

*IBM dilution refrigerator with  
50 superconducting qubits*



**WORKSHOP**

# Enabling Quantum Materials

Center for Computation & Technology, CCT  
Digital Media Center, LSU Main Campus  
340 East Parker Boulevard  
Baton Rouge, LA

February 8-9, 2019

# LSU Quantum Krewe (in alphabetical order)

**John DiTusa** Chair, Department of Physics and Astronomy, received his bachelor's degree from Oberlin College and his Ph.D. from Cornell. His research is focused on exploring the consequences of chiral and non-centrosymmetric crystal structures on the electronic, magnetic and phononic properties of materials, as well as their couplings. For example, relativistic (Dirac, Weyl and chiral) quasiparticles, helical, skyrmion lattice and magnetic soliton states.



**Jonathan Dowling** Professor of Physics and Astronomy, received his Ph. D. in Mathematical Physics from the University of Colorado, Boulder, in 1988. He is the Hearne Chair Professor of Theoretical Physics and Co-Director of the Hearne Institute for Theoretical Physics. His research focuses on investigations of quantum sciences and technologies for the Second Quantum Revolution. He has been instrumental in studies of quantum sensors and imagers. He is a Fellow of the American Association for the Advancement of Science and in 2018 was elected as a Distinguished Visiting Member of the Chinese Academy of Sciences.



**Rongying Jin** Professor of Physics and Astronomy, received her Ph.D. from ETH-Zurich, Switzerland. Dr. Jin's research focuses on the development of novel complex materials with intriguing physical properties, such as new phases that exist on the edge of instabilities (unconventional superconductivity, quantum topological phenomena, thermoelectricity, etc.). Her research effort is devoted to "science-driven" synthesis and investigation of basic physical properties (charge, spin and heat transport, magnetization, specific heat etc.).



**Richard L. Kurtz** Professor of Physics and Astronomy and CAMD Director, received his bachelor's degree from Brandeis University and his Ph.D. from Yale. His research interests are focused on using synchrotron radiation to study oxide and thin-film surfaces. Recent work includes studies of Fermi surfaces showing that both initial and final states in the photoemission process contribute to the measured k-space contours.



**Omar Magana-Loaiza** Assistant professor in Physics and Astronomy, with a bachelor's degree from Instituto Nacional de Astrofísica Óptica in Puebla Mexico and a Ph.D. from University of Rochester. His research explores the fundamental and applied aspects of optical physics and quantum optics, exploring novel properties of light and its potential for developing quantum technologies.



**Kevin McPeak** Cain Department of Chemical Engineering and Director of the Nanofabrication Facility, received a bachelor's degree from Northwestern University and his Ph.D. from Drexel University. His research focuses on areas such as photocatalysis, plasmonic materials, nanofabrication and nanoscale chirality.



**Juana Moreno** Associate Professor of Physics and Astronomy, received her bachelor's degree from Universidad Autónoma de Madrid (Spain) and her Ph.D. from Rutgers University. She uses a variety of computational tools, such as the dynamical mean-field theory, the dynamical cluster approximation and quantum Monte Carlo solvers, to simulate quantum materials quantitatively using parameters extracted from first principles calculations.



**Seung-Jong (Jay) Park** Computer Science Department and Center for Computation and Technology, received his bachelor's degree from Korea University in Korea and his Ph.D. from Georgia Institute of Technology. His research is in big data and deep learning using high-speed networking and high-performance computing for large-scale data analysis including text, image and video stream analysis.



**Ward Plummer** Professor of Physics and Astronomy, received a Bachelor of Arts degree from Lewis and Clark College in 1962 and his Ph. D. in Physics from Cornell University in 1968. He is a Boyd Professor of Physics and Astronomy and special assistant to the Vice President for Research. His research focuses on investigations of quantum phenomena associated with the unique environment at a surface or interface



driven by broken symmetry and reduced dimensionality. He has been instrumental in studies of quantum dynamical properties. He is a member of the National Academy of Science and in 2018 received the Foreign Science and Technology Award from Chinese president Jinping Xi.

**Daniel Sheehy** Associate Professor of Physics and Astronomy, LSU. He received his bachelor's degree in physics from Johns Hopkins University in 1995 and his Ph.D. from UIUC in 2001. His research focuses on superfluid phases of cold atomic gases, the electronic properties of graphene and topological phases of matter.



**W.A. Shelton** Professor of Chemical Engineering and Center for Computation and Technology, received his bachelor's degree and Ph.D. from University of Cincinnati. A computational condensed-matter theorist with deep experience with high performance computing, including shared memory, distributed memory and hybrid distributed memory parallel computing. His expertise is development of electronic-structure methods, including non-equilibrium, non-collinear magnetism, layered magnetic (CMR) systems with transport and advanced computing techniques.



**Phillip Sprunger** Department of Physics and Astronomy & Scientific Director of CAMD, received his bachelor's degree from University of Indiana and his Ph.D. from the University of Pennsylvania. His research focuses on elucidating surface electronic/vibrational/structural properties of model catalytic and environmental chemistry systems.



**Ilya Vekhter** Professor of Physics and Astronomy, studied at Moscow Institute of Physics and Technology before receiving his Ph.D. from Brown. His research interests include ordering phenomena in strongly correlated systems, especially magnetism and unconventional superconductivity, as well as interfaces of topological and other spin-orbit coupled materials. He is a Fellow of the American Physical Society.



**Georgios Veronis** Associate professor school of Electrical Engineering and Computer Science received his bachelor's degree from National Technical University in Athens Greece and his Ph.D. from Stanford University. His research activities are in theory and simulation of photonic materials and devices, nanoscale photonic devices, plasmonics and computational electromagnetics.



**Mark Wilde** Associate professor of Physics and Astronomy received his bachelor's degree from Texas A&M and his Ph.D. from University of Southern California. His research interests are quantum science and theory, quantum information theory, quantum computational complexity theory. He is the author of *Quantum Information Theory*, published by Cambridge University Press in 2013.



**Weiwei Xie** Assistant Professor of Chemistry, received her bachelor's degree from Nankai University in China and her Ph.D. from Iowa State University. Her research focuses on applying approaches and tools of chemistry to design and understand solid-state materials by coupling both experimental and theoretical aspects, with a specific emphasis on novel superconductors and magnetic topological quantum materials. In 2018, she was awarded Beckman Young Investigator Award.



**David Young** Professor of Physics and Astronomy and Webster Parish Alumni Professor, received his Bachelor's degree from Truman State University and his Ph.D. from Florida State University. His research focuses on the synthesis and characterization of intermetallic strongly correlated electron materials. He has experience in the growth of single crystals and has studied noncentrosymmetric and topological materials, magnetism, superconductivity and thermoelectrics.



**Jiandi Zhang** Professor of Physics and Astronomy, received a bachelor's degree from Nanjing University of Technology in China and a Ph.D. from Syracuse University. His main research interest is exploring novel properties of complex materials like transition-metal oxides by the effects of broken symmetry, reduced dimensionality and spatial confinement, and by controlling lattice strain and chemical composition. He is a Fellow of the American Physical Society (2014) and received an NSF CAREER Award.



# AGENDA

## Friday, February 8

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| 8:00 – 8:30 am   | Continental Breakfast/Registration   |
| 8:30 – 9:00 am   | Welcome -- Gus Kousoulas, Associate Vice President for Research<br>Genevieve Gorman, Office of La. Senator William Cassidy<br>Stacia Haynie, Provost -- Cynthia Peterson, Dean, College of Science<br>Ram Ramanujam, Director of Center for Computation Technology |
| Session 1: Topological Physics<br>Chair: Ward Plummer: Chair of the Organization Committee |  |
| 9:00 – 10:00 am  | Gene Mele<br>University of Pennsylvania<br>“The Winding Road from Topological Insulators”  |
| 10:00 – 10:15 am   | Coffee Break   |
| Session 2: Quantum Optical Materials<br>Chair: Omar Magana-Loaiza                          |  |
| 10:15 – 11:15 am   | Mercedeh Khajavikhan,<br>University of Central Florida<br>“Understanding Topological Transport of Light in Laser Cavities”   |
| 11:15 – 12:15 pm   | Hailin Wang<br>University of Oregon<br>“Phononic Networks of Spins in Diamond: A New Experimental Platform for Quantum Computing”  |
| 12:15 – 1:15 pm  | Lunch (outside the conference room)  |

Session 3: Machine Learning and Quantum Technology  
Chair: William Shelton

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| 1:15 – 2:15 pm  | Jay Park<br>Louisiana State University   | “Big Data and Deep Learning for Quantum Computing” |
| 2:15 – 3:35 pm  | Juliet Gopinath<br>University of Colorado-<br>Boulder<br>Seth Bank<br>University of Texas - Austin | “Quantum Optical Materials for Quantum Internet”   |
| 3:35 – 3:50 pm  |  | Coffee Break                                       |
| Session 4: Quantum Computing<br>Chair: Jonathan Dowling |  |  |
| 3:50 – 4:50 pm  | Stefano Curtarolo,<br>Duke University  | “Data, Disorder, and Materials”                    |
| 4:50 – 6:10 pm  | Panel Discussion I<br>Curtarolo, Park, Wilde   | “Machine Learning and Quantum Information”         |
| 6:10 pm   |  | Adjourn  |
| 6:30 pm   |  | Dinner<br>All invited speakers                     |

# Saturday, February 9

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| 8:00 – 8:30 am  | Continental Breakfast/Registration   |  |
| Session 5: Quantum Materials and Entanglement<br>Chair: John DiTusa   |  |  |
| 8:30 – 9:30 am  | Roberto Leon-Montiel<br>National Autonomous Univ. of Mexico                      | “Temperature-Controlled Entangled-Photon Absorption Spectroscopy”        |
| 9:30 – 10:30 am   | Rudy Wojtecki<br>IBM Research - Almaden  | “The Potential to Accelerate Materials Discovery with Quantum Computers” |
| 10:30 – 10:50 am  | Coffee Break   |  |
| 10:50 – 12:10 pm  | Panel Discussion II<br>Gopinath, Khajavikhan, Leon-Montiel, Mele, Wang, Wojtecki | “New Materials for Quantum Technology”                                   |
| 12:10 – 12:30 pm  | Closing Remark<br>Rongying Jin, Omar Magana-Loaiza                               |  |
| Session 6: In-State EPSCoR Proposal Discussion Among all LA Faculty<br>Chairs: Michael Khonsari, Ward Plummer |  |  |
| 12:30 – 1:30 pm   | Lunch (outside the conference room)  |  |
| 1:30 – 3:00 pm  | Panel Discussion III<br>Dowling, Mislove, Ramanujam, Wojtecki                    | “What Can We (LA) Contribute to Quantum Information Science?”            |

# Guest Speakers (in order of appearance)

## **Mercedeh Khajavikhan** **University of Central Florida**

“Understanding Topological Transport of Light in Laser Cavities”

Mercedeh Khajavikhan received her Ph.D. in Electrical Engineering from the University of Minnesota in 2009. Her dissertation was on coherent beam combining for high power laser applications. She received the NSF Early CAREER Award in 2015, the ONR Young Investigator Award in 2016, the University of Central Florida Reach for the Stars Award in 2017, as well as the DARPA Young Faculty Award and the UCF Luminary Award in 2018.



## **Hailin Wang** **University of Oregon**

“Photonic Networks of Spins in Diamond: A New Experimental Platform for Quantum Computing”

Hailin Wang received his B.S. and Ph.D. degrees in physics from the University of Science and Technology of China and the University of Michigan in 1982 and 1990, respectively. He joined the University of Oregon in 1995, where he is a professor of physics and holds the Alec and Kay Keith Chair in Physics. His current research interests include quantum optics of mechanical and solid-state spin systems and quantum information processing.



## **Juliet Gopinath** **University of Colorado at Boulder**

“Quantum Optical Materials for Quantum Internet”

Juliet Gopinath holds a B.S. degree in electrical engineering from the University of Minnesota and S. M. and Ph.D. degrees in electrical engineering from the Massachusetts Institute of Technology (MIT). She is the Director of the Quantum Interdisciplinary Research Theme at the University of Colorado-Boulder in the Electrical, Computer, and Energy Engineering, Physics, and Materials Science Departments.



## **Seth Bank** **University of Texas at Austin**

“Quantum Optical Materials for Quantum Internet”

Seth Bank received his B.S. degree from the University of Illinois at Urbana-Champaign in 1999 and his M.S. and Ph.D. degrees in 2003 and 2006 from Stanford University, all in electrical engineering. He joined the Department of Electrical and Computer Engineering at the University of Texas at Austin in 2007.



## **Stefano Curtarolo** **Duke University**

“Data, Disorder, and Materials”

Dr. Curtarolo research interests lie at the intersection of materials science, artificial intelligence and autonomous discovery of new materials. He received his M.S. in Physics from Penn State University in 1999, and a Ph.D. in Materials Science from MIT in 2003. Since then, he has been on the faculty of Materials Science at Duke University (Physics, Chemistry and Electrical Engineering included).



## **Roberto de J. León-Montiel** **National Autonomous University of Mexico (UNAM)**

“Temperature-Controlled Entangled-Photon Absorption Spectroscopy”

Dr. León-Montiel combines quantum optics, chemical physics and materials science in his research. He received his M.S. in Optics from the National Institute of Astrophysics, Optics and Electronics (INAOE) in 2010, and a Ph.D. in Photonics from The Institute of Photonic Sciences (ICFO) in Barcelona, Spain. He is currently the Chair of the Optical Society of America (OSA) Quantum Computing and Communication Technical Group.



## **Rudy Wojtecki** **IBM – Almaden Research Center**

“The Potential to Accelerate Materials Discovery with Quantum Computers”

Dr. Wojtecki graduated from Case Western Reserve University in 2013 with a Ph.D. in Macromolecular Science & Engineering under the auspices of Stuart J. Rowan (now at the Univ. of Chicago) and with the support of a NASA GSRP fellowship. In 2017 he was recognized as an IBM Master Inventor for work highlighted in over 100 patents and patent applications.



# Keynote Speaker

## Eugene Mele

**Winner of the 2019 Breakthrough Prize in Fundamental Physics, University of Pennsylvania**

### **“The Winding Road from Topological Insulators”**

“Our research group studies quantum electronic phenomena in condensed matter. We are particularly interested in so called “low dimensional” systems where the electron’s motion is geometrically restricted by the effective dimensionality of the structure.

This occurs in many physical systems, for example at the surfaces of solids, in nanostructures, and in molecular solids. We are currently exploring electronic phenomena in molecular solids that are derived from fullerene molecules, nanotubes and related carbon-derived structures. These provide a very interesting family of structures in which subtle changes in stoichiometry or geometry are known to lead to a wide range of electronic phenomena (conducting, insulating, magnetic and superconducting phases are known for these solids). We study how this range of properties depends on the microscopic structures of the constituents and how this behavior might be controlled at the molecular level. We are interested in better understanding the effects of strong repulsive interactions between electrons on the electronic properties.”



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The Enabling Quantum Materials Workshop brings together experts in the fields of quantum materials, topological photonics, quantum photonics and quantum information science and is sponsored by:

**LSU Office of Research and Economic Development**  
**LSU Center for Computation and Technology**  
**LSU Department of Physics and Astronomy**  
**LSU College of Science**  
**LSU Center for Advanced Microstructures and Devices**  
**IBM**

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