

Mihail Petrov

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Born: 06 October 1986, Tbilisi, Georgia

Citizenship: Russian

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Google scholar profile

Education

- **PhD, condensed matter physics/photonics (with distinction):** 2009-2013, double-PhD program.
University of Eastern Finland, Joensuu, Finland
Ioffe Physical Technical Institute Russian Academy of Science, Saint-Petersburg, Russia
Thesis title: “Glass-metal nanocomposites for photonics applications”
- **MSc, solid-state physics (with honours):** 2007 - 2009, Saint-Petersburg State Polytechnic University, Saint-Petersburg, Russia, solid-state physics
Thesis title: “Electric Field Modification of Glass-Metal Nanocomposites”
- **BSc, solid-state physics (with honours):** 2003 - 2007, Saint-Petersburg State Polytechnic University, Saint-Petersburg, Russia
Thesis title: “The mode analysis of asymmetric microdisk resonators containing InAs quantum dots”

Current position

- **Faculty fellow, research scientist, *Informational Technologies, Mechanics, and Optics University (ITMO University)*,** Faculty of Physics and Engineering, Centre of Nanophotonics and Metamaterials, Saint-Petersburg, Russia
<http://metalab.ifmo.ru/>

Research interests

Theoretical nanophotonics and plasmonics, all-dielectric photonics, nonlinear photonics, optical forces and manipulation, quantum optics and nanophotonic, metamaterials and metasurfaces.

Professional skills

Numerical and analytical modeling of light propagation and interaction with nanostructures media. Modeling in COMSOL Multiphysics. Basic programming in Matlab, Mathematica, Maple, C++, Fortran 90 (IMSL)

Awards, Grants & Honours

Competitive research funding

2019	DAAD fellowship for academicians exchange, <u>individual</u>
2018 – 2019	Grant of Russian Foundation of Basic Research, <u>manager</u>
2017 – 2020	Grant of Russian Science Foundation, <u>chief investigator, co-manager</u>
2016 – 2018	Russian Foundation of Basic Research Fellowship Scholarship, <u>individual</u>
2016 – 2017	Swiss-Russian bilateral grant of Russian Ministry of Education and Science, <u>chief investigator, co-manager</u>
2017 – 2018	Travel scholarship of Academy of Finland, <u>individual</u>
2014 – 2016	Travel scholarship of Academy of Finland, <u>individual</u>
2013	Russian Foundation of Basic Research, travel grant, <u>individual</u>
2012 – 2014	Grant of Russian Foundation of Basic Research for young scientists, <u>manager</u>
2011 – 2012	Russian Ministry of Education and Science grant for PhD students,
2008 – 2010	Grant of the Foundation for Assistance to Small Innovative Enterprises, <u>individual</u>

Academic awards

2017 – 2018	Foundation of Theoretical Physics Advancement Fellowship, Russia
2010, 2011	Awards of St. Petersburg Administration Science Committee for PhD students
2008, 2009	Awards of St. Petersburg Administration Science Committee for Master students

Teaching activities

• Current courses

- 2018 - present time. *Nanoplasmonics*. Master course at ITMO University. <https://physics.ifmo.ru/>
- 2013 - present time. *Introduction to Quantum Optics*. Master course at ITMO University and Saint-Petersburg Academic University. <https://physics.ifmo.ru/>

• Online courses

- 2019 Online course “Plasmonics: fundamentals and applications”, edX platform: <https://www.edx.org/course/plasmonics-fundamentals-modern-itmox-plasmx>
- 2016 Online course “Physics. Theoretical minimum” (in Russian only), Stepic platform: <https://stepic.org/s/vRZjOpRo>

• Previously taught courses

- 2005 – 2015: Mathematical Physics. Bachelor course at Saint-Petersburg State Polytechnical University. Practical classes and lectures.

- 2011: Light interaction with metal nanostructures. Special course for undergraduate students at Saint-Petersburg Academic University

- **Other teaching activities**

- Permanent popular lectures on physics for highschool students
- 2009-2012: Member of organizing committee of Russian student challenge on Computer Modelling of Nanostructures and Renewable Energy Sources (in Russian only): <http://nano.spb.ru/olymp/>

Publications

- [1] I. D. Toftul, D. F. Kornovan, and M. I. Petrov, “Self-trapped nanoparticle binding via waveguide mode,” *arXiv: 1905.13039* 1–9 (2019).
- [2] D. F. Kornovan, M. I. Petrov, and I. V. Iorsh, “Non-inverse dynamics of a quantum emitter coupled to an anisotropic metasurface,” *arXiv: 1903.07426v1* 1–10 (2019).
- [3] Z. Sadrieva, K. Frizyuk, M. Petrov, Y. Kivshar, and A. Bogdanov, “Multipolar origin of bound states in the continuum,” *arXiv: 1903.00309* 1–13 (2019).
- [4] K. V. Baryshnikova, K. Frizyuk, G. Zograf, S. Makarov, M. A. Baranov, D. Zuev, V. A. Milichko, I. Mukhin, M. Petrov, and A. B. Evlyukhin, “Revealing Low-Radiative Modes of Nanoresonators with Internal Raman Scattering,” *arXiv: 1905.04483* (2019).
- [5] R. S. Savelev, D. F. Kornovan, V. V. Yaroshenko, and M. I. Petrov, “Analogue of the Kerker effect for localized modes of discrete high-index dielectric nanowaveguides,” *Journal of Applied Physics* **125** (2019).
- [6] N. Kostina, A. Ivinskaya, S. Sukhov, A. Bogdanov, I. Toftul, M. Nieto-Vesperinas, P. Ginzburg, M. I. Petrov, and A. Shalin, “Optical binding via surface plasmon polariton interference,” *Physical Review B* **99**, 125416 (2019).
- [7] C. Renaut, L. Lang, K. Frizyuk, M. Timofeeva, F. E. Komissarenko, I. S. Mukhin, D. Smirnova, F. Timpu, M. Petrov, Y. Kivshar, and R. Grange, “Reshaping the Second-Order Polar Response of Hybrid Metal-Dielectric Nanodimers,” *Nano Letters* **19**, 877–884 (2019).
- [8] K. Frizyuk, I. Volkovskaya, D. Smirnova, A. Poddubny, and M. Petrov, “Second-harmonic generation in Mie-resonant dielectric nanoparticles made of noncentrosymmetric materials,” *Physical Review B* **99**, 075425 (2019).
- [9] A. Ivinskaya, N. Kostina, A. Proskurin, M. I. Petrov, A. A. Bogdanov, S. Sukhov, A. V. Krasavin, A. Karabchevsky, A. S. Shalin, and P. Ginzburg, “Optomechanical Manipulation with Hyperbolic Metasurfaces,” *ACS Photonics* **5**, 4371–4377 (2018).
- [10] F. L. Kien, D. F. Kornovan, S. S. S. Hejazi, V. G. Truong, M. I. Petrov, S. N. Chormaic, and T. Busch, “Force of light on a two-level atom near an ultrathin optical fiber,” *New Journal of Physics* **20** (2018).
- [11] K. Frizyuk, M. Hasan, A. Krasnok, A. Alu, and M. Petrov, “Enhancement of inherent Raman scattering in dielectric nanostructures with electric and magnetic Mie resonances,” *Physical Review B* **97**, 085414 (2018).

- [12] V. Rutckaia, F. Heyroth, A. Novikov, M. Shaleev, M. Petrov, and J. Schilling, “Quantum Dot Emission Driven by Mie Resonances in Silicon Nanostructures,” *Nano Letters* **17**, 6886–6892 (2017).
- [13] F. Timpu, N. R. Hendricks, M. Petrov, S. Ni, C. Renaut, H. Wolf, L. Isa, Y. Kivshar, and R. Grange, “Enhanced Second-Harmonic Generation from Sequential Capillarity-Assisted Particle Assembly of Hybrid Nanodimers,” *Nano Letters* **17**, 5381–5388 (2017).
- [14] D. Kornovan, M. Petrov, and I. Iorsh, “Transport and collective radiance in a basic quantum chiral optical model,” *Physical Review B* **96**, 115162 (2017).
- [15] I. S. Sinev, A. A. Bogdanov, F. E. Komissarenko, K. S. Frizyuk, M. I. Petrov, I. S. Mukhin, S. V. Makarov, A. K. Samusev, A. V. Lavrinenko, and I. V. Iorsh, “Chirality Driven by Magnetic Dipole Response for Demultiplexing of Surface Waves,” *Laser & Photonics Reviews* **11**, 1700168 (2017).
- [16] A. Ivinskaya, M. I. Petrov, A. A. Bogdanov, I. Shishkin, P. Ginzburg, and A. S. Shalin, “Plasmon-assisted optical trapping and anti-trapping,” *Light: Science & Applications* **6**, e16258–6 (2017).
- [17] G. P. Zograf, M. I. Petrov, D. A. Zuev, P. A. Dmitriev, V. A. Milichko, S. V. Makarov, and P. A. Belov, “Resonant non-plasmonic nanoparticles for efficient temperature-feedback optical heating,” *Nano Letters* **17**, 2945–2952 (2017).
- [18] S. V. Makarov, M. I. Petrov, U. Zywietz, V. A. Milichko, D. A. Zuev, N. Y. Lopanitsyna, A. Y. Kuksin, I. S. Mukhin, G. P. Zograf, E. V. Ubyivovk, D. A. Smirnova, S. V. Starikov, B. N. Chichkov, and Y. S. Kivshar, “Efficient Second-Harmonic Generation in Nanocrystalline Silicon Nanoparticles,” *Nano letters* **17**, 3047 (2017).
- [19] D. A. Lyashenko, Y. P. Svirko, M. I. Petrov, and A. N. Obraztsov, “The laser assisted field electron emission from carbon nanostructure,” *Journal of the European Optical Society-Rapid Publications* **13**, 4 (2017).
- [20] D. F. Kornovan, A. S. Sheremet, and M. I. Petrov, “Collective polaritonic modes in an array of two-level quantum emitters coupled to optical nanofiber,” *Physical Review B* **94**, 245416 (2016).
- [21] A. Andryieuski, A. V. Lavrinenko, M. Petrov, and S. a. Tretyakov, “Homogenization of metasurfaces formed by random resonant particles in periodical lattices,” *Physical Review B* **93**, 205127 (2016).
- [22] K. V. Baryshnikova, M. I. Petrov, V. E. Babicheva, and P. A. Belov, “Plasmonic and silicon spherical nanoparticle anti-reflective coatings,” *Scientific reports* **6**, 1 (2016).
- [23] A. Krasnok, S. Glybovski, M. Petrov, S. Makarov, R. Savelev, P. Belov, C. Simovski, and Y. Kivshar, “Demonstration of the enhanced Purcell factor in all-dielectric structures,” *Applied Physics Letters* **108**, 211105 (2016).
- [24] M. I. Petrov, S. V. Sukhov, A. A. Bogdanov, A. S. Shalin, and A. Dogariu, “Surface plasmon polariton assisted optical pulling force,” *Laser and Photonics Reviews* **10**, 116–122 (2016).
- [25] A. Krasnok, S. Makarov, M. Petrov, R. Savelev, P. Belov, and Y. Kivshar, “Towards all-dielectric metamaterials and nanophotonics,” *Proceedings of SPIE - The International Society for Optical Engineering* **9502** (2015).
- [26] K. V. Baryshnikova, M. I. Petrov, and T. A. Vartanyan, “Plasmon nanoruler for monitoring of transient interactions,” *Physica Status Solidi-Rapid Research Letters* **9**, 711–715 (2015).
- [27] V. Babicheva, M. Petrov, K. Baryshnikova, and P. Belov, “Reflection compensation mediated by electric and magnetic resonances of all-dielectric metasurfaces,” *Journal of Optical Society of America B* **34**, 18–28 (2015).

- [28] R. S. Savelev, D. S. Filonov, M. I. Petrov, A. E. Krasnok, P. A. Belov, and Y. S. Kivshar, “Resonant transmission of light in chains of high-index dielectric particles,” *Physical Review B* **92**, 1–5 (2015).
- [29] M. Petrov, “Disorder-induced Purcell enhancement in nanoparticle chains,” *Physical Review A* **91**, 023821 (2015).
- [30] E. L. Ivchenko and M. I. Petrov, “Near field of terahertz radiation transmitted through a lateral non-centrosymmetric grating,” *Physics of the Solid State* **56**, 1833–1839 (2014).
- [31] M. Petrov, *Glass-metal nanocomposites for photonics applications* (University of Eastern Finland, Joensuu, Finland, 2013).
- [32] I. S. Sinev, M. I. Petrov, A. K. Samusev, V. V. Rutckaia, and A. A. Lipovskii, “Nanoscale patterning of metal nanoparticle distribution in glasses,” *Nanoscale research letters* **8**, 260 (2013).
- [33] V. V. Zhurikhina, M. I. Petrov, O. V. Shustova, Y. P. Svirko, and A. A. Lipovskii, “Plasmonic bandgap in random media,” *Nanoscale research letters* **8**, 324 (2013).
- [34] M. I. Petrov, V. G. Melehin, V. V. Zhurikhina, Y. P. Svirko, and A. A. Lipovskii, “Dissolution of metal nanoparticles in glass under a dc electric field,” *Journal of Physics D: Applied Physics* **46**, 045302 (2013).
- [35] A. Bogdanov, V. Meshkov, A. Omelchenko, and M. Petrov, “ENUMERATING THE k-TANGLE PROJECTIONS,” *Journal of Knot Theory and Its Ramifications* (2012).
- [36] A. I. Denisyuk, M. a. Tinskaya, M. I. Petrov, A. V. Shelaev, and P. S. Dorozhkin, “Tunable Optical Antennas Based on Metallic Nanoshells with Nanoknobs,” *Journal of Nanoscience and Nanotechnology* **12**, 8651–8655 (2012).
- [37] M. I. Petrov, V. G. Melehin, and A. A. Lipovskii, “On the stability of elastic nanoparticles,” *Physica Status Solidi (B)* **249**, 2137–2139 (2012).
- [38] K. Sokolov, V. Melehin, M. Petrov, V. Zhurikhina, and A. Lipovskii, “Spatially periodical poling of silica glass,” *Journal of Applied Physics* **111**, 104307 (2012).
- [39] M. I. Petrov, Y. a. Lepen’kin, and a. a. Lipovskii, “Polarization of glass containing fast and slow ions,” *Journal of Applied Physics* **112**, 043101 (2012).
- [40] A. Bogdanov, V. Meshkov, A. Omelchenko, and M. Petrov, “Enumerating the k-tangle prjections,” *Journal of Knot Theory and Its Ramifications* **21**, 1–17 (2012).
- [41] A. A. Lipovskii, V. G. Melehin, M. I. Petrov, and Y. P. Svirko, “Thermal Electric Field Imprinting Lithography: Fundamentals and Applications,” in *Lithography: Principles, Processes and Materials*, T. C. Hennessy, ed. (Nova Science Publishers, New York, 2011), pp. 284.
- [42] M. I. Petrov, A. V. Omelchenko, and A. A. Lipovskii, “Electric field and spatial charge formation in glasses and glassy nanocomposites,” *Journal of Applied Physics* **109**, 094108 (2011).
- [43] A. A. Lipovskii, V. G. Melehin, M. I. Petrov, Y. P. Svirko, and V. V. Zhurikhina, “Bleaching versus poling: Comparison of electric field induced phenomena in glasses and glass-metal nanocomposites,” *Journal of Applied Physics* **109**, 011101 (2011).
- [44] A. A. Lipovskii, A. V. Omelchenko, and M. I. Petrov, “Modeling charge transfer dynamics and electric field distribution in glasses during poling and electrostimulated diffusion,” *Technical Physics Letters* (2010).

- [45] V. R. Meshkov, A. V. Omelchenko, M. I. Petrov, and E. A. Tropp, “Dyck and Motzkin Triangles with Multiplicities,” *Moscow Mathematical Journal* (2010).
- [46] V. R. Meshkov, A. V. Omelchenko, M. I. Petrov, and E. A. Tropp, “Dyck and motzkin triangles with multiplicities,” *Moscow Mathematical Journal* **10**, 611–628 (2010).
- [47] V. V. Afrosimov, B. Y. Ber, V. V. Zhurikhina, M. V. Zamoryanskaya, D. Y. Kazantsev, E. V. Kolesnikova, A. A. Lipovskii, V. G. Melekhin, and M. I. Petrov, “Mass transfer in thermo-electric-field modification of glass-metal nanocomposites,” *Technical Physics* **55**, 1600–1608 (2010).
- [48] V. V. Zhurikhina, M. I. Petrov, K. S. Sokolov, and O. V. Shustova, “Ion-exchange characteristics of sodium-calcium-silicate glass: Calculation from mode spectra,” *Technical Physics* **55**, 1447–1452 (2010).
- [49] M. Dussauze, V. Rodriguez, A. Lipovskii, M. Petrov, C. Smith, K. Richardson, T. Cardinal, E. Fargin, and E. I. Kamitsos, “How Does Thermal Poling Affect the Structure of Soda-Lime Glass?,” *The Journal of Physical Chemistry C* **114**, 12754–12759 (2010).
- [50] N. N. Aruev, A. A. Bogdanov, M. I. Petrov, A. M. Polyanskii, V. A. Polyanskii, R. V. Tyukal'tsev, and I. L. Fedichkin, “Mass-spectrometric study of the electron-beam-stimulated conversion of sulfur dioxide,” *Technical Physics Letters* (2009).
- [51] P. Brunkov, V. Goncharov, V. Melehin, A. Lipovskii, and M. Petrov, “Submicron Surface Relief Formation Using Thermal Poling of Glasses,” *e-Journal of Surface Science and Nanotechnology* **7**, 617–620 (2009).
- [52] P. N. Brunkov, V. G. Melekhin, V. Goncharov, A. A. Lipovskii, and M. I. Petrov, “Submicron-resolved relief formation in poled glasses and glass-metal nanocomposites,” *Technical Physics Letters* **34**, 1030–1033 (2008).

List of invited talks

- [1] M. I. Petrov, “Second harmonic generation from resonant dielectric and metal-dielectric nanoantenna”, Metamaterials Congress, 8-14 September 2019, Rome, Italy
- [2] M. I. Petrov, “Quantum transport and optical forces with spin-locked surface waves”, International School on Nanophotonics, Photovoltaics and Metamaterials 2019, 11-17 April 2019, Varadero, Cuba
- [3] M. I. Petrov, “Chiral light-matter coupling at nanophotonic interfaces”, Invited seminar at Langevin Institute, 05 December 2018, Paris, France
- [4] M. I. Petrov, “Non-plasmonic nanoresonators as a new multifunctional optical platform”, (plenary talk) Annual Sino-Russian Technical Universities Meeting, 22-25 November 2018, Guangzhou, China
- [5] M. I. Petrov, “Non-plasmonic resonant nanosystems for active photonics applications”, NanoMaterials Trends Workshop, 13-14 September 2018, Brescia, Italy.
- [6] M. I. Petrov “Light-matter interaction and optical forces mediated by surface guiding waves: the effects of spin-locking”, Invited seminar at Okinawa Institute of Science and Technology, 16 January 2018, Okinawa, Japan.
- [7] **M. I. Petrov**, V. E. Babicheva, K. V. Baryshnikova, P. A. Belov. “Reflection compensation with all-dielectric metasurfaces”, COMCAS 2017, 13-15 November, Tel-Aviv, Israel

- [8] **M.I. Petrov**, N.A. Kostina, A. Ivinskaya, P. Ginzburg, A. S. Shalin, S. Sukhov, Surface plasmon polaritons for opto-mechanical control of nanoparticles, SPIE: Optics+Photonics, August 6-10, 2017, San Diego, USA
- [9] A. Andryieuski, **M. Petrov**, A. Lavrinenko, S. Tretyakov. Understanding of increased diffuse scattering in regular arrays of fluctuating resonant particles, The SPIE Optics+photonics conference, August 9 - August 13, 2015, San Diego, USA

Scientific visits and seminars

- December 2018: visiting professorship at ESPCI, Langevin Institute, Paris, France. *Prof. Remi Carminati group.*
- January 2018: Okinawa Institute of Science and Technology, Okinawa, Japan. *Prof. Sile Nic Chormaic group.*
- August 2016: Australian National University, Canberra, Australia. *Prof. Yuri Kivshar group*
- October 2015: Fresnel Institute, Marseille, France. *Dr. Nicolas Bonod group*
- September 2014: Aalto University, Helsinki, Finland. *Prof. Sergey Tretyakov group*
- June 2013, Martin-Luther-Universität Halle-Wittenberg, Halle, Germany. *Prof. Gerhard Seifert group*
- April 2012: Rochester Institute of Optics, University of Rochester, USA, *Prof. Robert Boyds group*

Administrative activities and academic services

- **Head of Bachelor program** on Fundamental and Applied Physics at Faculty of Physics and Engineering, ITMO University
- **Mentoring:** since 2016 there have been 4 MSs and 2 BSc thesis defended under my supervision. Currently there are 2 PhD students under my co-supervision.
- **Secretary of Summer School** on Nanophotonics and Metamaterials: annual summer school for Master and PhD students held at ITMO University <https://school.metalab.ifmo.ru>
- **Program committee member** of special section on Optical Forces and Manipulation at MetaNano conference (2018, 2019), <https://metanano.ifmo.ru>
- **Reviewer** of international research journals: Optica, ACS Photonics, Nanophotonics, , Journal of Optical Society of America, Scientific Reports, Optics Letters, Physics Status Solidi B, Photonics and Nanostructures, and others