

## Petr Stepanov

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### Professional Appointments

**Jan 2023** – Assistant Professor of Physics and Astronomy. **University of Notre Dame, Notre Dame, IN, USA.** [Lab webpage](#).

**Sep 2018** – Marie Skłodowska-Curie Postdoctoral Fellow (PROBIST). **ICFO, Barcelona, Spain.** Supervised by Prof. Frank H.L. Koppens and Prof. Dmitri K. Efetov.  
**Dec 2022** 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** – Graduate Research Associate, Department of Physics, **The Ohio State University, Columbus, OH, USA.** Supervised by Prof. Jeanie CN Lau.  
**Aug 2018** Electronic transport studies of 2D materials and their applications.  
- Long-distance spin transport in graphene anti-ferromagnets.  
- Layered magnetic materials.

**Sep 2012** – Graduate Student Researcher, Department of Physics and Astronomy, **University of California, Riverside, CA, USA.** Supervised by Prof. Jeanie CN Lau.  
**Dec 2016** 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<sub>3</sub> etc.).

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

**Sep 2009** – Bachelor and Master Thesis Student, Junior Researcher. **Technological Institute for Superhard and Novel Carbon Materials, Troitsk, RU.** Supervised by Prof. Mikhail Y. Popov.  
**Jun 2012** Experimental studies of nanocomposite materials and their applications.  
- Successful improvement of thermoelectric properties of Bi<sub>2-x</sub>Sb<sub>x</sub>Te<sub>3</sub>-based nanocomposite materials.

## Education

- Sep 2012 – PhD in Physics, Ohio State University, Columbus, OH, USA**  
**Aug 2018** 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 – Diploma (BSc and MSc) in Applied Physics and Mathematics, Moscow**  
**Jun 2012** **Institute of Physics and Technology, Moscow, RU**  
Research under Prof. Mikhail Y. Popov's supervision.  
Thesis "Investigations of Nanostructured and Modified by C<sub>60</sub> Thermoelectric Materials Based on Bi<sub>2</sub>Te<sub>3</sub>" at Technological Institute for Superhard and Novel Carbon Materials. Troistk, RU.
- Sep 2002 – High School Diploma, Kaluga High School , Kaluga, RU**  
**Jun 2006** 1st place in Russian National High School Physics Olympiad (regional level).
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## Fellowships and Awards

- Apr 2019 –** European Union's Horizon 2020 research and innovation programme fellowship  
**Apr 2022** under the Marie Skłodowska- Curie grant agreement No. 754510.
- 2015 –** Benjamin C. Shen Award for outstanding 3<sup>rd</sup> year graduate student. UCR.
- 2007–2010** Innovation and Development Foundation undergraduate fellowship. MIPT.
- 2006 –** Russian National High School Physics Olympiad (regional level) – 1<sup>st</sup> prize.
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## 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.

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## Teaching Experience

**Sep 2013 – Discussion Teaching Assistant.**

**Dec 2016** 2A/2B/2C and 40A/40B/40C lecture discussion series at University of California, Riverside.

**Sep 2012 – Laboratory Teaching Assistant.**

**Jun 2013** 2LA/2LB/2LC experimental laboratory series at University of California, Riverside.

**2008 – Tutoring Physics and Math for high school students.**

**2012** My students got awarded with scholarships in the best physics and mathematics BSc undergraduate programs in Russia.

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## 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.

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## 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<sup>3</sup> 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)

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## Referee activity

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

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## References

Available upon request.

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## 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 Thilakar, 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<sub>2</sub> 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 Bi<sub>0.5</sub>Sb<sub>1.5</sub>Te<sub>3</sub>/C<sub>60</sub> 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  $\text{Bi}_{2-x}\text{SbxTe}_3$  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. “ $\text{C}_{60}$ -doping of nanostructured Bi–Sb–Te thermoelectrics.” Mikhail Popov, Sergei Buga, Phillip Vysikaylo, **Petr Stepanov**, Vasilii Skok, Viacheslav Medvedev, Evgeny Tatyani, Viktor Denisov, Alexei Kirichenko, Viktor Aksenkov, Vladimir Blank. *Phys. Status Solidi A*, 208, pp. 2783–2789. 2011

#### Popular Science Articles:

“Graphene with a twist”. [Culturico.com](http://Culturico.com). 2021

#### Patents:

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

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#### 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 Thilaha, 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 Thilaha, 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**