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Research Summary

My research lies in theoretical condensed matter and statistical physics, spanning disordered and interacting quantum systems, frustrated magnetism, including spin liquids and spin glasses, and topological semimetals. Physics of information is a unifying thread: I explore how quantum information is scrambled, transported, and protected in many-body systems, and how information-theory concepts can be used to describe both materials and engineered quantum platforms. This work connects fundamental theory to experiments in solid-state systems, superconducting qubits, and ultracold gases. I also contribute to outreach by organizing and teaching the COSMOS summer school cluster in Quantum Information Science and Engineering and mentoring in the Cal-Bridge program.

Research Interests

- Quantum chaos. Dynamics of quantum information in dissipative environments
- Quantum simulations with ultracold particles in optical and magnetic traps
- Spin liquids, spin glasses, geometrically frustrated magnets
- Physics of disordered systems. Localization-delocalization transitions
- Topological semimetals and semiconductors.
Graphene, Dirac and Weyl semimetals

Selected contributions

- Describing quantum information dynamics in environment-coupled quantum systems: out-of-time-order correlators in finite open systems and chaos in dissipative electronic systems [[PRB 97, 161114\(R\) \(2018\)](#) ; [Ann. Phys. 405, 1 \(2019\)](#) ; [PRB 100, 094304 \(2019\)](#)]
- Correlated states in quantum magnetic materials: discovery of the hidden energy scale and “eminuscent” phase [[PRL 134, 226701 \(2025\)](#); [Nature Comm. 13, 2993 \(2022\)](#); [Mater. Adv. 6, 1213-1229 \(2025\)](#)]
- Predicting magnetic behavior of non-magnetic impurities in magnetic materials with potential for memory applications [[PRB 106, L140202 \(2022\)](#); [PRB 108, 174436 \(2023\)](#); [PRB 111, 214427 \(2025\)](#)]
- Predicting topological phenomena in engineered platforms for quantum simulations and computation [[Nature Comm. 7, 13543 \(2016\)](#) ; [Nature Comm. 5, 5391 \(2014\)](#)]

Academic history

- July 2024– present, Associate Professor
Physics Department, University of California at Santa Cruz
- October 2017– June 2024, Assistant Professor
Physics Department, University of California at Santa Cruz
- September 2016– September 2017, Research Associate
Joint Quantum Institute, University of Maryland, USA
- October 2013– August 2016, Research Associate
University of Colorado at Boulder, USA
- October 2011– September 2013, Research Associate
(Wissenschaftlicher Mitarbeiter), Karlsruhe Institute of Technology, Germany
- September 2007 – September 2011, PhD student
(supervised by Prof. K.B. Efetov)
Ruhr-Universität Bochum, Germany

Education

Ruhr-Universität Bochum, Germany

PhD (Hons) in Theoretical Physics, May 2011

Thesis: “Transport in low-dimensional mesoscopic systems”

Advisor: **Prof. K.B. Efetov**

Moscow Institute of Physics and Technology (State University)

- **M.Sc.** (Hons) in Applied Physics and Mathematics, 8 June 2007
Thesis: “Effect of noise on Berry phases in multi-level systems”
Advisor: Dr. Yu. Makhlin
- **B.Sc.** (Hons) in Applied Physics and Mathematics, 23 June 2005
Thesis: “Dephasing of Josephson qubits close to optimal points”
Advisor: Dr. Yu. Makhlin

Professional service and outreach

- July-August 2023, 2024, 2026 instructor at [COSMOS](#) summer school for high-school students; designing and giving lecture course on “Quantum Information Science and Engineering”, designing and mentoring students’ research projects
- 2021-present, Mentor for [Cal-Bridge Programme](#) aimed to increase the number of PhD students from groups traditionally underrepresented in physics and to prepare them for graduate school
- Referee for the journals Phys. Rev. A, B, X and Lett., New Journal of Physics, Nature Communications, Annals of Physics, J. Low Temp. Phys., npj Quantum Materials (~ 10 assignments per year), National Science Foundation (NSF), Department of Energy (DoE)

Grants/awards

- [NSF DMR-2218130](#), “Collaborative Research: Frustration, glassiness and spin liquids: from dirty to pristine materials”, September 2022 – August 2026
- Supplemental funding for DoE grant DE-SC0017862; April 2025 – July 2026
- Fellowship of the Hellman Foundation, 2019-2020
- Feodor-Lynen Research Fellowship of the Alexander von Humboldt Foundation, 2014-2015

Selected courses taught

Graduate statistical physics (every year since 2018), graduate classical mechanics and thermal physics (2020-2023, 2025), introductory undergraduate electricity and magnetism (2023, 2024), advanced quantum mechanics (2022, 2026), graduate condensed matter physics (2018, 2019)

Graduate-student and postdoctoral supervision

PhD students: Phillip Popp (current); Aidan Lindhe-Johan (current); Siyu Zhu (2019–2025; now at Applied Optoelectronics, Inc.); Shijun Sun (2019–2023; proceeded to postdoc at Georgia Tech.)

Postdoctoral scholars: Grigory Bednik (2018–2020; proceeded to postdoc at MIT)

Co-advised PhD students: Sedik Elsayed (2020-2025), Mereyke Hoyer (2011-2013)

Other mentees: Markus Klug (exchange graduate student, 2018–2019)

Selected publications

- Phillip Popp, Arthur P. Ramirez, Sergey Syzranov
“Origin of the hidden energy scale and the f -ratio in geometrically frustrated magnets”
[Phys. Rev. Lett. **134**, 226701 \(2025\)](#)
- S.V. Syzranov, A.P. Ramirez
“Eminuscent phase in frustrated magnets: a challenge to quantum spin liquids”
[Nature Communications **13**, 2993 \(2022\)](#)
Popular highlight: [UC Santa Cruz Magazine](#)
- Markus J. Klug, Sergey V. Syzranov
“Chaos and the dynamics of information in dissipative electronic systems”
[Phys. Rev. B **100**, 094304 \(2019\)](#)
- Victor Galitski, Mehdi Kargarian, Sergey Syzranov
“Dynamo Effect and Turbulence in Hydrodynamic Weyl Metals”
[Phys. Rev. Lett. **121**, 176603 \(2018\)](#) , “Editor’s suggestion”
Popular highlights: [Physics World](#) , [Science News](#) , [Physics magazine](#) ,
[Phys.org](#) , [Russia Today](#) (in Spanish), [JQI Maryland](#)

- S.V. Syzranov, L. Radzihovsky
“High-Dimensional Disorder-Driven Phenomena in Weyl Semimetals, Semiconductors and Related Systems”
[Ann. Rev. Cond. Mat. Phys. 9, 35 \(2018\)](#)
- Sergey V. Syzranov, Michael Wall, Bihui Zhu, Victor Gurarie, Ana Maria Rey
“Emergent Weyl excitations in systems of polar particles”,
[Nature Comm. 7, 13543 \(2016\)](#)

Full list of publications

Journal articles:

- 1 Siyu Zhu, Arthur P. Ramirez, Sergey Syzranov
“Low-temperature entropies and possible states in geometrically frustrated magnets”
[arXiv:2511.02899](#)
- 2 Muhammad Sedik, Siyu Zhu, Sergey Syzranov
“Specific-heat anomaly in frustrated magnets with vacancy defects”
[arXiv:2506.17392](#)
- 3 Arthur P. Ramirez, Sergey Syzranov
“Short-range order and hidden energy scale in geometrically frustrated magnets”
[Mater. Adv. 6, 1213-1229 \(2025\)](#)
- 4 Phillip Popp, Arthur P. Ramirez, Sergey Syzranov
“Origin of the hidden energy scale and the f -ratio in geometrically frustrated magnets”
[Phys. Rev. Lett. 134, 226701 \(2025\)](#)
- 5 Muhammad Sedik, Shijun Sun, Arthur P. Ramirez, Sergey Syzranov
“Quasispins of vacancy defects and their interactions in disordered antiferromagnets”
[Phys. Rev. B 111, 214427 \(2025\)](#)
- 6 Shijun Sun, Arthur P. Ramirez, Sergey Syzranov
“Quasispins of vacancy defects in Ising chains with nearest- and next-to-nearest-neighbour interactions”
[Phys. Rev. B 108, 174436 \(2023\)](#)
- 7 Siyu Zhu, Sergey Syzranov
“BCS-like disorder-driven instabilities and ultraviolet effects in nodal-line semimetals”
[Ann. Phys. 459, 169501 \(2023\)](#)

- 8 Dmitry K. Efimkin, Sergey Syzranov
“Weyl excitations and arc surface states via helicon-phonon mixing in conducting materials”
[Phys. Rev. B **108**, L161411 \(2023\)](#)
- 9 Y. Li, D. Phelan, F. Ye, H. Zheng, E. Kriviyakina, A. Samarakoon, P.G. LaBarre, J. Neu, T. Siegrist, S. Rosenkranz, S.V. Syzranov, A.P. Ramirez
“The Geometrically Frustrated Spin Glass ($Fe_{1-p}Ga_p$) $_2TiO_5$ ”
[arXiv:2207.06354](#) [under review in Phys. Rev. B (Letters)]
- 10 S.V. Syzranov
“Effect of vacancy defects on frustrated magnets and quantum spin liquids”
[Phys. Rev. B **106**, L140202 \(2022\)](#)
- 11 Siyu Zhu, Grigory Bednik, S.V. Syzranov
“Weyl hydrodynamics in a strong magnetic field”
[Phys. Rev. B **105**, 125132 \(2022\)](#)
- 12 S.V. Syzranov, A.P. Ramirez
“Eminuscent phase in frustrated magnets: a challenge to quantum spin liquids”
[Nature Communications **13**, 2993 \(2022\)](#)
- 13 Shijun Sun, Sergey Syzranov
“Equivalence of interacting semimetals and low-density many-body systems to single-particle systems with quenched disorder”
[Phys. Rev. B **108**, 195132 \(2023\)](#)
- 14 Björn Sbierski, Sergey Syzranov
“Non-Anderson critical scaling of the Thouless conductance in 1D”
[Ann. Phys. **418**, 168169 \(2020\)](#)
- 15 P. G. LaBarre, D. Phelan, Y. Xin, F. Ye, T. Besara, T. Siegrist, S. V. Syzranov, S. Rosenkranz, A.P. Ramirez
“Fluctuation-Induced Interactions and the Spin Glass Transition in Fe_2TiO_5 ”
[Phys. Rev. B **103**, L220404 \(2021\)](#)
- 16 G. Bednik, K.S. Tikhonov, S.V. Syzranov
“Magnetotransport and internodal tunnelling in Weyl semimetals”
[Phys. Rev. Research **2**, 023124 \(2020\)](#)
- 17 S.V. Syzranov, V. Gurarie
“Duality between disordered nodal semimetals and systems with power-law hopping”
[Phys. Rev. Research **1**, 032035\(R\) \(2019\)](#)
- 18 Markus J. Klug, Sergey V. Syzranov
“Chaos and the dynamics of information in dissipative electronic systems”
[Phys. Rev. B **100**, 094304 \(2019\)](#)

- 19 S.V. Syzranov, Ya.I. Rodionov, B. Skinner
“Adiabatic dechiralisation and thermodynamics of Weyl semimetals”
[Phys. Rev. B **98**, 081114\(R\) \(2018\)](#)
- 20 Victor Galitski, Mehdi Kargarian, Sergey Syzranov
“Dynamo Effect and Turbulence in Hydrodynamic Weyl Metals”
[Phys. Rev. Lett. **121**, 176603 \(2018\)](#)
- 21 Paraj Titum, Victor L. Quito, Sergey V. Syzranov,
“Energy-level statistics in strongly disordered systems with power-law hopping”,
[Phys. Rev. B **98**, 014201 \(2018\)](#)
- 22 S.V. Syzranov, A.V. Gorshkov, and V.M. Galitski,
“Interaction-induced transition in the quantum chaotic dynamics of
a disordered metal”,
[Ann. Phys. **405**, 1 \(2019\)](#)
- 23 S.V. Syzranov, A.V. Gorshkov, V. Galitski
“Out-of-time-order correlators in finite open systems”
[Phys. Rev. B **97**, 161114\(R\) \(2018\)](#)
- 24 S.V. Syzranov, L. Radzihovsky
“High-Dimensional Disorder-Driven Phenomena in Weyl Semimetals,
Semiconductors and Related Systems”
[Ann. Rev. Cond. Mat. Phys. **9**, 35 \(2018\)](#)
- 25 S.V. Syzranov, B. Skinner
“Electron transport in nodal-line semimetals”
[Phys. Rev. B **96**, 161105\(R\) \(2017\)](#)
- 26 S.V. Syzranov, V. Gurarie, L. Radzihovsky
“Multifractality at non-Anderson disorder-driven transitions in Weyl semimetals
and other systems”
[Ann. Phys. **373**, 694 \(2016\)](#)
- 27 Sergey V. Syzranov, Michael Wall, Bihui Zhu, Victor Gurarie, Ana Maria Rey
“Emergent Weyl excitations in systems of polar particles”,
[Nature Comm. **7**, 13543 \(2016\)](#)
- 28 S.V. Syzranov, P.M. Ostrovsky, V. Gurarie, L. Radzihovsky
“Critical exponents at the unconventional disorder-driven
transition in a Weyl semimetal”,
[Phys. Rev. B **93**, 155113 \(2016\)](#)
- 29 M. Gärttner, S.V. Syzranov, A.M. Rey, V. Gurarie, L. Radzihovsky
“Disorder-driven transition in a chain with power-law hopping”,
[Phys. Rev. B **92**, 041406\(R\) \(2015\)](#)

- 30 Ya.I. Rodionov and S.V. Syzranov
“Conductivity of a Weyl semimetal with donor and acceptor impurities”
[Phys. Rev. B **91**, 195107 \(2015\)](#)
- 31 S.V. Syzranov, V. Gurarie, L. Radzihovsky,
“Unconventional localisation transition in high dimensions”,
[Phys. Rev. B **91**, 035133 \(2015\)](#)
- 32 M. Hoyer, M.S. Scheurer, S.V. Syzranov, J. Schmalian
“Pair-breaking due to orbital magnetism in iron-based superconductors”
[Phys. Rev. B **91**, 054501 \(2015\)](#)
- 33 Sergey V. Syzranov, Michael L. Wall, Victor Gurarie, Ana Maria Rey
“Spin-orbital dynamics in a system of polar molecules”
[Nature Comm. **5**, 5391 \(2014\)](#)
- 34 M. Hoyer, S.V. Syzranov, J. Schmalian,
“Effect of weak disorder on the phase competition in iron pnictides”,
[Phys. Rev. B **89**, 214504 \(2014\)](#)
- 35 S.V. Syzranov, L. Radzihovsky, V. Gurarie,
“Critical transport in weakly disordered semiconductors and semimetals”,
[Phys. Rev. Lett. **114**, 166601 \(2015\)](#)
- 36 S.V. Syzranov, Ya.I. Rodionov, K.I. Kugel, and F. Nori,
“Strongly anisotropic Dirac quasiparticles in irradiated graphene”,
[Phys. Rev. B **88**, 241112\(R\) \(2013\)](#)
- 37 J. Zimmer, N. Vogt, A. Fiebig, S.V. Syzranov, A. Lukashenko,
R. Schäfer, H. Rotzinger, A. Shnirman, M. Marthaler, A.V. Ustinov,
“Thermally activated conductance in arrays of small Josephson junctions”,
[Phys. Rev. B **88**, 144506 \(2013\)](#)
- 38 S.V. Syzranov, O.M. Yevtushenko, and K.B. Efetov,
“Fermionic and bosonic ac conductivities at strong disorder”,
[Phys. Rev. B. **86**, 241102\(R\) \(2012\)](#)
- 39 S.V. Syzranov and J. Schmalian,
“Conductivity close to antiferromagnetic criticality”,
[Phys. Rev. Lett. **109**, 156403 \(2012\)](#)
- 40 S.V. Syzranov, A. Moor, and K.B. Efetov,
“Strong quantum interference in strongly disordered bosonic insulators”,
[Phys. Rev. Lett. **108**, 256601 \(2012\)](#)
- 41 S. Mai, S.V. Syzranov, and K.B. Efetov,
“Photocurrent in a visible-light graphene photodiode”,
[Phys. Rev. B. **83**, 033402 \(2011\)](#)

- 42 S.V. Syzranov, I.L. Aleiner, B.L. Altshuler, and K.B. Efetov,
“Coulomb interaction and first order superconductor-insulator transition”,
[Phys. Rev. Lett. **105**, 137001 \(2010\)](#)
- 43 M.V. Fistul, S.V. Syzranov, A.M. Kadigrobov, and K.B. Efetov,
“Radiation-induced quantum interference in low-dimensional n-p junctions”,
[Phys. Rev. B **82**, 121409\(R\) \(2010\)](#)
- 44 S.V. Syzranov, K.B. Efetov, and B.L. Altshuler,
“dc Conductivity of an array of Josephson junctions in the insulating state”,
[Phys. Rev. Lett. **103**, 127001 \(2009\)](#)
- 45 S.V. Syzranov and Yu. Makhlin,
“Geometric phase via adiabatic manipulations of the environment”,
[JETP Lett. **87**, 390 \(2008\)](#) [Pis'ma v ZhETF 87, 453-457 (2008)]
- 46 S.V. Syzranov, M.V. Fistul, and K.B. Efetov,
“Effect of radiation on transport in graphene”,
[Phys. Rev. B **78**, 045407 \(2008\)](#)
- 47 S.V. Syzranov and Yu. Makhlin
“Dephasing of Josephson qubits close to optimal points”,
[JETP Lett. **83**, 83-86 \(2006\)](#) [Pis'ma v ZhETF 83, 93-96 (2006)]

Book chapters:

- 48 S.V. Syzranov and Yu.G. Makhlin,
“Geometric phases in open multi-level systems”, in
“[Electron Transport in Nanosystems](#)”, pp. 301-314,
eds. J. Bonca and S. Kruchinin (Springer, 2008)

Selected recent talks

- “Short-range order and hidden energy scale in geometrically frustrated magnets”, invited talk
Workshop “Current Trends in Strongly Correlated and Frustrated Systems”,
Dresden, Germany, 13 November 2025
- “Hidden Energy Scale and the Effects of Quenched Disorder in Geometrically Frustrated Magnets”, invited talk
Workshop “Frontiers in Physics of Quantum Materials”, Karlsruhe, Germany, 24 June 2025
- “Quenched Disorder and Hidden Energy Scale in Geometrically Frustrated Magnets”, remote invited talk
Workshop “Universalities, symmetries and correlations in low-dimensional electronic systems”, Bochum, Germany, 26 September 2024

- “Quenched disorder and hidden energy scale in geometrically frustrated magnets”, remote talk
Workshop “Localization: Emergent Platforms and Novel Trends”, Dresden, Germany, 17 September 2024
- “Effect of quenched disorder on quantum spin liquids”, invited talk
Conference “Landau Week 2023”, Yerevan, Armenia, 24 June 2023
- “Ultraviolet universalities in nodal semimetals and quantum gases”, invited talk
Conference “Localisation 2022”, Sapporo, Japan, 26 August 2022