

# 2021 Materials with Extreme Properties and Condensed Matter Physics Joint Review

Drs. Ali Sayir/Jiwei Lu | October 12-15, 18-22 & 25, 2021 | Virtual

## Review At-A-Glance

Day/Date	Talks/Theme	Start/End	Comments
<b>Tuesday/ Oct. 12</b>	8 Talks/ Quantum Materials: Defect and Disorder	1030 to 1630	
<b>Wednesday/ Oct. 13</b>	7 Talks and Poster Session/Quantum Matters	0845 to 1700	
<b>Thursday/ Oct. 14</b>	10 Talks/ $\beta$ -Ga <sub>2</sub> O <sub>3</sub>	0800 to 1730	
<b>Friday/ Oct. 15</b>	9 Talks/ Complex Oxides	1030 to 1630	
<b>Monday/Oct. 18</b>	8 Talks/Dielectrics	1030 to 1630	0.5 hr discussion
<b>Tuesday/ Oct. 19</b>	7 Talks/NSF&MEE	1100 to 1630	0.5 hr Q&A
<b>Wednesday/ Oct. 20</b>	5 Talks and Poster Session	1000 to 1700	1 hr Q&A
<b>Thursday/ Oct. 21</b>	8 Talks/Processing Science	1030 to 1500	
<b>Friday/ Oct. 22</b>	5 Talks/Dielectrics	1030 to 1400	
<b>Monday/Oct. 25</b>	6 Talks/Spin and Magnetism	1030 to 1600	1 hr discussion

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## Agenda Day 1 | October 12, 2021

Time	Topic	Speaker
9:45	Zoom Login	
10:15	WELCOMING REMARKS	A. Sayir & J. Lu, AFOSR
<b>QUANTUM MATERIALS: DEFECT AND DISORDER</b>		
10:30	Design and Synthesis of Materials with Targeted Quantum Characteristics	G. Galli & D. Awschalom U. CHICAGO J. Lebeau / MIT Z. Sitar / NCSU
11:30	Optically Active Single-defect Spin-qubits in Wide Bandgap ZnSe	E. Waks U. MARYLAND
12:00	PECASE Unraveling Phonons at the Atomic Scale	J. Lebeau MIT
12:30	<b>LUNCH</b>	
13:30	Effects of Disorder on Electronic Properties near Nematic Quantum Phase Transitions: Model Systems to Explore Fundamental Physics Relevant to the Discovery of New Superconducting Phases	I. Fisher STANFORD
14:00	Nanoscale Quantum Sensing and Imaging of Emergent Spin Behavior in an Antiferromagnetic Insulator	C. H. Du UCSD
14:30	Quantum Spin Dynamics, Coherence, and Disorder in Dense Magnetic Systems	D. Silevitch CALTECH
15:00	<b>BREAK</b>	
15:30	PECASE Towards Single Anyon Control in Graphene Heterostructures	A. Young UCSB
16:00	YIP Direct Visualization of Topological Superconducting States in the GHz Regime	M. Allen UCSD
16:30	<b>MEETING ADJOURN</b>	

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## Agenda Day 2 | October 13, 2021

Time	Topic	Speaker
8:45	Zoom Login	
<b>QUANTUM MATTERS: OPTICAL AND MAGNETIC EFFECTS</b>		
9:00	MURI Programmable Systems with Non-Hermitian Quantum Dynamics	S. K. Ozdemir PSU
10:00	Investigating the Role of Band Dispersion and Topology in Determining the Properties of Topological Phases of Matter	R. Agarwal U PENN
10:30	<b>BREAK</b>	
11:00	Optical Control of Electronic Topological States	M. Hafezi UMD
11:30	Light-matter interactions and many-electron excitations in quantum materials	L. Yang WUSTL
12:00	<b>LUNCH</b>	
13:00	Enhancing Topology with Twistronics	J. Cano STONY BROOK U.
13:30	Exploring Correlated Topological States with Charge Density Waves	K. Burch & L. Schoop BC and PRINCETON
14:00	PECASE Optical imaging of Magnetic Quantum Phase Transitions in 2D Materials	K. F. Mak CORNELL
14:30	<b>BREAK</b>	
14:45	<b>POSTER SESSION PART I</b>	
17:00	<b>ADJOURN</b>	

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## POSTER SESSION PART I October 13 - 2:45 PM

	Title	PI	Institution
1	Thermal Properties of Silicon-based Ceramic Aerogels under different Humidity and Temperature Levels	Ahmetoglu, Cekdar	Izmir Yuksek Teknoloji Enstitusu
2	Correlated Orbital Control Of Electronics, Magnetism, and Topological Behavior in Rhenates	Ahn, Charles	Yale University
3	Electromagnetically Induced Modification of Metal Optical Properties	Berg, Matthew	Kansas State University
4	Depscor: Discovering New Atomically Laminated Transition Metal Borides with Diverse Properties	Cakir, Deniz	University Of North Dakota
5	Semiconducting AlN: A New Pathway to High Voltage, Power and Temperature Ultra-Wide Bandgap Power Electronic Components	Doolittle, William	Georgia Tech
6	UV Photostimulation Effects on Semiconductor Defects and Transport	Ertekin, Elif	University Of Illinois
7	Dislocations as Nature's Quantum Wires	Ghazisaeidi, Maryam	Ohio State University
8	New Paradigms for Goniopolar Materials	Goldberger, Joshua	Ohio State University
9	Exploring Entanglement In Quantum Spin Liquids with Nonlinear Spectroscopy	Harter, John	University Of California, Santa Barbara
10	Search for Deep Center Defects for Quantum Applications in Znse	Irving, Douglas	North Carolina State University
11	Topological Quantum Electronics and Optoelectronics in Moire Superlattices	Jarillo-Herrero, Pablo	Massachusetts Institute Of Technology
12	YIP: Topological Superconductivity and Induced Phase Transitions in Strained Heusler Membranes and Twisted Bilayers	Kawasaki, Jason	University Of Wisconsin System
13	Unusual Physics in Dirac-Weyl Materials with a Flat Band	Lai, Ying-Cheng	Arizona State University
14	Ion Channels in Geopolymers: Artificial Synapses with Unique Electro-Mechanical Properties	Lamuta, Caterina	University Of Iowa
15	DEPSCOR: Time Reversal Symmetry Breaking in Quantum Materials without Magnetism	Monti, Oliver	University Of Arizona
16	Unconventional Topological Fermions	Morosan, Emilia	Rice University
17	Ferroelectric Control of Conductivity in Beta-Ga2O3 for Power Electronics	Barret, Nicholas	Commissariat L'energie Atomique, France

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## Agenda Day 3 | October 14, 2021

Time	Topic	Speaker
7:50	Zoom Login	
<b>EXTREME ENVIRONMENT ELECTRONICS: <math>\beta</math>-Ga<sub>2</sub>O<sub>3</sub></b>		
8:00	AOARD Growth and Study of Optical Properties of Ga <sub>2</sub> O <sub>3</sub>	D. Nath INDIAN INST. S &T, INDIA
8:30	Properties of Gallia Micro and Nanostructures	B. Mendez UCM, SPAIN
9:00	EOARD Growth Mechanism and Defect Formation in $\beta$ -(Al <sub>x</sub> Ga <sub>1-x</sub> ) <sub>2</sub> O <sub>3</sub> /Ga <sub>2</sub> O <sub>3</sub>	A. Popp and G. Wagner IKZ, GERMANY
9:30	YIP Investigation of Electron Transport in $\beta$ -(Al,Ga) <sub>2</sub> O <sub>3</sub> Thin Films	E. Ahmadi MICHIGAN
10:00	<b>BREAK</b>	
10:30	Extreme Environment Stability of Wide Band Gap $\beta$ -Ga <sub>2</sub> O <sub>3</sub>	N. Alem PSU
11:00	COE 18 AFRL-Cornell Center for Epitaxial Solutions (ACCESS)	M. Thompson CORNELL
12:00	<b>LUNCH</b>	
13:00	Fundamental Study of p-Type Doping in MOCVD-Grown Ga <sub>2</sub> O <sub>3</sub>	M. Razeghi NORTHWESTERN
13:30	MURI 18 Doping and Defects in Ga <sub>2</sub> O <sub>3</sub> for High Breakdown Field	M. Scarpulla U UTAH
14:30	<b>BREAK</b>	
15:30	MURI 18 Gallium Oxide Materials Science and Engineering (GAME)	J. Speck UCSB
16:30	Fabrication, Processing and Characterization of Contacts to $\beta$ -Ga <sub>2</sub> O <sub>3</sub>	R. V. Chintalapalle & L. Porter UTEP / CMU
17:00	<b>ADJOURN</b>	

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## Agenda Day 4 | October 15, 2021

Time	Topic	Speaker
9:45	Zoom Login	
<b>COMPLEX OXIDES</b>		
10:00	EOARD Anisotropy and Defects on the Electrocaloric Relaxor Ferroelectrics	E. M. Alkoy & B. Misirlioglu GEBZE / SABANCI U.
10:30	EOARD Controlling resistance degradation of high-permittivity dielectrics	A. Klein DARMSTADT
11:00	Defect Equilibration Studies in Binary Metal-Oxides	S. Ramanathan PURDUE
11:30	YIP Nanoscale Pyroelectric Hybrid Materials	J. Shi RPI
12:00	<b>LUNCH</b>	
13:00	MURI Cross-disciplinary Electronic-ionic Research Enabling Biologically Realistic Autonomous Learning (CEREBRAL)	W. A. Doolittle Ga. Tech.
14:00	Functional Nanostructured Strongly Correlated Solids	I. Schuller UCSD
14:30	<b>BREAK</b>	
15:00	The Strain-stress Relations for Bandgap, Phonon and Plasmon Energies	M. Schubert U. NEBRASKA LINCOLN
15:30	Extreme Nonlinearity in Transition Metal Oxides	A. Demkov and J. Ekerdt UT AUSTIN
16:00	Towards Dissipation-less Conduction in Oxide Topological Insulators	Y. Suzuki STANFORD
16:30	<b>ADJOURN</b>	



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## Agenda Day 5 | October 18, 2021

Time	Topic	Speaker
10:15	Zoom Login	
<b>EXTREME ENVIRONMENT ELECTRONICS</b>		
10:30	Co-doping Perovskite Dielectrics for Reliability under Extreme Voltages	E. Dickey NCSU
11:00	Metal/Dielectric Interface in Dielectric Degradation and Breakdown	D. Irving NCSU
11:30	Nonlinear Optical imaging of Coupled Breakdown in Dielectrics	S. Greenbaum and Y. Ren HUNTER COLLEGE
12:00	<b>LUNCH</b>	
13:00	Permittivity, Polarization, and Gas Dynamics in Electroceramics	B. Tilley WPI
13:30	Mechanisms of Electrical Contact Resistance	M. Baykara & A. Martini UC MERCED
14:00	<b>BREAK</b>	
14:30	Composite Material and Interface Physics of Cathode	W. Tang & T. Back AFRL
15:00	Hierarchical Evaporator for Extreme Thermal Management	E. Wang MIT
15:30	Window Development Tools for Hypersonic Applications	R. Hay AFRL
16:00	<b>DISCUSSION</b>	
16:30	<b>ADJOURN</b>	

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## Agenda Day 6 | October 19, 2021

Time	Topic	Speaker
10:45	Zoom Login	
11:00	WELCOMING REMARKS	A. Lewis & A. Sayir
<b>PREDICTIVE MATERIAL SCIENCE : NSF &amp; AFOSR PART I - QUANTITATIVE REPRESENTATION OF MICROSTRUCTURE (QRM)</b>		
11:30	QRM 18 Microstructural Quantification and Virtual Reconstruction	M. Maiaru U MASS LOWELL
12:00	QRM 18 Visual Info to Quantify Microstructure-Processing Relationship	E. Holm & B. Webler CMU
12:30	<b>LUNCH</b>	
13:30	QRM 18 Cellular Materials via a Multiscale Quantitative Representation	Y. Zhu & L. Li VIRGINIA TECH
14:00	QRM 18 Hybrid Adversarial-Training Methods for 3D Microstructures	S. Niezgoda & D. Dimiduk OSU
14:30	QRM 18 Microstructure Manifold Analysis Using Hierarchical Set of Morphological, Topological, and Process Descriptors	A. Wodo & B. Ganapathysubramanian SUNY BUFFALO / ISU
15:00	<b>BREAK</b>	
15:30	Locally Extracted Globally Organized Microstructure Models	V. Sundararaghavan U. MICHIGAN
16:00	In-Situ Experiments and Multiscale Modeling of the Thermo-Mechanical Properties of Micro-Architected Tungsten Coatings	J. El-Awady JHU
16:30	Q & A	A. Lewis & A. Sayir
17:00	<b>ADJOURN</b>	



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## Agenda Day 7 | October 20, 2021

Time	Topic	Speaker
10:45	Zoom Login	
<b>PREDICTIVE MATERIAL SCIENCE : PART II - MICROSTRUCTURE PROPERTY RELATIONSHIP</b>		
10:00	EOARD Metallic Glass/Nanocrystal Composites and NiTiHf Shape Memory Alloys for High Temperature Applications	E. Kalay & I. Kalay & B. Kockar ODTU / CANKAYA / HACETTEPE
10:30	Quantification of Atom Probe Tomography Data	W. Windl & E. Marquis OSU / U. MICHIGAN
11:00	High Temperature and Pressure Multicomponent Alloy Design	S. Yang SU A&M
11:30	<b>BREAK</b>	
12:00	Scientific Understanding of Interfaces	H. Sehitoglu UIUC
12:30	Quantifying the Defect Character of Grain Boundaries	H. B. Chew UIUC
13:00	<b>LUNCH</b>	
14:00	Q & A	A. Lewis & A. Sayir
15:00	POSTER SESSION II	
17:00	<b>ADJOURN</b>	

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## POSTER SESSION PART II October 20 - 3:00 PM

	Title	PI	Institution
1	Unraveling the Multi-Scale Structure-Performance Correlation of Temperature Stable Relaxors at Extreme Conditions	Ortalan, Volkan	University of Connecticut
2	All-Optical Transformations Performed using Diffractive Materials	Ozcan, Aydogan	University of California, Los Angeles
3	Wigner Crystals in Atomically thin Heterostructures	Park, Hongkun	Harvard College
4	Two-Dimensional Molecular Crystals for Hybrid Quantum Solids	Park, Jiwoong	University of Chicago
5	New Magnetic Interfaces for Quantum Phenomena	Pasupathy, Abhay	Columbia University
6	Growth and Characterization of Gallium-Oxide Epitaxial Films for High Performance Contact Structures	Ramana, Chintalapalle	University of Texas at El Paso
7	Picocavity QED: A New Materials Platform for Room-Temperature Control of Quantum Coherence	Raschke, Markus	Regents of The University of Colorado
8	Squeeze-Grown 2D Topological Insulators for Room Temperature Quantum Devices	Sanchez-Yamagishi, Javier	University of California, Irvine
9	Terahertz Electron Paramagnetic Resonance Ellipsometry Defect Characterization in Ultrawideband Gap Monoclinic Gallium Oxide and Related Alloys	Schubert, Mathias	Board of Regents of The University of Nebraska
10	Quantum Magnetotransport in Two-Dimensional Quatic Materials	Sevincli, Haldun	Izmir Yuksek Teknoloji Enstitusu
11	Engineering Superconductivity in Germanium	Shabani, Javad	New York University
12	In Situ Nanoscale Visualization of Peritectic Reactions	Shahani, Ashwin	Regents of The University of Michigan
13	Strongly Correlated Electrons for Topological Quantum Phases with Amplified Responses	Si, Qimiao	Rice University
14	Low Emissivity Window	Slovick, Brian	Sri International
15	Materials Science for Local Heating of Electronic Nanostructures	Stadler, Bethanie	Regents of The University of Minnesota
16	Correlations in Topological Heterostructures	Stemmer, Susanne	University of California, Santa Barbara
17	Chern Number Engineering in a Layered Topological Magnet	Xu, Xiaodong	University of Washington

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## Agenda Day 8 | October 21, 2021

Time	Topic	Speaker
10:15	Zoom Login	
<b>EXTREME ENVIRONMENT MATERIALS: PROCESSING SCIENCE</b>		
10:30	YIP Directionally-Solidified Spiral Eutectics: Towards Chiral Metamaterials	A. Shahani MICHIGAN
11:00	Short Range Order and Electronic Entropy: from Melts to Solids	A. Allanore MIT
11:30	Role of Carbon Vacancies on Properties of Transition-Metal Carbides	S. Kodambaka UCLA
12:00	High-Temperature Ceramic Grain Boundaries with Electric Fields	J. Luo UCSD
12:30	<b>LUNCH</b>	
13:30	Feasibility Investigation to the Interfacial Understanding of Dissolution	C. Randall PSU
14:00	Advances In Green Processing to form Transparent Ceramics	R. Speyer GIT
14:30	PECASE Soft Chemical Approaches to the Synthesis of Metastable Materials	D. Freedman MIT
15:00	Spin Configuration, Chemical Reactions, and Synthesis under EM Field	D. Vashaee NCSU
15:30	<b>ADJOURN</b>	

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## Agenda Day 9 | October 22, 2021

Time	Topic	Speaker
10:15	Zoom Login	
<b>DIELECTRIC COUPLING</b>		
10:30	EOARD 2D Metal Carbides for EM Shielding	G. Buke & C. Cevik TOBB / ANADOLU U.
11:30	EOARD Surface Roughness Effects in Reflection and Emission of IR Radiation	K. Sendur SABANCI
12:00	Millimeter Wave Interactions with High Temperature Materials	B. Hoff AFRL
12:30	<b>BREAK</b>	
13:30	Nonreciprocal Structures with Phase-Change Components	A. Chabanov & B. Stadler UTSA / MINNESOTA
14:00	Field Enhanced Optical Transmission in Metal	M. Berg KANSAS STATE
14:30	<b>ADJOURN</b>	

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## Agenda Day 10 | October 25, 2021

Time	Topic	Speaker
10:00	Zoom Login	
<b>MAGNETISM</b>		
10:30	UNDOPhase: UNcertainty-DOMinated Phase Transitions in Magnetic Materials	P. Acar VIRGINIA TECH
11:30	Multiferroic Heterostructures Towards High Frequency Acousto-Magnetic Electronics	M. Page AFRL RX
12:00	HBCU/MSI All-spin Logic enabled by 2D Materials	E. Ahn UTSA
12:30	<b>BREAK</b>	
13:00	PECASE Atomic-scale characterization of layered magnetic materials	P. Huang UIUC
13:30	YIP Speed Limit of Magnetization Dynamics in Magnetic Heterostructure	R. Kukreja UC DAVIS
14:00	HBCU/MSI Energy-efficient Sub-5-nm Magnetic Tunneling Junctions	N. Mohammed FLORIDA INTERNATIONAL
14:30	<b>BREAK</b>	
15:00	DISCUSSION	
16:00	<b>ADJOURN</b>	