational states.

The first protocol employs high-frequency SFQ pulse packets (N pulses per qubit period generated at the frequency of a high-frequency generator). Within a two-level approximation, we derive the condition for a π -rotation and determine the required number of pulse packet repetitions. Numerical simulations within a multilevel fluxonium model demonstrate X-gate fidelity $F = 99.995\%$ with leakage below 10^{-4} and a gate duration of approximately 68 ns. The protocol is shown to be robust against fluctuations in Josephson, charging, and inductive energies, as well as against flux deviations that maintain the operating point.

The second protocol, based on counter-rotating drives [3], combines flux and charge SFQ sequences with a quarter-period phase shift ($\pi/2$). This creates an effective rotating control field that suppresses the dominant counter-rotating error. For three experimentally relevant parameter sets, we demonstrate gate fidelities above 99.99% while reducing the gate duration to 16–25 ns.

We also propose a hardware realization based on NDRO and T-flip-flop cells for programmable generation of SFQ pulse packets. These results establish SFQ-based cryogenic control as a realistic and scalable route for fast and accurate fluxonium manipulation.

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O-23 | 15 September 2026 · 14:20–14:40 · T3

Matrix encoding method in measurement-based algorithms of matrix manipulations

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Keywords: quantum algorithm, matrix operations, measurement, unitary transformations

Quantum matrix-manipulation algorithms form a large class of algorithms intended to provide an advantage over classical counterparts. In the standard approach, the matrix of interest is encoded into a Hermitian operator, which is then exponentiated using the Trotter method to obtain a unitary operator. Matrix operations are thereby reduced to operations involving unitaries.

In our approach, we encode the elements of the $N \times N$ matrix into the states of a quantum system and perform matrix manipulation via the unitary transformations applied to the above quantum system involving an additional auxiliary subsystem. Finally, the measurement on a special qubit (ancilla) removes all extra states from the resulting superposition state thus leaving the matrix-manipulation result in the pure state of the quantum system. We propose algorithms for matrix addition and multiplication (the depth $O(\log N)$) [1], determinant calculation (the depth is $O(N \log^2 N)$), inversion of matrix (the depth is $O(N^2 \log N)$) and solving systems of linear algebraic equations (the depth is $O(N^2 \log N)$) [2]. The matrix encoding method was also effectively implemented in the variational quantum algorithms for singular value decomposition to calculate the objective function together with its derivatives with respect to the optimization parameters [3]. All these algorithms assume postselection with relatively low success probability. This postselection problem can be removed by implementing the so-called controlled measurement [4].

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O-24 | 15 September 2026 · 14:40–15:00 · T3

Quantum machine learning for quantum states processing

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Keywords: quantum machine learning, quantum kernels, support vector machines

Quantum machine learning (QML) [1] is a rapidly developing field at the intersection of quantum computing and data analysis. A particularly promising direction is the development of methods tailored for processing quantum data, which can reveal correlations and structures inaccessible to classical approaches.

In this work, we build upon the line of research initiated in Ref. [2], where quantum machine learning techniques were applied to the analysis of quantum states on a quantum processor. We consider an extension of this approach based on kernel methods and hybrid quantum–classical schemes for processing quantum data.

The quantum component is used to estimate overlaps between quantum states via a Hadamard-test-type procedure, which enables the construction of a quantum kernel matrix. This matrix is then processed using classical machine learning techniques, such as support vector machines, allowing one to extract relevant structure from the data and perform downstream analysis tasks.

A key feature of the considered approach is that the complexity of the classical post-processing scales polynomially with the number of samples and does not depend on the Hilbert space dimension, while the quantum subroutine is determined primarily by the state preparation procedure. This makes the framework well suited for implementation on noisy intermediate-scale quantum (NISQ) devices.

The proposed framework opens up several directions for further investigation, including the analysis of quantum states generated in experimental platforms, benchmarking and characterization of quantum devices, and the study of structure in parametrized quantum circuits. More broadly, such approaches may be useful in applications where direct classical processing of quantum states is infeasible due to the exponential growth of the state space.

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O-25 | 15 September 2026 · 15:20–15:35 · T4

Transmon in the straddling regimes across cavity photon number

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Keywords: superconducting qubits, transmon, spectroscopy, straddling regime

The straddling regime in superconducting qubits is used to improve the fidelity of dispersive readout and to suppress ZZ-interactions in two-qubit gates. In this regime, the spectra of transmon transitions exhibit avoided crossings of an unexplained nature – distinct from those arising from two-level systems, additional transmon harmonics, or interactions with the resonator.

To address this issue, we perform a detailed investigation of the transition landscape of a transmon coupled to a resonator in the straddling regime using cross-Kerr two-tone spectroscopy. We find that resonance occurs between higher modes of the resonator–transmon system when the excitation numbers of the transmon differ by exactly one. Additionally, we observe a nonlinear, nonmonotonic dependence of the transition frequencies on the readout power. This behavior is attributed to the growing contribution of the transmon's second and third excited states to the dispersive shift. Such complex dynamics result in an anharmonicity that varies with both the readout power and the qubit-resonator detuning. This tunability can be exploited for state-leakage control and for designing two-qubit gates that rely on opposite-sign anharmonicity.

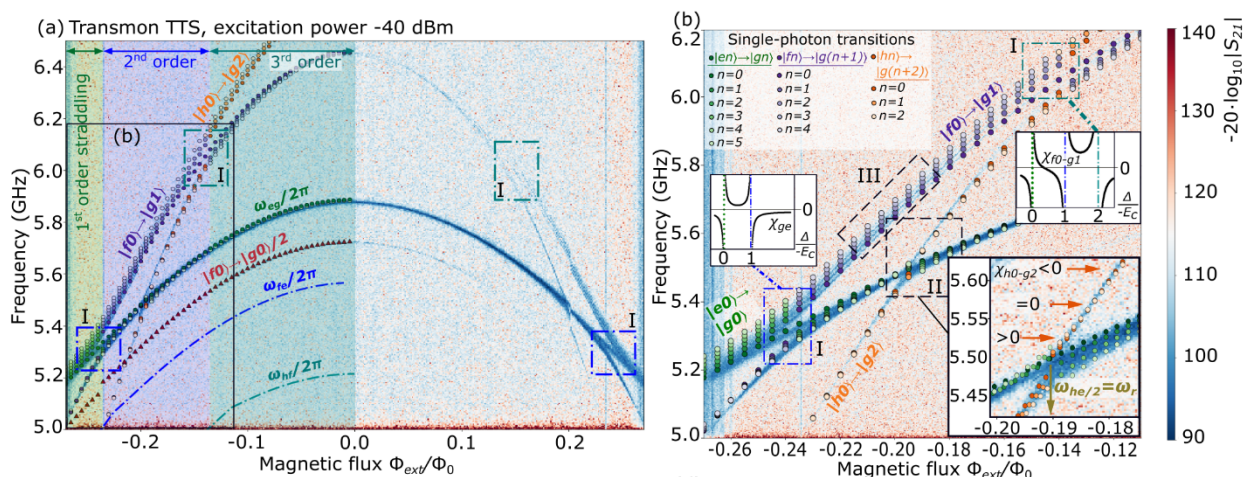


Fig. 1. Measured transmon spectra versus applied magnetic flux at an excitation power of -40 dBm, shown as color maps. Colored dots indicate numerically calculated single-photon transition frequencies.

Acknowledgments. The authors are grateful to the Russian Science Foundation Project No. 25-72-00088 for financial support.

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O-26 | 15 September 2026 · 15:35–15:50 · T4

Superconducting niobium TSV contacts for cryoelectronic devices: effect of supercycle etching on sidewall quality and qubit fabrication prospects

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Keywords: superconducting interconnects, sputter deposition, deep reactive ion etching, Bosch process, niobium, cryo-electronics, superconductors

The fabrication of superconducting interconnects using niobium-based through-silicon vias (TSVs) is the focus of this study. The impact of a supercycle—comprising sequential oxidation and chemical etching—on the quality of through-etch sidewalls was investigated. Experimental results demonstrate that incorporating this supercycle substantially improves TSV sidewall quality and eliminates scalloping defects. After twelve repetitions of the supercycle, dissipative electrical coupling is achieved between the superconducting strips on the front and back sides of the sample, with a critical current density of $5 \times 10^4 \text{ A cm}^{-2}$. The critical ratio of substrate thickness to hole diameter required to form such electrical coupling is found to be 3:1. This approach shows promise for application in the fabrication of superconducting qubits.

deep and removal of top and bottom silicon oxide in BOE solution; (c) and (d)—Re-oxidation and removing of silicon oxide several times from TSV channels; (e)—deposition of 200 nm thick niobium on both sides; (f)—lithography and etching of niobium layers on both sides.

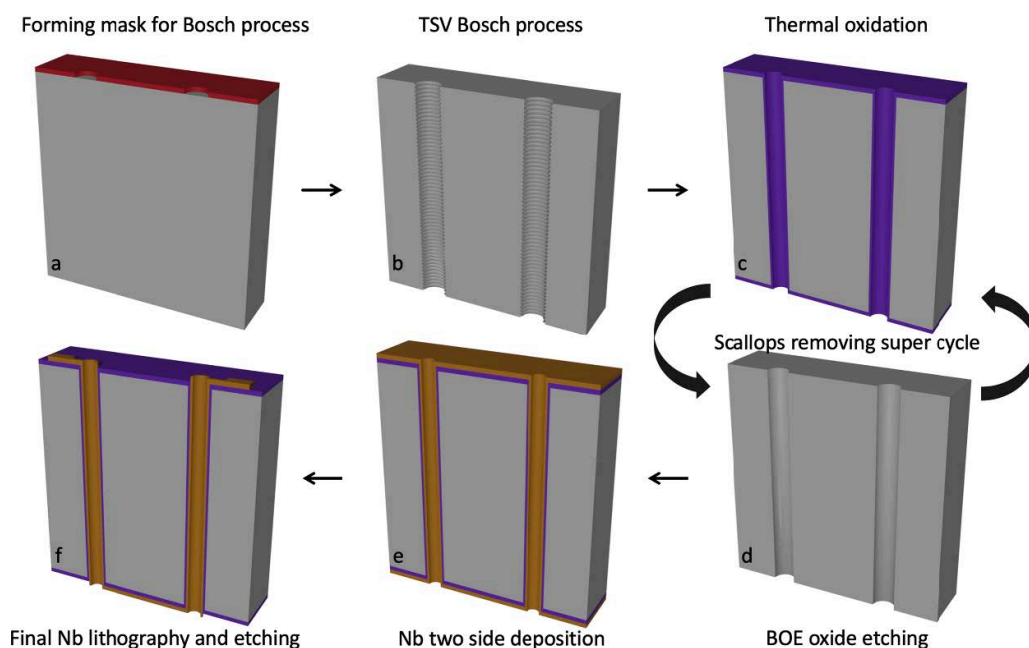


Fig. 1. Graphical presentation of the main steps in the process route for the fabrication of TSV interconnects: (a)—preparing mask for TSV etching, that is the window in SiO₂ layer by laser photolithography and plasma etched anisotropic process; (b)—Bosch process $460 \mu\text{m}$

Acknowledgments. The study was supported by project No. 125020501540-9 of the Ministry of Education and Science of the Russian Federation. Fabrication and technology characterization were carried out at large scale facility complex for heterogeneous integration technologies and silicon+carbon nanotechnologies.

O-27 | 15 September 2026 · 15:50–16:05 · T4

Revealing sensitivity of superconducting artificial atoms to photon statistics of scattered field

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Keywords: qubits, superconducting artificial atoms, quantum optics, microwave range, strong coupling of light and matter, cascaded quantum systems, single photon scattering, bichromatic qubit excitation, quantum wave mixing, four-wave mixing, antibunched light, photon statistics

The two-level system (TLS) is a central abstraction in quantum optics. Experiments with TLSs can use natural atoms or Josephson-junction-based superconducting artificial quantum systems. The latter offer several advantages: strong light–matter coupling, highly efficient on-demand single-photon sources, and directional emission in waveguide-coupled structures.

A key feature of superconducting artificial atoms interacting with microwave electromagnetic fields is the possibility of measuring the time-averaged scattered field. This enables the photon statistics of incident fields to be probed through the nonlinearity of an individual artificial atom using mean-field measurements. We report experiments on scattered fields in a cascaded system of two superconducting artificial atoms coupled to a common waveguide, with feedback suppressed by cryogenic circulators. The experiments examine scattering from a TLS driven by a superposition of a single photon and vacuum [1], as well as wave mixing [2] in which one signal mode is continuously coherent and the other contains a single photon [3] or antibunched light [4].

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O-28 | 15 September 2026 · 16:05–16:20 · T4

Runtime-efficient zero-noise extrapolation from mixed physical and logical data

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Keywords: quantum error correction, quantum error mitigation, quantum simulation

Partial quantum error correction and quantum error mitigation are expected to coexist in the prefault-tolerant regime, yet the resource advantage of combining them remains insufficiently quantified. We study zero-noise extrapolation constructed from mixed datasets that contain a small number of error-corrected data points together with data obtained without error correction. The low-noise logical points anchor the extrapolation, while the higher-noise physical points enlarge the noise baseline at a much smaller runtime cost. Under a simple model in which error correction suppresses the effective gate error rate from p to γp , we derive the variance of the zero-noise estimator and compare the physical runtime required to reach a target precision. For Richardson extrapolation, the mixed-data strategy reduces variance amplification and can lower the required physical runtime by several orders of magnitude when $\gamma \lesssim 0.1$. As a proof of principle, we apply the method to digital quantum simulation of a six-spin transverse-field Ising model and find that mixed physical/logical datasets yield lower-variance zero-noise estimates and outperform extrapolation based only on error-corrected data in the parameter regime studied here. These results identify hybrid error correction and error mitigation as a practical route to resource-efficient quantum computation before full fault tolerance. The study is described in Ref. [1].

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O-29 | 15 September 2026 · 16:20–16:35 · T4

Kinemon artificial atom for high-fidelity superconducting quantum operations

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Keywords: superconducting qubits, superconducting devices, kinetic inductance, thin films, quantum logical gates, nonlinear systems, coplanar resonators, nanofabrication

The current state of superconducting quantum technology largely relies on transmon qubits, which, despite their robustness, have several limitations. In particular, the charge sensitivity of higher energy levels and the low anharmonicity of the fundamental transition constrain the fidelity, speed, and compactness of quantum operations [1–4]. In this work, we propose using a new type of superconducting qubit, the kinemon, or kinetic-inductance-shunted transmon [5]. This transmon-like circuit, enhanced by a finite shunting kinetic inductance, is designed to achieve increased anharmonicity while maintaining coherence comparable to that of transmons using a similar fabrication process. At the same time, the design mitigates flux-qubit-like sensitivity to fabrication variations while enabling reproducible qubit frequencies within the transmon regime. The kinetic inductor is implemented as an ultrathin film of pure aluminum deposited at cryogenic nitrogen temperatures [6].

The proposed architecture also includes a tunable coupling element in a two-qubit kinemon circuit, enabling the experimental implementation and characterization of two-qubit operations. The first demonstration showed that kinemon qubits can be individually controlled using dedicated flux lines within a complex circuit architecture, while the coupling strength can also be tuned. A reproducible thin-film fabrication process has been developed, and the initial circuit performance has been characterized, including an average single-qubit gate fidelity of 99.6%. These results demonstrate the potential of the kinemon as a reproducible and scalable building block for high-coherence superconducting quantum circuits. This work was supported by the Russian Science Foundation Project (Grant No.24-72-00050 and 26-72-00036).

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O-30 | 15 September 2026 · 16:35–16:50 · T4

Reducing TLS defects using the air-qubit fabrication approach

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Superconducting qubits based on Josephson junctions are among the leading candidates for universal quantum computing. A key requirement for these qubits is a sufficiently long coherence time [1]. Efforts to meet this requirement address both quantum-engineering challenges [2] and fabrication-technology challenges.

In fabrication, the main challenge is to minimize defects introduced while forming the elements of superconducting quantum circuits—resonators, qubits and auxiliary components—and to use low-loss materials. All other factors being equal, two-level-system (TLS) defects play a major role in energy loss. Such defects occur within materials and at interfaces formed during circuit fabrication. Resonant coupling between a defect and a qubit opens an energy-dissipation channel, reducing the qubit relaxation and coherence times [3].

We propose a fabrication approach for multiqubit circuits in which the substrate–qubit and substrate–air interfaces are removed (Fig. 1). The aim is to minimize the influence of TLS defects on the resulting qubits and to increase the relaxation and coherence times of the completed circuit.

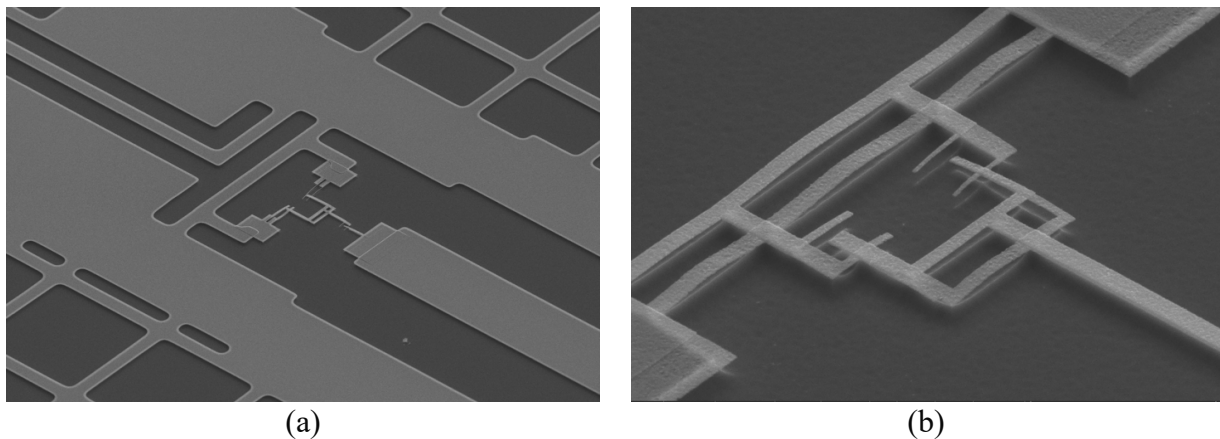


Fig. 1. Transmon qubit fabricated using the Air-Qubit approach: (a) scanning electron micrograph of the transmon; (b) transmon with the interface removed.

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O-31 | 15 September 2026 · 17:10–17:25 · T5

Demonstration of quantum error detection on a fluxonium–transmon–fluxonium processor

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Keywords: fluxonium qubits, superconducting processor, quantum error correction

Superconducting fluxonium qubits are a promising platform for fault-tolerant quantum computing, where quantum error correction plays a central role. We experimentally realize a scalable fluxonium–transmon–fluxonium architecture with microwave-driven single- and two-qubit gates. On this device, we demonstrate a logical qubit based on a two-qubit repetition code capable of detecting bit-flip errors arising from qubit relaxation. The implementation of the error-detection protocol enables first-order suppression of logical errors in the short-time regime and improves the effective storage of quantum information.

O-32 | 15 September 2026 · 17:25–17:40 · T5

Towards lasing-enhanced quantum sensing with organic spintronics

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Keywords: pentacene, pentacene-doped p-terphenyl, organic spintronic, ODMR

Crystal defects in solid-state spintronic materials are crucial for quantum information processing, yet leading inorganic platforms face limitations in material preparation and active spin density. To overcome this, we demonstrate the first room-temperature self-cavity lasing from pentacene-doped *p*-terphenyl (Pc:Ptp)—an easily prepared, highly tailorable organic spintronic material. This laser emission exhibits strong polarization and anisotropy due to unique molecular packing, and we establish optical coherence as a reliable metric to distinguish amplified spontaneous emission (ASE) from true lasing.

Building on this compact platform, we further investigated its potential for enhanced optical readout and sensitivity in quantum magnetometers. Under quasi-continuous pumping, we observed significant nonlinear emission behaviors. Steady-state simulations confirm that optical contrast is optimized near the lasing threshold rather than in the strong-pumping regime. Furthermore, using a quantum master equation, we systematically evaluated ODMR (optically detected magnetic resonance) sensitivity across varying pump rates, microwave driving frequencies, and magnetic fields. Notably, we discovered a wavelength-dependent microwave-driven optical contrast—a phenomenon unresolvable by traditional photon counting measurements—suggesting unexplored photophysical mechanisms within the pentacene molecule. These findings highlight the rich potential of the pentacene system for realizing next-generation solid-state quantum devices.

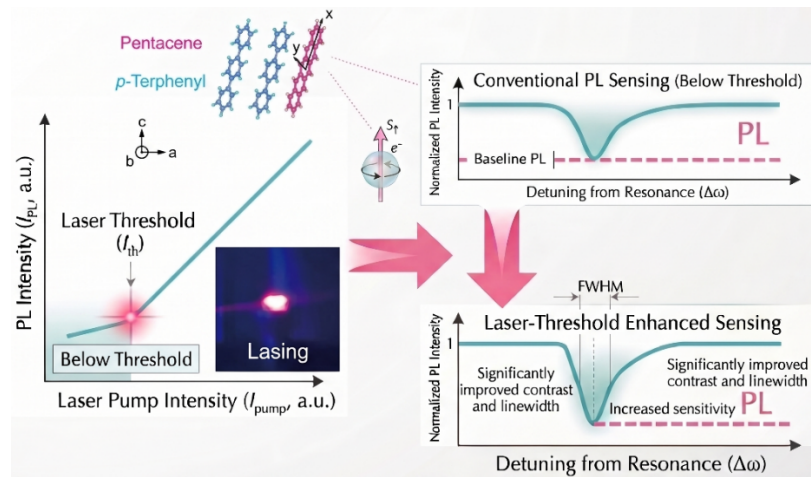


Fig. 1. Conceptual diagram of laser-enhanced quantum sensing.

O-33 | 15 September 2026 · 17:40–17:55 · T5

Broadband impedance-matched parametric amplifiers with accurately predicted central frequency, gain and bandwidth

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Keywords: josephson circuits, parametric amplifier, lumped elements, harmonic balance

Broadband parametric amplifiers are essential tools for high-fidelity readout of superconducting qubit states. Impedance-matched parametric amplifiers enable a system noise temperature approaching the standard quantum limit while maintaining high gain (over 15 dB) and a wide amplification bandwidth (exceeding 300 MHz) [1,2]. A key challenge for this type of device is the dependence of the gain profile on the measurement chain, which shifts the matching point away from the designed resonance frequency [3,4].

In this work, we present a detailed study of the development of impedance-matched broadband parametric amplifiers. We demonstrate approaches that reduce the sensitivity of the amplifier performance to the microwave environment, thereby improving the predictability of the device characteristics. Experimentally, we achieve a gain exceeding 15 dB over an amplification bandwidth of approximately 500 MHz, with an average saturation power of -107 dBm and a noise temperature at the standard quantum limit [5].

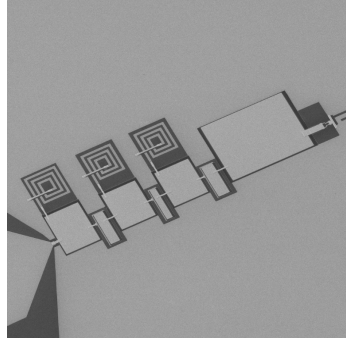


Fig. 1. SEM micrograph of a lumped-element broadband parametric amplifier

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O-34 | 15 September 2026 · 17:55–18:10 · T5

Analysis of the classical simulability of quantum circuits for approximate optimization

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Keywords: quantum optimization, quantum circuits simulation

This work considers the Quantum Approximate Optimization Algorithm (QAOA) and analyzes the classical simulability of the quantum states generated by the algorithm. An approach for the approximate simulation of these states is proposed, enabling the study of larger quantum registers and the optimization of algorithm parameters (angles) in high-dimensional settings. As a baseline, the QAOA configuration proposed in [1] is considered. The scalability of QAOA simulation is analyzed for unconstrained discrete optimization problems of the second and fourth order. The proposed approach not only enables more efficient optimization of QAOA parameters, but also opens new directions for quantum-inspired optimization.

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O-35 | 15 September 2026 · 18:10–18:25 · T5

Superconducting integrated on-demand quantum memory with microwave pulse preservation

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Keywords: Microwave quantum memory, on-demand storage, photon echo

We demonstrate an on-chip superconducting microwave memory featuring a dynamically controlled RF-SQUID coupler, achieving 57.5(4)% storage fidelity at single-photon excitations with a 1.51 μs memory cycle. The active coupler does not measurably degrade fidelity, with main losses stemming from impedance matching and material imperfections, and the device remains compatible with quantum state storage at low photon populations. This architecture enables scalable integration of qubits and memory for quantum error correction, identifying specific pathways to near-unity fidelity.

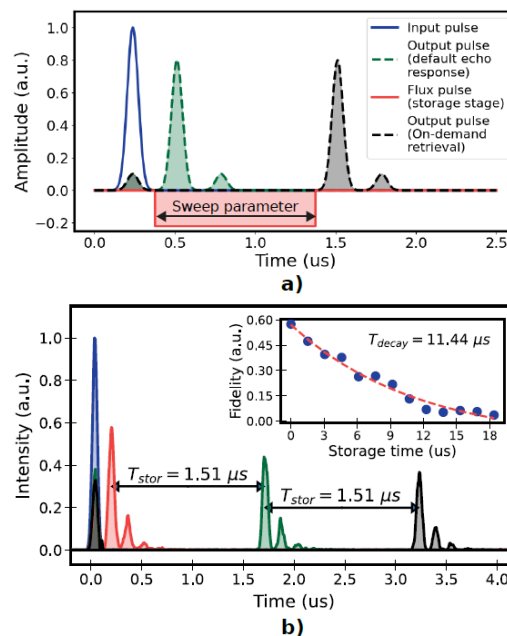


Fig. 1. Device fidelity measurements. a) Pulse sequence for fidelity measurements. The storage stage duration is varied to demonstrate on-demand retrieval capability. b) Quantum memory responses for the first three storage periods (red, green and black, respectively. Blue graph corresponds to reference). The memory cycle time is $T_{\text{stor}} = 1.51 \mu\text{s}$ and the fidelity of the first storage period is $F = 57.5(4)\%$. Inset: Fidelity versus storage time. Due to internal losses, it has exponential decay behavior with effective decay time $T_{\text{decay}} = 11.44(3.58) \mu\text{s}$, which corresponds to an effective quality factor of $Q_{\text{i,eff}} = 4.3 \times 10^5$.

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O-36 | 15 September 2026 · 18:25–18:40 · T5

Trotterization on NISQ processors: capabilities, limitations, and future directions

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Keywords: NISQ processors, Trotterization, quantum simulation, digital-analog simulation, error mitigation, low-energy-state search

Trotterized time evolution occupies a special place among NISQ-oriented quantum algorithms. Hamiltonian simulation is one of the clearest routes toward quantum advantage in many-body physics: interacting quantum dynamics is generically hard to represent classically, while a quantum processor follows the same unitary evolution directly. On present-day devices this promise is limited by Trotter error, noise accumulation, and shallow circuit depth. Our starting point was digital simulation of far-from-equilibrium spin dynamics on IBM superconducting processors, where short Trotter circuits already reproduced nontrivial interference- and entanglement-driven features, whereas deeper circuits rapidly crossed over to an effectively randomized regime because of gate errors [1].

One way to push this boundary is to reduce the digital overhead without abandoning the Trotter picture. In Hybrid digital-analog simulation of many-body dynamics with superconducting qubits [2], residual qubit-qubit couplings on IBM hardware were used as an analog resource for trotterized simulation of spin clusters, which decreased reliance on standard two-qubit gates. For the transverse-field Ising model this hybrid scheme outperformed a fully digital implementation on the same device. Another route is data-driven error mitigation. In [3,4], the repeated structure of Trotter circuits was used as prior information for neural-network post-processing, which substantially restored dynamical observables and extended the useful circuit depth, including the high-noise regime.

The same logic also points beyond direct real-time simulation. In the «Grover-Ising» scheme [5], evolution under an Ising Hamiltonian serves as a phase oracle for low-energy-state search. For commuting Ising models the oracle is exact, whereas for more general noncommuting Hamiltonians its construction naturally returns to trotterized evolution. Trotterization should therefore be viewed not only as a tool for dynamics, but also as a building block for spectral and search algorithms. The overall conclusion is pragmatic: despite clear NISQ limits, trotterization remains one of the most flexible algorithmic frameworks we have, and it is a natural candidate for future studies of more complex spin and fermionic lattice models.

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O-37 | 15 September 2026 · 19:00–19:15 · T6

High-fidelity gates in superconducting quantum coprocessor Snowdrop 8Q

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Keywords: Superconducting qubits; quantum coprocessor; gate fidelity

The development of practically useful quantum computers is limited by the fidelity of quantum logic gates, processor scalability, and the efficiency of quantum algorithms that are demanding of hardware parameters. The FMN Laboratory, a joint center of Bauman Moscow State Technical University and Dukhov Research Institute of Automatics (VNIIA), has developed Snowdrop 8Q, an eight-qubit superconducting quantum coprocessor. The coprocessor architecture is based on frequency-tunable transmon qubits [1] with tunable coupling [2]. This work presents the results of improvements to the architectural design of a scalable superconducting quantum coprocessor cell, the circuit fabrication processes, and an iterative, multistage calibration procedure for qubit operations. We demonstrate solutions to the primary factors limiting gate fidelity in multiqubit systems: crosstalk and parasitic interactions between qubits.

Circuit design improvements have led to enhanced gate and readout fidelities. We present results from both standard benchmarking of key multiqubit circuit parameters, quantum gates, and readout, and the implementation of quantum algorithms demonstrating the overall performance of the coprocessor.

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O-38 | 15 September 2026 · 19:15–19:30 · T6

Qudit transpilation techniques for trapped ions

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Keywords: Qudit, qubit, quantum circuit, quantum algorithms, trapped ions

The rapid progress in trapped-ion quantum computing motivates exploring higher-dimensional systems, qudits, as a resource-efficient alternative to traditional qubit encodings. In this work, we present a comprehensive transpilation pipeline that converts standard quantum assembly language (QASM) circuits into an equivalent qudit form optimized for trapped-ion hardware. Given the recent experimental progress in trapped-ion hardware, we specifically concentrate on qutrits ($d=3$) and ququarts ($d=4$) as the most accessible ion qudits at the present time. Building on transition-aware decomposition techniques, we design single-qudit gate decompositions that respect the physical level structure of trapped ions. For multiqubit operations on qutrits, we introduce an efficient realization of the generalized N -qubit Toffoli gate that scales linearly with the number of controls. On ququarts, where a single ququart encodes two qubits, we show how to implement qubit circuits while reducing the number of two-qubit gates by leveraging the four-level Hilbert space. We also discuss scalability of the proposed approaches and their experimental realization on a trapped-ion qudit processor. Our results establish trapped ions as a practical platform for qudit quantum computing, with our transpilation tools providing a direct pathway from high-level qubit circuits to efficient qudit-native execution.

Acknowledgments. We acknowledge support from the Russian Roadmap on Quantum Computing (Contract No. 868/1653, 21 August, 2025).

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O-39 | 15 September 2026 · 19:30–19:45 · T6

Experimental three-qubit processor unit with a native CCZ gate

Scheduled presenter: Grigoriy Mazhorin

National University of Science and Technology MISIS

The predominance of two-qubit gates in superconducting quantum processors is largely motivated by hardware simplicity, although many quantum algorithms naturally involve multiqubit primitives. Al-

though native multiqubit gates have been demonstrated experimentally, no implementation has yet competed with decompositions based on state-of-the-art two-qubit gates. It therefore remains unclear whether architectures based on native multiqubit operations can preserve the simple control, low coherent errors and scalability characteristic of conventional two-qubit approaches.

We present a superconducting three-qubit processor unit based on fluxonium qubits coupled through a microwave-driven transmon coupler. We experimentally realize a native CCZ gate using a single 65 ns microwave pulse with a fidelity of 99.4%, rivaling the performance achievable with decompositions based on the best reported two-qubit gates. We further show that the same physical principles enable scalable two-dimensional architectures with suppressed parasitic interactions, demonstrating the practical viability of native multiqubit superconducting processors.

ORAL PRESENTATIONS / SECTION 3

Devices based on superconducting functional materials

Wednesday, 16 September 2026

Hall to be confirmed by organisers the day before · O-40–O-53

W1 · Superconducting and magnetic materials

Proposed chair: Alexei VAGOV

W2 · Vortices and collective phenomena

Proposed chair: Rafael ZADOROSNY

W3 · Superconducting hybrid devices

Proposed chair: Mauro DORIA

O-40 | 16 September 2026 · 09:00–09:30 · W1

Commensurate resonances and the increase of the gap in superconducting films by non-superconducting layers

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Parallel plates immersed in a system have helped elucidate fundamental physical concepts, including the Casimir effect and the Fabry–Perot interferometer. Motivated by these phenomena, we consider films with an SISIS structure, where S and I represent superconducting and insulating layers, respectively. We find a new kind of resonance promoted by the normal layers, which act as parallel plates and produce spatially localized quantum states [1]. Strong localization has recently been shown to promote superconductivity [2]; here, however, the localization effect arises solely from commensurability.

The gap is substantially enhanced when the total film thickness is commensurate with the distance between the two insulating barriers. The superconducting gap between the normal layers is three to four times larger than the bulk value. This enhancement exceeds that produced by the well-known shape resonances proposed by Thompson and Blatt [3,4], which were subsequently used to explain the experimental variation of the critical temperature with superfluid density in a two-dimensional gas [5].

Observation of commensurate resonances requires quantum-size effects, as do shape resonances: the transverse modes must form standing waves perpendicular to the film. Our results are obtained from the Bogoliubov–de Gennes equations within the Anderson approximation developed for Bi films, where quantum-size effects are possible because of the unusually large mean free path.

Acknowledgments. The Brazilian participants acknowledge support from the INCT project “Advanced Quantum Materials”, Brazil.

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O-41 | 16 September 2026 · 09:30–10:00 · W1

Emergence of ferromagnetism at the nanoscale in antiferromagnetic crystals

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Keywords: antiferromagnets, ferromagnets, interface

The quasi-two-dimensional (Q2D) materials provide a unique platform for designing spintronic devices down to the atomically thin limit. However, this prospect is hampered by the limited number of antiferromagnetic Q2D materials that could be spatially coupled with ferromagnetic (FM) materials, as is necessary for the engineering of various device applications. If the Q2D antiferromagnetism could be converted to Q2D ferromagnetism, the range of 2D magnetic structures and their potential applications would be significantly broadened. Creating two-dimensional ferromagnetism from van der Waals antiferromagnets would inherently combine the advantages of the robust magnetic state of ferromagnets and the ultrafast dynamics of antiferromagnets, which could lead to potential breakthroughs in high-speed, low-power spintronics. In this regard, the natural FM-AFM interfaces emerging inside the bulk crystals represent a unique platform for studying the intrinsic physics of the FM-AFM interface and exploring the mechanism of ferromagnetism in quasi-two-dimensional AFM materials. This talk presents results showing that the polymorphic modification $\text{EuSn}^{(4+)}\text{As}_2$ (which emerges in the host $\text{EuSn}_2^{(2+)}\text{As}_2$ phase during high-temperature synthesis) forms a natural interface between antiferromagnetic and ferromagnetic regions, owing to the mixed valence of the Sn atoms.

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O-42 | 16 September 2026 · 10:00–10:30 · W1

Engineering microstructure in superconducting ceramics: from powder to fiber routes for enhanced functional performance

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Keywords: Solution blow spinning; ceramic nanofibers; YBCO; flux pinning; microstructure control; defect engineering

The performance of superconducting materials is strongly governed by their microstructural features, which are, in turn, highly sensitive to the synthesis and processing routes employed. In this work, we investigate the relationship between fabrication methodology and functional properties in superconducting ceramics, focusing on the transition from conventional powder-based processing to fiber-assisted routes. Using a solution-based approach combined with solution blow spinning (SBS), we produced nanostructured precursors and fiber-derived architectures, which were subsequently processed into bulk superconducting materials. Particular emphasis is given to the role of microstructure refinement, phase purity, and defect distribution in determining flux pinning and current-carrying capabilities. In the case of YBCO-based systems, the incorporation of Y-211 nano-whiskers synthesized via SBS resulted in a homogeneous distribution of nanoscale inclusions, leading to enhanced flux pinning and improved trapped magnetic field performance, while maintaining a sharp superconducting transition ($T_c \approx 91$ K). The results highlight the potential of fiber-based processing as a powerful tool for microstructural engineering in superconductors. More broadly, this work supports the concept of “synthesis engineering” as a key strategy to control structure–property relationships, paving the way for the development of advanced superconducting materials, including emerging systems such as superconducting nickelates. These findings provide a framework for designing materials with improved functional performance and contribute to the development of next-generation superconducting technologies.

O-43 | 16 September 2026 · 10:50–11:20 · W2

Vortex matter in superconducting structures with intrinsic diode effect

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Keywords: vortex matter, spin–orbit and exchange interaction

The distinctive features of vortex matter in superconductors with intrinsic diode effect are studied within the Ginzburg–Landau (GL) and Bogoliubov–de Gennes approaches. We consider an exemplary planar hybrid structure consisting of a thin superconducting film proximity coupled to a ferromagnetic insulator with an in-plane exchange field and strong Rashba spin–orbit interaction at the interface.

We demonstrate that the intrinsic superconducting diode effect can affect the structure, interactions and dynamics of Abrikosov vortices in noncentrosymmetric superconductor/ferromagnet hybrid structures. The GL theory accounting for the spin–orbit and exchange-field effects predicts a chiral distortion of the superfluid velocity, noncentral interaction forces, the resulting torque in a vortex-antivortex pair, anisotropy of the Bean-Livingston barrier and photogalvanic phenomena in the flux flow regime. These results are fully confirmed by time-dependent GL numerical simulations.

The nonreciprocal properties of the system reveal themselves in the breaking of the rotational symmetry of the local density of states (LDOS) profiles and in the appearance of the anisotropic spatial spin polarization of the LDOS inside the vortex core. The spatial splitting of the LDOS peak can be measured in spin-polarized scanning tunneling experiments and can provide the key information about the mechanism and characteristics of nonreciprocal current states in these hybrids.

By combining transparent analytics with quantitative numerics, the work provides the hallmarks of vortex physics in superconducting structures with an intrinsic diode effect and supplies the guidelines for designing nonreciprocal superconducting circuits, fluxonic logic elements, and kinetic-inductance devices.

Acknowledgments. This work was supported by the Russian Science Foundation (Grant No. 25-12-00042) and by the Grant of the Ministry of Science and Higher Education of the Russian Federation No. 075-15-2025-010.

O-44 | 16 September 2026 · 11:20–11:40 · W2

Gate-tunable Josephson diode effect mediated by topological surface states in BiSbTeSe₂ (BSTS) Josephson junctions

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Keywords: Josephson diode effect, topological surface states, finite-momentum pairing

Superconducting proximity effects in topological insulators enable novel phenomena such as the Josephson diode effect (JDE) [1–5], yet disentangling surface and bulk contributions remains challenging. Here we report a tunable JDE mediated by topological surface states in BiSbTeSe₂ (BSTS) Josephson junctions. Finite-momentum Cooper pairing of spin-helical surface states gives rise to a pronounced JDE under an in-plane magnetic field, with diode efficiency reaching up to 40%. Temperature-dependent measurements reveal that at higher temperatures, the supercurrent is dominated by surface states, resulting in a rapid increase in diode efficiency upon cooling, while the onset of bulk contributions at lower temperatures leads to efficiency saturation. Gate tuning approaching the Dirac point region enhances surface transport, increasing the diode efficiency from 40% to 50%. These results provide strong evidence for a dominant role of topological surface states in the nonreciprocal superconductivity and establish BSTS junctions as a promising platform for tunable, high-performance superconducting diodes.

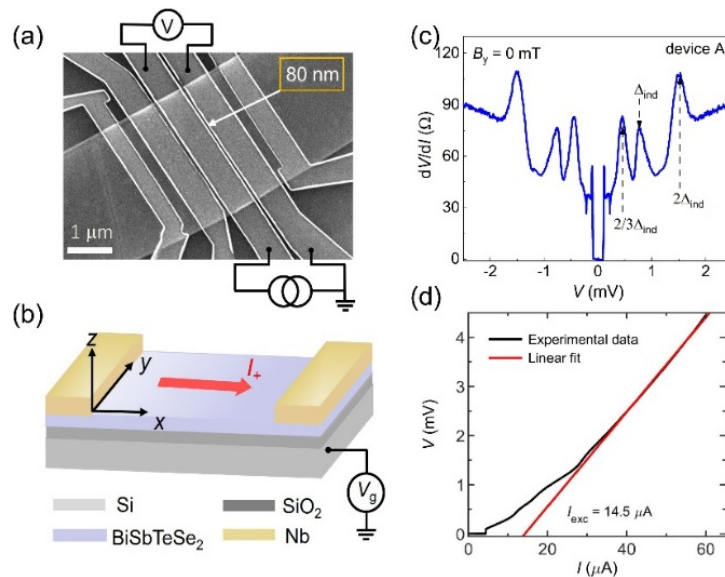


Fig. 1. Nb–BSTS–Nb device and basic transport: (a, b) planar junction, $L = 80$ nm and $W = 3.5$ μ m; (c) multiple Andreev reflections with $\Delta_{\text{ind}} = 0.76$ meV; (d) interface transparency $D \approx 0.93$ from the OTBK model.

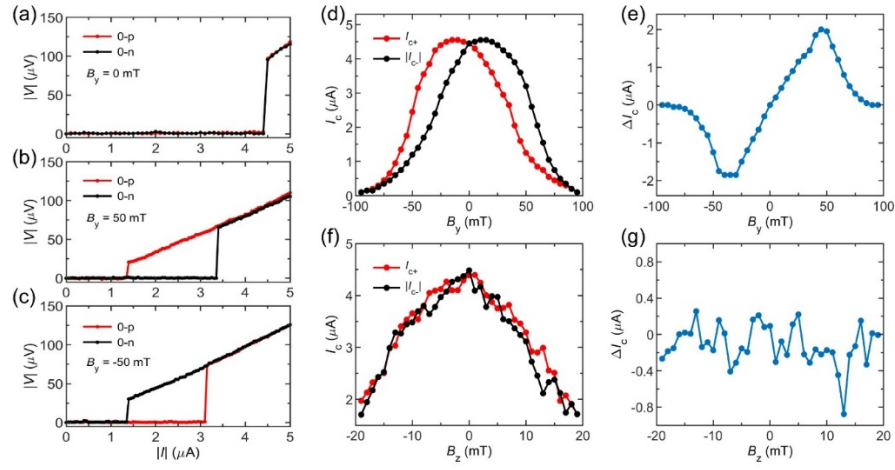


Fig. 2. JDE at 30 mK: (a–c) positive/negative current sweeps at $B_y = 0, 50, -50$ mT; (d, e) critical currents versus B_y ; (f, g) critical currents versus B_z .

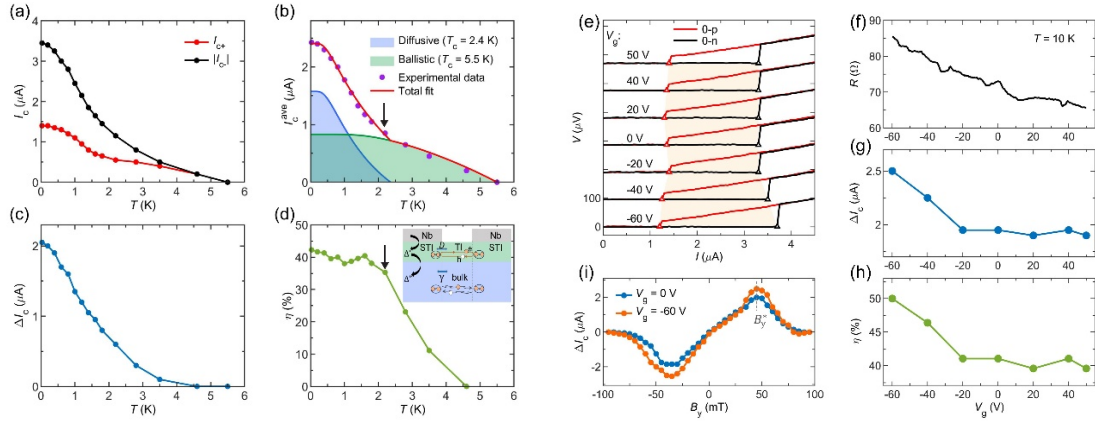


Fig. 3. Temperature and gate dependence: (a) critical currents; (b) ballistic surface (green), diffusive bulk (blue), and total (red) fits, with an arrow marking bulk-transport onset; (c) ΔI_c ; (d) efficiency η ; (e–h) gate dependence at $B_y = 50$ mT.

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O-45 | 16 September 2026 · 11:40–12:00 · W2

Unusual low-energy collective charge excitations in high-T_c cuprate superconductors

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In three-dimensional systems, charge collective excitations—plasmons—typically emerge at energy scales comparable to the conduction electron bandwidth, driven by long-range Coulomb interactions. In contrast, two-dimensional electron systems can support acoustic plasmons, low-energy modes characterized by a linear dispersion at small momenta. Recent advances in spectroscopic techniques, particularly resonant inelastic X-ray scattering (RIXS), have sparked renewed interest in detecting and characterizing these excitations. In this talk, I will review recent experimental evidence for acoustic plasmons in cuprates [1] and in Sr₂RuO₄ [2] and present our theoretical predictions for their existence and behavior in cuprate systems [3,4]. I will show that a new type of collective mode with unusually large intensity leads to a non-Lorentzian loss function. These excitations may have a significant impact on the low-energy physics of these materials.

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O-46 | 16 September 2026 · 13:30–13:50 · W3

Giant nonlinearity of kinetic inductance in superconducting hybrid strip

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Keywords: nonlinear kinetic inductance, superconductor/normal metal hybrid

We demonstrate giant nonlinearity of the kinetic inductance L_k in a superconducting NbN/Al hybrid strip. In contrast to ordinary superconductors, where the maximum observed current-induced varia-

tion of L_k does not exceed tens of percent, we observe a 50-fold change in L_k . Physically, this effect is connected with the proximity-induced superconductivity in the Al layer and the specific choice of parameters for which the dependence of the superconducting current I on the Cooper pair momentum h_q exhibits a plateau at a current I^* well below the depairing current. Formally, this leads to $L_k \sim dq/dI \rightarrow \infty$ as $I \rightarrow I^*$. We believe that our results open a new route for creating the next generation of highly sensitive detectors of electromagnetic radiation, calorimeters, parametric amplifiers, and magnetometers.

O-47 | 16 September 2026 · 13:50–14:10 · W3

Recovery of superconductivity in the applied magnetic field in Nb/Pt microbridges fabricated on YIG

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Keywords: superconductivity, ferromagnetic insulator, domain walls

Superconducting microbridge hybrid structures based on Nb and Pt on YIG GGG substrates were fabricated and investigated with low-temperature transport measurements in magnetic field, low temperature magneto-optical imaging technique [1], and with the decoration technique [2]. It was found that the temperature of superconducting transition T_c becomes larger in the magnetic field applied in plane of the sample. Magnetoresistance characteristics at the superconducting transition with final resistance show switching to the superconducting state when the applied magnetic field corresponds to the saturation of magnetization of YIG H_s . Moreover, hysteretic peaks at the coercive fields H_c due to the spontaneous vortex phase were observed [3] It was found that such a behavior caused by to the complicated domain structure of YIG with total in-plane magnetization but with strong out-of-plane component from the domain walls, which was visualized by magneto-optical imaging in dynamics and with decoration technique in basic state.

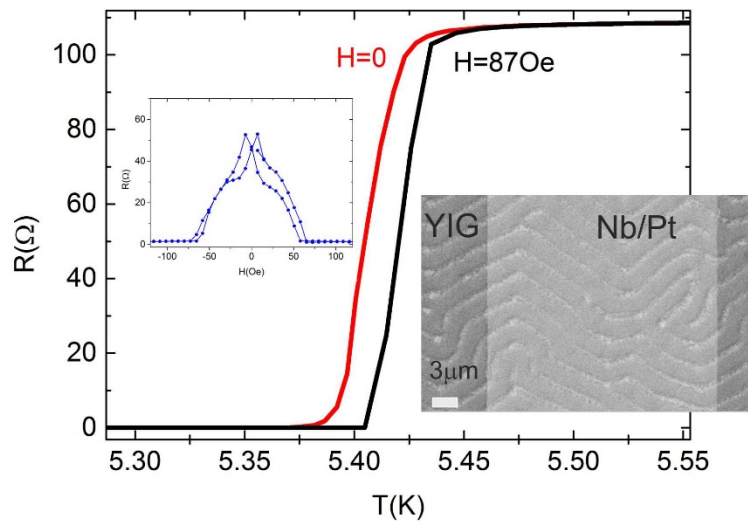


Fig. 1. Superconducting transition of Nb/Pt microbridge on YIG in 0 and 87 Oe in-plane magnetic field. Left insert – magnetoconductance in the center of transition. Right insert – SEM image of visualization of domain walls with the decoration technique.

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O-48 | 16 September 2026 · 14:10–14:30 · W3

Locking phenomena and magnetization dynamics in anomalous Josephson structures

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Keywords: superconductivity, magnetism, anomalous Josephson structures

We discuss the unification of superconductivity and magnetism in the superconductor-ferromagnet-superconductor Josephson φ_0 junction [1–3], leading to Buzdin and Kittel ferromagnetic resonances in one system. This unification also leads to two types of locking of Josephson oscillations and an external electromagnetic wave and the creation of Shapiro, Buzdin and chimera steps in the IV-characteristics [4–6]. Results of analysis of magnetization dynamics along the steps and its transformation away from the steps are presented. We show the realization of a unique ability to stabilize magnetization precession in the shunted φ_0 junction [7,8].

Acknowledgments. The work was supported by the Russian Science Foundation, Project No. 22-71-10022.

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O-49 | 16 September 2026 · 14:30–14:50 · W3

Role of Josephson SN-N-NS bridges in superconductor electronics

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Keywords: Josephson bridges, variable-thickness bridges, weak links, superconducting electronics

This talk reviews a series of niobium-based Josephson SN-N-NS bridges with different weak-link materials and geometries, including Cu and Au nanowires, Nb/Au planar SN-N-NS bridges, ferromagnetic Ni nanowire hybrids, and Al-based bridges with intrinsic superconductivity in the weak link. The discussed results show that Josephson transport in variable-thickness planar structures is strongly shaped by the interplay between proximity effect, current conversion at superconductor-normal metal interfaces, nonequilibrium heating, and the geometry of superconducting electrodes.

We compare these bridges with conventional tunnel Josephson junctions and discuss their relevance for future superconductor electronics. Planar bridges combine a compact layout, high critical-current density, and intrinsically low capacitance, while remaining well suited to niobium thin-film technology, which makes them attractive for scalable circuits. At the same time, their reproducible operation depends on how well the weak link, the electrode geometry, and the thermal environment are engineered. These properties indicate that Josephson planar bridges are promising candidates for use as a basic element of future superconducting electronic circuits.

Acknowledgments. The work is supported by the Russian Science Foundation (project no. 25-19-00057; <https://rscf.ru/project/25-19-00057/>)

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O-50 | 16 September 2026 · 15:05–15:20 · W3

Current transport in a spin valve with two ferromagnets

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Keywords: superconductivity, spin valve, kinetic inductance, ferromagnetism

Energy-efficient memory and control elements are a major goal of superconducting electronics [1–3]. Hybrid structures combining superconductors (S) and ferromagnets (F) exploit the interplay between superconducting and magnetic order to control superconducting properties and realize spin valves [4].

We investigate the spin-trigger effect in an $SF_1S_1F_2s$ structure. The superconductivity of the thin s layer, suppressed by the inverse proximity effect of the ferromagnet, is restored by pair correlations penetrating from the bulk S electrode, which supplies additional Cooper pairs. On this basis, a Josephson spin valve in an $SF_1S_1F_2sIS$ structure (I denotes an insulating layer) is developed to continuously control the critical current J_C . The source reports a high characteristic voltage in both 0 and "b" states. This state notation requires author confirmation; the proposed applications are logic and memory elements.

A kinetic-inductance control device is also developed using an $SF_1S_1F_2sN$ structure. A low-resistivity normal metal N enables substantial changes in the total kinetic inductance L_K by varying the relative magnetization angle of the F layers. Control of the kinetic inductance by a bias current is also demonstrated. These results open opportunities for tunable-inductance devices and for control of resonant frequencies in qubit operations.

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O-51 | 16 September 2026 · 15:20–15:40 · W3

Implementation of adiabatic neurons for superconducting neural networks

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Keywords: superconducting neural networks; Josephson interferometers; multilayer niobium technology; superconductivity

The growing number and complexity of problems solved using artificial neural networks are stimulating interest in the use of superconducting electronic components, which offer the advantages of high speed and energy efficiency. Previously, a concept of Josephson interferometers with a sigmoid (signal neuron) or Gaussian (gauss-neuron) activation function was proposed [1] which may serve as artificial neurons in perceptron or radial-basis-function types of neural networks respectively. Initial implementation attempts faced some difficulties related to achieving the required parameters of structures and parasitic interactions between neuron elements. Experimental and theoretical efforts were undertaken to characterize [2] and suppress [3] these undesired interactions. Now, we can present experimental results demonstrating the target shape of the transfer functions of the fabricated samples.

Acknowledgments. The work was done within RSCF project #23-72-00053.

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O-52 | 16 September 2026 · 15:40–15:55 · W3

Compact two-junction Josephson neuron based on nanoscale Nb/Au weak links

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Keywords: Josephson neuron, SNS junction, kinetic inductance, cryogenic electronics

Compact weak links and inductors are essential for integrating Josephson spiking circuits [1,2]. We fabricate a two-junction interferometer combining nanoscale Nb/Au/Nb superconductor–normal-metal–superconductor (SNS) bridges with a thin-film niobium loop and an on-chip control-current line.

Individual junctions reach a characteristic voltage $I_c R_n = 0.91$ mV at 0.2 K and exhibit nearly nonhysteretic current–voltage characteristics near 4 K. The complete device shows reproducible, electrically controlled critical-current modulation without a deliberately applied external magnetic field. Fits reveal one junction critical current approximately 30% larger than the other and a strongly temperature-dependent kinetic contribution to the loop inductance.

Using experimentally extracted critical currents, resistances and inductances, we calibrate an overdamped resistively shunted junction model. At 4.5 K, identical 90 μ A input-current pulses produce regular-spiking, subthreshold or branch-selective responses, depending on the dc control-current operating point (Fig. 1). Spikes correspond to 2π phase slips with localized voltage pulses. These time-domain responses are deterministic model predictions, not direct pulse measurements. The results identify junction asymmetry and kinetic inductance as design parameters for compact cryogenic neuromorphic elements.

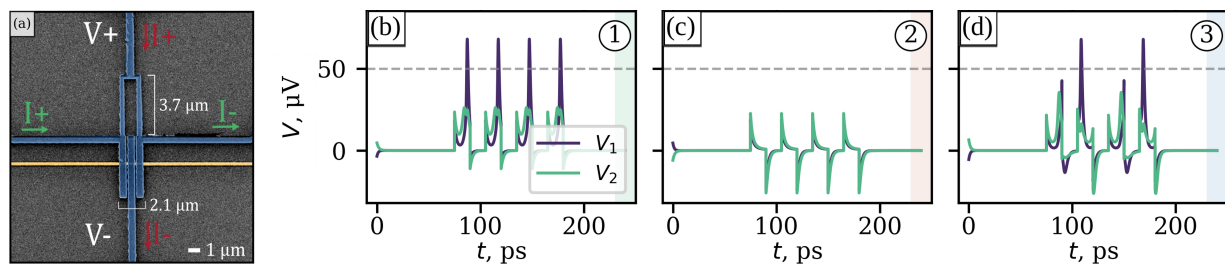


Fig. 1. Device micrograph (a) and calculated voltage responses at 4.5 K: regular spiking (b), subthreshold (c) and branch-selective (d); input pulse amplitude: 90 μ A.

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O-53 | 16 September 2026 · 15:55–16:10 · W3

Equidistant resonance jumps in superconducting coplanar resonators driven by Abrikosov vortices

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Keywords: superconducting resonators, Abrikosov vortices, vortex pinning

We investigate the magnetic-field response of quarter-wave coplanar resonators patterned from 100-nm-thick niobium films [1]. The complex transmission coefficient S_{21} is measured in perpendicular fields up to 40 Oe at temperatures from 18 mK to 5 K.

Beyond the reversible Meissner regime, the resonant frequency exhibits abrupt jumps. Immediately after field-sweep reversal, an almost equidistant sequence emerges with spacing $\Delta H \approx 1.7\text{--}1.8$ Oe (Fig. 1). Absolute jump fields differ between resonators, indicating a local origin. In the more homogeneous film, jumplike features persist up to at least 5 K; in the less homogeneous film, equidistance is absent and the response becomes largely smooth at 4.5 K.

Inductance estimates suggest that the observed jumps involve multiple vortices, with a characteristic number of order 10^2 per event. Calculations based on the time-dependent Ginzburg–Landau equation support the estimated single-vortex inductance scale. The nonproportional recovery of resonant frequency and internal quality factor is discussed in terms of pinned vortex–antivortex configurations, whose circulating currents can partly compensate without eliminating core-related dissipation. These results highlight the importance of both discrete vortex events and collective dynamics in the presence of pinning for superconducting microwave circuits.

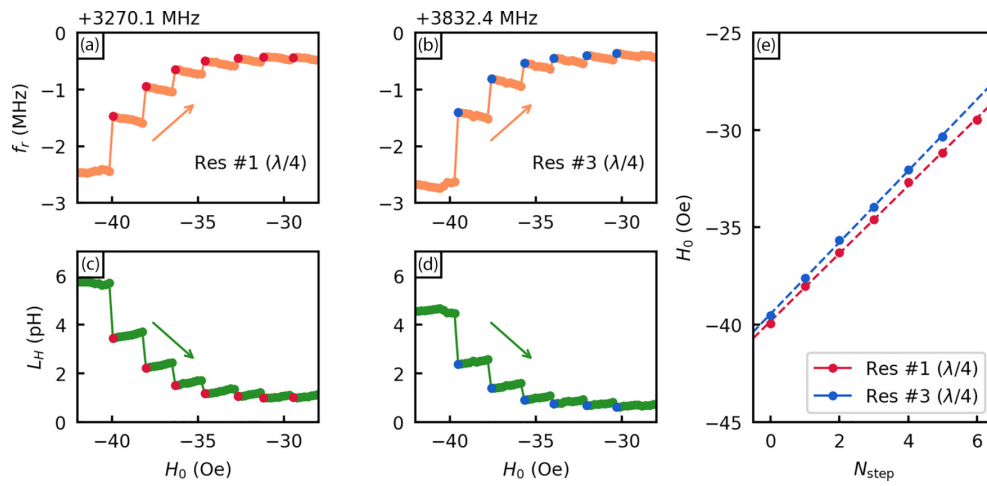


Fig. 1. Resonance frequency (a, b) and additional inductance (c, d) after field reversal; jump fields versus sequence number (e). Reproduced from [1].

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ORAL PRESENTATIONS / SECTION 4

Functional materials and quantum technology

Thursday, 17 September 2026

Hall to be confirmed by organisers the day before · O-54–O-74

Th1 · Magnetism and functional materials

Proposed chair: Alexander FROLOV

Th2 · Superconducting films and spectroscopy

Proposed chair: Boris GORSHUNOV

Th3 · Functional materials and light–matter interaction

Proposed chair: Denis VYALIKH

Th4 · Quantum and nanoscale devices

Proposed chair: Vadim GRINENKO

O-54 | 17 September 2026 · 09:00–09:30 · Th1

Origin of spontaneous magnetic fields in Sr_2RuO_4

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Keywords: time-reversal symmetry breaking, unconventional superconductivity

The nature of the broken time reversal symmetry (BTRS) state in Sr_2RuO_4 remains a long-standing puzzle, and its relation to superconductivity remains controversial. There are various universal predictions for the BTRS state when it is associated with a multicomponent superconducting order parameter [1]. In particular, in the BTRS superconducting state, spontaneous fields appear around crystalline defects, impurities, superconducting domain walls and sample surfaces. Here, we aimed to verify these predictions for Sr_2RuO_4 by performing muon spin relaxation (μSR) measurements on $\text{Sr}_{2-x}\text{La}_x\text{RuO}_4$ single crystals [2]. We observed that the enhanced muon spin depolarisation rate in the superconducting state $\Delta\Lambda$ monotonically decreases with La doping. The observed behaviour is consistent with $\Delta\Lambda \propto T_c^2$, indicating that homogeneous La substitution is not a source of spontaneous magnetic fields, but the spontaneous fields are altered by the suppression of superconducting critical temperature (T_c) with La-doping. Qualitatively different behaviour is observed for the effects of disorder and Ru inclusions. By analysing a large number of samples measured in the previous works, we found that the $\Delta\Lambda$ is small for pure Sr_2RuO_4 single crystals and increases with disorder or impurities. The strongest enhancement is observed in the crystals with Ru-inclusions, which show enhanced T_c . The comparative study allowed us to conclude that spontaneous fields in the BTRS superconducting state of Sr_2RuO_4 appear around inhomogeneities and, at the same time, decrease with the suppression of T_c . The observed behaviour is consistent with the prediction for multicomponent BTRS superconductivity.

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O-55 | 17 September 2026 · 09:30–10:00 · Th1

High-performance magnetic tunnel junctions and their applications in artificial intelligence and probabilistic computing

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Keywords: Magnetic Tunnel Junctions, Artificial Intelligence, Probabilistic Computing

Combinatorial optimization problems stand as fundamental hurdles across domains like artificial intelligence, logistics, and network architecture. Conventional algorithms - such as greedy techniques and dynamic programming - frequently falter in striking a balance between computational efficiency and solution quality, especially as problem complexity increases [1]. To address these constraints, we introduce an innovative, high-performance probabilistic optimization framework that incorporates true random number generators (TRNGs) built on high-barrier magnetic tunneling junctions (MTJs) [2-4]. The intrinsic stochastic switching behavior of MTJs allows for dynamic adjustment of random number distributions, a feature we exploit to infuse controlled randomness into a probabilistic greedy algorithm [3]. By modifying a temperature parameter, our algorithm smoothly shifts between deterministic and stochastic approaches, effectively harmonizing the exploration of solution spaces and the exploitation of promising solutions. We applied this framework to the traveling salesman problem (TSP) (Fig. 1), demonstrating its capacity to consistently generate high-quality results across various problem sizes. Compared to classical methods like simulated annealing and genetic algorithms, our algorithm exhibits superior performance in both solution quality and convergence rate. Notably, in larger TSP instances with up to 70 cities, it maintains its competitive edge, delivering near-optimal solutions with fewer iterations and reduced computational cost [5]. The MTJ can also function as a hardware accelerator to speed up computation of activation functions and their derivatives in artificial neural networks (ANN) and ease pruning of ANN and improve their training efficiency [6]. These advancements underscore the potential of integrating high-barrier MTJ-based TRNGs into optimization algorithms and artificial intelligence, laying groundwork for future advancements in probabilistic computing architectures.

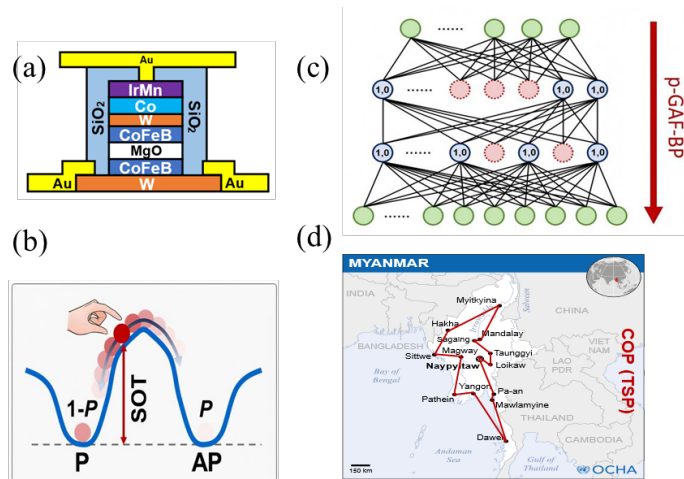


Fig. 1. (a) Structure of Magnetic Tunnel Junctions (MTJ), (b) Schematics of MTJ-based True Random Number Generators, (c) MTJ-TRNG for Dynamic Pruning of Artificial Neuron Networks, (d) MTJ-Enabled Probabilistic Computing for Combinatorial Optimization Problems

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O-56 | 17 September 2026 · 10:00–10:30 · Th1

4f-driven surface effects in lanthanide-based materials: re-orientation of 4f moments, 2D ferromagnetism, Kondo and Rashba effects

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Keywords: Lanthanides, ARPES, Magnetism, 4f materials, Kondo effect, Rashba effect

Traditionally, ARPES and XAS have been key tools for investigating the electronic and magnetic properties of lanthanide (Ln)-based materials, with a primary focus on bulk 4f-driven phenomena. This is particularly true for numerous XAS measurements performed at the Ln $M_{4,5}$ and $N_{4,5}$ edges, where spectral lineshape analysis is predominantly discussed in the context of bulk effects. In general, the

surfaces and their properties of Ln materials have received considerably less attention than the bulk. However, it is reasonable to anticipate that $4f$ -driven physics at the surface could be even richer and more compelling than in the bulk. The lack of inversion symmetry, spin-orbit coupling, the emergence of surface states and resonances, relaxation and reconstruction, as well as modifications of the CEF near and at the surface, all serve as driving forces for novel $4f$ -driven phenomena, distinct phases, and characteristic energy scales that differ dramatically from those in the bulk.

In this talk, I will present an overview of key results obtained by our team on surface $4f$ -driven phenomena and their characteristic temperature scales in lanthanide systems such as LnRh_2Si_2 and LnIr_2Si_2 , using ARPES and XAS. In particular, I will focus on Ce-based materials, known for their exotic bulk properties, including CeRh_2Si_2 and CeIrIn_5 . We will consider the valence-fluctuating material EuIr_2Si_2 , where Eu near the surface exhibits divalent behavior in contrast to its non-magnetic valence-fluctuating bulk properties, leading to the emergence of strong 2D ferromagnetism in the Si-Ir-Si-Eu surface block with its own temperature scale, accompanied by a cubic Rashba spin-orbit coupling effect.

Our findings reveal that $4f$ magnetic moments in such crystals reorient near the surface due to modifications in the crystal electric field compared to the bulk. By analyzing modeled spectra for each M_J state in comparison with experimental data, we can conclusively determine the orientation of magnetic moments both in the bulk and at the surface. Furthermore, we provide clear evidence of unexpectedly different Kondo-related properties at the Ce surface and in the bulk, as observed in CeRh_2Si_2 . The obtained results call for detailed studies of properties emerging at the surfaces of strongly correlated Ce-, Eu-, and Yb-based materials with quasi-2D structure. They also point to a route for designing novel functional and quantum materials using thin layers of $4f$ -electron systems as building blocks, where different combinations of fundamental interactions can be realized.

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O-57 | 17 September 2026 · 10:50–11:20 · Th2

Critical currents and nonlinearity of kinetic inductance in NbN/Mo bilayer structures

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Keywords: superconductor - normal metal bilayer, nonlinear kinetic inductance

We present a method to increase the nonlinearity of kinetic inductance by fabricating superconductor - normal metal (SN) bilayer structures [1, 2]. We investigate an SN structure consisting of 7.5-nm-thick NbN superconductor, and 5-nm-thick molybdenum (Mo) as the normal metal. Although Mo is a superconductor with $T_c \approx 0.9K$ in our experiment the temperature is always above 2.5K and Mo remains in the normal state. In such bilayer structures, we have successfully demonstrated a 70% increase in kinetic inductance near critical current, whereas in single-layer NbN samples the kinetic inductance increased by only 10% (Fig. 1a). Additionally, in these structures we observe an increase in critical current I_c^{SN} , as the normal layer contributes significantly to the supercurrent. They also exhibit a sharper temperature dependence of the critical current, and at temperatures much lower than the critical temperature, the absolute value of the critical current is nearly twice as high as in a single-layer NbN film (Fig. 1b). We used the approach from [1] based on the Usadel model to calculate the depairing currents I_{dep}^{SN} for SN bilayer, which gave the ratio I_c^{SN}/I_{dep}^{SN} as high as 0.78.

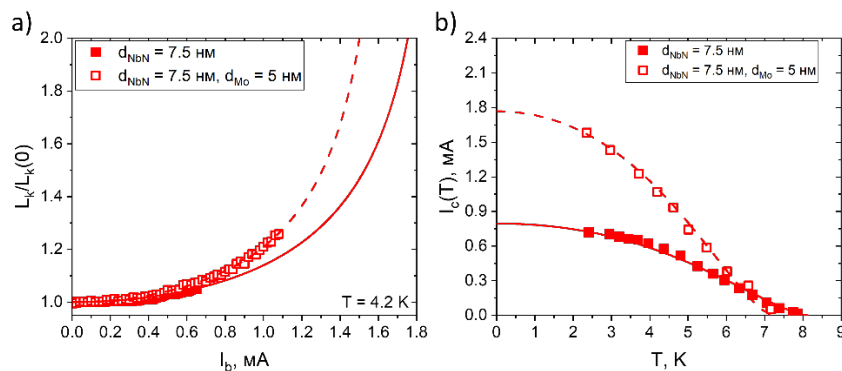


Fig. 1. (a) Current dependence of kinetic inductance for a single NbN layer (filled squares) and a NbN/Mo bilayer structure (open squares). (b) Experimental temperature dependence of the critical current for bilayer structures (open symbols) and a single NbN layer (filled symbols).

Acknowledgments. The study was supported by project No. 125020501540-9 of the Ministry of Education and Science of the Russian Federation. Fabrication and technology characterization were carried out at large scale facility complex for heterogeneous integration technologies and silicon+carbon nanotechnologies.

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O-58 | 17 September 2026 · 11:20–11:40 · Th2

Superconducting properties of thin NbN films on ScN buffer layer

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Keywords: superconducting thin films NbN, buffer layer ScN, superconducting transition temperature, critical current density, resistivity

We demonstrate that an ScN buffer layer enhances the superconducting properties of the NbN film due to matching crystal lattices. For this study, ScN and NbN were deposited in situ by DC magnetron sputtering on amorphous SiO₂. We varied the ScN thickness in the range 5 – 38 nm, while the thickness of NbN was kept constant at 29 nm, which allowed us to monitor its properties using X-ray diffractometry (XRD). The quality of the NbN film was evaluated by its resistivity ρ , critical temperature T_c and critical current I_c (the latter was measured on 10- μ m-wide strips in temperature range from 2.5 K to T_c) which were compared with the parameters of the reference NbN films deposited directly on SiO₂. We observe that with the increase of ScN thickness, critical currents and critical temperature of NbN also increase with the simultaneous decrease in resistivity. These parameters reach saturation at ScN thickness of 15-20 nm. At this thickness lattice parameter a_0 of NbN is about 4.380 – 4.385 Å (Fig. 1).

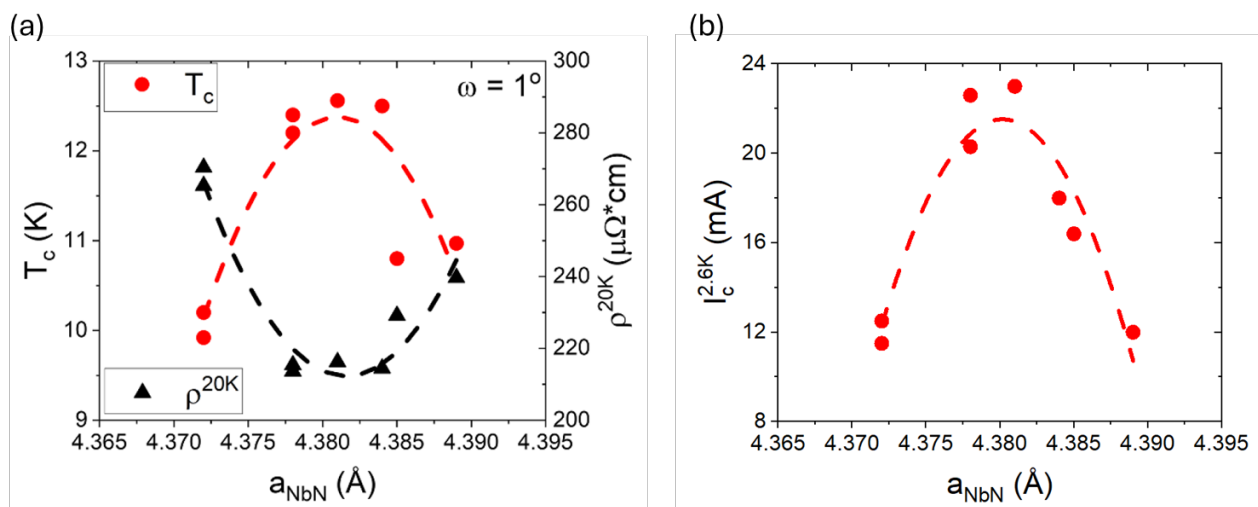


Fig. 1. Dependencies of NbN properties on ScN lattice parameter a_0 : (a) critical temperature T_c and resistivity ρ , and (b) critical current I_c at 2.6 K temperature.

Acknowledgments. The study was supported by project No. 125020501540-9 of the Ministry of Education and Science of the Russian Federation. Fabrication and technology characterization were carried out at large scale facility complex for heterogeneous integration technologies and silicon+carbon nanotechnologies.

O-59 | 17 September 2026 · 11:40–12:00 · Th2

Lattice softening and hidden charge order dynamics in CsV_3Sb_5 kagome superconductors

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Keywords: Kagome superconductors; ultrasound spectroscopy; CDW; superconductivity

We present the first ultrasound investigation of a CsV_3Sb_5 Kagome superconductor, combining elastic, transport, and magnetic measurements to probe its charge density wave (CDW) and superconducting states. Pronounced anomalies in the elastic constants c_{11} , c_{44} , and c_{66} are observed at the CDW transition $T_{\text{CDW}} \approx 95$ K, with significant softening of c_{66} above the transition, indicating strong electron–lattice coupling and enhanced susceptibility to symmetry-breaking fluctuations. Within the CDW phase, we resolve previously unreported fine structure in the elastic response, including a distinctive washboard-like anomaly in the c_{66} mode. This feature reveals that c_{66} is particularly sensitive to internal CDW reorganization, mesoscale dynamics, and the gradual development of coherence across the transition regime. In addition, subtle anomalies are detected near 60 K and 40 K, consistent with features reported in other experimental probes, suggesting additional restructuring or secondary ordering phenomena within the CDW state. Transport measurements confirm the CDW and superconducting transitions, while magnetic field studies show suppression of superconductivity with minimal impact on the CDW features, underscoring the robustness of the charge-ordered phase. These results establish ultrasound as a powerful probe of emergent electronic order in kagome systems and provide new insight into the complex, multistage nature of CDW formation in CsV_3Sb_5 .

O-60 | 17 September 2026 · 13:30–13:50 · Th3

Atomic disorder as an overlooked control parameter in topological insulators

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Keywords: topological insulators, antisite disorder, 124 compounds, surface states, electron transport

Layered chalcogenides MePn_2Ch_4 (the 124 structure type) and homologous compounds built from septuple-layer blocks intrinsically contain a high density of antisite defects. Here, disorder is treated

not as a scalar degradation of crystal quality but as a site- and element-selective control variable. Site-resolved structural probes, ARPES and spin-ARPES, STM/STS, magnetotransport, and DFT-VCA or KKR-CPA calculations are combined to connect atomic occupancies with band topology, quasiparticle scattering, magnetic exchange, and charge transport [1,2].

In GeBi_2Te_4 and SnBi_2Te_4 , extensive cation intermixing persists throughout the bulk. Equal Te/Se substitution forms 1222 phases with Te preferentially occupying outer anion sites and Se occupying inner sites. The 124-to-1222 transformation increases the bulk gap from 85 to 175 meV for Sn and from 180 to 195 meV for Ge, changes the conduction-band edge from W-shaped to nearly parabolic, and raises the TSS group velocity to about $4.0\text{--}4.1 \times 10^5 \text{ m s}^{-1}$. Simultaneously, $\text{Im}\Sigma$ increases in the gap, showing that anion substitution improves the energetic isolation of the surface channel but strengthens impurity scattering. This broadening is element-specific and is substantially stronger in Sn-based compounds [1].

Cation mixing can also change the topology itself. In $\text{Ge}_2\text{Bi}_2\text{Te}_5$, melt-grown and vapor-grown crystals have ordering parameters $\alpha = 0.41$ and 0.33 . As Bi increasingly occupies the central cation site, its weight at the valence-band maximum grows, the effective spin-orbit coupling is enhanced, and an inverted gap opens; the disorder-driven transition occurs near $\alpha \approx 0.5$. In magnetic $\text{Mn}(\text{Bi},\text{Sb})_2\text{Te}_4$, Mn antisites modify the exchange network: at approximately 17% Mn on the outer cation sites, J_2 changes sign and the interlayer order switches from AFM to FM. Structural changes without Mn antisites are insufficient to produce this transition.

The transport limit of disorder engineering is illustrated by $\text{Sn}_{0.37}\text{In}_{0.64}\text{Bi}_{1.99}\text{Te}_4$. An In 5s resonant state reduces the mean free path to about $1.1 \text{ \AA}$ and gives $kF\ell \approx 1.13$, producing bad-metal behavior; superconductivity nevertheless appears at $T_c = 2.16 \text{ K}$ with an STM gap $\Delta = 0.232 \text{ meV}$. In the natural QL/SL heterostructure GeBi_4Te_7 , donor-like Bi-on-Ge defects drive charge transfer between unlike blocks, generating a built-in field, termination-dependent band bending, and a $\approx 160 \text{ meV}$ offset between two Dirac points [2]. Thus, sublattice, orbital character, and spatial distribution - rather than average defect concentration alone - determine whether disorder tunes the topological gap, magnetism, and surface transport or drives the system toward localization.

Acknowledgments. The work was supported by RSF Grant 22-72-10074-P.

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O-61 | 17 September 2026 · 13:50–14:10 · Th3

Characterization of ferrimagnetic Fe-Gd coatings formed by magnetron sputtering

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Keywords: Fe-Gd; magnetron deposition; metallic glass; structure; MFM

A series of thin ($\leq 1 \mu\text{m}$ thick) Fe-Gd coatings were deposited onto a monocrystalline [001]-Si substrate using conventional magnetron sputtering. The deposition rates of pure components (Fe, Gd) were chosen so the chemical composition of the coatings met the criteria for a high glass-forming ability as predicted by Miedema's model. X-ray diffraction analysis confirmed an amorphous structure in the as-deposited Fe-Gd coatings, in which the content of a rare-earth metal fell within the range from ~25 at. % to ~38 at. %. Using atomic force microscopy, a nano-granular morphology of the coatings, exhibiting various surface roughness ($0.9 < R_a < 5.0 \text{ nm}$), was revealed. Additionally, the magnetic properties of the $\text{Fe}_{74}\text{Gd}_{26}$ (at. %) coating were examined by magnetic force microscopy at room (290 K) and cryogenic ($< 23 \text{ K}$) temperatures. Reversible magnetic domain reorientation was studied at the external magnetic field from -1000 G to +1000 G. Upon a zero-field cooling, the ferromagnetic-to-ferrimagnetic transition occurred that resulted in a significant alteration of the domain structure (Fig. 1). This allowed us to examine the field-driven dynamic evolution of the domain structures below the compensation point. Additionally, a short-range order was examined in the $\text{Fe}_{74}\text{Gd}_{26}$ glassy coating through the resolving of the radial distribution function. The magnetic behavior upon cooling down to 4.6 K is supposed to be a structural-dependent property and to depend on the amount of Fe- and Ge-enriched nanoclusters.

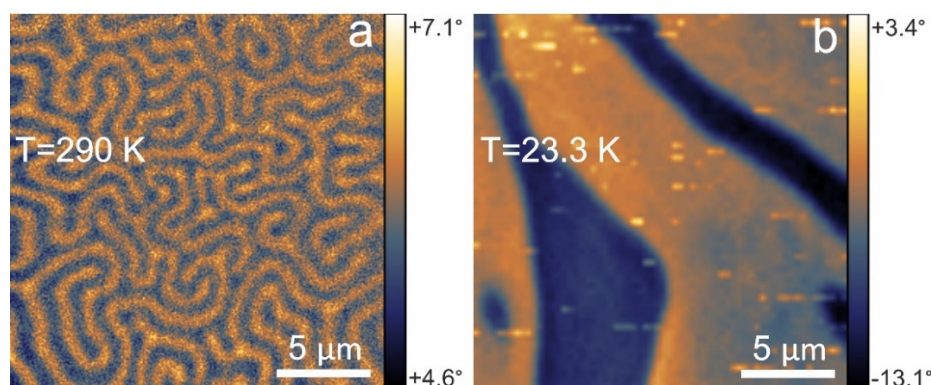


Fig. 1. Zero-field MFM images of the $\text{Fe}_{74}\text{Gd}_{26}$ (at. %) coating at room (a) and cryogenic (b) temperatures.

Acknowledgments. The microstructural characterization of the coatings was funded by the Russian Science Foundation No. 25-72-00041, <https://rscf.ru/project/25-72-00041/>.

O-62 | 17 September 2026 · 14:10–14:25 · Th3

Lattice-driven magnetic and topological phase transitions in monolayer 1T-CrTe₂: role of structural dimerization

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Keywords: TMD, magnetic ground state

The magnetic ground state (MGS) and physical properties of monolayer (ML) 1T-CrTe₂ remain unresolved. Using first-principles calculations, we elucidate the mechanism underlying its antiferromagnetic (AFM) MGS, accompanied by structural dimerization, and reveal a unique lattice-driven topological phase transition. The MGS exhibits pronounced sensitivity to the lattice constant, governed by the competition between AFM direct exchange and ferromagnetic (FM) superexchange interactions. Below a critical lattice constant of 7.56 Å, AFM coupling dominates, inducing magnetic frustration and subsequent structural dimerization. Within the dimerized phase, the magnetic easy axis transitions from in-plane to out-of-plane orientation as the lattice constant increases. Furthermore, we identify a different AFM topological phase transition driven by lattice variations unique to the dimerized system. These findings resolve the long-standing controversy regarding the MGS and uncover a lattice-driven PT-symmetric AFM topological insulator state.

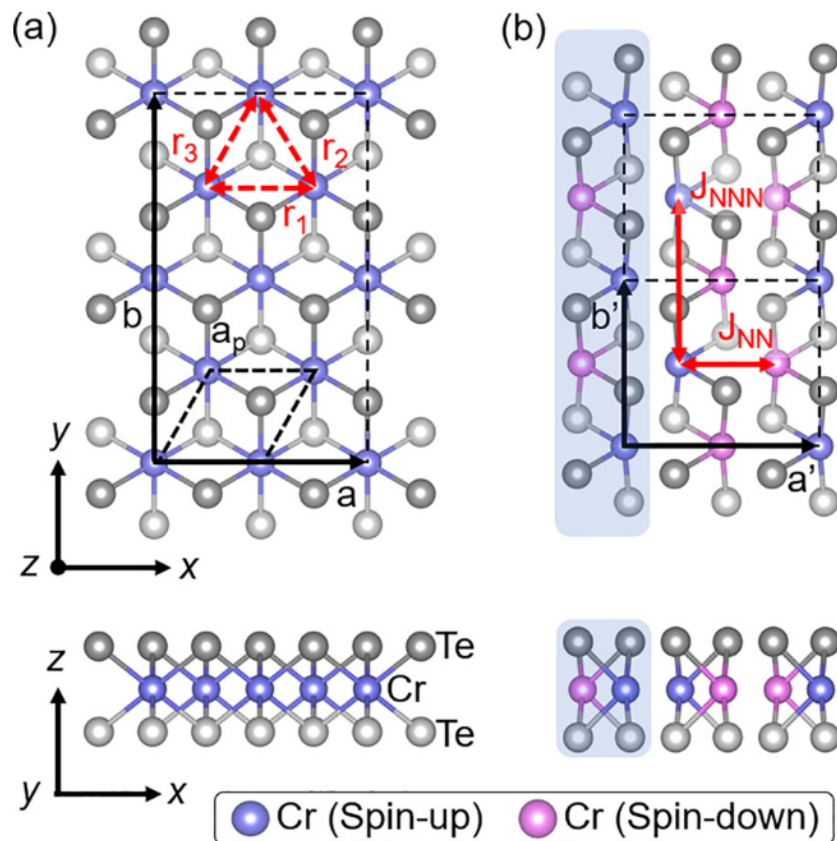


Fig. 1. Crystal structure and magnetic configurations of the 1T-CrTe₂ monolayer. (a) Top and side views of ML 1T-CrTe₂ in the paramagnetic/FM phase. (b) Top and side views of the dimerized structure in the AFM-ZZ state.

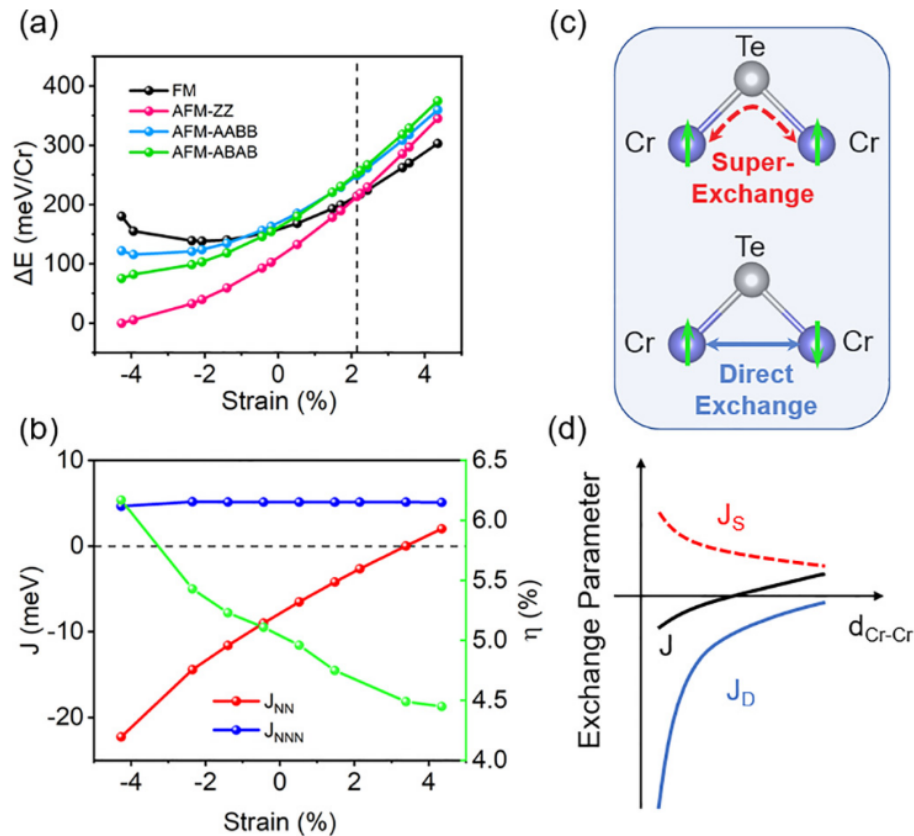


Fig. 2. Evolution of MGS and exchange coupling with strain. (a) Variation of energy with changing strain for four magnetic configurations with the dimerized structure. (b) Variation of spin exchange constants and distortion rate η with strain. (c) Schematic diagram illustrating the direct exchange and superexchange mechanisms between NN Cr pairs. (d) Schematic representation of the evolution of exchange coupling strength with NN Cr-Cr distance d_{Cr-Cr} .

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O-63 | 17 September 2026 · 14:25–14:45 · Th3

Low-variability hafnia-based memristors enabled by thermal exchange layer incorporation

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Keywords: hafnium oxide, tantalum suboxide, resistive switching, neuromorphic computing, thermal exchange layer

One of the most promising directions is neuromorphic systems that mimic the principles of biological systems. For neuromorphic system applications, the resistive switching of the memristive structure must be gradual. One approach to achieve this is introducing a thermal exchange layer [1], such as the

TaO_x with a resistivity of 160 mΩ·cm used in this work. An alternative method for achieving gradual resistive switching with comparable I-V characteristics is bipolar resistive switching with reverse polarity [2], which is closely related to complementary resistive switching in asymmetric memristive structures [3]. While this mode enables gradual switching and low cell-to-cell variability without a thermal exchange layer, it requires a complex forming process that includes waiting for device degradation. In contrast, introducing a thermal exchange layer into a hafnia-based memristor structure enables a simplified two-step electroforming process: (i) conductive filament formation at approximately 3 V, and (ii) switching the device off with a negative voltage at the standard RESET voltage. The resulting structures exhibit low device-to-device variability, even for large electrodes of 100 μm in diameter (Fig. 1). Additionally, current compliance is only required during electroforming, not during resistive switching, and the devices achieve a 79% yield, in the studied memristive structures.

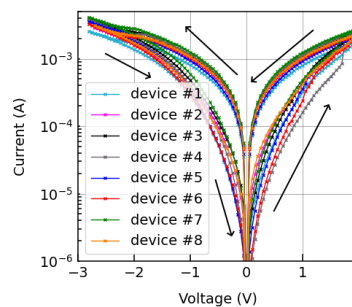


Fig. 1. First current-voltage curves after two-step electroforming for eight different devices with TiN/HfO₂(5nm)/TaO_x(40nm)/TiN/Al structure

Acknowledgments. The results presented were obtained with the support of the Russian Science Foundation, projects No. 26-19-00450.

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O-64 | 17 September 2026 · 15:10–15:30 · Th4

Single-photon spectroscopy of SiN_x using an integrated superconducting single-photon detector

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We use a superconducting NbN detector integrated with a SiN_x optical waveguide to perform single-photon spectroscopy under cryogenic conditions [1]. The detector is fabricated on the planarized surface of a protective SiO₂ cladding layer. The waveguide is 400 nm thick and 1.6 μm wide; the detector

consists of a 9-nm-thick NbN film patterned into 120-nm-wide superconducting strips with a total length of 600 μm .

Measurements were performed at 2.7 K over the wavelength range 1480–1640 nm. At a bias current of 0.9 times the critical current, the dark-count rate was approximately 100 Hz. The optical count rate was of the order of 10^6 Hz, and the system detection efficiency was approximately 2% at 1550 nm. The wavelength was swept at 1 nm s^{-1} , and the count rate was averaged over ten measurements; the relative standard deviation did not exceed 5%.

The photon-count spectrum exhibits a pronounced maximum in the 1540–1555 nm region, with peaks at 1543, 1549 and 1553 nm, consistent with the low-loss spectral region of SiN_x waveguides. The source manuscript tentatively associates the spectral dependence with N–H absorption overtones and notes that additional measurements, for example using ring resonators, are required for a more definitive assignment. These results support the use of integrated superconducting detectors for characterizing SiN_x photonic circuits under cryogenic, single-photon conditions.

Acknowledgments. The study was supported by project No. 125020501540-9 of the Ministry of Education and Science of the Russian Federation. Fabrication and technology characterization were carried out at the large-scale facility for heterogeneous integration technologies and silicon+carbon nanotechnologies.

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O-65 | 17 September 2026 · 15:30–15:45 · Th4

Nesting-driven ferromagnetism of itinerant electrons

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Keywords: ferromagnetism, nested Fermi surface, Stoner instability

We study a model of a conducting material in which nanostructured inhomogeneities arise due to perfect nesting between different sheets of the Fermi surface. Charge carriers of different types are assumed to interact both with each other and with the crystal lattice. It is shown that, in the absence of doping, the ground state of the model is an insulator with either a spin-density-wave (SDW) or charge-density-wave (CDW) order. Upon doping, a finite ferromagnetic polarization emerges. We demonstrate that the mechanism of ferromagnetism in this system differs fundamentally from the conventional Stoner mechanism. The phase diagram of the model is constructed, and various properties of the ordered phases are analyzed, revealing new perspectives for both fundamental physics and technological applications of magnetic materials.

(a) $\xi = \gamma x / (2N_F \Delta_0)$ is a dimensionless particle density. For definiteness, we use $gN_F = 0.5$. The curve ξ_1 becomes vertical as $\xi \rightarrow \exp(1/gN_F)$. (b) Phase diagram in universal units (independent of the coupling constant gN_F), plotted in terms of W and ξ for negative W . Both curves exhibit exponential asymptotic behavior at large $|W|$: $\xi_1(W) \rightarrow \exp(2|W|)/|W|$, while $\xi_2(W) = \exp(2|W|)$. SFHM denotes a spin-valley half-metal.

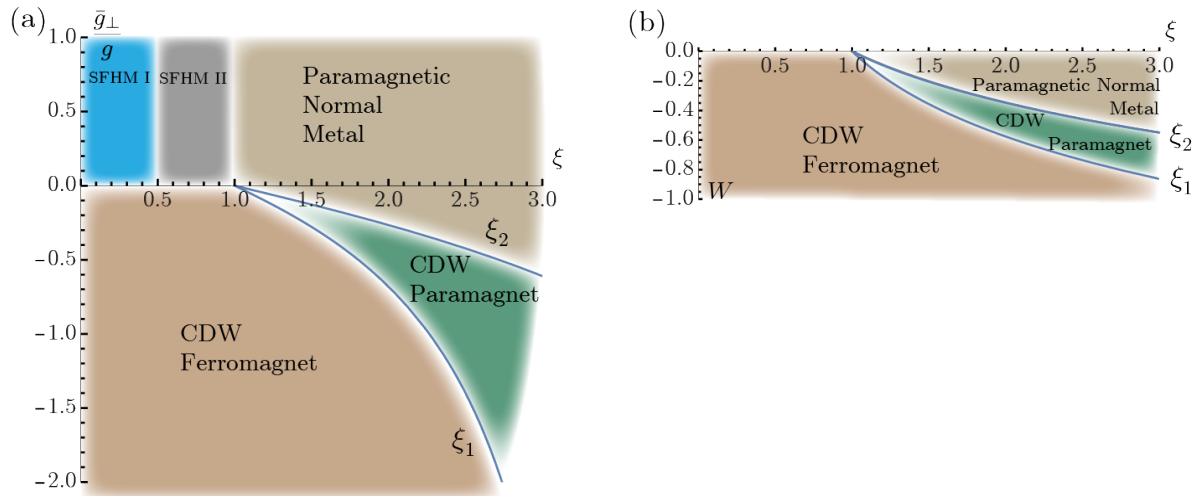


Fig. 1. Phase diagram.

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O-66 | 17 September 2026 · 15:45–16:00 · Th4

Sensitivity analysis of changes in the curvature parameter in spin dynamics

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Keywords: mathematical modeling, molecular dynamics, spin dynamics, LAMMPS, MEAM

The relevance of this study arises from the increasing demand for precise predictions of the physical, mechanical, and magnetic properties of ferromagnetic nanostructures used in microelectronic components and spintronic devices. Currently, commonly used computational approaches, including molecular dynamics methods, are marked by significant parametric uncertainty, which directly diminishes their predictive value. The principal source of ambiguity in the results lies in the absence of a systematic assessment of the models' sensitivity to variations in input parameters, while such an analysis is a prerequisite for verifying computational experiments. Therefore, the objective of this work is to quantitatively compare the impact of model parameters, such as curvature parameter, on the output characteristics of nanostructures. This will help bridge the gap between abstract mathematical descriptions and the physically accurate properties of real materials.

The model combines molecular dynamics (accounting for atomic motion) and spin dynamics (accounting for magnetism). The key result is obtained by jointly solving the Langevin and Landau–Lifshitz–Gilbert equations [1–2]. Additionally, the study quantitatively evaluates how variations in the exchange integral (in the Bethe–Slater form) affect the sensitivity of the atomistic model of a face-centered cubic cobalt nanocrystal.

A family of exchange integral curves has been plotted as the curvature parameter γ varies within a range of ± 0.1 from the reference value for Co-BCC. An increase in γ leads to a shift in the main maximum of the Bethe–Slater function towards larger interatomic distances, which is essential for an accurate description of the magnetic order in the system. Simultaneously, the influence of γ on the magnetic energy is minimal in weak fields and increases slightly with the field strength, indicating the stability of the equilibrium spin configuration against small perturbations of this parameter.

Acknowledgments. The work was carried out within the framework of the state assignment No. FUUE-2025-0001 «Modeling and experimental studies of the structure and magnetic parameters of a Josephson contact from a multilayer nanostructure», state registration No. 125020501412-9.

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O-67 | 17 September 2026 · 16:00–16:15 · Th4

KITWPA based on NbN/Mo superconducting thin film structure

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Keywords: kinetic inductance, traveling-wave parametric amplifier, bi-layer thin films, proximity effect

Quantum-limited microwave parametric amplifiers are genuine key pillars for rising quantum technologies and in general for applications that rely on the successful readout of weak microwave signals at cryogenic temperatures by adding only the minimum amount of noise allowed by quantum mechanics.

The main advantages of traveling-wave parametric amplifiers (TWPA) based on the nonlinear kinetic inductance offer a broad gain–bandwidth and a 1 cycle process flow fabrication.

Kinetic Inductance TWPAs based on dirty superconductors (or high-kinetic inductance materials) utilize the strong, intrinsic nonlinear kinetic inductance L_k of disordered thin films to provide amplification. However, the maximum achievable current in these devices, e.g. based on NbN, does not exceed 50% of the critical current, which corresponds to a relative change of $L_k(0)$ no more than 10%. This determines a physically possible limit of signal amplitudes used for parametric microwave interaction.

The purpose of this work is to design a KITWPA based on bilayer structure of superconductors. Such stack of thin films allows an increase in the current up to 81% of critical current and demonstrate a

relative change of L_k up to 50% due to proximity effect. Thus, it is possible to increase the gain value of the parametric amplifier.

Acknowledgments. The study was supported by project No. 125020501540-9 of the Ministry of Education and Science of the Russian Federation. Fabrication and technology characterization were carried out at large scale facility complex for heterogeneous integration technologies and silicon+carbon nanotechnologies.

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O-68 | 17 September 2026 · 16:15–16:30 · Th4

Vortex dynamics and anisotropy evolution in the double-dome kagome superconductor $\text{CsV}_3\text{Sb}_{5-x}\text{Sn}_x$

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Keywords: Kagome, double-dome superconductivity, fishtail effect, peak effect

The interplay between the charge density wave (CDW) and superconductivity in the Kagome superconductor CsV_3Sb_5 has attracted extensive attention. Structural investigations indicate that Sn dopants preferentially substitute for Sb atoms within the Kagome plane, effectively tuning the system's ground state. This study thoroughly investigates the vortex dynamics and critical fields within the double-dome superconducting phase diagram of $\text{CsV}_3\text{Sb}_{5-x}\text{Sn}_x$ ^[1]. In the first superconducting dome ($x=0.06$), the system exhibits a pronounced fishtail effect^[2, 3]. The normalized pinning force density ($F_p/F_{p,\text{max}}-h$) displays a single-peak structure centered at $h=0.47$, consistent with a normal-core point-defect pinning mechanism. In the second dome ($x=0.35$), a distinct peak effect emerges, characterized by a double-peak profile in the F_p curve, indicating an order-disorder transition of the vortex lattice near the upper critical field. Furthermore, WHH two-band model fittings reveal that the zero-temperature upper critical field anisotropy parameter $\Upsilon(H_{c2,\parallel a}/H_{c2,\parallel c})$ decreases sequentially from 6.48 ($x=0$) to 4.40 ($x=0.06$) and 2.35 ($x=0.35$). This progressive reduction physically highlights that as the CDW order is suppressed by in-plane Sn substitution, the superconducting anisotropy is significantly weakened. This work provides key experimental evidence for understanding the competing orders and microscopic pinning mechanisms in Kagome superconductors.

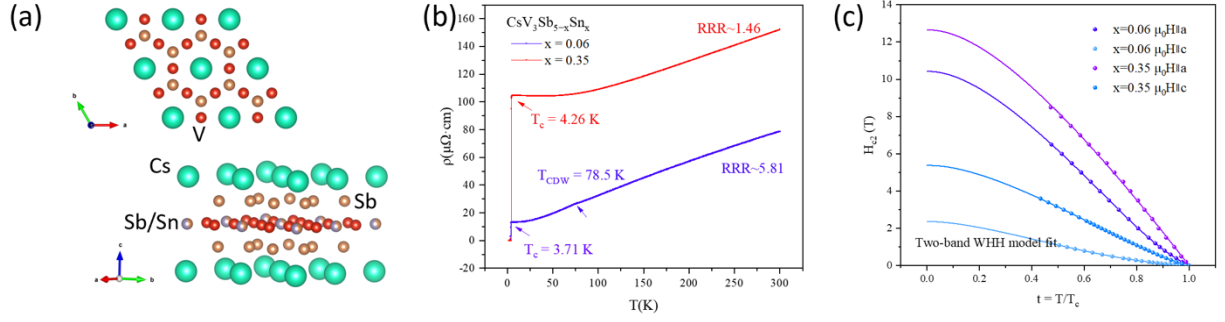


Fig. 1. (a) Crystal structure of $\text{CsV}_3\text{Sb}_{5-x}\text{Sn}_x$; (b) Temperature dependence of resistance for $x=0.06$ and $x=0.35$; (c) In-plane and out-of-plane upper critical fields for $x=0.06$ and $x=0.35$.

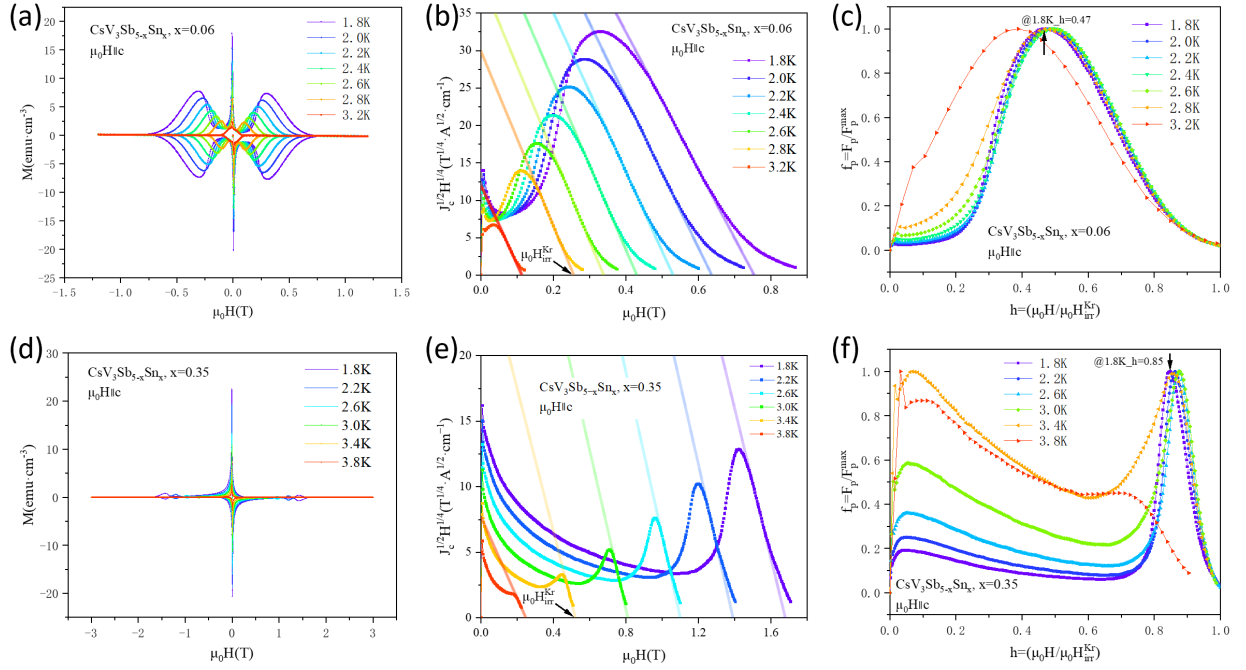


Fig. 2. (a)-(c) The fishtail effect in the $x=0.06$ sample; (d)-(f) The peak effect in the $x=0.35$ sample.

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O-69 | 17 September 2026 · 16:45–17:00 · Th4

Surface properties of the layered compounds CeCo_2P_2 , LaCo_2P_2 and TbCo_2B_2 investigated by scanning tunneling microscopy

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Keywords: STM/STS, surface terminations, Kondo effect, 122 compounds

Layered intermetallics with the ThCr_2Si_2 structure type exhibit superconductivity, magnetic order, heavy-fermion behaviour and Kondo physics [1], yet their surfaces remain far less explored than the bulk, despite cleaving into atomically clean terminations [2]. Here CeCo_2P_2 , LaCo_2P_2 and TbCo_2B_2 were studied by low-temperature STM/STS, with complementary DFT calculations for LaCo_2P_2 . This set separates the roles of the rare-earth 4f and cobalt 3d electrons and probes the replacement of phosphorus by boron.

Three terminations with clearly different dI/dV spectra were identified on CeCo_2P_2 , a square phosphorus lattice and reconstructed 2×1 and disordered cerium surfaces. A temperature-dependent pseudogap near the Fermi level appears on the cerium surface. It gradually fills on heating from $T = 1.3$ K to $T = 13$ K and vanishes at $T = 77$ K, while the phosphorus termination shows no such feature, pointing to a surface Kondo lattice [3]. Local work function maps agree, with both cerium regions showing lower values than the phosphorus one.

LaCo_2P_2 exhibits three analogous terminations, phosphorus, reconstructed 2×1 lanthanum and maze-like lanthanum without long-range order. Both La surfaces yield identical spectra and no pseudogap, confirming its origin in the Ce 4f states. On its phosphorus termination individual Bragg peaks in Fourier transforms of the dI/dV maps switch on and off with bias, indicating orbital selectivity of layer-resolved tunneling [2]. DFT finds the 2×1 reconstruction with linearly arranged La atoms more favourable than the 2×2 one; the maze-like surface reflecting intermediate La-layer filling.

For TbCo_2B_2 surface data are reported for the first time, revealing a B termination whose point-defect density is roughly three times higher than on the phosphides, reflecting the large difference between the ionic radius of Tb^{3+} and that of B. A long-period modulation of the electronic density, absent on the phosphides, is presumably linked to magnetic order of the Tb sublattice.

Thus, the local electronic structure is governed not only by bulk properties, but also by the termination, its filling and disorder.

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O-70 | 17 September 2026 · 17:00-17:15 · Th4

Anomalous magnetoresistance hysteresis in the two-dimensional superconducting state of PtBi₂ nanoflakes

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Keywords: Trigonal-PtBi₂, Anomalous magnetoresistance hysteresis, 2D superconductivity

Trigonal PtBi₂, a layered topological semimetal with intrinsic superconductivity, provides a promising platform for studying low-dimensional and nontrivial superconducting states. Here, through systematic transport measurements on exfoliated PtBi₂ nanoflakes, we identify a two-dimensional superconducting state accompanied by anomalous magnetotransport behavior. The two-dimensional nature is evidenced by the Berezinskii-Kosterlitz-Thouless transition, strong magnetic-field anisotropy, and Tinkham-type angular dependence of the upper critical field. In contrast to conventional thin-film superconductors, the superconducting transition temperature increases monotonically as the flake thickness decreases. Strikingly, the two-dimensional superconducting state exhibits an unusual magnetoresistance hysteresis that depends strongly on the magnetic-field sweep history and differs from conventional magnetic hysteresis. After the magnetic field is removed, the resistance relaxes slowly over several hundred seconds, indicating long-lived nonequilibrium dynamics. These results can be understood in terms of a two-level critical state involving vortex pinning and creep, indicating a heterogeneous pinning landscape in the two-dimensional superconducting state of PtBi₂.

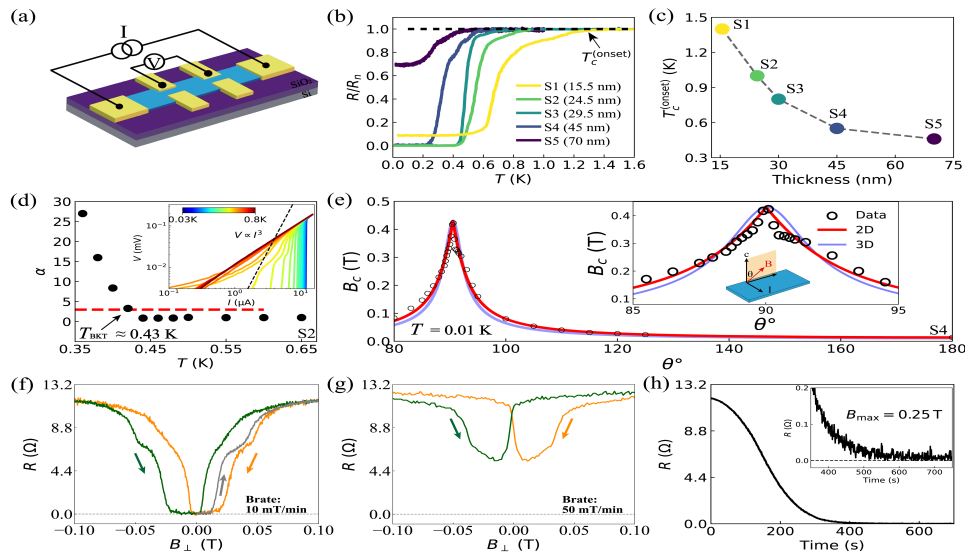


Fig. 1. Two-Dimensional Superconductivity and anomalous magnetoresistance hysteresis in PtBi₂ nanoflakes. (a) Schematic illustration of the PtBi₂ nanoflake device. (b)(c) R - T curves and thickness dependence of onset superconducting transition temperature $T_c^{(onset)}$. (d)(e) BKT analysis and 2D-Tinkham fitting, together revealing two-dimensional superconducting characteristics. (f)(h) Anomalous magnetic hysteresis loops and time-dependent resistance relaxation, revealing nonequilibrium vortex dynamics.

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O-71 | 17 September 2026 · 17:15–17:30 · Th4

Magnetically memorable inductance in superconducting multi-layer resonators

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Keywords: superconductivity, spin valve, kinetic inductance, magnetic memory

The spin-trigger effect offers magnetic control of superconducting kinetic inductance without switching the entire structure to a resistive state [1, 2]. We fabricated split-ring resonators from Nb(20)/Co(2.5)/Nb(8)/Co(1.5)/Nb(8)/Al(20) multilayers (thicknesses in nm) and measured their microwave transmission in longitudinal magnetic fields. Reference devices without Al and from a single Nb layer were studied for comparison.

At 2.5 K, the 4.7 GHz resonator exhibits a nonvolatile frequency shift of approximately 4 MHz at zero field after magnetic preparation (Fig. 1). A discrete contribution of about 0.5 MHz near 2.5 mT is attributed to reversal of the thinner Co layer. The larger, history-dependent contribution is interpreted as arising from magnetic domain configurations. Adding the proximitized Al layer enhances the frequency contrast approximately threefold and improves reproducibility; the Nb reference shows no noticeable memory effect.

A microscopic model based on the Usadel equations reproduces the low-temperature frequency contrast, but not the near-merging of the magnetic-state branches above approximately 4 K. These results establish a proof of principle for field-programmable inductive elements in superconducting digital and neuromorphic circuits.

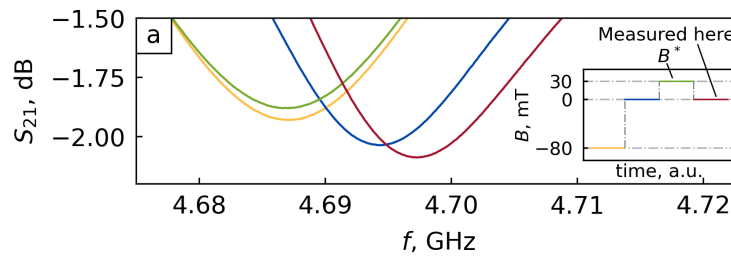


Fig. 1. Zero-field spectra at 2.5 K for parallel (blue) and antiparallel (red) magnetizations. Yellow and green curves were measured at -80 and +30 mT, respectively.

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O-72 | 17 September 2026 · 17:30–17:45 · Th4

Peculiarities of the vortex dynamics in a granular niobium superconducting bridge

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Keywords: superconductivity, vortex dynamics, niobium, nanostructures, negative differential resistance

We investigate the peculiarities of vortex dynamics in a submicron superconducting bridge fabricated from a granular niobium (Nb) film. The voltage–current (V-I) characteristics of the structure reveal anomalous regions with negative differential resistance (NDR), where the voltage decreases with increasing current. Such behavior cannot be explained by conventional overheating effects and is instead attributed to complex vortex motion in an inhomogeneous superconducting medium.

Magnetic force microscopy (MFM) and scanning quantum vortex microscopy (SQVM) measurements demonstrate that the granular structure of the Nb film forms a network of superconducting clusters separated by weaker intergranular boundaries. These boundaries act as preferential channels for Abrikosov vortex motion. The experiments show that vortices enter the bridge at currents exceeding the critical value and propagate along these weak links, forming a nanoscale transport network.

Theoretical modeling based on the time-dependent Ginzburg–Landau equations reproduces the observed nonmonotonic V-I characteristics. It is shown that even a system with only two interacting vortices moving along nearby defects can exhibit NDR and plateau-like behavior. The physical origin of this effect lies in vortex–vortex interaction, which reduces the average vortex velocity and leads to a decrease in voltage in a certain current range.

The results demonstrate that structural disorder in granular superconductors plays a crucial role in transport properties by controlling vortex dynamics. The observed effects can be tuned by engineer-

ing defect configurations, opening prospects for designing superconducting devices with controllable nonlinear transport characteristics.

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O-73 | 17 September 2026 · 17:45–18:00 · Th4

Controllable physical vapor deposition synthesis and one-dimensional hinge state transport of higher-order topological insulator α -Bi₄Br₄ nanostructures

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Keywords: α -Bi₄Br₄, HOTIs, PVD, AB oscillations

Higher-order topological insulators (HOTIs) are of paramount importance in the field of topological quantum computing due to their unique boundary state distribution, where the insulating bulk and surfaces support conductive one-dimensional (1D) hinge states. In this work, the controllable synthesis of high-quality α -Bi₄Br₄ nanobelts and nanowires via physical vapor deposition (PVD) is realized for the first time. By precisely tuning the growth temperature and duration, quasi-1D nanostructures with uniform thickness and atomically smooth edges were obtained, addressing the long-standing challenge of fabricating high-quality low-dimensional HOTI materials. Structural analysis reveals a highly ordered lattice arrangement composed of Bi-Br chains, exhibiting exceptional structural integrity. The demonstration of defect-free lattice packing and intrinsic atomically smooth edges provides an ideal platform for quantum coherent transport. Furthermore, low-temperature magnetoresistance measurements reveal distinct Aharonov-Bohm (AB) oscillations, providing direct evidence that charge carriers are confined within topologically protected hinge channels for coherent transport, thereby verifying the higher-order topological nature of the material. This study establishes a comprehensive framework ranging from material preparation to physical characterization, laying a solid experimental foundation for the development of low-power spintronic devices and quantum chips based on HOTI phases.

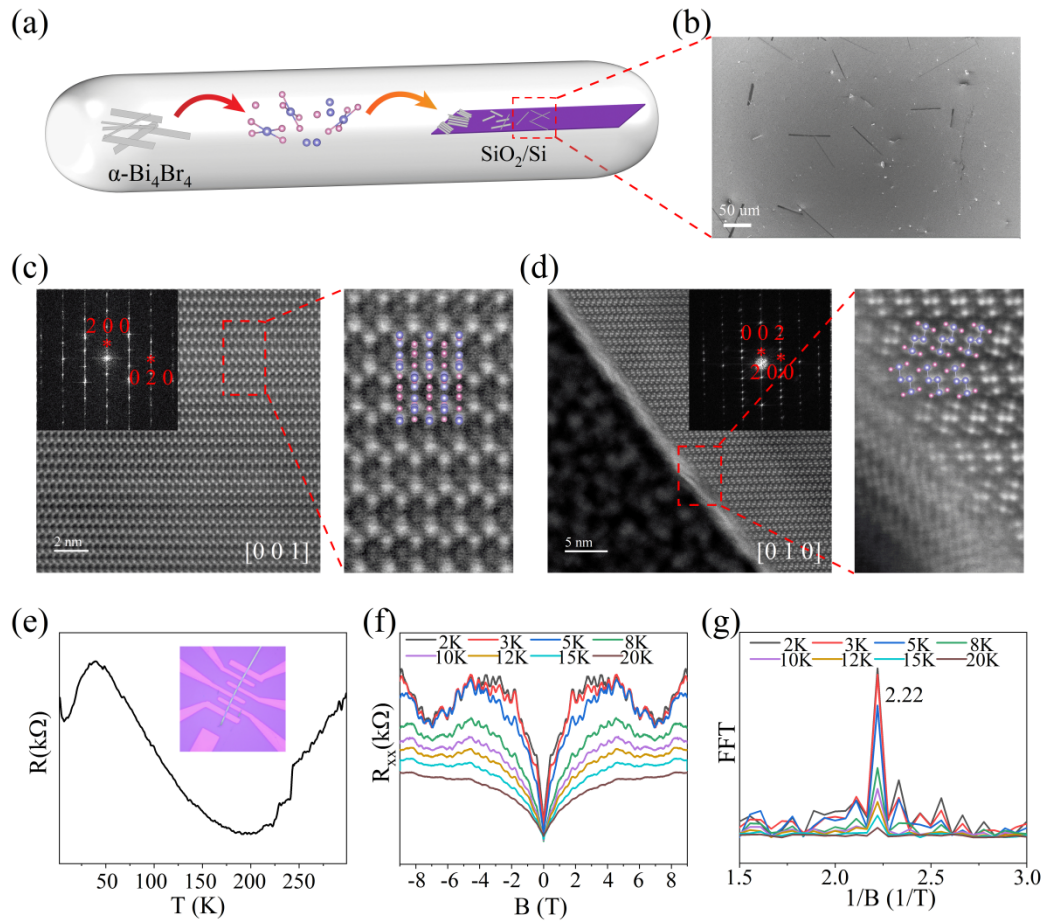


Fig. 1. (a) Schematic illustration of the PVD process used for the growth of α - Bi_4Br_4 nanostructures. (b) SEM images of α - Bi_4Br_4 nanobelts and nanowire samples. (c) STEM-HAADF image of α - Bi_4Br_4 nanobelt. The inset FFT pattern can be indexed to the [001] zone axis. The atomic arrangement matches the α - Bi_4Br_4 crystal structure viewed along the [001] direction. (d) STEM-HAADF image of a cross-sectional sample prepared by FIB perpendicular to the long axis of the α - Bi_4Br_4 nanobelt. The inset FFT pattern is indexed to the [010] zone axis. The atomic arrangement is consistent with the α - Bi_4Br_4 crystal structure viewed along the [010] direction, exhibiting atomically flat edges. (e) Temperature-dependent resistance of the α - Bi_4Br_4 nanowire. (f) In the magnetic field range of -9 T to 9 T, the magnetic field-dependent longitudinal resistance (R_{xx}) curves at different temperatures. (g) FFT spectrum of dR/dB over the entire magnetic field range, showing a prominent peak at 2.22 1/T.

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O-74 | 17 September 2026 · 18:00–18:15 · Th4

Stray-field-controlled Josephson switching in segmented Au/Ni/Au nanowire junctions

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Keywords: Josephson junctions, nanowires, magnetic fields, spintronics

Hybrid S/F/S structures are promising for superconducting spintronics due to the possibility of magnetic control of Josephson transport [1–2]. In this work, hybrid Nb/Au–Ni–Au/Nb structures based on individual segmented metallic nanowires were investigated, with the ferromagnetic Ni segment incorporated into the weak-link region between superconducting Nb electrodes.

For structures with a diameter of about 68 nm and a weak-link length of approximately 285 nm, a reproducible hysteretic multipeak dependence of the switching current on the external magnetic field was observed. This behavior was absent in control Nb/Au/Nb structures without a ferromagnetic segment. The characteristic magnetic-field response persists with increasing temperature, indicating the robustness of the observed supercurrent-control mechanism. It was shown that magnetic reconfiguration of the Ni segment is accompanied by step-like modulation of the switching current and can be described in terms of additional effective internal magnetic fields of about 1–1.5 kOe. Thus, changes in the magnetic state of the ferromagnetic segment directly affect the characteristics of the Josephson weak link.

HAADF-STEM/EDX measurements revealed pronounced spatial inhomogeneity of the Ni segment and the presence of regions with different Ni concentrations, which is consistent with a scenario involving successive magnetic switching of individual parts of the ferromagnetic segment. In addition, structures with Ni interlayers only a few nanometers thick were investigated, for which critical current densities of up to $3.8 \cdot 10^6$ A/cm² were measured. This demonstrates that the introduction of a thin ferromagnetic segment does not prevent the realization of Josephson transport with a high critical current density.

The obtained results demonstrate the potential of segmented nanowires as a platform for studying the interplay between superconductivity and ferromagnetism, as well as for developing magnetically controllable Josephson elements and cryogenic devices for superconducting spintronics.

Acknowledgments. Supported by the Ministry of Science and Higher Education of the Russian Federation (Agreement No. 075-15-2025-010) and RSF project No. 25-72-10127.

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ORAL PRESENTATIONS / SECTION 5

Spintronics and photonics

Friday, 18 September 2026

Hall to be confirmed by organisers the day before · O-75–O-95

F1 · Institutional cooperation and spintronics

Proposed chair: Irina BOBKOVA

F2 · Spin, light, and hybrid systems

Proposed chair: Vladimir BELOTELOV

F3 · Materials, photonics, and energy conversion

Proposed chair: Alexey BOLSHAKOV

F4 · Correlated materials and hybrid quantum devices

Proposed chair: Wei JIANG

O-75 | 18 September 2026 · 09:30–10:00 · F1

Antiferromagnet-Cyclotron Hybridization in a Back-Gated 2D Electron System on an Antiferromagnetic Film

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We theoretically investigate the hybridization of cyclotron resonance (CR) with antiferromagnetic resonance (AFMR) in a cavity formed by a gated high-mobility two-dimensional electron system (2DES) on an insulating antiferromagnetic film, taking MnF_2 as a prototype. We calculate the electromagnetic absorption spectra for in-plane and out-of-plane easy-axis configurations. In both cases, the spectra reveal a pronounced anticrossing between the resonances, and we derive a simple analytical description of their coupled dynamics analogous to two coupled classical harmonic oscillators. We show that the coupling strength is characterized by a cooperativity parameter on the order of 10^3 for the $\text{MnF}_2/\text{Ga(Al)As}$ system, making such hybrid structures a promising platform for strong coupling between these collective electronic and magnetic excitations. In addition, gate-voltage control provides an extra degree of freedom for potential application.

O-76 | 18 September 2026 · 10:00–10:30 · F1

Spin-photonics at optical and THz frequencies

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Keywords: magneto-photonics, antiferromagnetic resonance

To advance the development of modern microelectronics devices, a substantial increase in their clock frequencies to the terahertz range is required. This necessitates the use of electromagnetic waves from the optical and terahertz spectra for device control. However, the current efficiency of such control is insufficient for practical applications, largely due to the constraints imposed by the diffraction limit. This work focuses on addressing the aforementioned challenge through the design and implementation of nano- and microstructures with inherent optical and terahertz resonances. Such structures include plasmonic and dielectric gratings and metasurfaces. Excitation of the optical resonances provides localization, modification and enhancement of the near field of the electromagnetic waves interacting with magnetic media. As a result, impact of light [1] and THz [2] radiation on magnets is significantly modified. Therefore, nanophotonic structures combined with magnetic materials facilitate the efficient excitation of high-frequency spin dynamics and achieving ultra-fast magnetization reversal by pulses of

the electromagnetic radiation. These capabilities are essential for the functionality of information storage and retrieval devices, terahertz emitters and detectors, as well as magnon and spintronic memory components.

Optical and THz frequency range differ much in the sense of the physical mechanisms underlying the interaction between light and electromagnetic waves. Thus, for the light pulses impinging on a transparent magnet (e.g. iron garnet), these are nonthermal inverse magneto-optical (or in other words, “optomagnetic”) effects that govern this interaction. Therefore, the interaction is non-resonant, though light can still excite spin waves and magnetization reversal. If the magnetic film is contacted with a 1D or 2D nonmagnetic nanograting, then the distribution of the effective magnetic field of the inverse Faraday effect describing that interaction is drastically modified at a scale of 100 nm which provides excitation of short spin waves of 100 nm wavelength by a light beam of diameter around 10 μm with increased efficiency [1]. Moreover, if a magnetic film is perforated itself by a nanograting then light can excite exchange dominated spin waves [3].

When passing to THz regime the situation alters. If one deals with rare-earth ferrimagnets or antiferromagnets, then the spin resonance might coincide with frequency of the incident electromagnetic pulse that provides resonant excitation of spins. We have recently demonstrated that a metasurface adjusted to a THz frequency provides additional THz-magnetic field component in the near field and therefore allows to efficiently excite exchange spin modes in a ferrimagnet [2].

Consequently, it is very advantageous to apply the concepts of nanophotonics and metaphotonics for spin control in low-dissipation magnets.

Acknowledgments. This work is financially supported by Russian Science Foundation, project No. 23-62-10024.

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O-77 | 18 September 2026 · 10:50–11:20 · F2

Quantized spin Hall effect in 3D nodal-ring semimetal: geometric scaling and symmetry-engineered spin response

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Keywords: Spin Hall effect, Scaling law, nodal-ring semimetal

The anomalous Hall conductivity in magnetic Weyl semimetals scales linearly with the momentum separation between Weyl nodes, establishing a geometric paradigm for three-dimensional Hall responses. Here we discover an analogous phenomenon in the spin Hall effect, a quantized spin Hall conductivity (SHC) in nodal-ring semimetals that scales linearly with the nodal-ring radius R . From an ideal model with a single nodal ring, we derive analytically that the SHC inside the spin–orbit-coupled gap obeys

$\sigma_{\alpha\beta}^{S,3D} = \sigma_0^{S,2D} \bullet (\pi R/2\pi)$, where $\sigma_0^{S,2D} = (e^2/h) \bullet (h/2e)$ is the two-dimensional quantum spin-Hall conductance. Crucially, the symmetry of the spin-orbit coupling acts as an independent switch, where Rashba coupling generates purely conventional SHC components, while Weyl coupling additionally activates unconventional ones, providing separate control over response magnitude and tensor symmetry. We validate this principle in yttrium nitride, where strain tunes R and symmetry breaking toggles between response types. Our work establishes a new paradigm for engineering quantized geometric responses in three dimensions, opening pathways to tailored spin-orbit functionalities.

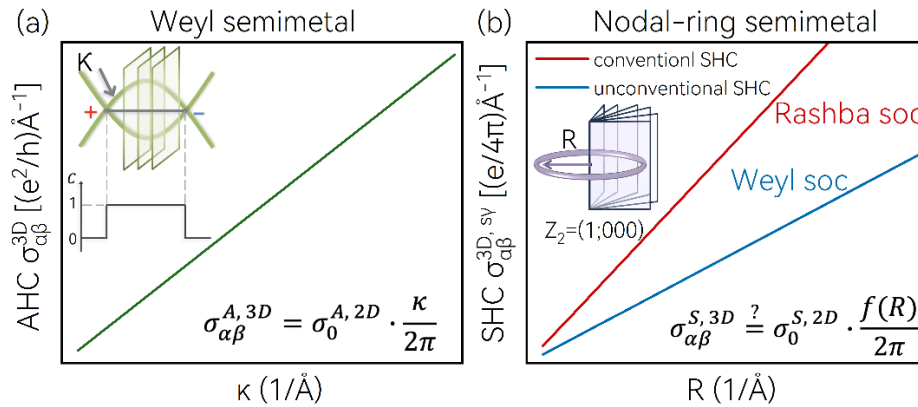


Fig. 1. Geometric scaling of Hall responses in topological semimetals.

O-78 | 18 September 2026 · 11:20-11:40 · F2

Resonant photonics, optical routing and hybrid photonic sources based on 2D materials and nanowires

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Keywords: photonics, 2D, nanowire

Two-dimensional (2D) materials and semiconductor nanowires have emerged as highly promising building blocks for next-generation photonic and optoelectronic devices, owing to their unique optical and electronic properties. 2D materials, such as transition metal dichalcogenides (TMDs), exhibit strong excitonic effects and tunable bandgaps, while nanowires offer exceptional waveguiding capabilities and resonant light-matter interactions at the nanoscale. In this talk, we explore the resonant photonic properties of semiconductor nanowires, including Mie-type scattering and their ability to function as efficient nanoscale optical antennas. We further examine their collective optical behavior when organized into metasurfaces, enabling advanced control over light propagation and emission.

Additionally, we present innovative approaches to on-chip optical routing using nanowires as low-loss waveguides, facilitating integrated photonic circuits with high spatial confinement. Beyond nanowires, we investigate the potential of van der Waals materials for reconfigurable photonic circuitry, leveraging their compatibility with heterogeneous integration. Finally, we discuss the prospects of hybrid photonic devices that combine resonant semiconductor nanostructures with optically active materials, such as TMDs and perovskites, to achieve enhanced light emission and modulation. These hybrid systems

open new pathways for compact, tunable, and high-performance photonic sources, critical for future optoelectronic applications.

O-79 | 18 September 2026 · 11:40–12:00 · F2

Ultrastrong light–matter coupling in superconductor/(anti)ferromagnet and superconductor/ferroelectric nanostructures

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Keywords: ultrastrong light–matter coupling, superconductor-based heterostructures, THz, magnon-polaritons, ferron-polaritons

The talk discusses the emergence of ultrastrong light–matter coupling in superconductor-based hybrid nanostructures, demonstrating how superconducting layers fundamentally enhance and control interactions between collective excitations and confined photons. We first show that in S/F/I/F/S heterostructures, Meissner currents mediate an ultrastrong magnon-magnon coupling between spatially separated ferromagnets, with an anisotropic strength exceeding conventional dipolar interactions by orders of magnitude [1]. Extending this platform to antiferromagnets (S/AF/S), we predict ultrastrong magnon-photon coupling at terahertz frequencies, achieving coupling constants exceeding 100 GHz and high cooperativity, with external magnetic field providing tunable coupling selectivity between the two antiferromagnetic modes [2]. Finally, we introduce a novel ferroelectric analogue—the ferron-polariton—in S/FE/S structures, where the electric dipole coupling between ferroelectric excitations (ferrons) and Swihart photons produces a giant terahertz spectral gap, orders of magnitude larger than in magnetic systems, reflecting the superior strength of electric dipole interactions [3]. Collectively, these results establish superconductor-based heterostructures as a versatile and powerful platform for extreme light–matter interactions, enabling tunable, low-loss, and high-frequency hybrid quasiparticles for quantum magnonics, ferronics, and signal processing.

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O-80 | 18 September 2026 · 13:30–13:50 · F3

Crystal growth for advanced studies and applications

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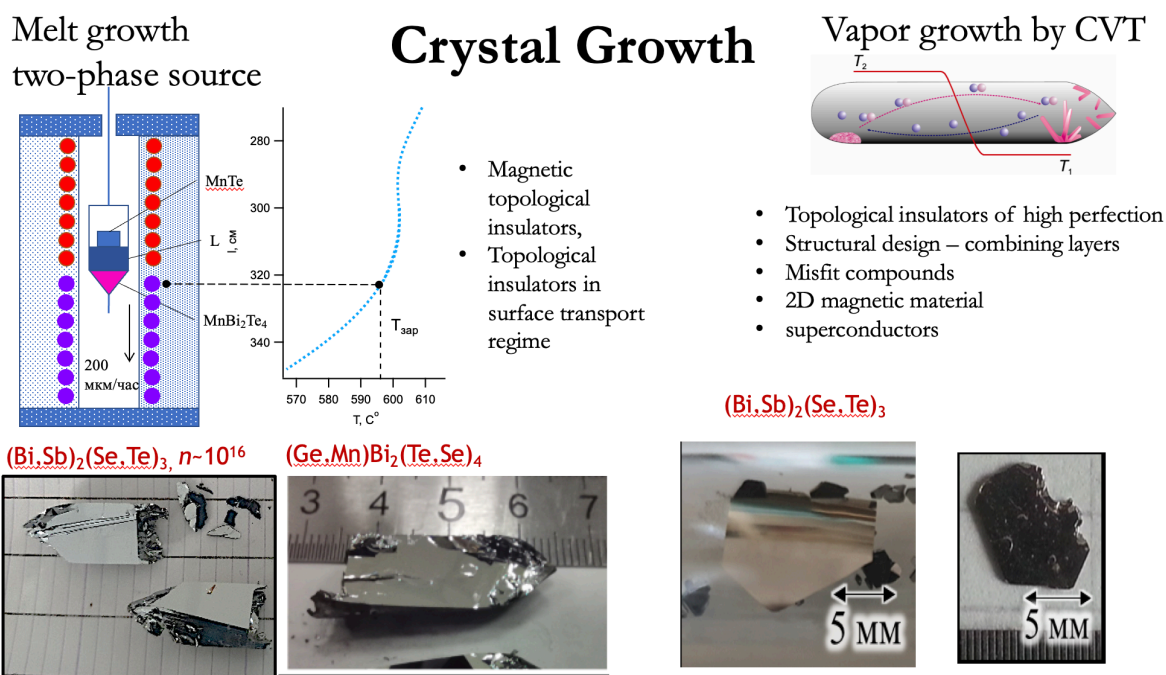
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Keywords: crystal growth, melt growth, chemical vapor transport, topological insulators

Bulk crystals remain essential for applications and especially for research, which requires tunable, simple, and broadly applicable laboratory growth methods. Melt and vapor growth cover many practical cases. Crystal-growth theory and practice have evolved from a simple atomistic picture to quantitative descriptions of growth processes on realistic time and length scales, including crystal composition and properties. Many industrial systems operate interactively.

For the search for new materials, Bridgman directional crystallization is attractive because of its simplicity and the possibility of varying the composition of multicomponent phases and solid solutions. Its applicability is limited by melting temperature and reactivity with quartz ampoules. Vapor growth is even more flexible when transport agents are used. It generally produces smaller crystals with greater crystalline perfection.



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Fig. 1. Crystal growth of topological insulators

O-81 | 18 September 2026 · 13:50–14:10 · F3

On-chip optical memory enabled by bound states in the continuum – a silicon-erbium hybrid platform

Pai Zhou¹, Yu-Hui Chen^{1,*}¹ School of Physics, Beijing Institute of Technology, Beijing, ChinaContact: stephen.chen@bit.edu.cn**Keywords:** quantum memory, rare earth ions, silicon photonics, bound states in the continuum

Storing and retrieving photonic qubits are key functionalities for future optical quantum networks, and integrating scalable optical memory units is crucial as these networks expand. Erbium-doped crystals are a promising material platform due to their long coherence times and compatibility with telecom wavelengths. However, traditional quantum memory designs combining silicon-based photonic chips with erbium-doped crystals face challenges: the high refractive index of silicon confines the optical field, leading to weak light–matter interaction and decoherence of erbium ions near interfaces. Consequently, existing integrated quantum memories lag far behind bulk crystal demonstrations in many key performance metrics.

Here, we present an efficient silicon-chip platform utilizing a designed bound state in the continuum (BIC) within a silicon-erbium hybrid system to overcome these limitations. Compared to conventional silicon waveguide hybrid structures, our BIC platform achieves an order-of-magnitude enhancement in light absorption alongside a low propagation loss of 0.5 ± 0.5 decibels per centimeter. Moreover, we demonstrated the storage of photon echo signals at telecom wavelengths. The measured coherence time of 2.6 ± 0.6 microseconds at zero magnetic field closely matches that of bulk crystals. This BIC-based platform, compatible with standard silicon manufacturing, provides a foundational and promising pathway toward practical, scalable quantum memory chips for optical quantum networks.

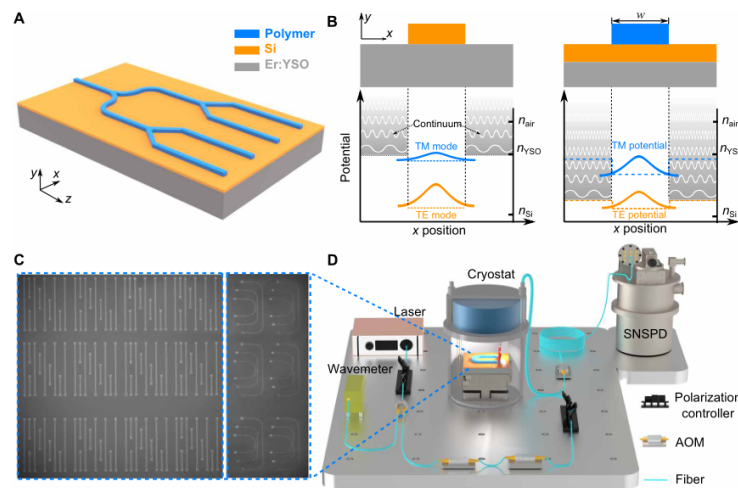


Fig. 1. Illustration of optical memory chip.

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O-82 | 18 September 2026 · 14:10–14:30 · F3

Solid-phase synthesis, properties, and ab initio investigation of $\text{Gd}_{1-x}\text{Re}_x\text{TiO}_3$ titanates

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Keywords: synthesis, titanates, ab-initio investigation

Perovskite-like rare-earth metal oxides attract significant attention due to their magnetic properties and pronounced magnetocaloric effect [1]. Among these compounds, gadolinium titanates $\text{Gd}_{1-x}\text{Re}_x\text{TiO}_3$, containing titanium in the +3 oxidation state, are of particular interest. These materials are considered promising candidates for solid-state magnetic refrigeration applications [2].

In this work, the solid-phase synthesis of titanates with the general formula $\text{Gd}_{1-x}\text{Re}_x\text{TiO}_3$ was investigated, where Re denotes a rare-earth element. The aim of the study was to determine the synthesis features and optimal conditions for obtaining single-phase products. Various starting materials were used, including metallic titanium, titanium (IV) oxide, and rare-earth oxides of gadolinium and Re. The synthesis was carried out in argon or argon–hydrogen atmospheres at temperatures of 1200–1400 °C with durations of 10–20 hours.

Phase composition and crystal structure were analyzed using X-ray diffraction combined with Rietveld refinement. The results confirm the formation of single-phase crystalline compounds with a pyrochlore structure over a wide range of synthesis conditions, largely independent of the titanium precursor and synthesis atmosphere.

The study demonstrates that the solid-phase synthesis of $\text{Gd}_{1-x}\text{Re}_x\text{TiO}_3$ titanates requires careful control of synthesis parameters, which depend on the specific composition.

Our work will include first-principles calculations of the structural, spectral, and magnetic properties of these compounds within the framework of density functional theory depending on the content of rare earth ions.

Acknowledgments. The research was supported by the Russian Science Foundation grant No. #25-22-00324

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O-83 | 18 September 2026 · 14:45–15:05 · F3

Novel 2D magnetic materials for spintronic applications

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Keywords: 2D materials, ferromagnets, spintronics

The recent discovery of 2D magnets prompted the design of novel magnetic materials at the 2D limit. The high tunability of 2D magnetic states brings forward a wealth of spintronic applications. A bottleneck in the applications is that the materials should be integrated with technologically relevant semiconductors, Si or Ge.

We have developed new classes of rare-earth based 2D ferromagnetic materials [1-4]. Silicene and germanene, Si and Ge counterparts of graphene, can be functionalized by Eu or Gd to form layered structures [1,2]. These compounds evolve from bulk antiferromagnets to 2D ferromagnets at the monolayer limit. Analogous ternary compounds MAISi exhibit advanced transport properties being ferromagnetic metals in the monolayer [3]. Scaling such magnets beyond the monolayer limit results in submonolayer magnetic materials [4].

Altermagnets, combining functional properties of ferromagnets and antiferromagnets, open new paradigms in spintronics. So far, the research has been focused on bulk altermagnets. We pushed this field to the 2D limit [5-7]. Epitaxial monolayer films of GdAlSi and GdAlGe exhibit spontaneous Hall effect, pointing at non-relativistic spin splitting [5,7]. Further miniaturization allows for submonolayer altermagnetic materials demonstrating colossal negative magnetoresistance [6].

2D magnets coupled to other 2D materials form functional heterostructures. In particular, this is a way to make graphene magnetic. We have fabricated heterostructures of graphene with 2D rare-earth magnets [8-10]. Unlike graphene, the materials exhibit the anomalous Hall effect and negative magnetoresistance.

Acknowledgments. This work was supported by the Russian Science Foundation (grants 24-19-00038 and 25-79-10047).

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O-84 | 18 September 2026 · 15:05–15:25 · F3

Efficient and stable perovskite solar cells: new materials and modeling

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Perovskite solar cells (PSCs) have attracted widespread attention in academia and industry due to their high-power conversion efficiency (PCE) and potential for low-cost, sustainable, and large-scale manufacturing. We have incorporated two-dimensional (2D) materials to enhance the performance of double-cation mixed halide perovskite ($\text{Cs}_{0.17}\text{FA}_{0.83}\text{Pb}(\text{I}_{0.83}\text{Br}_{0.17})_3$) solar cells. We developed Nb_2O_5 ETL layers by adding $\text{Ti}_3\text{C}_2\text{T}_x$ MXene into a solution processable ink [1]. The addition of MXene increased the PCE (19.46% for the champion device) and the stability (96% of its original PCE after 500 hours) compared to pristine devices. The improved performance of the Nb_2O_5 – Ti_3C_2 is attributed to the alignment of the energy bands between perovskite and the ETL layer. In inverted or p-i-n PSCs we used an ultrathin poly(methyl methacrylate) (PMMA) layer to passivate interfacial defects between the perovskite and the ETL layer [2]. The addition of $\text{Ti}_3\text{C}_2\text{T}_x$ MXene resulted in improvement of the PSC photovoltaic parameters, boosting their efficiency to $21.30 \pm 0.51\%$ (22.1% for the benchmark PSC). The PMMA:MX based devices maintained 95% of their original PCE after 3000 h (ISOS-D-1I) and took three times longer to reach T80 compared to the control PSC under heat and light soaking (ISOS-L-2). We use amino functionalized $\text{Ti}_3\text{C}_2\text{T}_x$ as an effective additive for a methyl-ammonium free perovskite in p-i-n devices [3]. Amino groups helped mitigate non-radiative recombination and to increase charge carrier lifetime and density of photogenerated charges, resulting in improved V_{oc} and J_{sc} . The MXene also increased device stability which was approximately four times greater under ISOS-L-2 protocol. We will also present a conceptual framework for characterizing photovoltaic devices by integrating cyclic voltammetry (CV) and impedance spectroscopy (IS) [4].

Acknowledgments. The authors acknowledge FAPESP (Projects: 2020/12356-8 and 2013/07296-2), FINEP, CAPES and CNPq (INCT NanoVida) for financial support.

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O-85 | 18 September 2026 · 15:45–16:05 · F4

Fractionalization of ionic spin and orbital dimerization in $\text{La}_3\text{Ni}_2\text{O}_7$ high- T_c superconductors

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Keywords: unconventional superconductivity, nickelate superconductors, strongly correlated materials

The recent discovery of 80 K superconductivity in pressurized $\text{La}_3\text{Ni}_2\text{O}_7$ and its related families has inspired active research. Here, two essential pressure-induced physical effects are identified through a multienergy-scale analysis of the bifurcating emergent quantum many-body dynamics. First, an unusual fractionalization of Ni^{2+} ionic spin from 1 to $1/2$ is revealed below the eV scale, resulting from a strong inter-atomic super-exchange that *exceeds* the intra-atomic Hund's exchange. In turn, the emergent sub-eV quantum many-body dynamics resembles that of the cuprates and thus naturally explains the observed high-temperature superconductivity and the strange metal normal-state properties. Second, an inter-atomic orbital dimerization is found associated with the formation of a spin-singlet covalent bond. This provides a generic mechanism for first-order structural transitions widely observed in many functional materials.

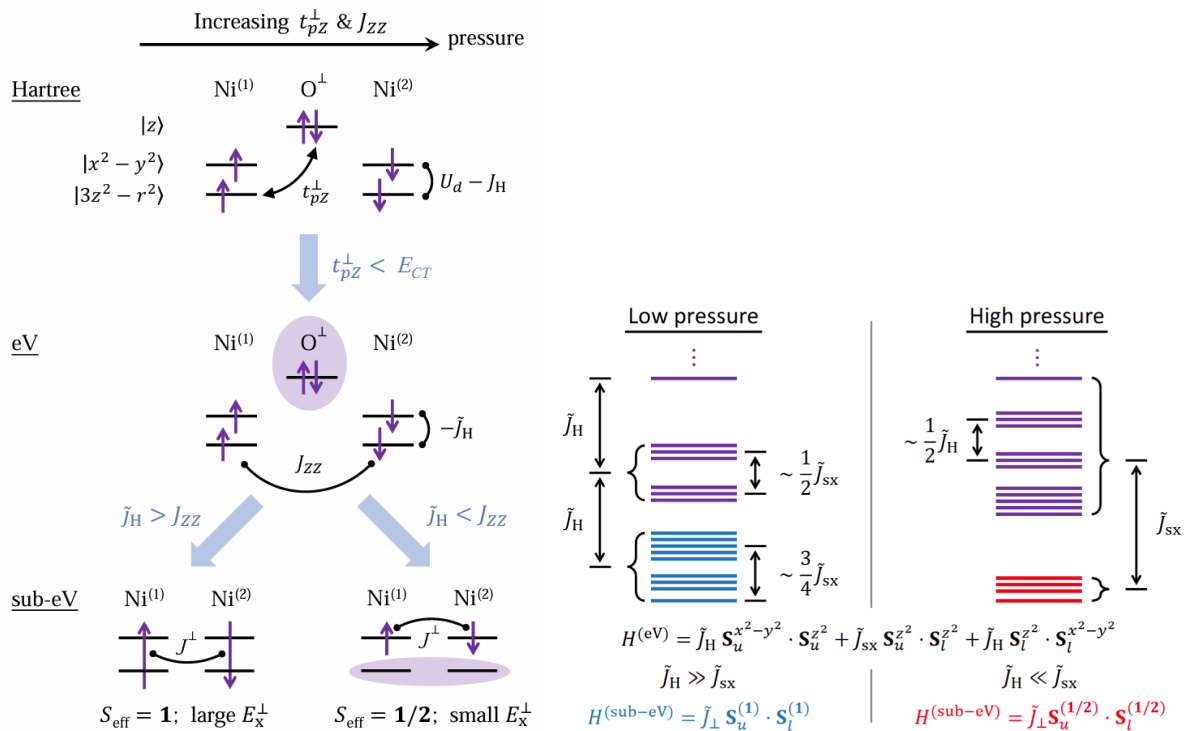


Fig. 1. Bifurcation in multi-scale evolution of quantum dynamics

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O-86 | 18 September 2026 · 16:05–16:25 · F4

Magneto-spin-orbit graphene: Chern topology and photoinduced Hall response

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Keywords: graphene, proximity magnetism, Rashba spin–orbit coupling, moiré superlattices, Chern topology, photoinduced Hall response

Pristine graphene combines a gapless Dirac spectrum with weak intrinsic spin–orbit coupling and no magnetic order. Placing it on a heavy-metal spacer supported by a ferromagnet can preserve the Dirac cone while inducing exchange and Rashba interactions, creating magneto-spin–orbit graphene. Previous ARPES, spin-ARPES and STM/STS studies of Gr/Au/Co(0001) revealed quasifreestanding graphene with sublattice ferrimagnetism and a Dirac gap of about 30 meV under out-of-plane magnetization, as well as spin-polarized states associated with triangular misfit dislocations [1,2]. These results motivate a systematic assessment of how spacer chemistry, magnetic layer, moiré stacking and buried-interface reconstruction control the graphene-derived bands.

We compare four out-of-plane magnetized heterostructures, Gr/(Au,Pt)/(Co,Mn), using carbon-projected first-principles calculations for commensurate (2×2) and moiré (9×9) supercells. For the Co-based interfaces, both defect-free structures and models containing a triangular misfit dislocation are considered. The unfolded graphene bands are fitted with an effective four-band Hamiltonian that separates uniform and staggered exchange, Rashba spin–orbit coupling and sublattice asymmetry. The fits are then used to determine Chern numbers and to calculate the helicity-dependent photoinduced Hall response.

The small commensurate cells substantially overestimate charge transfer and amplify valley asymmetry because they sample only a restricted set of local registries. Moiré averaging reduces the n-doping from hundreds to tens of meV and allows both valleys to be described with a common parameter set, while sizable proximity-induced spin splittings remain. Pt produces stronger hybridization, Rashba coupling and uniform exchange than Au in the Co-based systems. Among all compositions, only Gr/Pt/Co consistently realizes an effective ferromagnetic Chern phase with $C = 2$ in the commensurate, defect-free moiré and reconstructed models. Gr/Au/Co, Gr/Pt/Mn and Gr/Au/Mn are ferrimagnetic and topologically trivial ($C = 0$) in the moiré description. The comparison shows that topology is controlled chiefly by the balance between uniform and staggered exchange on the two graphene sublattices: a large spin–orbit coupling or Dirac gap alone does not guarantee a Chern phase [3].

Buried-interface reconstruction provides a distinct tuning mechanism without changing the topological classification. In Gr/Au/Co, the dislocation increases the calculated Dirac gap from approximately 10 to 30 meV, in close agreement with the STM/STS scale, whereas in Gr/Pt/Co it enhances the spin splitting from approximately 60 to 90 meV while leaving the gap nearly unchanged. Despite $C = 0$, the ferrimagnetic systems retain valley-resolved Berry curvature. Circular photoexcitation therefore produces a finite helicity-dependent Hall response: reconstruction amplifies and broadens this response several-fold in Gr/Au/Co, while Gr/Pt/Mn provides the clearest spectrally separated low-energy helicity-selective channel. The results identify complementary design roles: composition selects

the exchange and Chern sector, moiré modeling establishes whether the classification is robust, and buried-interface reconstruction tunes the spectral and photoinduced Hall response.

Acknowledgments. This work was supported by the Russian Science Foundation (Grant No. 25-22-00615).

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O-87 | 18 September 2026 · 16:25–16:40 · F4

Selective ultrafast optical excitation of high-k spin dynamics in a magnetophotonic nanostructure

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Keywords: nanophotonics, optomagnonics, spin waves, magnetophotonic nanostructures

Ultrafast optomagnonics is a promising platform for next-generation data storage and processing devices [1]. However, optically excited spin waves are fundamentally diffraction-limited, while short-wavelength spin waves have so far been excited mainly by microwave antennas [2]. Here we propose and demonstrate a nonthermal method for the selective optical generation of short magnetostatic spin waves (SMSW) [3] using a magnetophotonic waveguide structure (MPWS) — a bismuth-substituted iron garnet film covered by a dielectric TiO₂ grating. A circularly polarized femtosecond pump pulse tuned to the optical TE mode resonance makes the inverse Faraday effect (IFE) profile sign-changing and subdiffractive, so the periodic magnetic torque launches narrowband exchange-dominated SMSW with a wavelength of 300 nm.

Pump-probe measurements reveal a high-frequency SMSW peak in the transient Faraday rotation spectra, and its group velocity of about 1.4 km/s is an order of magnitude higher than that of the long spin waves. The SMSW wavelength is set by the grating period and can be scaled down to 100 nm, promising smaller and faster optomagnonic devices, up to THz rates in antiferromagnets.

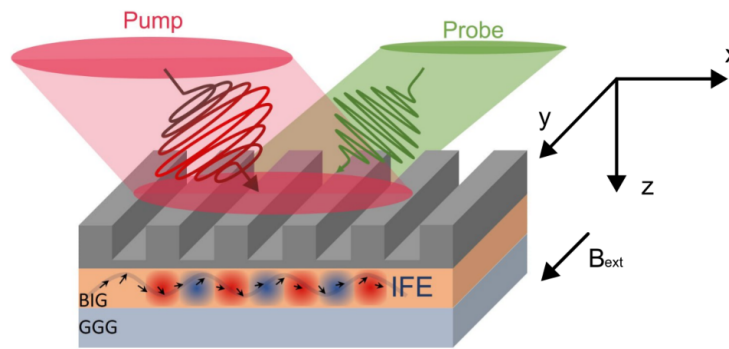


Fig. 1. Scheme of the SMSW excitation via the MPWS.

Acknowledgments. This work was supported by the Russian Science Foundation, project N 23-62-10024.

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O-88 | 18 September 2026 · 16:40–16:55 · F4

Unveiling phase-magnetization dynamics in anomalous Josephson junctions

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Keywords: Ferromagnetic Josephson junction, Ferromagnetic resonance, Magnetization dynamics

Anomalous Josephson structures containing a ferromagnet combine the superconducting and magnetic properties. An example of this is the φ_0 junction in which unification is based on the presence of an additional phase shift in the current–phase relation, which depends on the values of the spin–orbit coupling and magnetization in the ferromagnetic interlayer [1–4].

This talk presents the peculiarities of Josephson phase and magnetization dynamics in anomalous φ_0 Josephson junctions coupled to a ferromagnet [5–6]. In particular, we discuss the influence of Josephson current on dynamical precession of the magnetization and reorientation of the easy-axis, the effect of external ac drive on junction dynamics, and the realization and switching of distinct magnetization dynamical states on synchronized steps of the current-voltage characteristics. In addition to this, I am going to present the possibility of emergence of an intrinsic space-time crystalline-like pattern in a long ferromagnetic φ_0 Josephson junction on a topological insulator, achieved without external periodic modulation of the critical current [7]. The obtained results open new perspectives for the control and manipulation of magnetization in such devices.

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O-89 | 18 September 2026 · 16:55–17:10 · F4

Knight shift anisotropy in dirty superconductor-altermagnet hybrids

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Keywords: superconductivity, altermagnetism, disorder

We present a microscopic derivation of Usadel-type theory describing superconductor–altermagnet hybrid structures in the dirty limit. The combined influence of the momentum-dependent exchange field and potential scattering at nonmagnetic impurities is shown to result in the appearance of effective magnetic scattering in analogy to the Dyakonov-Perel spin-relaxation mechanism. The disorder, thus, can compensate the destructive effect of the altermagnetic exchange field on the superconducting gap, which can be probed by standard experimental techniques sensitive to the energy dependence of the density of states. The effective magnetic impurities reveal the uniaxial anisotropy determined by the Néel vector of the altermagnet. This anisotropy could be detected, e.g., by the Knight shift measurements in NMR experiments.

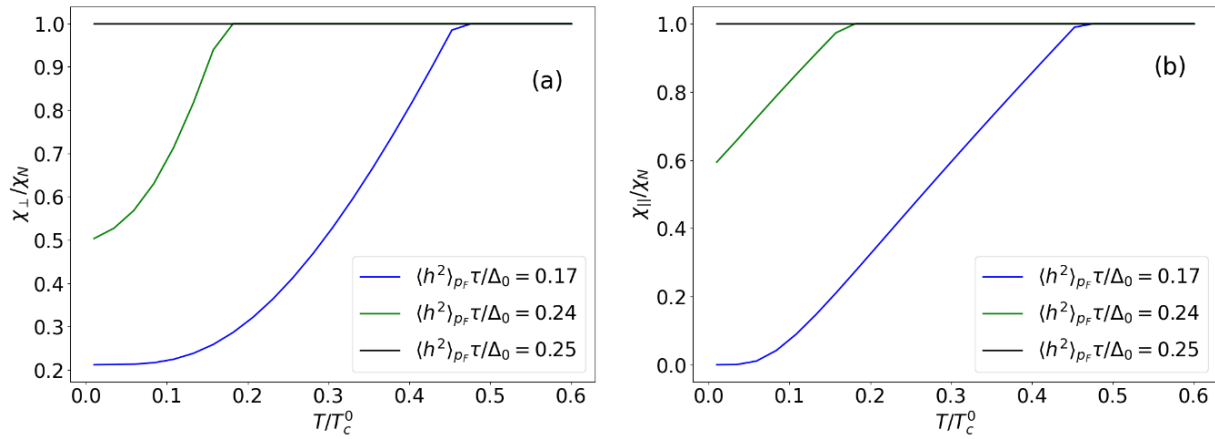


Fig. 1. a) Paramagnetic susceptibility for magnetic field transverse to the Néel vector $\chi_{\perp}$ as a function of temperature T , plotted for different depairing factors $\langle \tau h^2 \rangle_{pF}$. (b) Paramagnetic susceptibility for magnetic field along the Néel vector $\chi_{\parallel}$ as a function of temperature T , plotted for different depairing factors $\langle \tau h^2 \rangle_{pF}$.

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O-90 | 18 September 2026 · 17:25–17:40 · F4

Synergistic modulation of electro-phonon transport in AgSbTe₂ via Pb-doping for enhanced thermoelectric performance

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Keywords: lead doping, phonon scattering, thermoelectric performance

AgSbTe₂ is a premier candidate for mid-temperature thermoelectric applications due to its intrinsically ultralow lattice thermal conductivity; however, its potential is often constrained by the formation of deleterious n-type Ag₂Te secondary phases and the inherent challenge of decoupling electronic and thermal transport. In this work, we demonstrate that Pb-doping is a potent strategy to overcome these bottlenecks through the synergistic optimization of charge and phonon transport. Rather than enhancing carrier mobility, Pb substitution at the Sb sites effectively suppresses Ag₂Te impurities, thereby significantly improving the structural stability of the AgSbTe₂ matrix. This substitutional approach fa-

cilitates precise tuning of the carrier concentration while simultaneously inducing a substantial increase in the density of states (DOS) effective mass (m^*). Such electronic modulation leads to a markedly improved electrical conductivity of $222 \text{ S}\cdot\text{cm}^{-1}$ at 573 K and a high power factor of $15.6 \mu\text{W}\cdot\text{cm}^{-1} \text{ K}^{-2}$, even while maintaining a robust Seebeck coefficient of $265 \mu\text{V}\cdot\text{K}^{-1}$. Regarding thermal transport, the incorporation of Pb^{2+} (119 pm) mitigates the potential fluctuations arising from the significant charge and size mismatch between Ag^+ (115 pm) and Sb^{3+} (76 pm), thereby promoting the formation of nanoscale ordered superstructures. These multiscale features, visualized through digital image filtering of high-resolution images, enhance the scattering efficiency of heat-carrying phonons and result in an ultralow lattice thermal conductivity of $0.32 \text{ W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$. Consequently, a peak zT of 1.72 is achieved in p-type $\text{AgSb}_{0.92}\text{Pb}_{0.08}\text{Te}_2$ at 573 K. This study illustrates a lattice regulation approach to enhance both the thermal stability and thermoelectric performance of AgSbTe_2 , providing key insights into the role of cation ordering in disordered chalcogenides.

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O-91 | 18 September 2026 · 17:40–17:55 · F4

High-frequency vortex dynamics and kinetic inductance: the role of charge-imbalance potential relaxation

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Keywords: Abrikosov vortices, charge imbalance, kinetic inductance, TDGL

We investigate how relaxation of the charge-imbalance potential generated by vortex motion affects the microwave response of superconducting circuits (Fig. 1). Starting from time-dependent Ginzburg–Landau (TDGL) theory for dirty, gapless, strong type-II superconductors near the critical temperature T_c , we derive the linear-response equation [1]:

$$\left[\eta_{\text{Rel}} + \frac{\eta_{\text{Ohm}}}{1 - i\omega\tau_E} - \frac{\eta_{\text{tot}}\omega_k}{i\omega} \right] \tilde{\mathbf{v}}(\omega) = \tilde{\mathbf{F}}_L(\omega).$$

Here $\tilde{\mathbf{v}}$ and $\tilde{\mathbf{F}}_L$ are Fourier amplitudes of the vortex velocity and Lorentz force, ω is angular frequency, η_{Rel} and η_{Ohm} are the relaxational and Ohmic viscosities, $\eta_{\text{tot}} = \eta_{\text{Rel}} + \eta_{\text{Ohm}}$, and ω_k is the depinning frequency. The relaxation time $\tau_E = l_E^2/D \propto (T_c - T)^{-1}$, where l_E is the supercurrent-to-normal-current conversion length and D is the diffusion coefficient.

For $\omega\tau_E \ll 1$, expansion of the retarded kernel yields the formal effective mass $m_{\text{eff}} = -\eta_{\text{Ohm}}\tau_E$; the full kernel is essential for a consistent dynamical description. For $\omega\tau_E \gg 1$, the Ohmic channel becomes predominantly reactive, adding a pinninglike contribution and renormalizing the depinning frequency, while dissipative drag is governed by η_{Rel} .

We obtain the vortex contribution to the complex impedance and kinetic inductance. For weak pinning at low frequencies, $\omega_k \ll \omega \ll \tau_E^{-1}$, charge-imbalance relaxation produces a positive intrinsic inductive correction, proportional to vortex density at fixed temperature. The calculation assumes isolated vortices, fields well below the upper critical field, and $l_E \ll \xi$, where ξ is the coherence length. In the electron–phonon TDGL limit, the high-frequency window is $\tau_E^{-1} \ll \omega \ll \tau_{ph}^{-1}$, where τ_{ph} is the electron–phonon relaxation time.

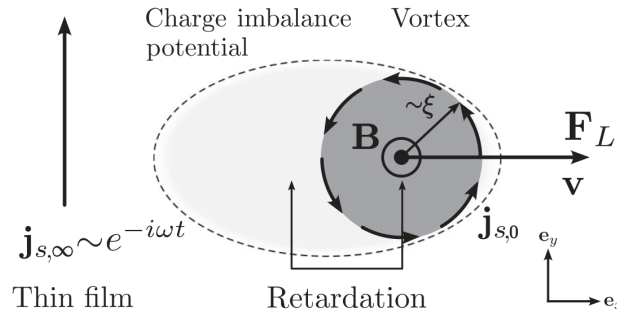


Fig. 1. Vortex motion under the Lorentz force F_L of the ac current $j_{s,\infty}$. The dashed contour marks the induced charge-imbalance potential; $j_{s,0}$ is the circulating supercurrent. Reproduced from [1].

Acknowledgments. This work was supported by the Russian Science Foundation (Grant No. 25-12-00042) and by the Grant of the Ministry of Science and Higher Education of the Russian Federation No. 075-15-2025-010.

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O-92 | 18 September 2026 · 17:55–18:10 · F4

Enhancement of the anomalous Nernst and thermal Hall effects in topological flat-band systems

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Keywords: topological flat-band, anomalous thermoelectric transport

The anomalous Nernst and anomalous thermal Hall effects are prominent manifestations of Berry curvature in topological magnets. However, their electrical and thermal responses are governed by different moments of the Berry curvature spectrum, making their simultaneous enhancement in a single material a significant challenge. Here, we propose a universal strategy to overcome this fundamental trade-off by exploiting the unique properties of flat bands. We demonstrate that in magnetic Weyl semimetals, suppressing band dispersion to approach a flat band concentrates the Berry curvature, leading to a synergistic enhancement of both the anomalous Nernst and thermal Hall conductivities. This mechanism is systematically validated, first through a minimal Weyl model and then in a realistic

pyrochlore lattice tight-binding model. To bridge theory with experiment, we employ first-principles calculations to identify candidate materials such as ZnV_2O_4 and $\text{Co}_3\text{Sn}_2\text{S}_2$, demonstrating that their native flat bands provide a platform for strain engineering to directly control the transverse thermoelectric and thermal responses. Our work establishes flat bands as a powerful design principle for developing high-performance energy conversion and topological quantum devices.

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O-93 | 18 September 2026 · 18:10–18:25 · F4

Temperature-dependent exceptional points in S/AF/S heterostructures

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Keywords: magnon-photon coupling, exceptional points

Magnonic systems are of interest for observing exceptional points, which are special singularities in the spectrum of a non-Hermitian Hamiltonian with simultaneous coalescence of both the eigenvalues and eigenvectors of the system. The practical interest of studying exceptional points is their ability to transform energy losses from a drawback to a platform for enhancing the sensitivity of magnonic devices. For various magnonic systems possibilities to create exceptional points by varying different parameters of the system, such as the width of the magnetic layer [1], the applied ac current [2] or magnetic field [3], were predicted.

For practical applications it would be especially promising to find a system where exceptional points can appear as a result of varying some easily-tunable external parameter. We theoretically predict that for S/AF/S heterostructures temperature can be such a parameter. In our previous work [4] we have demonstrated ultrastrong magnon-photon coupling in such structures in the case of zero temperature. Now we study the magnetic excitations in an S/AF/S system in the full temperature range from zero to the superconducting critical temperature. We observe the points in the temperature dependence of the magnon-polariton frequency gaps where both real and imaginary parts of these gaps turn to zero, suggesting the occurrence of exceptional points.

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O-94 | 18 September 2026 · 18:25–18:40 · F4

Paramagnetic spin-based chiral cavity quantum electrodynamics at ambient conditions

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Keywords: Nonreciprocity, gyromagnetic effect, EPR, quantum electronics

Nonreciprocal microwave transmission, arising from broken time-reversal symmetry, is a key functionality in classical microwave components such as isolators and circulators, and is essential for protecting and controlling quantum systems. While strong nonreciprocity is routinely achieved in ferromagnetic systems with large spin densities, these approaches typically require substantial bias magnetic fields. In contrast, paramagnetic systems with intrinsic zero-field splitting enable microwave spin manipulation and sensing at low or even zero field, but their relatively weak gyrotropic response makes it challenging to realize robust nonreciprocal transmission, particularly at room temperature. Here, we demonstrate a cavity quantum electrodynamics platform with chiral characteristics under ambient conditions, based on a paramagnetic ruby crystal. Strong coupling between a Cr^{3+} spin ensemble and high-Q whispering gallery modes gives rise to a pronounced gyrotropic response, which breaks time-reversal symmetry in the coupled spin-cavity system. This drives a transition from standing-wave to traveling-wave modes, yielding a chiral cavity field with directional asymmetry between clockwise (CW) and counterclockwise (CCW) modes. Beyond demonstrating nonreciprocity, we further realize dynamic magnetic sensing in this platform, including zero-field operation and enhanced robustness against saturation. Our results provide a pathway toward microwave nonreciprocal devices and spin-based sensors operating at room temperature.

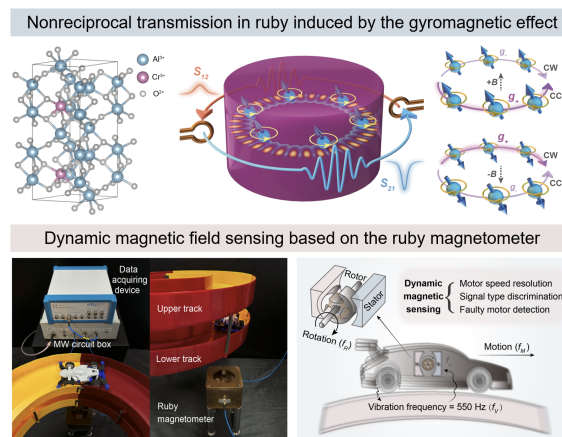


Fig. 1. Schematic of nonreciprocal transmission in ruby and dynamic magnetic sensing setup.

O-95 | 18 September 2026 · 18:40–18:50 · F4

Superconducting heterostructures based on spin–orbit-coupled strontium iridate thin films

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Keywords: strontium iridate, spin–orbit coupling, epitaxial thin films, Josephson effect, Fiske steps, cuprate heterostructures, anomalous transport, $J_{\text{eff}} = 1/2$ Mott insulator

Epitaxial thin films of strontium iridates ($\text{Sr}_{n+1}\text{Ir}_n\text{O}_{3n+1}$ type) and superconducting heterostructures based on cuprate superconductor $\text{YBa}_2\text{Cu}_3\text{O}_7$ and a Nb–Au bilayer have been fabricated [1,2]. For Sr_2IrO_4 films, an exponential temperature dependence of the conductivity was obtained, indicative of a thermally activated gap in the electronic spectrum. The temperature dependences of the electrical conductivity of SrIrO_3 films show semimetallic paramagnet behavior. A pronounced dependence of the interplanar spacing and the resistivity of SrIrO_3 films on substrate type and film thickness was observed experimentally [3,4]. The DC and AC Josephson effect was observed in heterostructures with both types of interlayer SrIrO_3 and Sr_2IrO_4 .

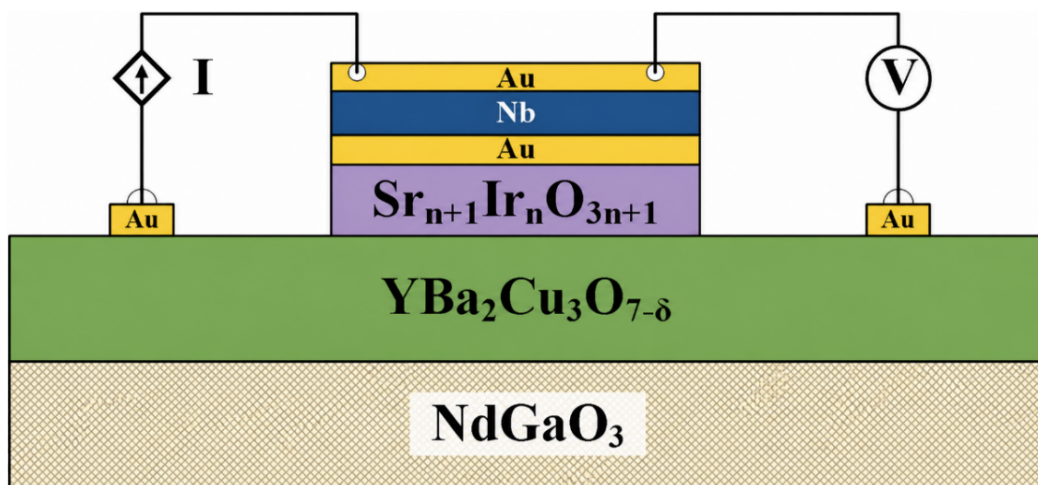


Fig. 1. Schematic cross-section of the superconducting heterostructure with a $\text{Sr}_{n+1}\text{Ir}_n\text{O}_{3n+1}$ interlayer and measurement leads for I–V curve characterization. Layer thicknesses: $\text{YBa}_2\text{Cu}_3\text{O}_7$ 60–70 nm, Au 10–20 nm, Nb 200 nm; SrIrO_3 interlayer 14 nm or Sr_2IrO_4 5 nm.

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WEDNESDAY 16 SEPTEMBER 2026 · 16:30–18:00

Poster session

Proposed chairs: Irina BOBKOVA and Alexey ALADYSHKIN.

Poster session for young scientists with a best poster award.

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P-01 | 16 September 2026 · 16:30-18:00 · PS

Transfer characteristics of antiferromagnetic waveguides

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Keywords: antiferromagnet, waveguide, transfer function, equivalent electrical circuit

Currently, the application of spintronic devices for transmitting and processing data is actively investigated [1]. Structures based on multisublattice magnetic materials, in particular, on antiferromagnets (AFM), can be used as components for such devices [2]. Spin waves can propagate in such materials, and quanta of these waves (magnons) are information carriers in spintronic devices [3]. Previously, models of sensors and memory elements based on AFM were described in detail theoretically [4,5]. One of the advantages of AFM compared to other magnetic materials is the possibility of exciting high-frequency spin waves in them (in the sub- and terahertz ranges), as well as high resistance to magnetic fields. In this work the transfer function of AFM waveguide based on NiO film with exciting and receiving microstrip antennas is calculated using a lumped equivalent electrical circuit [6] (Fig. 1). It consists of the self- and mutual inductances of the antennas, as well as radiation and Ohmic resistances and reactive components. NiO has two eigenmodes - quasi-ferromagnetic (low frequency) and quasi-antiferromagnetic (high frequency).

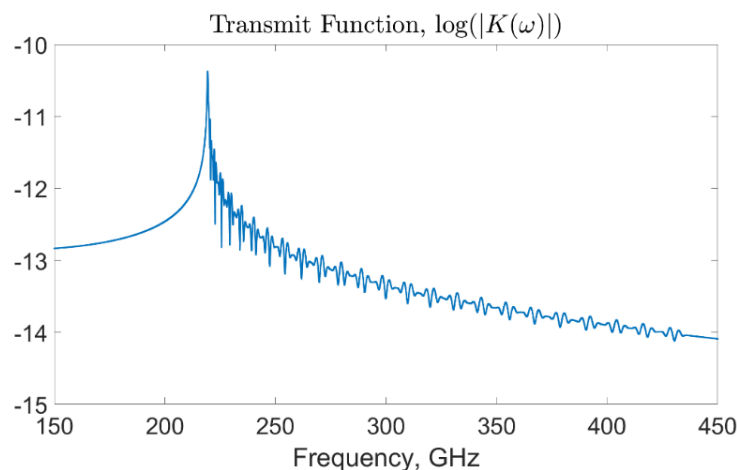


Fig. 1. Transfer function of AFM waveguide. Low frequency mode (quasi-ferromagnetic).

Acknowledgments. This work was carried out within the framework of the state assignment of the Kotelnikov Institute of Radio-Engineering and Electronics of the Russian Academy of Sciences.

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P-02 | 16 September 2026 · 16:30-18:00 · PS

Simultaneous microwave CZ gates on the fluxonium architecture superconducting processor

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Keywords: superconducting qubits, fluxonium, transmon, CZZ gate, simultaneous gates

For the realization of a superconducting processor with high-fidelity entangling operations and low parasitic interactions between qubits, one of the most promising architectures is the “fluxonium–transmon–fluxonium” configuration, where fluxoniums serve as computational qubits and transmons act as couplers. In this architecture, two-qubit operations are performed via microwave excitation of the couplers [1]. In this work, we present an experimental implementation of simultaneous microwave-driven CZ gates on the superconducting processor consisting of a linear chain of 20 fluxonium qubits and 19 transmon couplers. The specific configuration of the couplers in our superconducting processor [2] enables simultaneous CZ gates on adjacent qubit pairs, effectively implementing a three-qubit CZZ gate. This operation constitutes a valuable resource for quantum algorithms, most notably for quantum error correction codes [3, 4]. The CZZ gate is realized by applying simultaneous microwave 2π pulses to adjacent couplers. On a three-qubit subarray of the experimental device (Fig. 1), we perform calibration and benchmarking of both sequential and simultaneous CZ operations. We experimentally established that the simultaneous execution of CZ gates reduces the error by more than 40% compared to sequential CZ operations. This corresponds to an increase in CZZ operation fidelity from 98.4% to 99.1% (Fig. 1(c)). Furthermore, we demonstrate the application of simultaneous CZ gates in a quantum error detection code.

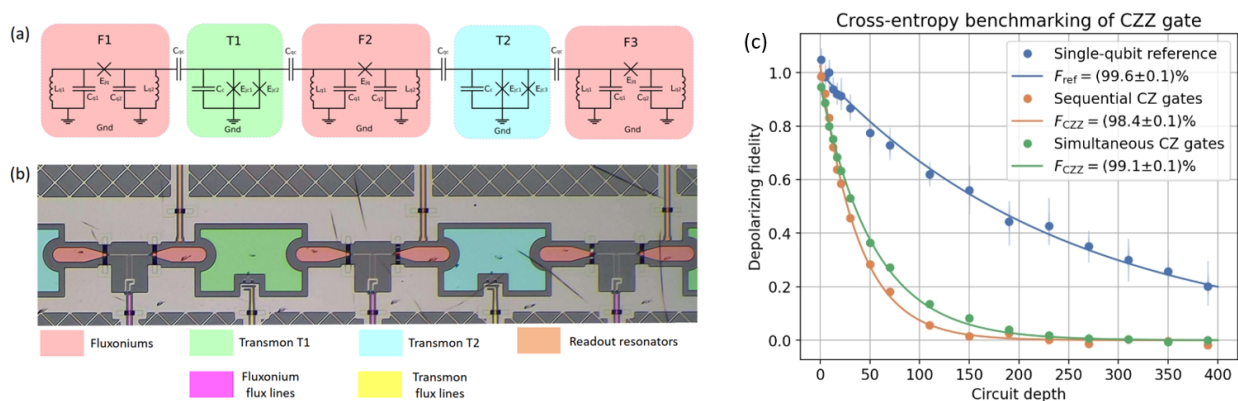


Fig. 1. (a) Equivalent electrical circuit of the three-qubit subarray used in the experiment. F1, F2, F3 are fluxonium computational qubits; T1, T2 are transmon coupler qubits. (b) False-colored optical micrograph of the quantum processor. (c) Results of cross-entropy benchmarking of the three-qubit CZZ gate constructed from sequential and simultaneous CZ operations.

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P-03 | 16 September 2026 · 16:30-18:00 · PS

Laser-induced modification of van der Waals materials: case of 1T'-MoS₂

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Keywords: 1T'-MoS₂; laser patterning; two-dimensional materials; topological insulator; nonlocal transport; Raman spectroscopy

In [1], laser patterning of 2H-MoS₂ crystals was proposed as a method for local formation of 1T'-phase regions. This phase demonstrated signatures of the quantum spin Hall effect at room temperature. However, the results of Ref.[1] were based mainly on local transport measurements, while detailed nonlocal transport studies and unambiguous identification of edge states were not performed.

The aim of the present work is to develop and apply a method for controlled laser modification of thin MoS₂ layers, enabling reproducible local formation of 1T'-phase regions and investigation of their transport properties. Particular attention is paid to possible manifestations of edge states and to assessing the applicability of this approach for locally tunable topological structures.

An experimental setup was designed and assembled using an evacuated optical cryostat chamber fabricated with 3D-printing techniques. A confocal optical scheme and motorized XYZ positioning enable laser scanning according to predefined patterns, removal and modification of material. Modification is indicated by a change in the optical contrast (Fig. 1). Raman spectroscopy and atomic force microscopy are used for structural verification.

After the fabrication of metallic contacts by photolithography, local and nonlocal transport measurements are performed. In the laser-patterned regions, the conductance increases substantially and its gate-voltage dependence changes strongly compared with the 2H phase, indicating structural changes. Nevertheless, our nonlocal measurements do not confirm formation of a two-dimensional topological-insulator phase. Our setup could be further used for the modification of other 2D materials and lithography (controllable material removal with micrometer resolution).

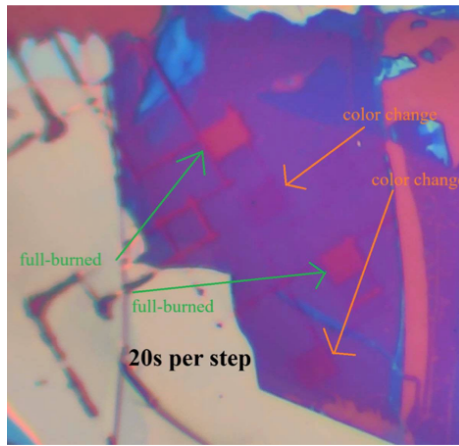


Fig. 1. Optical-microscope comparison of laser-irradiated regions (1T') and 2H regions of MoS₂ on SiO₂.

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P-04 | 16 September 2026 · 16:30-18:00 · PS

Silicon nitride integrated photonic platform: towards a balance between low loss and functionality

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Keywords: integrated photonics, silicon nitride, nonlinear optics

Integrated optics and photonics are currently developing at an explosive pace. One of the most mature and promising platforms in this field is silicon nitride [1,2]. Its key advantages — record-low material losses (below 0.1 dB/cm) and significant Kerr nonlinearity — open up broad opportunities for creating diverse devices for a myriad of applications [3-5]. However, the functionality of conventional purely silicon nitride photonic integrated circuits (PICs) remains limited due to the only available control mechanism — the slow thermo-optic effect. This issue calls for a comprehensive approach to overcome this barrier.

Here, we present the latest achievements of our project aimed at the comprehensive development of the silicon nitride platform, focusing both on improving the optical quality of waveguides and on enhancing PIC functionality. Key results include: a PECVD process for fabricating silicon nitride with losses as low as 0.03 dB/cm; highly efficient ScN/Nb/ScN heaters featuring 100 GA/m² critical current density and low thermal crosstalk; carbon nanowall-based detectors; local formation of ultralow confinement waveguides; precision fiber alignment structures for high-efficiency PIC coupling; an original Plasma Phononic Damascene Process enabling the formation of high-quality waveguides using optical lithography; and a novel four-component compound material enabling integration of high-speed active elements in silicon nitride PICs.

Acknowledgments. The study was supported by project No. 125020501540-9 of the Ministry of Education and Science of the Russian Federation. Fabrication and technology characterization were carried out at large scale facility complex for heterogeneous integration technologies and silicon+carbon nanotechnologies.

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P-05 | 16 September 2026 · 16:30-18:00 · PS

Current-driven vortex dynamics in two-band superconductors

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Keywords: Composite vortices; Molecular dynamics; Ginzburg–Landau; fractional vortices; Low-dissipation transport; Advanced functional materials

Multiband superconductors exhibit complex vortex dynamics due to the coexistence of multiple superconducting condensates and their electromagnetic coupling [1]. In this work, we investigate the interaction and dynamical behavior of distinguishable vortices in a two-band superconductor using a molecular dynamics approach. The vortex motion is described by coupled equations incorporating inter-vortex interactions mediated by magnetic screening and modified Bessel-function kernels [2,3]. Attention is devoted to the conditions under which vortices from different bands remain dynamically locked or become decoupled under an applied current. In addition, characteristic timescales associated with the superconducting condensate and electromagnetic relaxation are analyzed within the time-dependent Ginzburg–Landau framework. Our estimates indicate that the dissociation current strongly depends on the ratio between the Ginzburg–Landau characteristic time and the electromagnetic relaxation time and on the conductivity dependence of the viscosity coefficient. These features play a central role in determining whether dissociation occurs within the superconducting state.

Acknowledgments. This work was supported by the São Paulo Research Foundation (FAPESP), grants 2024/21788-0 and 2025/22669-7; Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES), Finance Code 001; the INCT project Advanced Quantum Materials, involving CNPq (Proc. 408766/2024-7), FAPESP (Proc. 2025/27091-3), and CAPES; and CNPq (grant 302786/2025-2).

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P-06 | 16 September 2026 · 16:30-18:00 · PS

Field-free superconducting diode effect in S/MTI/S hybrid structures

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Keywords: magnetic topological insulator, quantum anomalous Hall effect, superconducting diode effect, Josephson junction, Kwant

The superconducting diode effect (SDE) allows dissipationless supercurrent to flow in only one direction. It usually requires simultaneous breaking of time-reversal and spatial inversion symmetries [1]. Magnetic topological insulators (MTIs) in the quantum anomalous Hall (QAH) state inherently break time-reversal symmetry [2], making them a promising platform for a field-free SDE. We theoretically investigate Josephson transport in a superconductor/MTI/superconductor (S/MTI/S) hybrid structure and show that the junction geometry itself can produce the diode effect.

We use an effective four-band Bogoliubov–de Gennes (BdG) Hamiltonian on a discrete square lattice to model the proximitized QAH insulator. Superconducting regions are introduced through a local pairing potential Δ with a phase difference φ , simulating the proximity effect in an MTI/S bilayer. We construct the lattice using the Kwant tight-binding package [3] and calculate the Josephson current within the standard BdG formalism [4]. Two geometries are considered: a symmetric arrangement with superconductors attached to opposite edges (Fig. 1a), and an asymmetric arrangement with both superconductors on the same edge (Fig. 1b).

The spatial configuration strongly affects transport. The symmetric arrangement yields a reciprocal supercurrent, carried by a chiral edge state along equivalent paths in opposite directions. The asymmetric arrangement does not have this property. Its current–phase relation (Fig. 1c) yields unequal critical-current magnitudes in opposite directions, confirming a pronounced field-free SDE. We estimate the diode quality to quantify its efficiency. The results establish asymmetric S/MTI/S structures as a platform for studying field-free superconducting diodes.

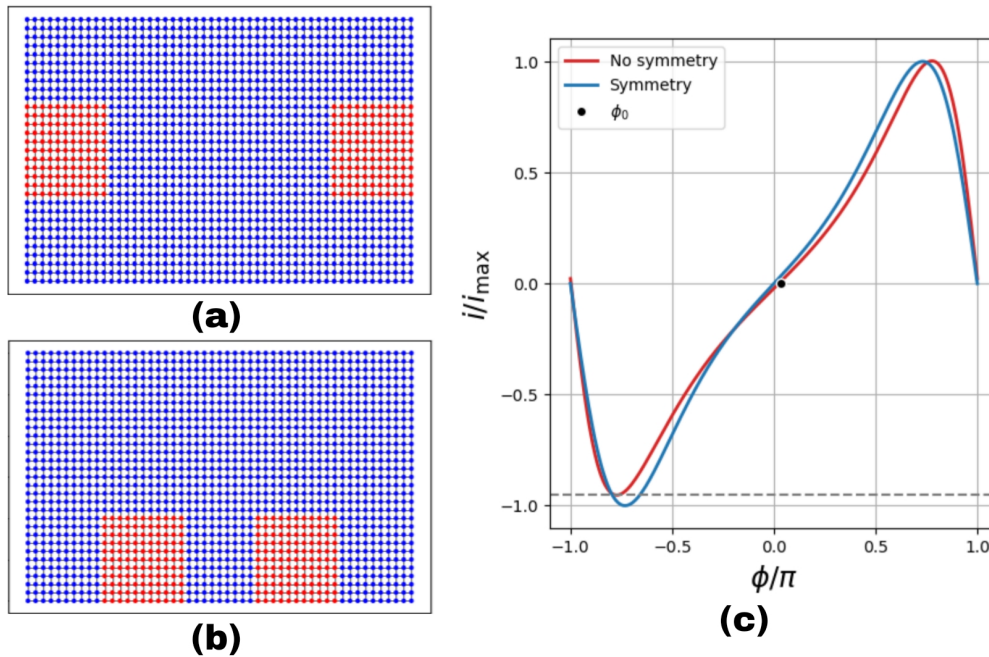


Fig. 1. Tight-binding lattice geometries for (a) symmetric and (b) asymmetric S/MTI/S configurations. (c) Normalized current–phase relations $I(\varphi)/I_{\max}$, where $I_{\max}$ is the maximum absolute current for each curve. The gray dashed line highlights unequal critical-current magnitudes in the asymmetric case.

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P-07 | 16 September 2026 · 16:30-18:00 · PS

Evolution of the electronic structure and topological surface states in In-doped MnBi_2Te_4

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Topological insulators are often considered systems with topologically protected edge states. The surface channels of three-dimensional topological insulators are protected from backscattering, but this protection applies only to impurities with a scalar scattering potential that preserves time-reversal symmetry (TRS). For TRS-breaking impurities, mass renormalization has been observed [1]. This effect is predicted theoretically and does not require global magnetic order.

We investigate the electronic and magnetic properties of In-doped MnBi_2Te_4 to explore its prospects for topological superconductivity. Single crystals with nominal compositions $\text{MnIn}_x\text{Bi}_{2-x}\text{Te}_4$ and varying In concentrations in the starting mixture were grown from high-purity Mn, Bi, In and Te using a two-

phase-source Bridgman method in a four-zone vertical furnace. The In solubility limit restricts its concentration in the crystals; In can substitute at both Mn and Bi sites. SQUID measurements reveal a reduction in the magnetic moment per Mn atom upon In doping.

The electronic structure was studied by angle-resolved photoelectron spectroscopy (ARPES) using He-I α radiation and a 6.3 eV laser source in the appropriate energy range. At the He-I α photon energy, In doping substantially modifies the electronic structure near the Fermi level. Rapid broadening of valence- and conduction-band states indicates increased electron scattering and is accompanied by an increase in the spectral bulk band gap. The total density of states in this energy range does not decrease: additional spectral weight appears within the gap, presumably associated with an In 5s resonant state.

Topological surface states (TSS) were studied by spin-resolved ARPES using the laser source. In pristine MnBi₂Te₄, the TSS show a helical spin texture with opposite spin polarizations at -k and +k. Even a small In concentration strongly modifies the TSS: the spin polarization decreases and a nonmagnetic gap opens at the Dirac point, persisting above and below the magnetic ordering temperature. With increasing In concentration, the spin polarization near k = 0 gradually vanishes. At higher concentrations, the Dirac-cone states disappear, possibly indicating a transition from a topological to a trivial insulator. However, determining the topological class in the presence of strong disorder remains challenging.

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P-08 | 16 September 2026 · 16:30-18:00 · PS

Features of the transmon spectrum at high cavity photon number in the straddling regime

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Dispersive readout infers a transmon state from the state-dependent resonator shift, $\chi = (\omega_r^{|e\rangle} - \omega_r^{|g\rangle})/2$. The straddling regime, $\omega_{fe} < \omega_r < \omega_{eg}$, enhances this shift [1] and suppresses unwanted ZZ interactions [2]. Although this regime is studied for two-qubit operations [3, 4], the response of a single transmon–resonator system to increasing readout power requires further investigation.

We combine cross-Kerr two-tone spectroscopy with numerical analysis of a transmon capacitively coupled to a $\lambda/4$ coplanar resonator (Fig. 1). The transmon is tuned by magnetic flux Φ . Calculated transition frequencies depend on the resonator population $\bar{n}_r$ and flux. The measured spectra show non-linear, nonmonotonic frequency shifts; in particular, ω_{eg} deviates from the linear ac-Stark prediction $\Delta_{\text{Stark}} = 2\chi\bar{n}_r$, with $\chi = -g^2E_C/[\Delta(\Delta + E_C)]$.

Photon-number splitting [5] is nearly uniform far from resonances, but decreases with increasing photon number near resonances [6] (Fig. 2). The anharmonicity, $\alpha = \omega_{fe} - \omega_{eg} = 2(\omega_{fg/2} - \omega_{eg})$, is also power dependent. Its magnitude governs leakage to noncomputational states [7]. Depending on the operating regime, the anharmonicity increases, decreases, or varies nonmonotonically with $\bar{n}_r$. Calculations in a Floquet-state representation [8] are used to exclude computational artifacts associated with state dressing at elevated photon populations (Fig. 3).

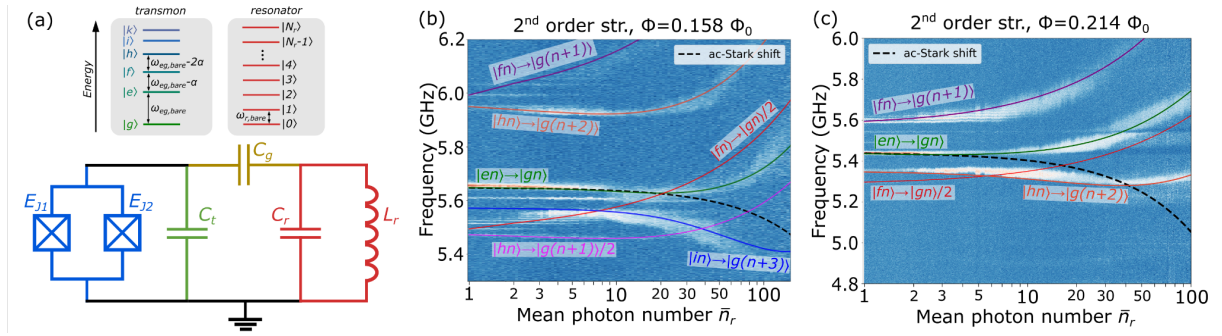


Fig. 1. (a) Transmon–resonator circuit; (b, c) transition spectra at different magnetic fluxes.

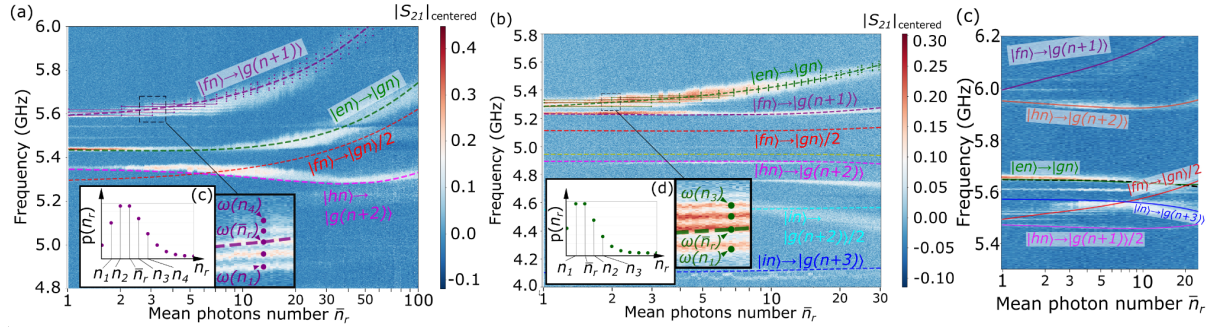


Fig. 2. Photon-number splitting: (a) the $f0-g1$ sideband; (b) the $e-g$ transition; (c) near the $f0-g1$ and $h0-g2$ sideband resonance.

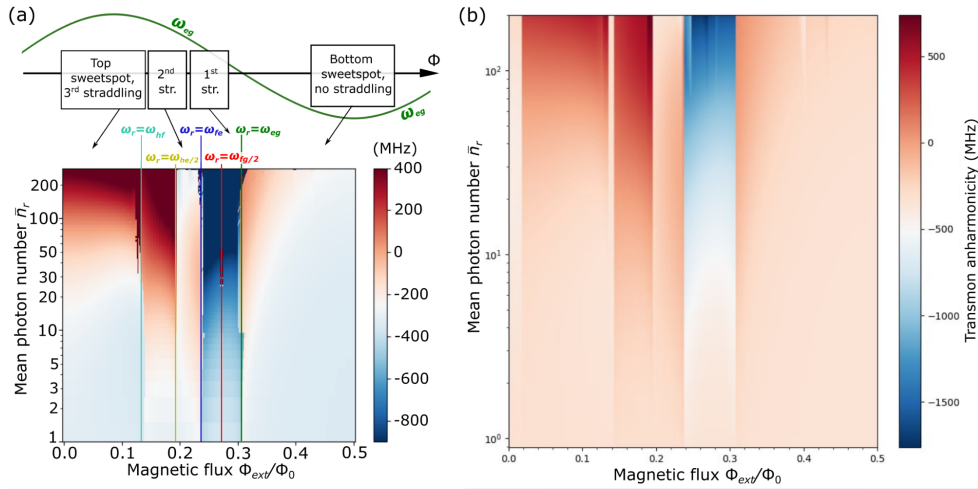


Fig. 3. Anharmonicity versus resonator population at different fluxes: (a) numerical calculations; (b) Floquet-state calculations [8].

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P-09 | 16 September 2026 · 16:30-18:00 · PS

Photogating conductivity of CVD graphene in the visible and near-infrared spectral ranges

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Photodetectors operating in the visible and near-infrared spectral ranges are key components of modern optoelectronic systems. Photodetection technologies based on Si, GaAs, or HgCdTe are fundamentally constrained either by the finite bandgap or by thermal noise limitations [1]. In contrast, graphene, owing to its gapless Dirac electronic spectrum, exhibits broadband optical absorption extending from the ultraviolet to the terahertz spectral range, making it a highly promising platform for broadband photodetection.

One of the main challenges in graphene-based photodetectors is the nonuniformity of graphene films and the poor reproducibility of small devices. The use of large-area CVD graphene films with a controlled number of layers improves the uniformity and stability of the photoresponse signal. Such multilayer graphene structures provide a broadband photoconductive response over large areas, which is important for applications.

We studied CVD-grown monolayer graphene transferred onto SiO₂/Si substrates with Cr/Au contacts. The distance between the contacts was 1 mm, while the channel width was 2 mm. A stepped structure containing regions of mono-, bi-, and trilayer graphene was formed on a single substrate by stacking individual graphene monolayers. This configuration made it possible to compare the photoresponse of graphene structures with different numbers of layers under identical experimental conditions.

The dependence of the photoconductivity amplitude on the number of graphene layers, incident optical power, and excitation wavelength was investigated. Monolayer graphene on a SiO₂/Si substrate demonstrates high photosensitivity in both the visible and near-infrared spectral ranges. For photon energies exceeding the bandgap of Si, the photoresponse power dependence measured using a dual-frequency modulation technique (Fig. 1) exhibits strongly nonlinear behavior. This nonlinearity indicates that photogating is the dominant photoresponse mechanism and qualitatively resembles the response of the human eye, where sensitivity decreases with increasing light intensity. At longer wavelengths, the intrinsic conductivity response of graphene becomes dominant.

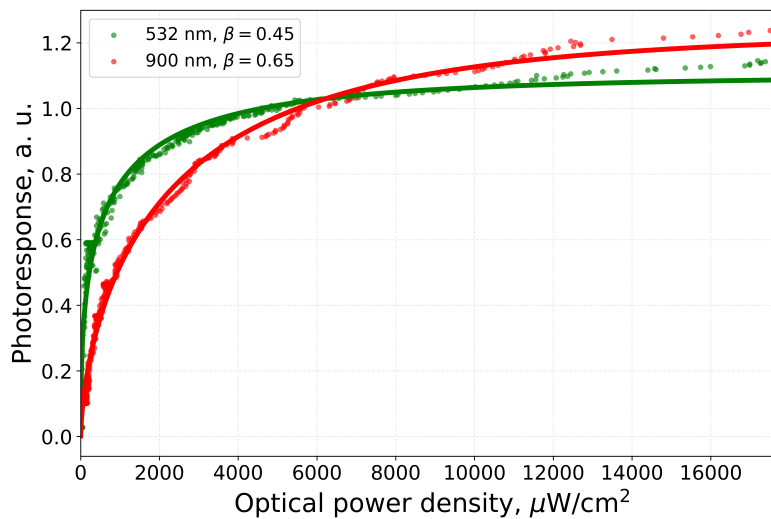


Fig. 1. Dependence of the photoresponse amplitude on the incident optical power density for excitation wavelengths of 532 and 900 nm using a laser beam with a diameter of 1 mm. Solid lines represent fits using a sublinear saturation model.

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P-10 | 16 September 2026 · 16:30-18:00 · PS

Hamiltonian formalism for nonreciprocal spin waves in multilayer magnetic structures

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Keywords: spin waves, nonreciprocity, multilayer structures, Hamiltonian formalism

The investigation of nonreciprocal spin waves in multilayer magnetic structures containing magnetic materials such as ferromagnets, antiferromagnets, and ferrimagnets is of fundamental and practical interest [1, 2]. Such magnon waveguides can be used, for example, to design logic devices, neuromorphic computing, and magnetic field detection. One of the key features of spin waves important for these devices is nonreciprocity, that is, the dependence of the amplitude and frequency on the direction of propagation. Recently [3, 4], a dynamic matrix method has been proposed that makes it possible to describe the spectra and profiles of spin waves in ferromagnetic multilayer structures. This method is based on dividing the studied structures into sublayers, for each of which the Landau–Lifshitz equation is written. Linearization and analysis of solutions of the obtained system of equations allows the description of the spectra and profiles of spin waves. Here we generalize such a method to account for

the magnetization dynamics in multisublattice magnetic materials. The application of the Hamiltonian formalism method made it possible to write dynamic equations with respect to the complex amplitude of the magnetization precession. Thus, a simpler form of the dynamic matrix is obtained. The derived Hamiltonian equations with respect to complex amplitudes have the following form

$$\frac{dc_n^\dagger}{dt} = (i\omega_{0n} - \Gamma_n)c_n^\dagger + \sum_{\substack{p=1 \\ p \neq n}}^N (\Pi_{pn^\dagger}c_p^\dagger + \Pi'_{pn^\dagger}c_p),$$

$$\frac{dc_n}{dt} = (-i\omega_{0n} - \Gamma_n)c_n + \sum_{\substack{p=1 \\ p \neq n}}^N (\Pi_{pn}c_p + \Pi'_{pn}c_p^\dagger).$$

where c_n is the complex amplitude for the n th magnetic moment; ω_{0n} – eigenfrequency; Γ_n – damping coefficient, which arises due to Gilbert damping; Π_{pn}, Π'_{pn} – interaction coefficients, which allow one to take into account nonuniform exchange, dipolar interaction and boundary conditions for magnetic layers. The eigenvalues of the obtained system of equations make it possible to describe nonreciprocal spin wave spectra in multilayer magnetic structures containing multisublattice magnetic materials.

Acknowledgments. This work was carried out within the framework of the state assignment of the Kotelnikov Institute of Radio-Engineering and Electronics of the Russian Academy of Sciences.

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Interaction of the resonant modes in the canted antiferromagnet/ferromagnet heterostructure

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Keywords: spintronics, magnonics, ferromagnetic resonance, hybridization

The interaction of the resonant modes in the exchange-coupled two-layer canted antiferromagnet/ferromagnet heterostructure has been theoretically investigated. Expressions describing the dependence of the resonant frequencies of magnetization oscillations on the external magnetic field have been obtained by the method of Hamiltonian formalism [1 – 4]. The effect of the coupling

strength between the ferro- and antiferromagnetic layers on the width of the anti-crossing gap between the resonant mode of ferromagnet and the soft mode of antiferromagnet and on the magnitude of the external magnetic field at which hybridization is observed has been investigated. It is shown that an increase in the antiferromagnet/ferromagnet exchange coupling constant leads to an increase in the width of the anti-crossing gap and the magnitude of the external magnetic field at which hybridization is observed.

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P-12 | 16 September 2026 · 16:30-18:00 · PS

Ferron-polaritons in superconductor/ferroelectric/superconductor heterostructures

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Keywords: superconductor/ferroelectric/superconductor heterostructure, ferron, Swihart photon, ferron-polariton, light–matter quasiparticle, ultrastrong coupling, terahertz photonics, quantum technology

We predict the formation of a ferron-polariton — a hybrid light–matter quasiparticle arising from the coupling between collective ferroelectric excitations (ferrons) and Swihart photons in a superconductor/ferroelectric/superconductor heterostructure [1]. The coupling provides direct evidence for ferrons and reaches the ultrastrong-coupling regime, with a spectral gap in the terahertz range, orders of magnitude larger than those in magnetic analogues, reflecting the superior strength of electric dipole interactions. Our work establishes superconductor-ferroelectric heterostructures as a novel platform for exploring extreme light–matter coupling and for developing high-speed, ferroelectric-based quantum technologies at terahertz frequencies.

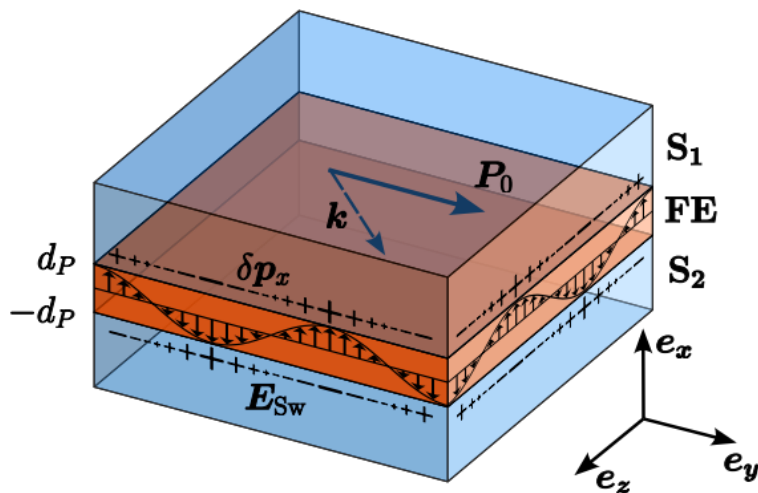


Fig. 1. Schematic of the S/FE/S heterostructure.

Acknowledgments. The work was supported by the Russian Science Foundation via the project No. 24-12-00152.

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P-13 | 16 September 2026 · 16:30-18:00 · PS

Applied quantum computing for modelling emergent information spaces: quantum-native frameworks for human-centric digital twins of post-cyber-physical systems

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Keywords: applied quantum computing, emergent information spaces, quantum-native digital twins, synergetic frameworks, human-centric post-cyber-physical systems, Landauer principle, quantum thermodynamics, quantum machine learning, quantum databases, quantum energy, time-symmetric modelling, functional quantum materials

We propose a quantum-native framework for modeling emergent information spaces and constructing human-centric digital twins of post-cyber-physical systems. Motivated by the relation between information and energy, Landauer's principle, and quantum thermodynamics [1], the framework treats the Hilbert spaces of hybrid quantum–classical models as computational environments for complex sociotechnical, socioeconomic, and industrial systems. Its complexity-theoretic interpretation concerns problem classes close to BQP [3].

NMR-based quantum circuits provide an experimentally accessible platform for low-dimensional optimization, sampling, and modeling, including Petz-like recovery maps [6]. Hardware-aware neural-impulse compilation, zero-noise extrapolation, and probabilistic error cancellation are incorporated. Quantum-machine-learning pipelines trained on economic and socioeconomic data [2] are interpreted in terms of an emergent information geometry. Proposed extensions address cognitive states, collective behavior, socionic typologies, and hybrid decision-making models for country-management scenarios.

The data architecture uses Quantum Column-Oriented Store (QCOS) and Quantum Row-Oriented Store (QROS) methods for encoding and searching relational tables in qubit registers [5]. QCOS maps tables to a universal QuadrupleTable with logarithmic qubit-count scaling; Grover-type search with an allowance threshold is followed by classical post-processing. The framework further combines quantum graph neural networks, graph-guided compression, approximate nearest-neighbor search, quantum-partitioned databases, a hybrid SQL engine, and QNodeOS-based scheduling. The submitted work reports small-scale computational prototypes on quantum processors, simulators, and cloud platforms, with industrial-scale deployment envisaged on future fault-tolerant hardware.

Energy-related scenarios include spintronic and magnonic information transport, optomagnonic logic, Dicke quantum batteries and collective charging effects, superconducting transmission, and bio-inspired “information batteries” [4]. Quantum optimization is considered for power grids and logistics; the source also discusses community detection on quantum annealers for instances of up to forty vertices.

The resulting multiscale description connects quantum materials and devices with industrial, macroeconomic, and cognitive-social models. Proposed time-symmetric digital twins reconstruct trajectories from prescribed final conditions through post-selected scenario analysis and may be integrated with large language models and agent-based systems. The framework links these computational aims to millisecond coherence times, high-fidelity operations, and possible topological protection in superconducting circuits and topological-insulator/superconductor heterostructures. It is presented as a conceptual bridge between functional quantum materials, computational architectures, and human-centric digital twins.

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Gate-controlled dynamics of a Josephson junction with anomalous phase shift

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Superconductor/ferromagnet/superconductor (S/F/S) Josephson junctions (JJs) exhibiting an anomalous ground-state phase shift $\varphi_0 \neq 0, \pi$ —referred to as φ_0 -S/F/S JJs—establish a direct coupling between the superconducting phase and the magnetization of the ferromagnetic interlayer. This property makes them promising candidates for superconducting memory and logic circuits. In this work, we demonstrate that both the current–phase relationship (CPR) and the anomalous phase shift φ_0 can be tuned by applying a gate voltage. As the junction’s interlayer, we consider an ultrathin film of the intermetallic lanthanide-based compound GdIr_2Si_2 . Based on the results of the density functional theory (DFT), we construct an effective tight-binding Hamiltonian (TBH) that shows high quantitative agreement with the DFT-derived electronic properties. This TBH is employed to compute the CPR within the Bogoliubov–de Gennes framework. The calculated CPRs reveal a pronounced sensitivity of φ_0 to the applied gate voltage. Furthermore, the dynamics of the magnetic subsystem also respond to the gate voltage, opening new avenues for controlling such φ_0 -JJs.

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Observation of topological vortex solitons on disclinations

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Keywords: topological photonics, vortex solitons, higher-order topological insulators, disclination lattice, laser-written waveguides

Topological photonic systems support robust localized states governed by lattice geometry and topology. Inspired by topological insulators [1], engineered photonic lattices have enabled the observation of protected boundary and defect states. In higher-order topological insulators, localized modes may

occur at edges, corners and crystallographic defects such as disclinations, where rotational symmetry is modified [2]. Strong spatial confinement makes these defect states promising for nonlinear photonics and self-localized states.

We experimentally demonstrate stable topological vortex solitons localized at disclination defects in photonic higher-order topological insulators. Femtosecond-laser-written waveguide arrays in fused silica provide controlled coupling, symmetry and nonlinear response [3]. The arrays contain a fivefold disclination core. A spatial light modulator shaped a picosecond Ti:sapphire laser beam to control the amplitude and phase at the central waveguides. Output intensities were recorded at the exit facet, and the phase was reconstructed by off-axis digital holography in a Mach–Zehnder interferometer.

Fork-type dislocations in the interference patterns confirm phase singularities with topological charge $m = +1$ (Fig. 1). At low input power, a vortex state is localized at the disclination core by the underlying topological defect mode. With increasing power, the field evolves into a strongly localized nonlinear state while preserving the global vortex charge. Localization remains stable; reversing the phase winding produces opposite-charge vortices with similar confinement. These observations confirm topological vortex solitons supported by orbital angular momentum, nonlinear self-action, lattice geometry and topological protection.

The demonstrated thresholdless localization at a disclination core opens a route to nonlinear control of topological defect states and establishes a platform for studying nonlinear topological states with nontrivial phase structure.

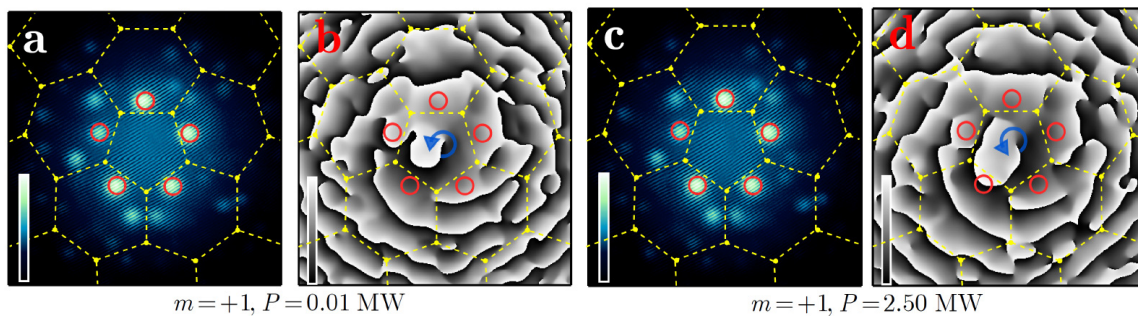


Fig. 1. Single-shot interference patterns, normalized intensity and retrieved phase distributions for vortex states with topological charge $m = +1$ at low input power $P = 0.01$ MW and high input power $P = 2.50$ MW.

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Control of temperature dependence of coercive force in multi-layer epitaxial films $\text{Pd}_{96-x}\text{Fe}_4\text{Co}_x$

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Keywords: ferromagnetic thin films, temperature dependence of coercivity, Pd–Fe–Co alloys, molecular beam epitaxy (MBE), magnetic hysteresis loops, coercive force

Ferromagnetic thin films, including gradient structures and systems with variable compositions, are being actively investigated in connection with the possibility of controlling their magnetic properties, in particular, the coercive force H_C and its temperature dependence $H_C(T)$ [1].

In the classical case of homogeneous ferromagnets, the coercive force typically decreases with increasing temperature. However, in gradient and compositionally inhomogeneous films, the behavior of $H_C(T)$ can deviate significantly from the classical one [1].

For example, in epitaxial Co–Ru films with a given Ru concentration profile, the temperature dependence of the coercive force can change substantially [2,3]. In a specific temperature range, the coercive force may remain nearly constant, enabling the design of magnetic structures with tailored temperature stability of their properties.

In this paper, we study a series of single-layer and multilayer epitaxial ferromagnetic thin films based on a Pd–Fe alloy with a fixed iron content (4 at. %) and a variable concentration of cobalt. The Co concentration varies in the range $x=0-4$ at. %, while the palladium content decreases from 96 to 92 at. %, which corresponds to the composition of $\text{Pd}_{96-x}\text{Fe}_4\text{Co}_x$.

The samples were grown by molecular beam epitaxy in an ultrahigh vacuum "SPECS" system on crystalline magnesium oxide (MgO) substrates. The growth process and surface quality were monitored in real time using low-energy electron diffraction (LEED). The final film thickness was controlled using a Bruker DektakXT stylus profilometer. The composition and its distribution were analyzed using an ultrahigh vacuum analytical module equipped with X-ray photoelectron spectroscopy. Magnetic and magnetotransport properties were measured using a Quantum Design PPMS-9 system in the temperature range of 5–400 K. This allows us to determine the nature of the magnetization reversal process and to assess the contributions of domain wall nucleation and pinning mechanisms to the formation of the coercive force.

The results obtained can be used in the development of multilayer and composite magnetic structures with a given temperature dependence of the coercive force. Varying the alloy composition and forming complex profiles make it possible to stabilize the coercive force over a wide temperature range or to realize its nonmonotonic behavior, including growth in a given temperature range.

Acknowledgments. This work was supported by the RFBR Grant No. 25-22-00705.

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Resonance fluorescence in a coupled resonator-TLS system

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Keywords: resonance fluorescence, quantum optics, superconducting qubits

The research focuses on the resonance fluorescence spectrum of a two-level system (TLS) coupled to a driven resonator. The experiments were conducted using a platform of superconducting artificial atoms and supported by computer modeling. Both experimental and theoretical approaches revealed an intriguing behavior of the system when the amplitude of the driving field is equal to half of the TLS-resonator coupling constant [1]. At this critical point, the spectral characteristics of the scattered light undergo a transition from a root-form multiplet structure, which matches the energy level structure predicted in [1], to a triplet structure predicted in [2]. The state of the field in the resonator also experiences a strong change, resulting in a modification of the level population picture. A theoretical approach is proposed that explains the origin of this transition and allows for approximate calculation of the spectral line positions.

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The effect of chargeable defects at interfaces on the functional properties of M/HZO/M (M=TiN, W) ferroelectric memory capacitors

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Keywords: functional materials, ferroelectrics, ferroelectric memory device, interfacial defects, device reliability

Increasing demands for mass data storage and emerging computing paradigms are driving the need for energy-efficient, fast, nonvolatile memory devices. Ferroelectric $\text{Hf}_{0.5}\text{Zr}_{0.5}\text{O}_2$ (HZO) is a leading candidate owing to its excellent CMOS compatibility [1]. In this work, we correlate the switching-pulse-amplitude dependence of reliability data for TiN/HZO/TiN and W/HZO/W memory capacitors with the energy distribution of chargeable defects, presumably oxygen vacancies, in HZO band gap, measured via the Step-Recovery with Multi-Pulse Test (SRMPT) technique [2]. We further utilize SRMPT-derived information on the energy landscape of defects to perform consistent calculations of the evolution of the defects spatial distribution as well as the associated internal electric fields across the ferroelectric HZO layer under applied voltage pulses. By aligning experimental data with time-dependent charged defects dynamics and local electric fields, we establish the link between the interface defects fingerprint and reliability outcome of the ferroelectric capacitors, which are the functional basis of FRAM.

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Simple rescaling of observables due to depolarizing noise in digital quantum simulation

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Keywords: quantum simulation, Trotterization, noisy quantum computing

Quantum simulation of unitary dynamics is one of the most promising applications of quantum computing, since the classical description of many-body quantum systems generally requires resources that grow exponentially with system size. In digital simulation, the evolution operator is decomposed

into elementary quantum gates through Trotterization, enabling the study of broad classes of quantum systems and nonequilibrium phenomena.

The applicability of Trotter-based simulation is limited by noise: deep circuits lead to a growing average number of errors. The key question is whether noisy algorithm outcomes retain useful information about exact unitary dynamics. This issue is especially important because many algorithms are highly sensitive to unitary and depolarizing errors [1,2]. A natural framework for this analysis is an effective global noise channel connecting the ideal quantum channel to its noisy implementation [3]. While global depolarizing behavior is well understood for random quantum circuits [4], such channels have not been studied in Trotterized circuits.

We address this problem by analyzing local depolarizing errors in deep Trotter circuits in the strong-noise regime, where the average number of errors is large but the Trotterization error remains small. Two regimes of internal simulation time are identified, with the transition between them governed by the Loschmidt echo. At large internal times, the global action of depolarizing noise on observables reduces approximately to an effective rescaling or, more generally, a simple linear transformation. This transformation becomes independent of internal simulation time and is determined only by the noise level.

Thus, severely noisy digital simulation preserves some information about exact unitary dynamics. The emerging noise model supports simple error-mitigation strategies, including multiexponential global-folding zero-noise extrapolation [5]. We also establish a correspondence with Markovian open-system dynamics: local circuit-level depolarization can induce a global Markovian description of noisy simulated evolution. These results clarify the applicability of digital quantum simulation under realistic noisy conditions.

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Switchable SNS contacts based on charge density wave material 1T-TaS₂

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Keywords: tantalum disulfide, charge density wave, electrical switching, Andreev reflection

The 1T polytype of tantalum disulfide is a transition metal dichalcogenide with a rich phase diagram that includes charge-density-wave (CDW) states up to room temperature [1]. Beyond the charge density wave, TaS₂ can be driven into a so-called hidden state by an electrical [2] or optical pulse. The hidden

state is a mosaic of CDW regions separated by a network of highly conductive domain walls. This state is metastable and persists at low temperatures (up to about 70 K) for extended periods. Warming restores the original charge-density-wave state. We examined a superconductor – TaS₂ – superconductor junction, where the superconductor was amorphous rhenium with elevated critical temperature (5 K vs. 1.7 K in bulk crystals) and high critical fields [3]. TaS₂ flakes were placed onto Re contacts using a dry hot-transfer technique.

Differential resistance was measured on several identical samples as a function of temperature, magnetic field, and the degree of switching. Switching was performed with 2- μ s electrical pulses. We could apply several pulses before heating (relaxation to initial CDW state). The fully switched sample no longer changed its resistance after additional pulses.

In the unswitched state the differential resistance exhibits a large peak at zero bias. Upon switching this peak shrinks significantly in amplitude, nearly vanishing in the fully switched sample. We attribute the effect to a change in the Andreev-reflection channel from the partially gapped charge-density-wave state to quasi-metallic conductive channels along the domain walls in the hidden state.

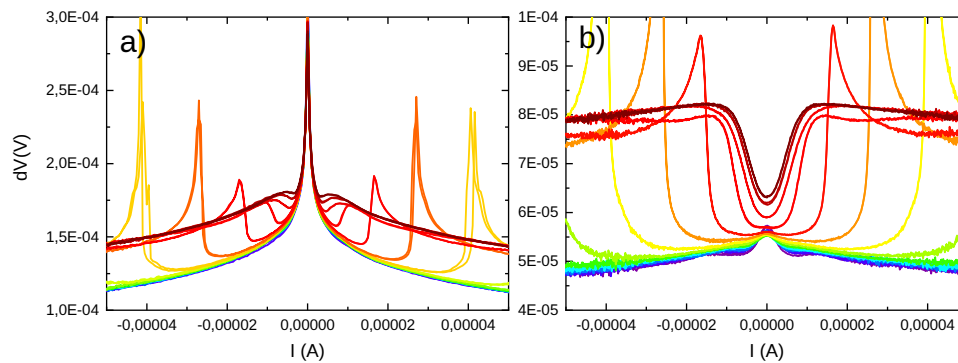


Fig. 1. Differential voltage of the sample before and after switching at different magnetic fields: (a) initial state, (b) after switching to the hidden state. Color intensity increases with magnetic field; the blue line represents zero field and the saturated red line corresponds to 3 T.

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Low-confinement silicon nitride waveguides manufactured via direct glass bonding

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Keywords: bonding, planar technology, integrated photonics, silicon nitride, low confinement, fiber-to-chip coupling

Reduction in fabrication cost of photonic integrated circuits, together with low optical losses and process simplicity, is essential for their large-scale adoption. In standard fabrication approaches, the dielectric cladding surrounding waveguides is typically limited to about $20\ \mu\text{m}$ [1], which makes it difficult to suppress radiation losses and parasitic scattering. Here, we introduce and experimentally validate an alternative technique for creating low-confinement waveguides in Borofloat 33 glass, based on thermal fusion bonding of two glass wafers. The fabrication process is as follows: nanoscale trenches are etched into the glass, filled with silicon nitride, excess material is removed, and the wafers are bonded, yielding high-quality interfaces and a thick, symmetric dielectric cladding. As a proof of concept, straight waveguides were fabricated with a core height of 50 nm and widths ranging from 1.3 to $3.5\ \mu\text{m}$. Using butt coupling to a standard SMF-28 single-mode fiber at 1550 nm, transmission reached up to 60%, corresponding to coupling losses of about 1 dB per facet, in agreement with numerical predictions.

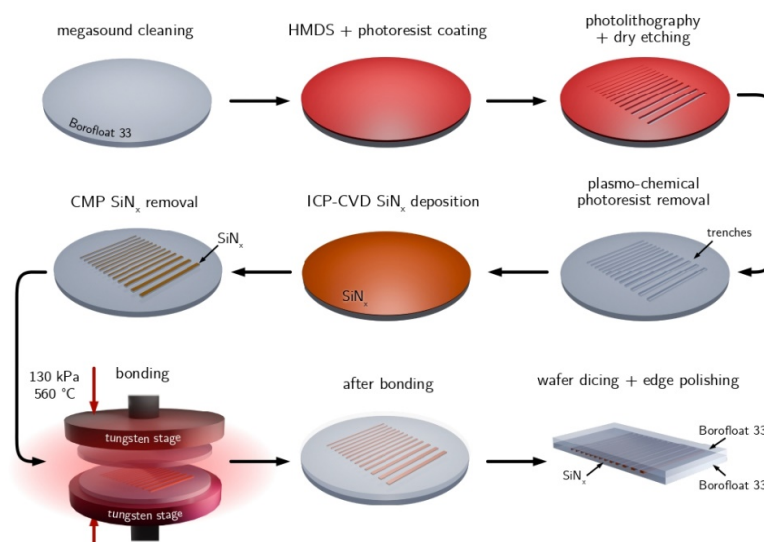


Fig. 1. Fabrication low-confinement waveguide

Acknowledgments. The study was supported by project No. 125020501540-9 of the Ministry of Education and Science of the Russian Federation. Fabrication and technology characterization were carried out at large scale facility complex for heterogeneous integration technologies and silicon+carbon nanotechnologies.

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Temperature dependence of ferromagnetic resonance parameters in yttrium iron garnet in the millikelvin range

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Keywords: yttrium iron garnet (YIG), ferromagnetic resonance (FMR), hybrid quantum systems

In this work, two configurations of YIG samples were compared: a disk grown on substrates of gadolinium gallium garnet ($\text{Gd}_3\text{Ga}_5\text{O}_{12}$) and yttrium–scandium gallium garnet ($\text{Y}_3\text{Sc}_2\text{Ga}_5\text{O}_{12}$) [1], and a sphere made from bulk single-crystal YIG (free from substrate influence). FMR spectra were measured in a BlueFors dilution refrigerator over a temperature range from 16 mK to 9 K and in external magnetic fields from 3 to 5 T. Microwave measurements were performed using vector network analysis techniques. The resonance curves were analyzed using a model based on the Landau–Lifshitz–Gilbert (LLG) equation. Numerical modeling of the frequency dependence of the resonance field and FMR linewidth was carried out. The Gilbert damping parameter α was extracted by fitting the experimental data using solutions of the LLG equation [2].

For the disk, with an optimized substrate, a result comparable to that of a bulk single crystal is achieved. Such values of the damping parameter can provide sufficiently long coherence times for quantum systems. The nonlinear behavior observed for the disk is likely associated with the presence of a paramagnetic substrate.

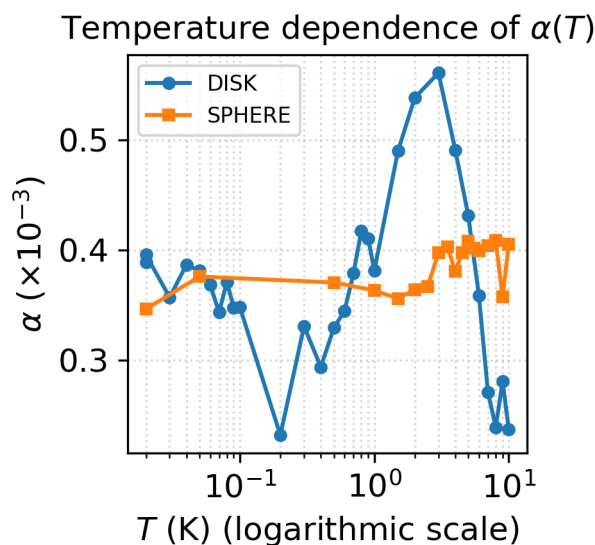


Fig. 1. Temperature dependence of the Gilbert damping parameter α for the disk and sphere

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Distribution of spin-polarized current induced torque for skyrmion oscillators

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Keywords: skyrmion, spin-transfer oscillator, nonlinear dynamics, spin-polarized current

Spin-transfer nano-oscillators (STNO) are nanoscale devices and promising sources of microwave signals. Of particular interest are STNOs whose free layer hosts stable vortex-like magnetization configurations, known as magnetic skyrmions [1, 2]. In such devices, oscillations can be excited due to the passage of a spin-polarized current. Here, we study the spatial dependence of the spin-transfer force driving skyrmion dynamics in a nanocylinder. As a magnetic skyrmion approaches the boundary of the structure, its profile becomes deformed, and, as shown in [3], this significantly affects the excited dynamics. Therefore, in the magnetization distribution $\mathbf{m}(\mathbf{r}, \mathbf{R})$, it is necessary to take into account not only the presence of the skyrmion but also the inhomogeneities at the boundary. To describe the dynamics under such coordinate-dependent magnetization, one should use the generalized Thiele equation

$$\mathbf{G}(\mathbf{R}) \times \frac{d\mathbf{R}}{dt} + \alpha \widehat{D}(\mathbf{R}) \frac{d\mathbf{R}}{dt} + \mathbf{F}(\mathbf{R}) + \mathbf{F}_{STT}(\mathbf{R}) = 0,$$

where $\mathbf{R}$ is the displacement of the skyrmion center relative to the center of the cylindrical free layer, $\widehat{D}$ is the damping tensor, $\mathbf{G}$ is the gyrovector, $\mathbf{F}$ is the potential force, and $\mathbf{F}_{STT}$ is the torque induced by the spin-polarized current. A situation is often considered [1] in which the fixed layer adjacent to the free layer is smaller in size. In this case, a linear approximation is used for CPP torque. However, using the developed theory we show that this approximation holds only for a certain range of guiding center displacements (Fig. 1).

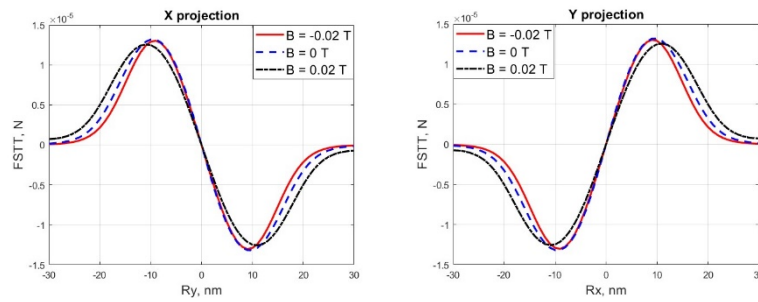


Fig. 1. Dependence of the spin-transfer torque components on the position of the skyrmion center for various external fields.

Acknowledgments. This work was carried out within the framework of the state assignment of the Kotelnikov Institute of Radio-Engineering and Electronics of the Russian Academy of Sciences.

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P-24 | 16 September 2026 · 16:30-18:00 · PS

Generation of second-harmonic response of superconducting films irradiated by structured light

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Keywords: TDGL, structured light, Laguerre–Gaussian beam, SHG

We develop a phenomenological theory of second-harmonic generation in superconductors driven by structured light [1,2]. Within the time-dependent Ginzburg–Landau framework, the nonlinear source at 2ω originates from the coupling between the order-parameter amplitude modulation and the induced superfluid velocity. For Laguerre–Gaussian beams, the emitted second-harmonic field inherits characteristic features of the pump spatial structure and orbital angular momentum, making far-field radiation a direct probe of photoinduced superconducting currents. In thin films, the signal is strongly enhanced by the increase of Meissner screening current density across the film thickness.

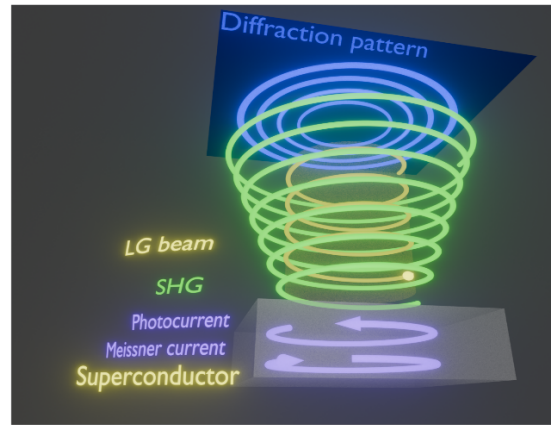


Fig. 1. Possible experimental setup: second-harmonic generation driven by a Laguerre–Gaussian beam.

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P-25 | 16 September 2026 · 16:30–18:00 · PS

Proximity-induced orbital antiferromagnetism in Ising superconductors

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Keywords: superconducting heterostructures, proximity effect, van der Waals materials

The interplay between superconductivity and magnetism gives rise to exotic superconducting states, most notably the conversion of singlet Cooper pairs into odd-frequency triplets in superconductor/ferromagnet (S/F) heterostructures. Remarkably, similar triplet correlations also emerge in compensated antiferromagnets with zero net magnetization, leading to Néel triplet Cooper pairs that alternate in sign with the underlying magnetic sublattice. While these nontrivial correlations suppress the singlet order parameter, they do not fundamentally alter its structure. In contrast, under specific conditions, a macroscopic exchange field can induce a qualitative reconstruction of the superconducting order parameter, such as the Fulde–Ferrell–Larkin–Ovchinnikov (FFLO) state or the helical state. However, no such inhomogeneous superconducting state has been reported to date in compensated antiferromagnets. In this work, we predict a fundamentally new superconducting state in superconductor/antiferromagnet (S/AF) heterostructures with Ising-type spin–orbit coupling. In this state, the phase of the superconducting order parameter acquires a modulation dictated by the lattice periodicity, accompanied by atomic-scale loop currents that induce opposite magnetic moments on neighboring unit cells—a phenomenon we term proximity-induced orbital antiferromagnetism. Using analytical arguments, we show that the emergence of this phase inhomogeneity requires at least three non-equivalent atoms per unit cell and the presence of spin–orbit coupling. As a concrete example, we consider a heterostructure composed of a superconducting NbSe₂ monolayer and an antiferromagnetic MnPS₃ monolayer. Combining first-principles electronic structure calculations with

the Bogoliubov–de Gennes method, we quantify the phase modulation and the resulting spontaneous loop currents. We further propose a detection scheme based on a characteristic feature in the density of states accessible by scanning tunneling microscopy. This state fundamentally differs from the FFLO and helical states: the phase gradient varies on the atomic scale, the state carries a finite current, and it remains uniquely stable over the entire investigated range of temperatures and exchange fields. Moreover, unlike previously studied orbital antiferromagnetism in correlated systems, the atomic-scale loop currents in our case exist only in the superconducting state and are carried by Cooper pairs. Our findings open a new avenue for superconducting spintronics with antiferromagnets, enabling nanoscale control of unconventional superconductivity without stray fields.

Acknowledgments. The work was supported by the Russian Science Foundation via the project No. 24-12-00152.

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Comparative Study of Morphological and Superconducting Properties of Granular Niobium Films

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Keywords: superconductivity, granular niobium films, vortex core, scanning tunneling spectroscopy

In clean, homogeneous type-II superconductors, a vortex line has a well-known spatial structure: the superconducting gap $\Delta(r)$ vanishes at the vortex core and increases monotonically with distance, reaching its equilibrium value Δ_0 outside the core on length scales exceeding the coherence length ξ [1–3]. In granular superconducting samples, where the grain size (3–10 nm) is comparable to the effective coherence length, the spatial evolution of the gap inside a vortex can be significantly modified due to the influence of intergranular boundaries. Investigating this effect is the main objective of the present study.

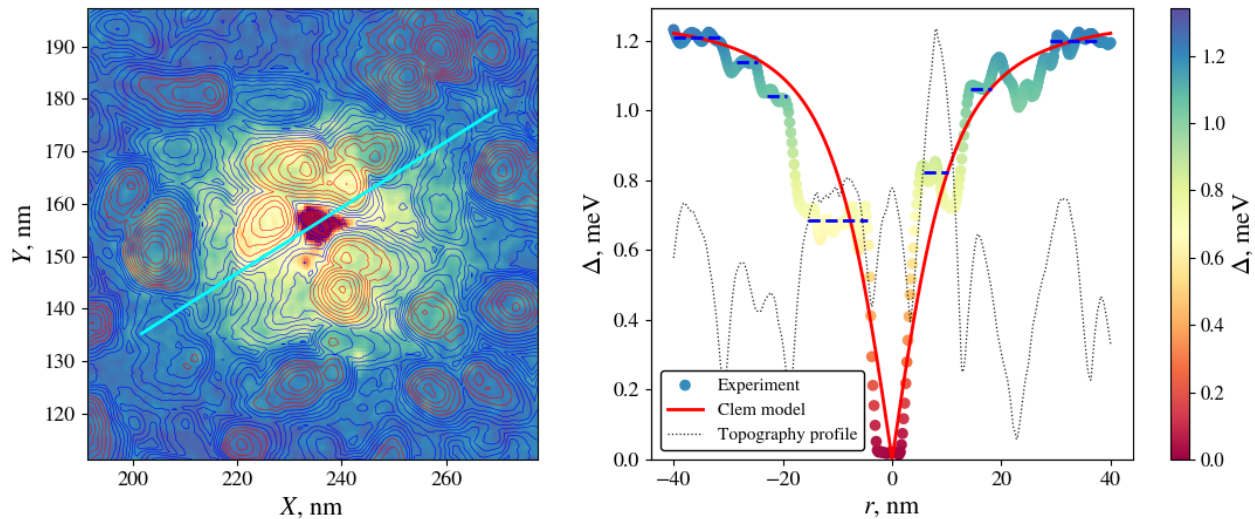


Fig. 1. Left: a spatial map of the superconducting gap $\Delta(x, y)$ for the core of a single-quantum vortex. Right: the gap profile $\Delta(r)$ taken along a line passing through the vortex center. The black dashed line shows the surface topography profile along the same direction.

Figure 1 shows a map of the superconducting gap distribution for a single-quantum vortex, extracted from scanning tunneling spectroscopy data and the profile $\Delta(r)$ taken along a line passing through the vortex center. For comparison with the sample morphology, surface topography profiles are also plotted along the same directions. We show that the increase of the superconducting gap with distance from the vortex center occurs in a step-like manner: within individual grains, Δ remains nearly constant, whereas abrupt changes are observed when crossing intergranular boundaries. Thus, the spatial structure of vortex cores in a granular niobium film strongly depends on the local granular structure of the sample. The results of this study are presented in Ref. [4].

Further work will involve numerical modeling of vortex core structure within the framework of the Bogoliubov–de Gennes equations for model inhomogeneous superconducting systems. The main objective is to identify the effect of spatial inhomogeneity on the distribution of the order parameter and the local density of states near a vortex. Particular attention will be paid to analyzing modifications of the spectrum of bound states in the vortex core [2] and to comparing the modeling results with experimentally observed features of the spatial evolution of the superconducting gap in granular films.

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Analytical theory of quantum wave mixing in cascaded superconducting qubits system

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Keywords: qubit, photon, quantum optics

A cascaded system of two-level superconducting artificial atoms - a source and a probe - is an attractive platform for studying non-classical effects in quantum optics. Quantum wave mixing (QWM) [1] appears to be a promising tool for investigating such effects.

In the present work, we develop analytical and fully controllable theoretical approaches to describe a cascaded system, which are applicable in two opposite limits. The first one is a regime of strong drive applied to the source qubit, while the second one is the regime of the weak drive.

In particular, it is shown that, depending on the strength of the coherent drive on the source and the ratio of the spectral widths of the source and the probe, QWM can exhibit both bunching and antibunching. Thus, the QWM spectrum of light emitted by the strongly driven source and the coherent signal on the probe has the same form as the spectrum in the case of mixing squeezed light at the output of a degenerate parametric amplifier (DPA) with a coherent signal [2], which indicates the presence of correlated photon pairs or squeezed light in the emission of a strongly driven two-level system.

When the source is driven weakly, the spectrum changes. Two opposite limits appear, depending on the ratio of the spectral widths of the qubits. When the spectral width of the probe is much larger than that of the source, the QWM spectrum indicates antibunching. In the opposite case, the QWM spectrum is the same as the spectrum of the mixing of two coherent signals.

Both cases show that QWM spectra can be used to analyze photon statistics of incident field, which is of particular importance in microwave domain.

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Low-temperature quantum effects in SrIrO_3

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Keywords: iridate, thin film, semimetal, anomalous Hall effect, spin-orbital interaction

Strontium iridate SrIrO_3 is a correlated 5d perovskite oxide in which strong spin-orbit coupling and electronic correlations cooperate to produce a non-trivial Berry curvature landscape near band-crossing points. This makes SrIrO_3 a promising platform for studying intrinsic quantum transport phenomena, including magnetoresistance (MR) and the anomalous Hall effect (AHE), as well as for spin-current generation in oxide heterostructures [1]. This work is aimed to introduce a range of quantum effects observed in SrIrO_3 nano-scale thin films ($d=35$ nm). In low temperature range 2–20 K anomalous Hall effect and weak antilocalization [2] — arising from strong SOC appear.

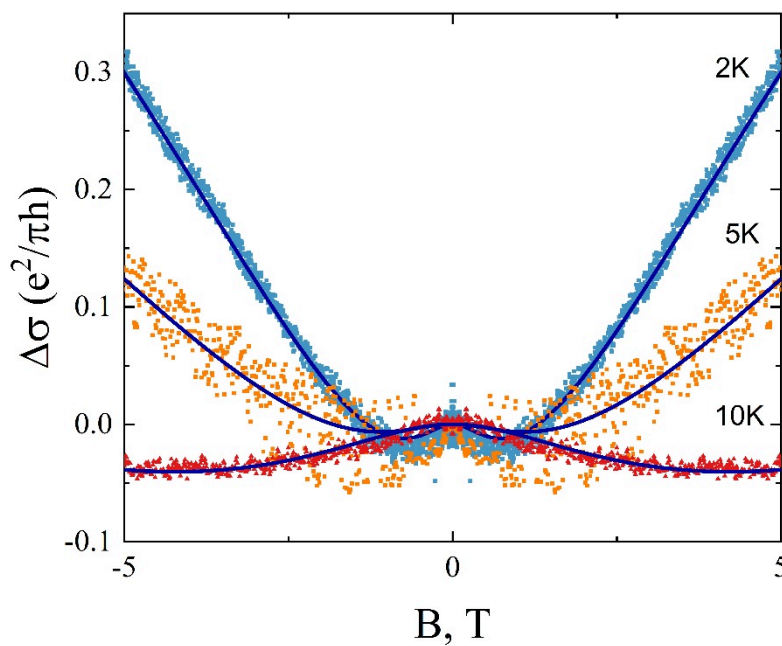


Fig. 1. SrIrO_3 thin film magnetoconductance with Maekawa-Fukuyama quantum correction model approximation.

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Two-dimensional control of superconducting kinemon qubits for high-fidelity two-qubit gates

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Keywords: superconducting quantum computing, kinetic inductance, transmon qubit

Superconducting quantum processors are one of the most promising platforms for quantum computing [1]. The core element of such processors is superconducting artificial atom. The most popular implementation of superconducting artificial atom is the transmon qubit, which consists of a dc-SQUID with large shunt capacitance [2]. Transmon qubits exhibit frequency tunability, which allows for implementation of fast quantum gates [3] and frequency crowding mitigation [4]. However, frequency tunability also makes such qubits sensitive to low-frequency flux noise away from a limited set of points called sweet spots [2].

In our work, we show that the set of sweet spots available in transmon qubits requires some qubits to be biased away from sweet spots during a two-qubit gate in a large scale fixed-frequency superconducting quantum processor, leading to gate fidelity decrease. We propose to replace transmons with kinemon qubits [5] to solve this problem. We show that the presence of the inductive shunt and an additional superconducting loop yields a different set of sweet spots in two-dimensional control flux space for the kinemon qubit. Therefore, we propose a control scheme that utilizes sweet spots of the kinemon qubit to implement high-fidelity iSWAP gates in a kinemon architecture. We show that the proposed scheme utilizes fewer control lines than transmon architecture modifications, such as tunable coupling architectures [6], while allowing for implementation of high-fidelity gates.

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Investigation of the Spin Dynamics Properties of the Magnetic Topological Insulator MnSb_2Te_4

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Keywords: ferromagnetic resonance, magnetic topological insulator, magnetocrystalline anisotropy

Magnetic topological insulators (MTIs), such as MnSb_2Te_4 (MST), represent a promising class of materials that combine magnetic ordering with topological electronic band structures [1], offering a platform for exotic quantum phenomena like the quantum anomalous Hall effect and holding potential for spintronic and quantum computing applications. However, their magnetic properties remain insufficiently understood.

In this work, we employed ferromagnetic resonance (FMR) spectroscopy to investigate the magnetic characteristics of MST single crystals grown by a modified Bridgman method. The temperature dependence of the effective anisotropy fields was measured and found to be in excellent agreement with theoretical curves based on the classical single ion approximation [2]. At the same time, analysis of the resonance linewidth as a function of both frequency and temperature revealed that the Gilbert damping [3] described by the standard Landau–Lifshitz–Gilbert equation is not the dominant mechanism of the line broadening in MST.

Our results not only establish the fundamental magnetic parameters of MST but also highlight the critical role of atomic substitutions on magnetic parameters of the MTI. Overall, a detailed investigation of the magnetic properties of MST was conducted using FMR spectroscopy. It was shown that the broadening of the ferromagnetic resonance line is not well captured by the Landau–Lifshitz–Gilbert equation, while the theoretical temperature dependence of the anisotropy fields agrees well with the experimental results.

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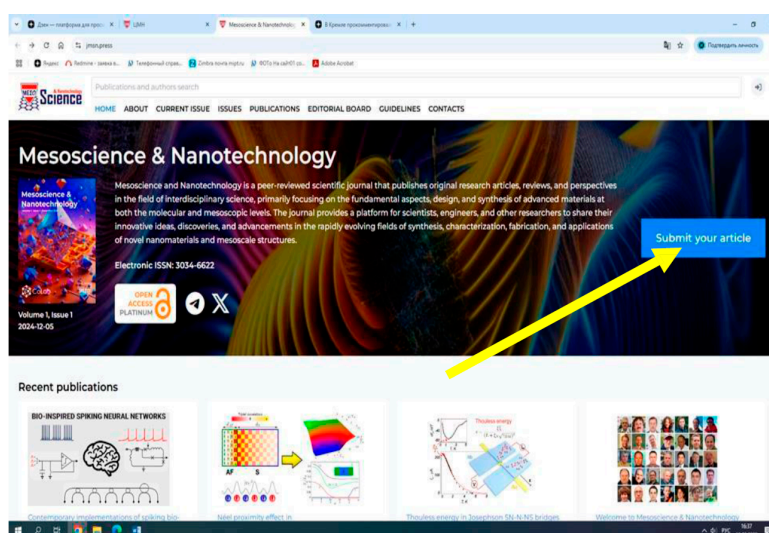
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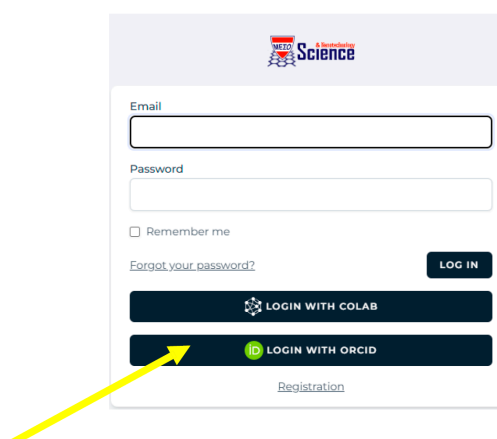
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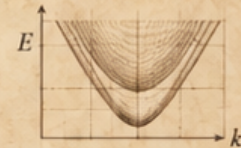
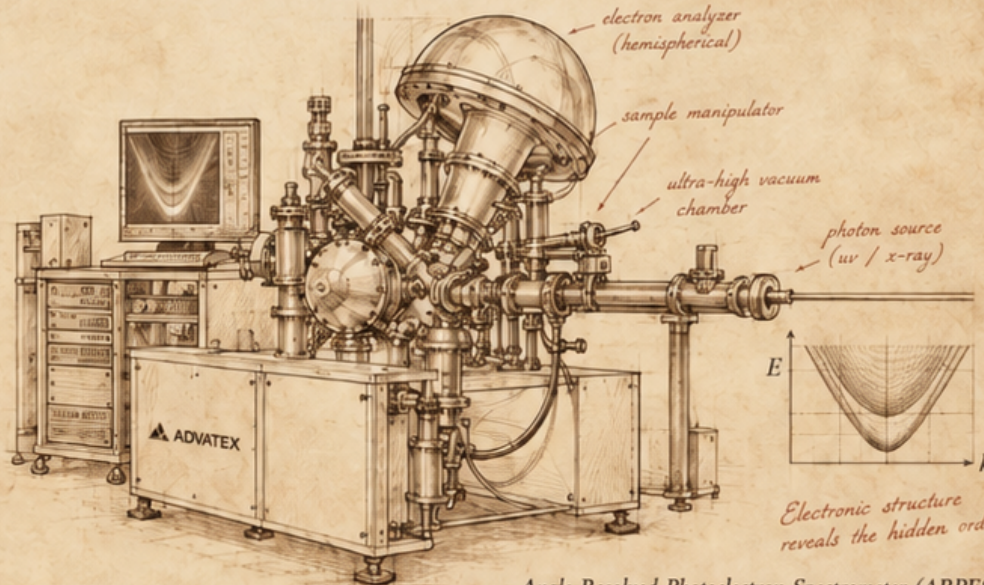
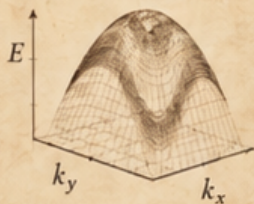


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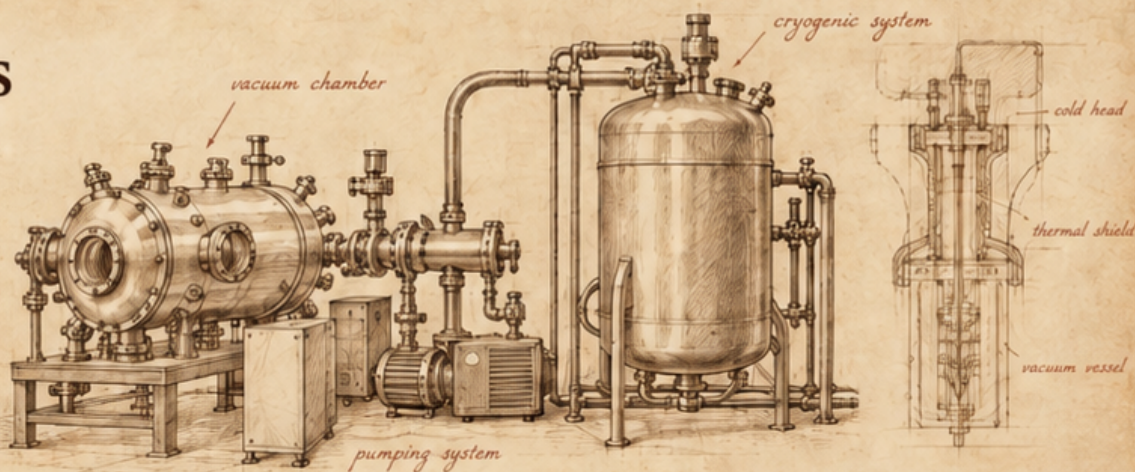
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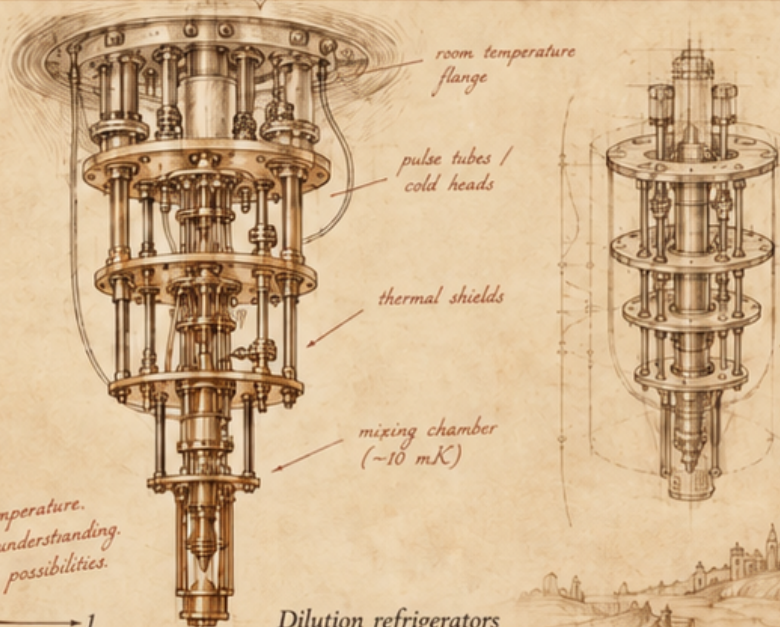
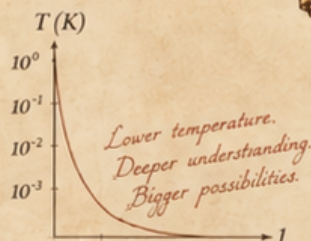
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