Annual Report of the Center for Nanophysics and Advanced Materials, University of Maryland
January 1 – December 31, 2013
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The Center for Nanophysics and Advanced Materials (CNAM) was established on July 1, 2007, to unify the former Center for Superconductivity Research (CSR) and Experimental Condensed Matter Physics groups into a single cohesive research entity covering all of experimental condensed matter physics, nanoscience, and related sciences and technologies. CNAM’s mission is to provide the necessary research infrastructure support to enable top-ranked externally-funded research in these areas.

CNAM has more than 140 faculty members, affiliates, post-docs, graduate students and undergraduate students working to solve the most important problems in condensed matter physics, many of which will have an impact on future technologies and society’s pressing problems such as obtaining, storing, transporting, and efficiently using renewable energy. CNAM researchers are searching for new superconductors which may operate at elevated temperatures, and could be used to transmit electrical power over long distances without energy losses. CNAM researchers are also exploring nanoelectronic and spintronic devices that could lead to new low-power computing schemes, as well as studying quantum-computing devices that could be used to solve problems that are practically impossible on a conventional (classical) computer.

CNAM supports condensed matter physics research in several ways. CNAM runs an extensive suite of shared equipment supported by two full-time engineers, including two X-ray diffractometers, two superconducting-magnet cryostats, two PPMS systems, a dilution refrigerator, electron-beam lithography and nanofabrication, thin-film deposition, and materials synthesis facilities. Maintaining these state-of-the-art shared facilities not only provides the tools for cutting-edge research, but also provides a collaborative environment where students and faculty of different groups work together. As part of our collaborations, we also provide significant support for the Joint Quantum Institute and the Condensed Matter Theory Center. CNAM sponsors a weekly CNAM Colloquium, bringing world-renowned speakers to Maryland, and also runs a weekly graduate student seminar, which also helps establish a collaborative atmosphere and sense of community among all researchers. CNAM also offers support for graduate students and postdoctoral researchers to travel to conferences to present their research results to their colleagues.

In 2013, CNAM welcomed two new faculty members, Jimmy Williams and Vladimir Manucharyan.

Jimmy Williams received his PhD from Harvard in 2009. He worked with Charlie Marcus on transport in graphene, including quantum Hall effect in electrostatically-gated p-n junctions,
noise spectroscopy, and fabrication of “nanoribbons”. After graduating, he was the Karl van Bibber Postdoctoral Fellow in the Department of Physics at Stanford in David Goldhaber-Gordon’s group, where he worked on unconventional Josephson effects in hybrid topological insulators-superconductor devices, important in the context of the continuing search for experimental signatures of Majorana fermions.

Vladimir Manucharyan received his PhD from Yale in 2010. His thesis research was carried out in Michel Devoret’s lab, working on superconducting circuits employing quantum-limited microwave amplifiers and quantum non-demolition measurement for ultimate use in quantum information. He then joined Harvard University with a prestigious Junior Fellowship. This position allows much freedom as an independent researcher for 3 years. During this time he initially worked with Charlie Marcus on proximity-induced superconductivity in semiconducting nanowires. Following Marcus’ departure from Harvard in early 2012, he collaborated with Mischa Lukin on detection of current fluctuations in superconducting and normal thin films using decoherence coupling of optically-active NV centers in diamond.

With the 2012 departure of CNAM Director Michael Fuhrer for Monash University, Rick Greene agreed to be Interim Director of CNAM for one year so that I could complete my sabbatical. As founding Director of the CSR, Rick combined scientific insight and an up-beat and supportive management style to build up a world-class research center. I am very grateful to him for stepping back into the harness to give me some extra time for research, and hope that I’ve learned a thing or two (about science and directing!) from him over the years.
Awards/Fellowships

Prof. Steven Anlage, received the Naval Research Laboratory Alan Burman Research Publication Award for 2013.

Prof. Daniel Lathrop was named the 2013 Lorenz Lecturer by the National Geophysical Society.

Prof. Min Ouyang was named a Scialog Fellow for solar energy conversion.

Prof. Johnpierre Paglione received the DOE Early Career award.
Invited Talks 2013

Anderson, J. Robert


A similar talk was given in Kyoto, Japan, January 14, 2013.

Anlage, Steven


“Nonlinear time reversal in a wave chaotic system”, SPIE Optics and Photonics Conference, San Diego, CA, August 28, 2013.


Did a review of Quantum Mechanics and Modern Physics on the GRE for UMD Physics Majors, September, 2013.

**Appelbaum, Ian**

“Harmonic Detection of the 'Majorana Fermion’”, University of Pittsburgh, Condensed Matter seminar, October 18, 2013.


**Fuhrer, Michael S.**


**Greene, Richard L.**

“Overview of recent results from the MURI search for new superconductors”, Third China/US Workshop on Novel Superconductors, Hong Kong, China, January 24, 2013.


“Surface states in the Kondo insulator SmB6”, Workshop on Topology, Correlations and Interfaces in Quantum Matter, Orsay, France, September 18, 2013.

“Fermiology and phase diagram of electron-doped cuprates”, CIFAR Quantum Materials Program meeting, Vancouver, BC, Canada, October 18, 2013.

Manucharyan, Vladimir

“Induced Superconductivity with a Single Cooper Pair”, Northwestern University, Condensed Matter Seminar, April, 2013.

“Induced Superconductivity with a Single Cooper Pair”, University of Waterloo, Waterloo, Canada), Institute for Quantum Computing, April, 2013.


Ouyang, Min


“All optical spin manipulation in bottom-up colloidal nanostructures”, International Workshop on Nanophysics, Advanced Materials and Nanodevices, P.R. China, 2013.


“All Optical Manipulation of Phonon and Spin Dynamics at the Nanoscale”, LPS, USA, 2013.

Paglione, Johnpierre

“Toward true topological insulators”, CIFAR Quantum Materials Program Meeting, Vancouver, Canada, October 2013.

“Separation of magnetism and high-Tc superconductivity in Ca1-xRxFe2As2 under pressure”, International Workshop on Fe-based High-Tc Superconductors, Riverhead, NY, September 2013.

“Separation of magnetism and high-Tc superconductivity in Ca1-xRxFe2As2 under pressure”, International Materials Research Conference XX, Cancun, Mexico, August 2013.


“Toward true topological insulators”, Seminar: Johns Hopkins University, Baltimore, MD, November 2013.

“Separation of Magnetism and Superconductivity in Rare Earth-Doped CaFe2As2 by Pressure”, Seminar: Princeton University, Princeton, NJ, February 2013.

Williams, James

Publications in 2013

Anderson, J. Robert


Anlage, Steven M.


“Mitigating the Effect of Non-Uniform Loss on Time Reversal Mirrors”, Binnyam T. Taddese, Thomas M Antonsen, Edward Ott, Steven Mark Anlage, arXiv:1208.5431v1


“Predicting the statistics of wave transport through chaotic cavities by the Random Coupling Model: a review and recent progress”, Gabriele Gradoni, Jen-Hao Yeh, Bo Xiao, Thomas M. Antonsen, Steven M. Anlage, Edward Ott, Submitted to Wave Motion, 2013. arXiv:1303.6526

Appelbaum, Ian

“Anisotropy-driven Spin Relaxation in Germanium”, Pengke Li, Jing Li, Lan Qing, Hanan Dery, and Ian Appelbaum, Phys. Rev. Lett. 111, 257204 (2013). ("Editor's Suggestion")


“Microwave Manipulation of Electrically Injected Spin Polarized Electrons in Silicon”, C.C. Lo,


Drew, H. Dennis


Fuhrer, Michael S.


Greene, Richard L.


Lathrop, Dan P.


Lobb, Christopher


Manucharyan, Vladimir E.


Ouyang, Min

Paglione, Johnpierre


Wellstood, Fred


Williams, James


## Seminars

**CNAM Condensed Matter Colloquium**

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<thead>
<tr>
<th>Date</th>
<th>Speaker</th>
<th>Title</th>
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<tr>
<td>January 24</td>
<td>Nathaniel Gabor, MIT</td>
<td>Photoresponse in Graphene Quantum Devices: Hot Dirac Fermions and the Emergence of Nonlocality</td>
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<tr>
<td>January 31</td>
<td>Vladimir Mancharyan, Harvard University</td>
<td>Proximity-induced superconductivity in a few-electron system</td>
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<td>February 7</td>
<td>Milan Allan, ETH Zurich</td>
<td>Atomic-scale Visualization of Electronic Nematicity and Cooper Pairing in Iron-based Superconductors</td>
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<td>February 14</td>
<td>Kin Chung Fong, Caltech</td>
<td>Listening to graphene noise: Can we hear a single microwave photon?</td>
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<tr>
<td>February 21</td>
<td>James Williams, Stanford University</td>
<td>Josephson Junctions with Topological-Insulator Weak Links</td>
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<td>February 27-28</td>
<td>J.C. Seamus Davis, Cornell University</td>
<td>CNAM Distinguished Lecturer Series</td>
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<td>March 7</td>
<td>Hanhee Paik, Raytheon BBN</td>
<td>L3D circuit QED architecture: Demonstrating high-coherence and high-fidelity quantum operation in superconducting circuits</td>
</tr>
<tr>
<td>March 14</td>
<td>Subir Sachdev, Harvard University</td>
<td>Metals near the onset of antiferromagnets: instabilities to d-wave pairing and bond order</td>
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<tr>
<td>April 4</td>
<td>Farhan Rana, Cornell University</td>
<td>Graphene Micro and Nano-Plasmonics</td>
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<td>April 18</td>
<td>Joseph Stroscio, NIST</td>
<td>Scanning Tunneling Microscopy of Topological Insulators and Superconductors</td>
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<tr>
<td>April 25</td>
<td>Andrei Bernevig, Princeton University</td>
<td>Fractional Topological Insulators</td>
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<tr>
<td>May 2</td>
<td>Leonid Glazman, Yale University</td>
<td>Nonlinear Quantum Liquids in One Dimension</td>
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<tr>
<td>Date</td>
<td>Speaker and Affiliation</td>
<td>Topic</td>
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<tr>
<td>September 5</td>
<td>Victor Yakovenko, University of Maryland</td>
<td>Spiral twisting of the anapole moments of loop currents as a possible origin of gyrotropy in cuprates</td>
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<tr>
<td>September 12</td>
<td>Ian Appelbaum, University of Maryland</td>
<td>Anisotropy-driven spin relaxation in germanium</td>
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<tr>
<td>September 19</td>
<td>Ian Spielman, NIST and University of Maryland</td>
<td>Engineering gauge fields: concept to reality</td>
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<td>September 26</td>
<td>Jing Xia, UC Irvine</td>
<td>Surface Transport in Topological Kondo insulator SmB6</td>
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<td>October 3</td>
<td>Ian Appelbaum, University of Maryland</td>
<td>Harmonic Detection of the &quot;Majorana Fermion&quot;</td>
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<td>October 10</td>
<td>Roald Sagdeev</td>
<td>Anomalous effects at transition layer to negative refraction index in metamaterials</td>
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<tr>
<td>Oct. 24</td>
<td>Gabriel Kotliar, Rutgers University</td>
<td>Iron Pnictides and Chalcogenides: doped Mott insulators, itinerant magnets or Hund's metals?</td>
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<tr>
<td>Oct. 31</td>
<td>Lu Li, University of Michigan</td>
<td>Quantum oscillations in Kondo insulator SmB6</td>
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<tr>
<td>November 7</td>
<td>David Vanderbilt, Rutgers University</td>
<td>Introduction to the theory of topological insulators</td>
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<tr>
<td>November 14</td>
<td>Johnpierre Paglione, University of Maryland</td>
<td>Toward true topological insulator materials</td>
</tr>
<tr>
<td>November 21</td>
<td>Louis Taillefer, Université de Sherbrooke</td>
<td>The two mysteries of superconductivity</td>
</tr>
</tbody>
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Personnel

Faculty

J. Robert Anderson
Steven Anlage
Ian Appelbaum
H. Dennis Drew (Emeritus)
Richard Greene
Daniel Lathrop
Christopher Lobb
Vladimir Manucharyan
Min Ouyang
Johnpierre Paglione
Frederick Wellstood
Ellen Williams (on leave)
James Williams

Faculty Affiliates

Nicholas Butch
John Cumings
Michael Dreyer
Liangbing Hu
Bruce Kane
Sang Bok Lee
Kevin Osborn
Ben Palmer
Raymond Phaneuf
Efrain Rodriguez
Lourdes Salamanca-Riba
Lawrence Sita
Ichiro Takeuchi
Edo Waks

Research Scientists

William Cullen
Greg Jenkins
Shanta Saha
Don Schmadel
Andrei Sushkov
R.D. Vispute

Affiliate Research Scientists

Binhui Hu
Don Martin

Research Faculty

Michael S. Fuhrer
### Research Associates

Benjamin Cooper  
Li Geng  
Jianxiao Gong  
Brian Hemingway  
Jared Hertzberg  
Joshua Higgins  
Halyna Hodovanets  
Ye-Ping Jiang  
Hyunsoo Kim  
Myoung-Hwan Kim  
Pengke Li  
Yasuyuki Nakajima  
Tim Stacey  
Micah Stoutimore  
Kefeng Wang  
Limin Wang  
Pengpeng Wang  
Xiangfeng Wang  
Jen-Hao Yeh  
Jie Yong

### Affiliate Research Associates

Wenzhong Bao  
Tim Corrigan  
Lei Fang  
Tieren Gao  
Sergey Gladchenko  
Jia Huang  
Sung Kyoung Kim  
Arron Gilad Kusne  
Shingo Maruyama  
Tiberiu Onuta  
Aruna Ramanayaka  
Dana Rami  
Jenn Robinson  
Yaniv Rosen  
Jongmoon Shin  
Santiago Triana  
Yiming Wu  
Waltraut Wustmann  
Peng Xu  
Xiaohang Zhang  
Daniel Zimmerman
Graduate Students

Paris Alexander
Ryan Artuso
Cody Ballard
Rangga Budoyo
Xinghan "Harold" Cai
Joyce Coppock
Tyler Brunson Drye
Jonathon Duay
Chris Eckberg
Jack Hellerstedt
Alex Jeffers
Moe Khalil
Hyun Soo Kim
Kai Li
Liang Li
I-Lin Liu
Tristin Metz
Josue Morales
Sergey Novikov
Oliver Oberg
Sergey Pershoguba
Jinglei Ping
Connor Roncaioli
Anita Roychowdhury
Nat Steinsultz
Baladitya Suri
Paul Syers
Biniyam Taddese
Tamin Tai
Holly Tinkey
Jacob Tosado
Melissa Trepanier
Kristen Voigt
Renxiong Wang
Zhili Yang
Jen-Hao Yeh
Shangjie Yu
Daimeng Zhang
Steve Ziemak

Affiliate Graduate Students

Matthew Adams
John Bavier
Stephen Daunheimer
Jasper Drisko
Sean Fackler
Eleanor Gillette
Lauren Graham
Zhe Gui
Junkai Hu
H.M. Jaim
Khim Karki
David Meichle
Pavel Nagomykh
Hanna Nilsson
Hansen Nordsieck
Myunghwan Park
Shavindra Premaratne
Chad Ropp
Luz Sanchez
Bahman Sarabi
Gupta Shilpi
Da Song
Jaehee Song
Rich Suchoski
Jeremy Ticey
Norvik Voskanian
Jiayu Wan
Yi Wang
Meghdad Yazdanpanah

Staff

Douglas Bensen
Margaret Lukomska
Brian Straughn
Mary Sutton