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Director’s Message

The Center for Nanophysics and Advanced Materials (CNAM) was established on July 1, 2007, and unifies the former Center for Superconductivity Research and Condensed Matter Physics groups into a single cohesive research entity covering all of condensed matter physics (theory and experiment), 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 is more than 200 people engaged in research at the University of Maryland. CNAM comprises 18 faculty, 15 faculty affiliates, 7 staff members, 6 research scientists, 4 research scientist affiliates, 32 postdoctoral researchers, 12 postdoctoral researcher affiliates, 57 research graduate assistants, 50 research graduate assistant affiliates, and numerous undergraduate researchers and visitors.

CNAM researchers are 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 pursuing nanoelectronic and spintronic devices that could lead to new low-power computing schemes, as well as studying schemes for quantum computation that could be used to solve problems that are practically impossible on a conventional (classical) computer.

During 2009, CNAM has seen significant evidence of success in its mission. CNAM researchers were awarded two large Multidisciplinary University Research Initiative (MURI) awards from Department of Defense agencies: Prof. Richard Greene is Principal Investigator for the MURI “Broad-Based Search for New and Practical Superconductors,” funded by the Air Force Office of Scientific Research; and Prof. Michael Fuhrer is Principal Investigator for the MURI “Tailoring Electronic Properties of Graphene at the Nanoscale,” funded by the Office of Naval Research. Together with two MURI awards to the Joint Quantum Institute, the Department of Physics at Maryland won more MURI awards than any other University! Prof. Fuhrer and Prof. John Cumings also participate in the Department of Energy funded Energy Frontier Research Center “Nanostructures for Electrical Energy Storage” which was awarded in 2009. The excellence of research in CNAM has propelled the Condensed Matter Physics program at Maryland to a #10 ranking in the 2010 US News & World Report survey.

2009 has also been a time of significant change in CNAM. Prof. Ellen Williams announced she would take a leave of absence starting Jan. 1, 2010 to serve as Chief Scientist at BP. CNAM pursued two faculty searches in 2009-2010. The experimental search is ongoing at the time of this message, but the theory search has gained us an outstanding new faculty member; Mike Levin of Harvard University will be joining the faculty in Fall 2010. Levin is a young rising star known for his research on topological phases of matter.
CNAM supports condensed matter physics research in several ways. CNAM runs numerous shared equipment facilities supported by two full-time engineers. 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 often work together. 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 the graduate student researchers. CNAM offer support for graduate students and postdoctoral researchers to travel to conferences to present their research results to their colleagues.

Michael S. Fuhrer  
Director, Center for Nanophysics and Advanced Materials
Invited Talks in 2009

Anderson, J. Robert


“Quantum Computing Based on Josephson-Junction SQUID Phase Qubits,” Colloquium, Georgia State University, 6 November 2009 (invited).

Anlage, Steven M.


“Can Waves Be Chaotic?” Seminar, Sensors Directorate, Wright-Patterson AFB, Dayton, OH, 8 July 2009 (invited).


“The Physics of Superconducting Metamaterials,” NSU Center for Materials Research Seminar, Norfolk State University, Norfolk, VA, 12 November 2009.

Appelbaum, Ian

University of Maryland, College Park, Electrical Engineering, seminar, 27 February 2009.

10th Int’l Conference on Ultimate Integration of Silicon, Aachen 18 March 2009.


Weizmann Institute, Rehovot Israel, Physics, seminar, 4 May 2009.


Jaszowiec 2009, Krynica, Poland, 26 June 2009.


ATI Spintronics Discussion Meeting, Tokyo, Japan, 3 October 2009.

IMR Workshop on Group IV Spintronics, Tohoku U., Sendai, Japan, 5 October 2009.


New York University, Condensed Matter seminar, 13 November 2009.

**Das Sarma, Sankar**

Director’s Talk, Low Dimensional Program, KITP, UCSB, Spring 2009.

Invited Talk on Fractional Quantum Hall Effect, Low Dimensional Program, KITP, UCSB, Spring 2009.


Chair, Symposium on Graphene at the APS March Meeting, Pittsburgh, PA, Spring 2009.


Public Lecture on Quantum Reality, KITP, UCSB, Spring 2009.

Seminar on Quantum Decoherence, Q Station, Microsoft, UCSB, Spring 2009.

Special Condensed Matter Physics Seminar on Graphene: Transport Theory and Beyond, UCSD, Spring 2009.

Invited Talk on Plasmons in Graphene, 9th Annual Workshop on Nanophotonics, ICQS, Beijing, China, Summer 2009.


Invited Talk on Topological Quantum Computation using Quantum Hall States and Superconductors, Topological Order Conference, Dresden, Germany, Summer 2009.

Invited Talk on Spin Qubits, QCPR, Minneapolis, MN, Summer 2009.


Invited Talk on Topological Quantum Computation using Non-Abelian Anyons, ICREA Workshop on Quantum Gauge Theories and Ultracold Atoms, Sant Benet, Spain, Fall 2009.

Invited Talk on Studying Unusual Phases using Cold Atoms, Bose-Einstein Condensation: Fronteirs in Quantum Gases Conference, Sant Feliu, Spain, Fall 2009.

Invited Talk on Graphene, ONR-MURI Kickoff, Greenbelt, MD, Fall 2009.

Invited Talk on Enhancing Spin Coherence by Dynamical Decoupling, Dynamical Decoupling Workshop, Boulder, CO, Fall 2009.

Invited Talk on Localization in One-Dimensional Cold Atomic Gases, CECAM-ETH Strong Correlation Workshop, Zurich, Switzerland, Fall 2009.

Microsoft Q Workshop, Talk on Bilayer FQHE, Santa Barbara, CA, Fall 2009.

Invited Talk on Quantum Spin Coherence, KITP Program on Quantum Information, UCSB, Fall 2009.
Seminar on Majorana Modes in Semiconductor-Superconductor Sandwiches, Q Station, Microsoft, UCSB, Fall 2009.

Chez Pierre Seminar, talk on Theory of Graphene: QED and FET on a Pencil Tip, MIT, Fall 2009.

Talk on Quantum Mechanics, Montgomery Blair High School, Silver Spring, MD, Winter 2009.

Talk on Quantum Computation, Montgomery Blair High School, Silver Spring, MD, Winter 2009.

**Einstein, Theodore, L.**

“Narrowing of Terrace-width Distributions During Growth on Vicinals,” (with Ajmi BH. Hamouda and Alberto Pimpinelli), American Physical Society, Pittsburgh, March 2009.


“Steps on Surfaces and Their Evolution: From Elementary Models to Universal Fluctuation Phenomena: What does the time between buses in Cuernavaca have to do with step separations?” Virginia Tech, Blacksburg, August 2009.

Galitski, Victor

"Paired Electron Pockets in the Hole-Doped Cuprates," Department of Physics, University of Fribourg, Fribourg, Switzerland, September, 2009.


"Quantum fluctuations in superconductors," Physics Department Colloquium, Georgetown University, Washington, DC, March, 2009 (invited colloquium).

"A general theory of spin relaxation in semiconductors," Presentation at the Fifth International School and Conference on Spintronics and Quantum Information Technology, SPINTECH V, Krakow, Poland, July 2009.

"General Theory of Spin Diffusion," CM seminar, Department of Spintronics and Nanoelectronics, Institute of Physics of the Academy of Sciences of the Czech Republic, Prague, Czech Republic, August, 2009.

"Exotic states of quantum matter," Award presentation at the University of Maryland Board of Visitors Meeting, College Park, MD.


"Quantum Fluctuations in Superconductors," Virginia Tech Department of Physics, Blacksburg, VA, December, 2009 (invited colloquium).

"Topological Phases in Cold Atom Systems," Presentation at the NSF site visit, Joint Quantum Institute, University of Maryland, College Park, MD, November, 2009.

Greene, Richard L.


*Approximately 15 contributed talks or posters given by postdocs or graduate students or Dr. Greene at the APS March meeting and two other international conferences.*

**Ouyang, Min**

“Controlled Crystallinity and Fundamental Coupling Interactions in Nanocrystals,” American Physical Society meeting, Pittsburgh, March 2009.

Oak Ridge National Lab Seminar.

ASU seminar.

University of Delaware, Physics Department.

University of Delaware, Materials Science Department.

4th International workshop on nanomaterials, devices and physics properties, Beijing, China.

4th US-China international Nano workshop, USTC.

UH seminar, Physics Department.

**Paglione, Johnpierre**


"Superconductivity, magnetism and lattice structure in the iron arsenides", Johns Hopkins University - Condensed Matter Seminar, November 2009.

Wellstood, Frederick C.


“A scanning SQUID microscope for imaging high-frequency magnetic fields,” (with C. P. Vlahacos and J. Matthews), Meeting of the APS, talk Y34.00012, March 2009.


Williams, Ellen


“Seeing Atoms: the beginnings of nanoscience,” Opening address for the Workshop on Women in Physics, Kansas State University, February 2009.


Yakovenko, Victor


"Theoretical models of spontaneous time-reversal symmetry breaking in Sr2RuO4 and in underdoped cuprates," colloquium, Indian Association for the Cultivation of Sciences, Kolkata, India, 13 March 2009.

"New developments in statistical mechanics of money, income, and wealth," colloquium, Kavli Institute for Theoretical Physics, University of California at Santa Barbara, 13 May 2009.


"Theories of the time-reversal symmetry breaking and the polar Kerr effect in Sr2RuO4 and in underdoped cuprates," condensed matter seminar, University of Maryland, 19 November 2009.


"Angular oscillations in a tilted magnetic field in layered metals and bilayers: Q2D, Q1D, graphite/graphene, etc. ," talk at the program on Low Dimensional Electron Systems, Kavli Institute for Theoretical Physics, University of California at Santa Barbara, 21 April 2009.

"Statistical mechanics of money, income, and wealth," talk at the 2nd International Symposium on Neural Networks and Econophysics: from superconducting junctions to financial markets, Department of Physics and Business School, Loughborough University, UK, 14 June 2009.

"Spontaneous spin accumulation in singlet-triplet Josephson junctions," talk at 2nd International Symposium on Neural Networks and Econophysics: from superconducting junctions to financial markets), Department of Physics and Business School, Loughborough University, UK, 16 June 2009.
"Statistical mechanics of money, income, and wealth," talk at the workshop Money - Interdisciplinary Perspectives, Department of Sociology, Free University of Berlin, Germany, 26 June 2009.

"d+id density-wave as the origin of the time-reversal symmetry breaking in underdoped cuprates," talk at the ICAM-I2CAM Cargese Summer Workshop, Corsica, France, 8 July 2009.


"Statistical distributions of money, income, and wealth," talk at the working group Universal Diversity Patterns Across the Sciences, Santa Fe Institute, NM, 24 February 2009.


"Statistical mechanics of money, income, and wealth," guest lecture in the course PHYS 615 Nonlinear Dynamics of Extended Systems taught by Michelle Girvan, University of Maryland, 6 October 2009.
Publications in 2009

Anlage, Steven M.


Appelbaum, Ian


Das Sarma, Sankar


**Einstein, Theodore L.**


Fuhrer, Michael S.


Galitski, Victor


Lobb, Chris


**Paglione, Johnpierre**


S.R. Saha et al., "Superconducting and ferromagnetic phases induced by lattice distortions in stoichiometric SrFe2As2 single crystals," Phys Rev. Lett. 103, 037005 (2009).


**Williams, Ellen D.**


Yakovenko, Victor M.


Seminars

CNAM Condensed Matter Colloquium

February 5, 2009  Prof. Jeremy Levy – University of Pittsburgh
Oxide Nanoelectronics On Demand

February 12, 2009  Prof. Sondan Durukanoglu – MIT & Istanbul Technical University
Atomistic Calculations on Nano-structured Materials

February 19, 2009  Prof. Senthil Todadri – MIT
Critical Fermi Surface and Non-Fermi Liquid Metals

February 26, 2009  Prof. Vivek Shenoy – Brown University
Mechanics of Graphene: Stability and the Role of Functional Groups

March 5, 2009  Prof. Christopher C. Davis – University of Maryland
The Nano-Optics of Surface Plasmon Polaritons, and their Applications in Cloaking and Microscopy

March 12, 2009  Prof. Jairo Sinova – Texas A&M University
Spin-Injection Hall Effect: A New Member of the Spintronics Hall Family

April 2, 2009  Dr. C. Stephen Hellberg – Naval Research Laboratory
The Polar Catastrophe in LaA1O3 on SrTiO3

April 9, 2009  Prof. Gregory A. Fiete – University of Texas - Austin
Multi-Channel Kondo Models in Non-Abelian Quantum Hall Droplets

April 16, 2009  Prof. Yong-Baek Kim – University of Toronto
From Frustration to Correlation via Fluctuation

April 23, 2009  Prof. Michael Gershenson – Rutgers University
Superconducting Nanocircuits for Topologically Protected Qubits

September 17, 2009  Prof. Shoucheng Zhang – Stanford University
Quantum Spin Hall Effect and Topological Insulators

September 24, 2009  Prof. Lev Ioffe/Lara Faoro – Rutgers University
The Problem(s) of Very Low Temperature Noise in Superconducting Circuits

October 1, 2009
Dr. Jorg Wunderlich – Hitachi Cambridge Laboratory
Spin Injection Hall Effect in a Photovoltaic Cell

October 8, 2009
Prof. Nitin Samarth – Pennsylvania State University
Transporting and Controlling Spin in Mesoscale Ferromagnetic Semiconductor Devices

October 22, 2009
Prof. Shuheng Pan – University of Houston
Direct Probe of the Key Building Block of the Fe-Based Superconductors with Scanning Tunneling Microscopy/Spectroscopy

October 29, 2009
Prof. Eric Pop – University of Illinois-Urbana Champaign
Carbon Nanoelectronics: Towards Energy-Efficient Computing

November 5, 2009
Prof. Nader Engheta – University of Pennsylvania
Extreme Metamaterials

November 12, 2009
Dr. Mark Johnson – Naval Research Laboratory
Electric Field Induced Spin Precession in a Spin Injected FET

November 19, 2009
Prof. Victor Yakovenko – University of Maryland
Theories of the Time-Reversal Symmetry Breaking and the Polar Kerr Effect in Sr2RuO4 and Underdoped Cuprates

December 3, 2009
Prof. Douglas Natelson – Rice University
Atomic- and Molecular- Scale Devices: Beyond DC Electronic Transport

December 10, 2009
Prof. Alexander Govorov – Ohio University
Exciton-Plasmon Interactions in Hybrid Nanostructures
W. J. Carr Lecture

The W. J. Carr Lecture Series on Superconductivity and Advanced Materials was established by Dr. James L. Carr in 1989 in honor of his father and respected scientist, Walter J. Carr. Walter Carr joined the magnetism group at the Westinghouse research labs in Pittsburgh, Pennsylvania in 1942. His first assignment was working on naval magnetism problems as part of the war effort. He worked at the Westinghouse research labs for his entire career except for a sabbatical assignment to Harwell in the United Kingdom. In 1985, he officially retired as an industrial research physicist, but continued working as a consultant up until last year when he fell ill at the age of 89. Dr. Carr has over 100 scientific papers, two books and a dozen patents to his credit in the fields of ferromagnetism and superconductivity. His most recent paper was published in 2007.

The annual series supports a distinguished guest lecturer at the University of Maryland. It aims to contribute to the advancement of students in the UMD physics program and the Center for Nanophysics and Advanced Materials.

The 2009 Carr Lecture, *An Odyssey of Discovery: Between Science and Administration, from Houston to Hong Kong*, was presented by Paul Ching-Wu Chu of the University of Houston, at 4 p.m. on Tuesday, October 13.

About The Speaker

Paul Ching-Wu Chu was until recently President and Professor of Physics at the Hong Kong University of Science and Technology.

Born in Hunan, China, Professor Chu received his B.S. degree from Cheng-Kung University in Taiwan. He earned his M.S. degree from Fordham University, New York, and completed his Ph.D. degree at the University of California at San Diego. Each of his three degrees is in physics.

After two years’ industrial research with Bell Laboratories at Murray Hill, New Jersey, Professor Chu was appointed Assistant Professor of Physics at Cleveland State University. He was subsequently promoted to Associate Professor and Professor of Physics. He later took up an appointment as Professor of Physics at the University of Houston and became Director of the Texas Center for Superconductivity. He has served as the TLL Temple Chair of Science at the same university since 1987. He also served as a consultant and visiting staff member at Bell Laboratories, Los Alamos Scientific Laboratory, the Marshall Space Flight Center, Argonne National Laboratory, and DuPont at various times.

Professor Chu has received numerous awards and honors for his outstanding work in superconductivity, including the US National Medal of Science, the Comstock Award and the International Prize for New Materials. He was an invited contributor to the White House National Millennium Time Capsule at the National Archives in 2000 and was selected the Best Researcher in the U.S. by U.S. News and World Report in 1990. He is a member of the U.S.
National Academy of Sciences, American Academy of Arts and Sciences, Chinese Academy of Sciences (foreign member), Academia Sinica, the Academy of Sciences for the Developing World; and a Fellow of the Russian Academy of Engineering. In 2007, he was appointed as a Member of the U.S. President’s Committee on the National Medal in the U.S. His research activities extend beyond superconductivity to magnetism and dielectrics. His work has resulted in the publication of more than 530 papers in refereed journals.

Abstract

According to Mark Twain, the famed American author and humorist, man’s noblest delight in life is DISCOVERY – to know that you are walking where no others have walked; that you are beholding what no human eye has seen; that you are breathing a virgin atmosphere. Indeed, what better joy can there be for a scientist than to discover a new material, phenomenon or theory; for a philosopher than to give birth to a new thought or paradigm; for an entrepreneur than to create new wealth; for a university president than to develop a haven for innovation and creativity; or for an explorer to find a new world?

Discovery goes beyond science. It is discovery that has changed for the better this world where we live. To discover involves pushing back the frontier, thinking outside the box, dreaming the impossible dream and taking the unthinkable risk. The human spirit, courage and ingenuity displayed by these discoverers are always a great inspiration to us all.

Ben Franklin, a scientist, a statesman, a diploma and an entrepreneur, is an embodiment of these all. The path of discovery is full of excitement, although often dotted with agonies of defeat. The year of 2009 holds special meaning and poses great challenges for us all as the U.S. inaugurates its first black president, faces the onslaught of the economic tsunami, and, in a small way, witnesses the discovery of a new class of high temperature superconductors.

In this lecture, Dr. Chu would like to share with the audience some of the exciting moments of a scientist oscillating between discovery in his lab in Houston and development of an intellectual powerhouse at the institute in Hong Kong he led, at this extraordinary time. Life is full of never-ending dreams and excitements, and more is yet to come.
Personnel

Faculty
James R. Anderson
Steve Anlage
Ian Appelbaum
Satindar Bhagat
Sankar Das Sarma
H. Dennis Drew
Theodore L. Einstein
Michael S. Fuhrer
Victor Galitski
Richard Greene
Theodore Kirkpatrick
Michael Levin
Daniel Lathrop
Christopher Lobb
Min Ouyang
Johnpierre Paglione
Frederick Wellstood
Ellen Williams
Victor Yakovenko

Faculty Affiliates
John Cumings
Michael E. Fisher
John Fourkas
Christopher Jarzynski
Bruce Kane
Sang Bok Lee
Gottlieb Oehrlein
Kevin Osborn
Raymond Phaneuf
Kristine M. Rosfjord
Lourdes Salamanca-Riba
Lawrence Sita
Charles Tahan
Ichiro Takeuchi
Edo Waks
John D. Weeks

Research Scientists
William Cullen
Daniel Hines
Euyheon Hwang
Yuan Lu
Dmitri Petrovkh
Don Schmadel
R.D. Vispute
Gus Vlahacos

Research Associates
Ryan Barnett
Merijn Bronsgeest
Nicholas Butch
Jianhao Chen
Dimitrie Culcer
Maxim Dzero
Behnood Ghamsari
Diego Luis Gonzalez Cabrera
Lifeng Hao
Jia Huang
Greg Jenkins
Kui Jin
Jason Kestner
Kwangmoo Kim
Cihan Kurter
Roman Lutchyn
Michael Peterson
Stephen Powell
Enrico Rossi
Shanta Saha
Jay Deep Sau
Tigran Sedrakyan
Rajdeep Sensarma
Kai Sun
Andrei Sushkov
Chris Varney
Bin Wang
Jun Yan
Jiatao Zhang
Xiaohang Zhang
Qi Zhou
**Visitors**

Paoloa Barbara  
Robert Galazka  
Malgorzata Gorska  
Ajmi B.H. Hammouda  
William Johnson  
Qi Liu  
Chril Richardson  
Daw-Wei Wang

**Graduate Students**

Brandon Anderson  
Paul Bach  
John Biddle  
Rangga Budoyo  
Kristin Burson  
Jianhao Chen*  
Meng Cheng  
Sung Jae Cho  
Enrique Cobas  
Brad Conrad*  
Benjamin Cooper  
Alexandra Curtin  
Tyler Brunson Drye  
Anirban Gangopadhyay  
Michelle Groce  
Mark Gubrud  
Micah Hawkins  
Chaun Jang  
Moe Khalil  
Dohun Kim  
Zaeill Kim  
Kevin Kirshenbaum  
Hyeokshin Kwon  
Kwan Lee  
Dan Lenski  
Jing Li  
Kai Li  
Liang Li  
Quizi Li  
Joseph Mitchell  
Kaushik Mitra  
Tracy Moore  
Sergey Novikov  
Oliver Oberg  
Paul Patrone  
Saurabh Paul  
Sergeii Pershogubua  
Jinglei Ping  
Anthony Przybysz  
Andrew Robertson  
Anita Roychowdhury  
Abraham Aklog Sahilemeskel  
Vinod Sangwon*  
Rajesh Sathiyaranarayanan*  
Samar Singla  
Adrian Southard  
William Stem  
Tianshu “James” Sun  
Baladitya Suri  
Garnder Swan  
Paul Syers  
Biniyam Taddese  
Tamin Tai  
Yun Tang  
Harita Tenneti  
Ted Thorbeck  
Jacob Tosado  
Andrew Tunnell  
Gus Vlahacos*  
Hui Wang*  
Lin Weng  
Justin Wilson  
Shudong Xiao  
Mahito Yamamoto  
Jen-Hao Yeh  
Vitaley Zaretskey  
Steve Ziemak

*Students graduating with a Ph.D. in 2009

**Undergraduate Students**

John Abrahams  
Isaac Carruthers  
Erik Crowe  
Patrick Donnelly  
Jeffrey Magill  
Uneeb Qureshi  
Maxim Wolf
Staff
Douglas Bensen
Rachael DeNale
Cheryl Ekstrom
Yuri Kubota
Margaret Lukomska
Musharraf Nazir
Brian Straughn