Petr Stepanov

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Professional Appointments

Jan 2022 – Current Assistant Professor of Physics and Astronomy. **University of Notre Dame, Notre Dame, IN, USA.** Lab webpage.

Sep 2018 – Dec 2022 Marie Skłodowska-Curie PostDoctoral Fellow (PROBIST). **ICFO, Barcelona, Spain.** Supervised by Prof. Frank H.L. Koppens and Prof. Dmitri K. Efetov.
Optics and electronic transport studies of strongly correlated phenomena in 2D moiré materials.
- Superconductivity and orbital magnetism (magic angle twisted bilayer graphene).
- Photocurrent nanoscopy and near-field optics.

Jan 2017 – Aug 2018 Graduate Research Associate, Department of Physics, **The Ohio State University, Columbus, OH, USA.** Supervised by Prof. Jeanie CN Lau.
Electronic transport studies of 2D materials and their applications.
- Long-distance spin transport in graphene anti-ferromagnets.
- Layered magnetic materials.

Sep 2012 – Dec 2016 Graduate Student Researcher, Department of Physics and Astronomy, **University of California, Riverside, CA, USA.** Supervised by Prof. Jeanie CN Lau.
Electronic transport studies of 2D materials and their applications.
- Quantum Hall Effect in 2D multi-band heterostructures.
- Phase diagrams in 2D multi-band heterostructures.
- Transport properties of 2D semiconductor materials (TMDs, InSe, CrI_3 etc.).

Sep 2011 – Dec 2011 Exchange Master Thesis Student, Department of Physics, **Arizona State University, Tempe, AZ, USA.** Supervised by Prof. Robert J. Nemanich.
Experimental studies of thickness dependence of photo and thermionic emission from nitrogen-doped diamond thin films.

Sep 2009 – Jun 2012 Bachelor and Master Thesis Student, Junior Researcher. **Technological Institute for Superhard and Novel Carbon Materials, Troitsk, RU**. Supervised by Prof. Mikhail Y. Popov.
Experimental studies of nanocomposite materials and their applications.
- Successful improvement of thermoelectric properties of $Bi_{2-x}Sb_xTe_{3-}$-based nanocomposite materials.

Education

Sep 2012 – Aug 2018 **PhD in Physics, Ohio State University, Columbus, OH, USA**
Research under Prof. Jeanie CN Lau's supervision.
Thesis "Spin and Charge Transport in Monolayer and Trilayer graphene in the Quantum Hall Regime".

Sep 2006 – Jun 2012 **Diploma (BSc and MSc) in Applied Physics and Mathematics, Moscow Institute of Physics and Technology, Moscow, RU**
Research under Prof. Mikhail Y. Popov's supervision.
Thesis "Investigations of Nanostructured and Modified by C_{60} Thermoelectric Materials Based on Bi_2Te_3" at Technological Institute for Superhard and Novel Carbon Materials. Troistk, RU.

Sep 2002 – Jun 2006 **High School Diploma, Kaluga High School , Kaluga, RU**
1st place in Russian National High School Physics Olympiad (regional level).

Fellowships and Awards

Apr 2019 – Apr 2022 European Union's Horizon 2020 research and innovation programme fellowship under the Marie Skłodowska- Curie grant agreement No. 754510.

2015 – Benjamin C. Shen Award for outstanding 3rd year graduate student. UCR.

2007–2010 Innovation and Development Foundation undergraduate fellowship. MIPT.

2006 – Russian National High School Physics Olympiad (regional level) – 1st prize.

Publication Summary

25 publications with citations >2000 (Google Scholar) including papers in **Nature (x2), Nature Physics (x4), PRL (x5), PNAS (x1), Science Advances (x1), NanoLetters (x4)** highlighted by JCCMs, the New York Times, Le Monde, Spektrum, Physics Today, Physics World and more.

Teaching Experience

Sep 2013 – Dec 2016 **Discussion Teaching Assistant.**
2A/2B/2C and 40A/40B/40C lecture discussion series at University of California, Riverside.

Sep 2012 – Jun 2013 **Laboratory Teaching Assistant.**
2LA/2LB/2LC experimental laboratory series at University of California, Riverside.

2008 – 2012 **Tutoring Physics and Math for high school students.**
My students got awarded with scholarships in the best physics and mathematics BSc undergraduate programs in Russia.

Supervising graduate students

2014 – Supervised >10 graduate students in groups of Prof. Jeanie CN Lau, Prof. Frank H. L. Koppens and Prof. Dmitri K. Efetov.

Invited Talks

Jul 2022 “Cryogenic Photovoltage Nanoscopy of Strong Electronic Correlations in Moiré Materials”. **Invited Talk at Graphene 2022**. Aachen, Germany.

Sep 2021 “Magic angles in graphene”. **Invited Seminar at ITMO University**. Saint-Petersburg, Russia. In-person.

Oct 2020 “Magic angles in graphene”. **Invited seminar at MIPT.** (In Russian). Moscow, RU. ***YouTube*.**

May 2020 “Untying the insulating and superconducting orders in magic-angle graphene”. **NGI Friday Seminar**. Manchester, UK. Online

Jul 2019 “Superconductors, Orbital Magnets, and Correlated States in Magic Angle Bilayer Graphene”. **The challenge of Two-Dimensional Superconductivity**. Leiden, NL. Presentation slides can be found at https://2dsuperconductivity.blogspot.com/2019/07/slides-of-presentations.html.

Jun 2017 “Long-Distance Spin Transport Through a Graphene Quantum Hall Antiferromagnet”. **CDT Summer Conference,** Cambridge, UK, 2017.

Skills

Lab skills

Cryogenic scanning near-field optical microscopy (SNOM). Dilution and He^3 refrigerators. High magnetic fields (up to 45T). Nanofabrication (e-beam lithography and thin film deposition, plasma etching, wet etching, sputtering, 2D layers dry and wet transfer techniques). AFM. Raman Spectroscopy. TEM. FTIR.

Computing

Igor Pro, OriginLab, MatLab, Python (Data Analysis packages: NumPy, Seaborn, SciKitLearn), C/C++, Objective-C, Swift, Blender, DesignCAD, MySQL, LabVIEW.

Languages

English (full proficiency), Russian (native), Spanish (fair), German (fair)

Referee activity

Nature, Nature Physics, Nature Comm., PRL, PRB, APL, LSA.

References

Available upon request.

Full list of publications

Selected:

1.“Competing zero-field Chern insulators in Superconducting Twisted Bilayer Graphene”. **Petr Stepanov**, Ming Xie, Kenji Watanabe, Takashi Taniguchi, Xiaobo Lu, Allan H MacDonald, B Andrei Bernevig, Dmitri K Efetov. ***Phys. Rev. Lett.***, 127, 197701. *2021. Editor’s Suggestion.*

2.“Untying the insulating and superconducting orders in magic-angle graphene”. **Petr Stepanov**, Ipsita Das, Xiaobo Lu, Ali Fahimniya, Kenji Watanabe, Takashi Taniguchi, Frank HL Koppens, Johannes Lischner, Leonid Levitov, Dmitri K Efetov. ***Nature***, 583, 375-378. *2020.* Highlighted by: *Nature News and Views*; *JCCM by T. Senthil*; and more.

3.“Superconductors, orbital magnets, and correlated states in magic angle bilayer graphene”. Xiaobo Lu, **Petr Stepanov**, Wei Yang, Ming Xie, Mohammed Ali Aamir, Ipsita Das, Carles Urgell, Kenji Watanabe, Takashi Taniguchi, Guangyu Zhang, Adrian Bachtold, Allan H MacDonald, Dmitri K Efetov. ***Nature***, 574, 653-657. *2019.* Highlighted by: *JCCM by M. Zaletel*;

The New York Times; and more.

4."Long-Distance Spin Transport Through a Graphene Quantum Hall Antiferromagnet." **Petr Stepanov***, Shi Che*, Dmitry Shcherbakov, Jiawei Yang, Kevin Thilahar, Greyson Voigt, Marc W. Bockrath, Dmitry Smirnov, Kenji Watanabe, Takashi Taniguchi, Roger K. Lake, Yafis Barlas, Allan H. MacDonald, Chun Ning Lau. ***Nature Physics***, 14(9), 907-911. *2018.* Highlighted by: *Nature Phys. News and Views*; *physicsworld.org*.

5."Quantum Parity Hall effect and Topological Phases in ABA Graphene." **Petr Stepanov**, Yafis Barlas, Shi Che, Kevin Myhro, Greyson Voigt, Ziqi Pi, Kenji Watanabe, Takashi Taniguchi, Dmitry Smirnov, Maxim Kharitonov, Fan Zhang, Roger K. Lake, Allan H. MacDonald, Chun Ning Lau. ***PNAS***, 116, 10286-10290. *2019*

6."Tunable Symmetries of Integer and Fractional Quantum Hall Phases in Heterostructures with Multiple Dirac Bands." **Petr Stepanov**, Yafis Barlas, Tim Espiritu, Shi Che, Kenji Watanabe, Takashi Taniguchi, Dmitry Smirnov, and Chun Ning Lau. ***Phys. Rev. Lett.***, 117, 076807. *2016*

7."Tuning Spin Transport in a Graphene Antiferromagnetic Insulator." **Petr Stepanov**, Dmitry L. Shcherbakov, Shi Che, Marc W. Bockrath, Yafis Barlas, Dmitry Smirnov, Kenji Watanabe, Takashi Taniguchi, Roger K. Lake, Chun Ning Lau. ***Phys. Rev. Applied.,*** 18, 014031. *2022*

Other (listed chronologically):

8."Imaging Chern mosaic and Berry-curvature magnetism in magic angle graphene". Sameer Grover , Matan Bocarsly , Aviram Uri , **Petr Stepanov** , Giorgio Di Battista , Indranil Roy , Jiewen Xiao , Alexander Meltzer , Yuri Myasoedov , Keshav Pareek , Kenji Watanabe , Takashi Taniguchi , Binghai Yan , Ady Stern , Erez Berg , Dmitri K. Efetov and Eli Zeldov. ***Nature Physics***. https://doi.org/10.1038/s41567-022-01635-7. *2022*

9. "Collective excitations in twisted bilayer graphene close to the magic angle". Niels CH Hesp, Iacopo Torre, Daniel Rodan-Legrain, Pietro Novelli, Yuan Cao, Stephen Carr, Shiang Fang, **Petr Stepanov**, David Barcons-Ruiz, Hanan Herzig-Sheinfux, Kenji Watanabe, Takashi Taniguchi, Dmitri K Efetov, Efthimios Kaxiras, Pablo Jarillo-Herrero, Marco Polini, Frank HL Koppens. ***Nature Physics,*** 17, pp. 1162-1168. *2021*. Highlighted by: *phys.org*

10. *"*Layer- and gate-tunable spin-orbit coupling in a high-mobility few-layer semiconductor*".* Dmitry Shcherbakov, **Petr Stepanov**, Shahriar Memaran, Yaxian Wang, Yan Xin, Jiawei Yang, Kaya Wei, Ryan Baumbach, Wenkai Zheng, Kenji Watanabe, Takashi Taniguchi, Marc Bockrath, Dmitry Smirnov, Theo Sigrist, Wolfgang Windl, Luis Balicas, Chun Ning Lau. ***Science Advances***, 7(5), eabe2892. *2021*

11. *"*Direct evidence for flat bands in twisted bilayer graphene from nano-ARPES*".* Simone Lisi*, Xiaobo Lu*, Tjerk Benschop*, Tobias A de Jong*, **Petr Stepanov**, Jose R Duran, Florian Margot, Irène Cucchi, Edoardo Cappelli, Andrew Hunter, Anna Tamai, Viktor Kandyba, Alessio Giampietri, Alexei Barinov, Johannes Jobst, Vincent Stalman, Maarten Leeuwenhoek, Kenji

Watanabe, Takashi Taniguchi, Louk Rademaker, Sense Jan van der Molen, Milan Allan, Dmitri K Efetov, Felix Baumberger. ***Nature Physics,*** 17(2), pp. 189-193. *2021*

12.“Mapping local heterogeneity in open twisted bilayer graphene devices”. Tjerk Benschop*, Tobias A. de Jong*, **Petr Stepanov***, Xiaobo Lu , Vincent Stalman, Sense Jan van der Molen, Dmitri K. Efetov, Milan P. Allan. ***Physical Review Research***, 3(1), 013153. *2021*

13.*“*Substrate-Dependent Band Structures in Trilayer Graphene/hBN Heterostructures*”.* Shi Che*, **Petr Stepanov***, Supeng Ge, Menglin Zhu, Dongying Wang, Yongjin Lee, Kevin Myhro, Yanmeng Shi, Ruoyu Chen, Ziqi Pi, Cheng Pan, Bin Cheng, Takashi Taniguchi, Kenji Watanabe, Yafis Barlas, Roger K. Lake, Marc Bockrath, Jinwoo Hwang, and Chun Ning Lau. ***Phys. Rev. Lett.***, 125, 246401. *2020*

14.“Magic-Angle Bilayer Graphene Nanocalorimeters: Toward Broadband, Energy-Resolving Single Photon Detection.” Paul Seifert, Xiaobo Lu, **Petr Stepanov**, José Ramón Durán Retamal, John N Moore, Kin-Chung Fong, Alessandro Principi, Dmitri K Efetov. ***NanoLetters***, 20(5). *2020*

15.“Raman Spectroscopy, Photovoltaic Degradation, and Stabilization of Atomically Thin Chromium Tri-iodide.” Dmitry Shcherbakov, **Petr Stepanov**, Daniel Weber, Yaxian Wang, Jin, Hu, Yanglin Zhu, Kenji Watanabe, Takashi Taniguchi, Zhiqiang Mao, Wolfgang Windl, Joshua Goldberger, Marc Bockrath, Chun Ning Lau. ***NanoLetters*****,** 18(7), pp. 4214-4219. *2018*

16.“Integer and Fractional Quantum Hall effect in Ultrahigh Quality Few-layer Black Phosphorus Transistors.” Jiaqie Yang, Son Tran, Jason Wu, Shi Che, **Petr Stepanov**, Kenji Watanabe, Takashi Taniguchi, Hongwoo Baek, Dmitry Smirnov, Ruoyu Chen, Chun Ning Lau. ***NanoLetters*****,** 18(1), pp. 229-234. *2018*

17.“Energy Gaps and Layer Polarization of Integer and Fractional Quantum Hall States in Bilayer Graphene.” Yanmeng Shi, Yongjin Lee, Shi Che, Ziqi Pi, Timothy Espiritu, **Petr Stepanov**, Dmitry Smirnov, Chun Ning Lau, and Fan Zhang. ***Phys. Rev. Lett.***, 116, 056601. *2016*

18.“Ionic Liquid Gating of Suspended MoS_2 Field Effect Transistor Devices**.”** Fenglin Wang, **Petr Stepanov,** Mason Gray, Chun Ning Lau, Mikhail E. Itkis, Robert C. Haddon. ***NanoLetters*****,** 15(8), pp. 5284-5288. *2015*

19.“Annealing and Transport Studies of Suspended Molybdenum Disulfide Devices.” Fenglin Wang, **Petr Stepanov**, Mason Gray and Chun Ning Lau. ***Nanotechnology***, 26(10). *2015*

20.“Interface and interlayer barrier effects on photo-induced electron emission from low work function diamond films.” Tianyin Sun, Franz A. M. Koeck, **Petr Stepanov**, Robert J. Nemanich. ***Diamond and Related Mat.***, 44, pp. 123-128. *2014*

21.“Thermoelectric properties of Bi0.5Sb1.5Te3/C60 nanocomposites.” Vladimir Blank, Sergei

Buga, Vladimir Kulbachinskii, Vladimir Kytin, Viacheslav Medvedev, Mikhail Popov, **Petr Stepanov**, Vasilii Skok. ***Phys. Rev. B***, 86, 075426. *2012*

22."Composites of $Bi_{2-}xSbxTe_3$ nanocrystals and fullerene molecules for thermoelectricity." Vladimir Kulbachinskii, Vladimir Kytin, Mikhail Popov, Sergei Buga, **Petr Stepanov**, Vladimir Blank. ***Journal of Solid State Chemistry***, 193, pp. 64-70. *2012*

23."C_{60}-doping of nanostructured Bi–Sb–Te thermoelectrics." Mikhail Popov, Sergei Buga, Phillipp Vysikaylo, **Petr Stepanov**, Vasilii Skok, Viacheslav Medvedev, Evgeny Tatyanin, Viktor Denisov, Alexei Kirichenko, Viktor Aksenenkov, Vladimir Blank. ***Phys. Status Solidi A***, 208, pp. 2783–2789. *2011*

Popular Science Articles:

"Graphene with a twist". *Culturico.com***.** *2021*

Patents:

"High resolution superconducting nano-calorimeter". US20210140833A1. Dmitri K Efetov, Paul Seifert, Xiaobo Lu, José Durán, **Petr Stepanov**

Conferences and Workshops (only contributed talks listed):

1."Long-Distance Spin Transport Through a Graphene Quantum Hall Antiferromagnet". **Petr Stepanov***, Shi Che*, Dmitry Shcherbakov, Jiawei Yang, Kevin Thilahar, Greyson Voigt, Marc W. Bockrath, Dmitry Smirnov, Kenji Watanabe, Takashi Taniguchi, Roger K. Lake, Yafis Barlas, Allan H. MacDonald, Chun Ning Lau. **APS March Meeting**. *2018*

2."Robust Spin Transport Through a Graphene Quantum Hall Antiferromagnet." **Petr Stepanov**, Shi Che, Dmitry Shcherbakov, Jiawei Yang, Kevin Thilahar, Greyson Voigt, Marc W. Bockrath, Dmitry Smirnov, Kenji Watanabe, Takashi Taniguchi, Roger K. Lake, Yafis Barlas, Allan H. MacDonald, Chun Ning Lau. Spin, Valley and Topological phases in 2D materials. The Ohio State University, **Department of Physics Workshop**. *2017*

3."Topological phases in a multi-band 2D electron gas". **Petr Stepanov**, Yafis Barlas, Chun Ning Lau, Dmitry Smirnov, Kenji Watanabe, Takashi Taniguchi, Maxim Kharitonov, Fan Zhang, Allan MacDonald. **APS March Meeting**. *2017*

4."Symmetry protected topological phases in a multi-band 2D electron gas." **Petr Stepanov**, Yafis Barlas, Chun Ning Lau, Dmitry Smirnov Kenji Watanabe, Takashi Taniguchi. **APS March Meeting**. *2016*

5.“Quantum Hall Effect in ABA-stacked Trilayer Graphene.” **Petr Stepanov**, Yafis Barlas, Takashi Taniguchi, Nathaniel Gillgren, Chung Ning Lau. **Graphene Week**. *2015*

6.“Quantum Hall Effect (QHE) in ABA stacked trilayer graphene”. **Petr Stepanov**, Yafis Barlas, Nathaniel Gillgren, Takashi Taniguchi, Jeanie Lau. **APS March Meeting**. *2015*