# Tigran Kalaydzhyan

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**MAJOR PROJECTS AND CONTRIBUTIONS**

- Simulation software for NASA fundamental physics programs on board of the International Space Station. I played a role of consultant and lead theorist for various space missions. Sole contributions:
  - Theory of relativistic clock desynchronization for systems of communicating clocks subject to gravitational forces, data analysis for the ACES atomic clock mission and tests of gravity on the basis of performed data analysis. The code is written in **Python**/SciPy.
  - Molecular dynamics **Mathematica** codes for atomic clouds in a magnetic trap created in the NASA Cold Atom Laboratory. Feasibility studies for the proposed cooling protocols.
  - **Matlab** nonlinear PDE-solver for simulations of Bose-Einstein Condensates in microgravity. The code exploits time-splitting spectral methods and various finite difference schemes.
  - General methods of searching for stochastic or oscillating backgrounds of new fields with networks of atomic sensors (atomic clocks and atom interferometers).

- High-performance Monte-Carlo package for lattice quantum chromodynamics, about 300k LOC. The program predicts electromagnetic and topological properties of quark matter at high temperatures and strong magnetic fields. Languages used: **C, C++, Perl, Fortran, Bash, Mathematica, Assembly**. My contributions included:
  - Applying stochastic methods (Heat bath, Metropolis, Cabibbo-Marinari, overrelaxation) to the simulation of gluonic fields and extracting physical observables from the simulated data.
  - Developing algorithms for calculation of the Dirac operator spectra with the use of Krylov subspace methods (Arnoldi, Lanczos, GMRES, BiCGSTAB, etc) and code optimization.
  - Developing scripts for automatic distribution of parallel lattice QCD calculations at the International Lattice Data Grid infrastructure, as well as at German and Russian cluster/supercomputer facilities. Maintaining large-scale calculations. 3 years of experience as a **Linux system administrator** of the DESY theory group.

- Set of theoretical methods, connecting dynamics of classical fields and strings in high-dimensional curved spaces with real-life properties of quark matter in accelerator experiments. My contributions included:
  - Solving time-dependent nonlinear ODEs and PDEs for numerical relativity, supergravity and string theory with the use of, e.g., fixed-point iteration, shooting methods, simulated annealing, etc. The code is written in **Mathematica** and **Maple**.
  - Finding exact solutions of Einstein, Maxwell-Chern-Simons, Born-Infeld and Dirac equations. Interpreting the results in terms of quantum properties of quark-gluon plasma and contrasting them with experimental data from RHIC and LHC colliders.

- Set of theoretical hydrodynamic methods predicting properties of quark-gluon plasma in heavy-ion collisions, cosmic rays and the early universe. My contributions include:
  - Discovery of hydrodynamic properties of high-multiplicity collision states of two protons at LHC.
  - Exact solutions of hydrodynamic equations in presence of electromagnetic fields, rotation and quantum anomalies (in- and out-of-equilibrium).
  - Monte-Carlo protein-folding codes in **C** and **Mathematica**, molecular dynamics code in **Fortran** for solving many-body problems in nuclear collisions.

- Theoretical analysis of gravitational properties of elementary particles. Putting first ever constraints on the difference between the gravitational and inertial masses of the electron/positron on the basis of HERA, Tevatron, LHC and LEP accelerator data.

**TECHNICAL SKILLS**

- Data analysis and predictive modeling for fundamental and applied physics. Analytic and numeric calculations in various branches of science. Conducting first-class internationally recognized research, in a team and independently. Over 12 years of research experience (9 years full-time), **34** papers in top journals (21 of them as a leading or single author), accumulated **675** citations and presented more than **100** talks (please refer to the personal website for publications and talks). Serving as a referee for top physics journals and a panelist for U.S. and EU national scientific organizations. Status of U.S. Permanent Resident granted on the basis of **extraordinary ability** in the field.

- Analysis of experimental and simulated data. Statistical and spectral methods. Stochastic algorithms.

- Advanced knowledge of C, C++ (98, 11, 14), Python, Matlab, Mathematica, Fortran, Perl, x86/ARM assembly. Object-oriented software design, version control (git), system programming, static and dynamic testing.

- Machine learning, deep learning, convolutional and recurrent neural networks, TensorFlow, Keras.

- Stock market investing, stock options trading, basic knowledge of accounting, derivative pricing and security analysis. Strong interest in financial markets.

**EDUCATION**

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| 2017 | Coursera.org certificate in Deep Learning, License# HAW4JL726QV9 |
| 2010 – 2013 | Ph.D. studies at the University of Hamburg, Germany. Degree of Doctor of Natural Sciences, with honors. Thesis: “Quark-gluon plasma in strong magnetic fields". |
| 2004 – 2010 | Lomonosov Moscow State University. Diploma in **Theoretical Physics**, with honors. (GPA: 4.0/4.0, *Summa cum laude*) Department of Physics. Chair of Quantum Statistics and Field Theory. Thesis: “Black hole creation in three-dimensional anti-de Sitter space". |

**PROFESSIONAL EXPERIENCE**

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| 2016 – pres. | Postdoctoral associate at NASA-JPL, California Institute of Technology, CA, U.S.A. |
| 2015 – 2016 | Postdoctoral associate in Theoretical Nuclear Physics, University of Illinois at Chicago, U.S.A. |
| 2013 – 2015 | Postdoctoral associate in the Nuclear Theory Group, Stony Brook University, NY, U.S.A. |
| 2010 – 2013 | Scientific fellow of the String Theory Group. Accelerator Centre DESY-Hamburg, Germany. |
| 2009 – 2012 | Research fellow of the ITEP Lattice Group, Moscow, Russia. |
| 2006 – 2009 | Research assistant at the Steklov Mathematical Institute and Moscow State University. |

**PUBLICATIONS**

**T. Kalaydzhyan**, N. Yu, *“Searching for stochastic background of ultra-light fields with atomic sensors”*, Universe 2018, 4(10), 99.

**T. Kalaydzhyan**, N. Yu, *“Extracting dark matter signatures from atomic clock stability measurements”*, Phys. Rev. D 96 (2017) 075007.

**T. Kalaydzhyan**, E. Murchikova, *"Thermal chiral vortical and magnetic waves: new excitation modes in chiral fluids"*, Nucl. Phys. B 919 (2017) 173.

**T. Kalaydzhyan**, *"Comment on Testing Planck-scale gravity with accelerators*", Phys. Rev. Lett. 116, 209001 (2016).

**T. Kalaydzhyan***, "Gravitational mass of positron from LEP synchrotron losses"*, Sci. Rep. 6, 30461 (2016) [Nature Publishing Group].

**T. Kalaydzhyan**, *"Gravitational mass of relativistic matter and antimatter"*, Phys. Lett. B 751 (2015) 29.

**T. Kalaydzhyan**, *"Testing general relativity on accelerators",* Phys. Lett. B 750 (2015) 112.

**T. Kalaydzhyan**, E. Shuryak, *"Collective ow in high-multiplicity proton-proton collisions",* Phys. Rev. C 91 (2015) 054913.

**T. Kalaydzhyan**, E. Shuryak, *"Gravity waves generated by sounds from Big Bang phase transitions",* Phys. Rev. D 91 (2015) 083502.

**T. Kalaydzhyan**, E. Shuryak, *"Explosive regime should dominate collisions of ultra-high energy cosmic rays"*, arXiv:1407.3270 [hep-ph].

**T. Kalaydzhyan**, E. Shuryak, *"Collective interaction of QCD strings and early stages of high multiplicity pA collisions"*, Phys. Rev. C 90 (2014) 014901.

**T. Kalaydzhyan***, "On the temperature dependence of the chiral vortical effects"*, Phys. Rev. D 89 (2014) 105012

**T. Kalaydzhyan**, E. Shuryak, *"Self-interacting QCD strings and string balls"*, Phys. Rev. D 90 (2014) 025031.

M. N. Chernodub, **T. Kalaydzhyan**, J. Van Doorsselaere, H. Verschelde, *"Fermion zero modes in a chromomagnetic vortex lattice"*, Phys. Rev. D 89 (2014) 065021

Id. Ben-Dayan, **T. Kalaydzhyan**, *"Constraining the primordial power spectrum from SNIa lensing dispersion"*, Phys. Rev. D 90 (2014) 083509.

M.N. Chernodub, **T. Kalaydzhyan**, J. Van Doorsselaere, H. Verschelde, *"On chromoelectric (super)conductivity of the Yang-Mills vacuum"*, Phys. Lett. B 730 (2014) 63

**T. Kalaydzhyan***, "Chiral superuidity of the quark-gluon plasma"*, Nucl. Phys. A 913 (2013) 243.

Il. Gahramanov, **T. Kalaydzhyan**, I. Kirsch, *"Anisotropic hydrodynamics, holography and the chiral magnetic effect"*, Phys. Rev. D 85, 126013 (2012).

P. V. Buividovich, **T. Kalaydzhyan**, M. I. Polikarpov, *"Fractal dimension of the topological charge density distribution in SU(2) lattice gluodynamics"*, Phys. Rev. D 86, 074511 (2012).

**T. Kalaydzhyan**, I. Kirsch*, "Fluid-gravity model for the chiral magnetic effect"*, Phys. Rev. Lett. 106, 211601 (2011).

V. Braguta, P. Buividovich, **T. Kalaydzhyan**, S. Kuznetsov, M. Polikarpov, *"The Chiral Magnetic Effect and chiral symmetry breaking in SU(3) quenched lattice gauge theory"*, Phys. Atom. Nucl. 75, 488.

N. Evans, **T. Kalaydzhyan**, K. -y. Kim, I. Kirsch, *"Non-equilibrium physics at a holographic chiral phase transition"*, JHEP 1101, 050 (2011).

**T. Kalaydzhyan**, I. Kirsch, *"Holographic dual of a boost-invariant plasma with chemical potential"*, JHEP 1102, 053 (2011).

P. V. Buividovich, M. N. Chernodub, D. E. Kharzeev, **T. Kalaydzhyan**, E. V. Luschevskaya, M. I. Polikarpov, *"Magnetic-Field-Induced insulator-conductor transition in SU(2) quenched lattice gauge theory"*, Phys. Rev. Lett. 105, 132001 (2010).

**T. Kalaydzhyan**, *"Testing gravity on accelerators"*, Proceedings of CPT'16, Bloomington, Indiana, USA.

**T. Kalaydzhyan**, *"Testing general relativity on accelerators"*, Proceedings of KSM2015 conference, Frankfurt, Germany.

**T. Kalaydzhyan**, *"Chiral Superuidity for QCD"*, Proceedings of QUARKS-2014 conference, Suzdal, Russia.

**T. Kalaydzhyan**, E. Shuryak, *"Why is the radial flow in central pA collisions stronger than in AA?"*, Nucl. Phys. A 931 (2014) 899.

**T. Kalaydzhyan**, *"Chiral Superuidity for the Heavy Ion Collisions"*, PoS CONFINEMENT X, 302 (2013).

**T. Kalaydzhyan**, I. Kirsch, *"Chiral magnetic effect and holography"*, PoS CONFINEMENT X, 262 (2013).

V. Braguta, P. Buividovich, **T. Kalaydzhyan**, M.I. Polikarpov, *"Topological and magnetic properties of the QCD vacuum probed by overlap fermions"*, PoS CONFINEMENT X, 085 (2013).

P. V. Buividovich, M. N. Chernodub, **T. Kalaydzhyan**, D. E. Kharzeev, E. V. Luschevskaya, M. I. Polikarpov, *"Magnetic-field-induced insulator-conductor transition in quenched lattice gauge theory"*, PoS LATTICE2010, 076 (2010).

V. V. Braguta, P. V. Buividovich, **T. Kalaydzhyan**, S. V. Kuznetsov, M. I. Polikarpov, *"The Chiral Magnetic Effect and chiral symmetry breaking in SU(3) quenched lattice gauge theory"*, PoS LATTICE2010, 190 (2010).

M. I. Polikarpov et al*., "Conductivity of SU(2) gluodynamics vacuum induced by magnetic field"*, AIP Conf. Proc. 1343, 630-631 (2011).