Dr. Ivan V. Borzenets

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Research interests:

Experimental condensed matter physics focusing on few-millikelvin temperature electronic transport at DC and RF frequencies. Studies of hybrid nano-structures: carbon nanotubes, graphene/graphene-like, GaAs. Superconductivity, topological states, Quantum information.

Appointments:

- **2021 (Aug. 11)-Now:** Assistant Professor, Texas A&M University, Department of Physics & Astronomy
- **2017-2021 (Aug. 10):** Assistant Professor, City University of Hong Kong Physics Department (Low-Dimensional Systems)
- **2012- 2017:** Assistant Professor/Postdoctoral Fellow, The University of Tokyo Applied Physics Department, Tarucha-Yamamoto Lab

Education:

- **2006-2012: Duke University**
  - Ph.D. Physics, Awarded: 13-05-2012 (Advisor: Prof. Gleb Finkelstein)
  - M.S. Electrical Engineering, Awarded: 15-05-2011 (Advisor: Prof. Jungsang Kim)
  - Nanotechnology Certificate
- **2002-2006: University of California Berkeley**
  - B.S. Engineering Physics, Awarded: 19-05-2006

Awards/Fellowships/Grants:

- **2020** CityU New Research Initiatives/Infrastructure Support (APRC): 7005498
- **2020** Teaching Excellence Award (Nomination, results pending)
- **2020** AAPPS-APCTP C.N. Yang Award (Nomination, results pending)
- **2019** Research Grants Council (Hong Kong) GRF/ECS: 11303619
- **2018** Research Grants Council (Hong Kong) GRF/ECS: 21301818
- **2017** CityU New Research Initiatives/Infrastructure Support (APRC): 9610395
- **2013** Japan Society for the Promotion of Science (JSPS) fellowship, Tokyo
- **2011** Fritz London fellowship, Duke University
- **2006** G.P. Nano (Nanoscience) fellowship, Duke University
- **2001** State of California Governor's Scholars Award Program

Major Research Contributions:

- First experimental evidence on the extent of the Kondo Cloud (U. Tokyo, City U.)
    - Use of novel detection technique for distributive states: resonance structure plus perturbative barriers[1,25].
- Comprehensive study of the physical properties of Graphene Josephson junctions (Duke, U. Tokyo, City U.)
    - Investigation of the governing parameters of Graphene Junctions in different regimes. E.G.: short vs long, ballistic vs diffusive[7,10,14].
    - Mapping the effects of the environment on junction behavior[2,22,26].
- First observation (and applications) of the existence of superconductivity in the Quantum Hall regime. (U. Tokyo, City U.)
    - Development of ultra-clean graphene devices efficiently coupled to superconductors with a high critical field[13].
    - Observation of Andreev edge states[9,13].
    - Coupling between two opposing Andreev edge states[5,8].
- Manipulation of the valley degree of freedom in graphene (U. Tokyo)
    - Observation of pure valley current without accompanying charge current[3,15,16,17].
- Study on the thermal properties of Graphene at low temperatures (City U, U. Tokyo, Duke)
    - Conceptual demonstration on the use of graphene in single photon detection[6,7,19].
- Demonstration of a high efficiency quantum entrangler (U. Tokyo)
    - Enhancement of efficiency via the enhancement of superconducting coherence length[12].
- Observation of Majorana quantum critical behavior (Duke)
    - Coupling of a resonant level to a dissipative environment[21,29].
    - Observation of the quantum critical phase transition[21,24].
- Development of efficient, microscopic neural electrodes (Duke)
    - Use of nanotube bundles to surpass the limitations of the conventional glass neural probes[20,23].

Patents:

I. Borzenets, I. Yoon, K. Hamaguchi, R. Mooney, B. Donald, G. Finkelstein; "Carbon nanotube fibril based probe as a scanning microscopy tip, and a neural electrode" U.S. Patent pending PTO 61/711,511; (22 claims).

Publications:

1) M. Tanaka, Y. Shimazaki, I. Borzenets, K. Watanabe, T. Taniguchi, S. Tarucha, M. Yamamoto, "Charge Neutral Current Generation in a Spontaneous Quantum Hall Antiferromagnet", Phys. Rev. Lett., 126, 016801, DOI:10.1103/PhysRevLett.126.016801 2021

2) **I. Borzenets**, J. Shim, J. Chen, A. Ludwig, A. Wieck, S. Tarucha, H. S. Sim, M. Yamamoto, "Observation of the Kondo Screening Cloud", **Nature**, vol. 579, 210, DOI: 10.1038/s41586-020-2058-6, 2020

3) J. Tang, M.T. Wei, A. Sharma, E. G. Arnault, A. Seredinski, Y. Mehta, K. Watanabe, T. Taniguchi, F. Amet, **I. Borzenets**, "Overdamped Phase Diffusion in hBN Encapsulated Graphene Josephson Junctions", arXiv:2011.04142, 2020

4) E. G. Arnault, T. Larson, A. Seredinski, L. Zhao, H. Li, K. Watanabe, T. Taniguchi, I. Borzenets, F. Amet, G. Finkelstein, "The Multi-terminal Inverse AC Josephson Effect", arXiv: 2012.15253, 2020

5) C. T. Ke, A. Draelos, A. Seredinski, M. T. Wei, H. Li, M. Hernandez-Rivera, K. Watanabe, T. Taniguchi, M. Yamamoto, S. Tarucha, Y. Bomze, **I. Borzenets**, F. Amet, G. Finkelstein, "Anomalous periodicity of magnetic interference patterns in encapsulated graphene Josephson junctions", **Phys. Rev. Research**, 1, 0330842, DOI: 10.1103/PhysRevResearch.1.033084, 2019

6) M. T. Wei, A. Draelos, A. Seredinski, C. T. Ke, H. Li, Y. Mehta, K. Watanabe, T. Taniguchi, M. Yamamoto, S. Tarucha, G. Finkelstein, F. Amet, **I. Borzenets**, "Chiral Quasiparticle Tunneling Between Quantum Hall Edges in Proximity with a Superconductor", **Phys. Rev B** (rapid communication), 100, 121403(R), DOI: 10.1103/PhysRevB.100.121403, 2019

7) A. Draelos, A. Silverman, B. Eniwaye, E. Arnault, C. T., Ke, M. T. Wei, I. Vlassiouk, **I. Borzenets**, F. Amet, G. Finkelstein, "Subkelvin lateral thermal transport in diffusive graphene", **Phys. Rev. B**, 99, 12, 125427, DOI: 10.1103/PhysRevB.99.125427, 2019

8) A. Draelos, M. Wei, A. Seredinski, H. Li, Y. Mehta, K. Watanabe, T. Taniguchi, **I. Borzenets**, F. Amet, G. Finkelstein, "Supercurrent Flow in Multi-Terminal Graphene Josephson Junctions", **Nano Letters**, 19, 2, p. 1039, DOI: 10.1021/acs.nanolett.8b04330, 2019

9) A. Seredinski, A. Draelos, M. Wei, C. Ke, T. Fleming, Y. Mehta, E. Mancil, H. Li, T. Taniguchi, K. Watanabe, S. Tarucha, M. Yamamoto, **I. Borzenets,** F. Amet, G. Finkelstein, "Supercurrent in Graphene Josephson Junctions with Narrow Trenches in the Quantum Hall Regime", **MRS Advances**, 3, 47-48, 2855, DOI: 10.1557/adv.2018.469, 2018

10) A. W. Draelos, M. T. Wei, A. Seredinski, C. T. Ke, Y. Mehta, R. Chamberlain, K.Watanabe, T. Taniguchi, M. Yamamoto, W. Tarucha, **I. Borzenets**, F. Amet, G. Finkelstein, "Investigation of Supercurrent in the Quantum Hall Regime in Graphene Josephson Junctions", **Journal of Low Temperature Physics**, 191, 5-6, p. 288-300, DOI: 10.1007/s10909-018-1872-9, 2018

11) **I. Borzenets**, F. Amet, C. T. Ke, A. W. Draelos, M. T. Wei, A. Seredinski, K. Watanabe, T. Taniguchi, Y. Bomze, M. Yamamoto, S. Tarucha, G. Finkelstein, "Ballistic graphene Josephson junctions from the short to the long regime", **Phys. Rev. Lett.**, 117, 237002, DOI: 10.1103/PhysRevLett.117. 237002, 2016

12) Y. Shimazaki, T. Yoshizawa, **I. Borzenets**, K. Wang, X. Liu, K. Watanabe, T. Taniguchi, P. Kim, M. Yamamoto, S. Tarucha, "Landau level evolution driven by band hybridization in mirror symmetry broken ABA-stacked trilayer graphene", arXiv:1611.02395, 2016

13) **I. Borzenets**, Y. Shimazaki, G. Jones, M. Craicun, S. Russo, M. Yamamoto, S. Tarucha, "High Efficiency CVD Graphene-lead (Pb) Cooper Pair Splitter", **Scientific Reports**, 6, 23051, DOI: 10.1038/srep23051, 2016

14) F. Amet, C. T. Ke, **I. Borzenets**, Y-M. Wang, K. Watanabe, T. Taniguchi, R.S. Deacon, M. Yamamoto, Yu. Bomze, S. Tarucha, Finkelstein, "Supercurrent in the quantum Hall regime", **Science**, 6288, 966, DOI: 10.1126/science.aad6203, 2016

15) C. Ke, **I. Borzenets,** A. W. Draelos, F. Amet, G. Jones, M. Craciun, S. Russo, Y. Bozme, G. Finkelstein, M. Yamamoto, S. Tarucha, "Critical current scaling in long diffusive graphene-based Josephson junctions", **Nanoletters**, DOI: 10.1021/acs.nanolett.6b00738, 2016

16) Y. Shimazaki, M. Yamamoto, **I. Borzenets**, S. Tarucha, "Valley Hall effect in two-dimensional hexagonal lattice systems", **Kotai Butsuri**, 51, 8, 429, 2016. (In Japanese)

17) Y. Shimazaki, M. Yamamoto, **I. Borzenets**, K. Watanabe, T. Taniguchi, S. Tarucha, "Generation and detection of pure valley current by electrically induced Berry curvature in bilayer graphene", **Nature Physics,** 11, 1032, DOI: 10.1038/nphys3551, 2015

18) M. Yamamoto, Y. Shimazaki, **I. Borzenets**, Seigo Tarucha, "Valley Hall effect in two-dimensional hexagonal lattices.", **J. Phys. Soc. Jpn.** 84, 121006, DOI: 10.7566/JPSJ.84.121006, 2015

19) H. Mebrahtu, **I. Borzenets**, H. Zheng, Yu. Bomze, A. I. Smirnov, S. Florens, H.U. Baranger, G. Finkelstein, "Observation of Majorana quantum critical behaviour in a resonant level coupled to a dissipative environment", **Nature Physics**, 9**,** 11, 732, DOI: 10.1038/nphys2735, 2013

20) **I. Borzenets**, U.C. Coskun, H.T. Mebrahtu, Yu. Bomze, A.I. Smirnov, G. Finkelstein "Phonon bottleneck in graphene-based Josephson junctions at millikelvin temperatures", **Phys. Rev. Lett.**, 111**,** 027001, DOI: 10.1103/PhysRevLett.111.02700, 2013

21) I. Yoon, K. Hamaguchi, **I. Borzenets**, G. Finkelstein, R. Mooney, B.R. Donald, "Intracellular Neural Recording with Pure Carbon Nanotube Probes", **PLOS ONE**, 8 (6), e65715, DOI: 10.1371/journal.pone.0065715, 2013

22) H. Mebrahtu, **I. Borzenets**, D. Liu, H. Zheng, Y. Bomze, A. Smirnov, H. Baranger, G. Finkelstein, "Quantum phase transition in a resonant level coupled to interacting leads", **Nature**, 488, 61, DOI: 10.1038/nature11265, 2012

23) **I. Borzenets**, U. Coskun, H. Mebrahtu, G. Finklestein, "Pb–Graphene–Pb Josephson Junctions: Characterization in Magnetic Field", **IEEE Transactions on Applied Superconductivity**, 22, 5, 1800104, DOI: 10.1109/TASC.2012.2198472, 2012

24) **I. Borzenets**, I. Yoon, M. Prior, B. Donald, R. Mooney, G. Finkelstein, "Ultra-sharp metal and nanotube based probes for applications in scanning microscopy and neural recording.", **Journal of Applied Phys.**, Vol 111, 7**,** 074703, DOI: 10.1063/1.3702802, 2012

25) H. Mebrahtu, **I. Borzenets**, Yu. Bomze, G. Finkelstein, "Observation of Unitary Conductance for Resonant Tunneling with Dissipation", **Journal of Physics: Conference Series**, 400, 042007, DOI: 10.1088/1742-6596/400/4/042007, 2012

26) P. Li, P.M. Wu, Y. Bomze, **I.Borzenets**, G. Finkelstein, A.M. Chang, "Retrapping current, self-heating, and hysteretic current-voltage characteristics in ultranarrow superconducting aluminum nanowires", **Phys. Rev. B**, 84, 184508, DOI: 10.1103/PhysRevB.84.184508, 2011.

27) **I. Borzenets**, U. Coskun, S.Jones, G.Finklestein," Phase diffusion in graphene-based Josephson junctions", **Phys. Rev. Lett.**, 107, 137005, DOI: 10.1103/PhysRevLett.107.137005, 2011

28) P. Li, P.M. Wu, Y. Bomze, **I.Borzenets**, G. Finkelstein, A.M. Chang, "Switching Currents Limited by Single Phase Slips in One-Dimensional Superconducting Al Nanowires", **Phys. Rev. Lett.,** 107**,** 137004, DOI: 10.1103/PhysRevLett.107.137004, 2011

29) Y. Bomze, **I. Borzenets**, H. Mebrahtu, A. Makarovski, H. Baranger, G. Finkelstein, "Two-Stage Kondo and Level Spectroscopy of the Kondo Box in Carbon Nanotube", **Phys. Rev. B**, 82,16**,** 161411, DOI: 10.1103/PhysRevB.82.161411, 2010

30) Y. Bomze, H. Mebrahtu, **I. Borzenets** , A. Makarovski , G. Finkelstein "Resonant tunneling in a dissipative environment", **Phys. Rev. B**, 79, 241402, DOI: 10.1103/PhysRevB.79.241402, 2009

Skills:

Electronics: low level signal, low frequency, RF/microwave, cryogenic electronics
Mechanics: CAD design, machining (small parts), cryogenics
Data Analysis: statistical analysis, curve fitting, simulations, signal detection, digitization
Microfabrication: lithography, scanning probe (AFM, STM), nanomaterials, SEM, Raman
Device Fabrication: graphene, nanotubes, 2DEG, quantum information, Josephson junctions
Measurement: electron transport, noise, lifetime/statistical, superconductivity, scanning probe
Low temperature/Cryogenics: Sterling coolers, VTI, Pumped Helium 4, He3, Dilution fridge
Writing: scientific papers, conference presentations, grant applications, review articles, lectures

Languages:

- English: Native
- Russian: Native
- Japanese: Basic

International Collaborations:

He, Hongtao (SUSTECH, Shenzhen China); Sim, Heung Sun (Korean Institute of Science and Tecnhology); Amet, Francois (Department of Physics and Astronomy, Appalachian State University); Aoki, Hiedo (Department of Physics, The University of Tokyo); Baranger, Harold (Physics Department, Duke University); Chang, Albert (Physics Department, Duke University); Deacon, Russell (Advanced Device Laboratory, RIKEN); Finkelstein, Gleb (Physics Department, Duke University); Ke, Chung-Ting (QUTech, TUDelft); Russo, Saverio (Physics and Astronomy, University of Exeter); Smirnov, Alex (Chemistry Department, North Carolina State University); Tarucha, Seigo (Applied Physics, The University of Tokyo); Yamamoto, Michihisa (Center for Emergent Material Science, RIKEN)

References:

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