Summer 2023 Newsletter

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Important Dates

**September 01, 2023** Application deadline for the Richard L. Greene Dissertation Award in Experimental Condensed Matter or Materials Physics: https://www.aps.org/programs/honors/prizes/greene.cfm.

**August 31, 2023 - October 20, 2023** Abstract submission open for 2024 APS March Meeting. Submission is via the web at https://march.aps.org/attendees-presenters/abstracts.

**November 13, 2023** Application deadline for the DMP Ovshinsky Student Travel Awards and the DMP Post-Doctoral Travel Awards. Advisors will be asked to complete a letter of support by **November 28, 2023**.

**March 4 - March 8, 2024** (with short courses/tutorials on March 3): APS March Meeting in Minneapolis, Minnesota.

A Note from the Chair

We hope you are enjoying the summer months. With the Las Vegas March Meeting in the rear view mirror, we are now in the midst of preparing for next year’s March Meeting in Minneapolis and finalizing DMP award, prize and fellowship recognition. As always, your participation in nominating speakers and giving us feedback is key to the success of DMP’s activities.
We are excited to convene in Minneapolis for the 2024 March Meeting from March 4-8, 2024. It is hard to believe that it has been over two decades since the March Meeting was last in Minneapolis in 2000. James Rondinelli, DMP Chair-Elect, is our 2024 March Meeting DMP program chair. He is putting together an exciting program with help from the entire Executive Committee. As described below, James has assembled a strong line-up of 21 Focus Topics, covering a diverse range of contemporary topics in materials physics, including the exciting physics that arises at the intersection of materials science with topology, strong correlations, quantum information, and reduced dimensionality. We anticipate that the DMP Focus Topics will continue to attract outstanding invited and contributed talks as well as posters. We appreciate your continued support in nominating excellent speakers is key for the success of our DMP Focus Topics.

Focus Topic sessions provide an excellent venue for the presentation of your most recent exciting advances among descriptions with your students and colleagues, so that you can plan in advance about submitting your most exciting advances to relevant sessions. As you know, the March Meeting provides an excellent venue for both advancing the state of knowledge in our research areas as well as training beginning scientists in the skill sets that are so crucial for their professional development.

DMP also facilitates the recognition of the many achievements of our community via awards, prizes and fellowship. First of all, I would like to thank the DMP community for submitting strong nominations. I would also like to thank my colleagues from the community as well as the DMP Executive Committee who chaired and served on selection committees for APS Fellows, the James C. McGroddy Prize for New Materials, and the David Adler Lectureship in Materials Physics. DMP also has representation on the selection committee for the Mildred Dresselhaus Prize in Nanoscience and Nanomaterials. These committees have been hard at work over the summer months, selecting winners from the nominations from the APS community. The final selections will be announced by APS in late Fall. If you wish to nominate well deserving colleagues for the above recognition in the future, please note that the DMP nomination deadline for APS fellowship is usually the beginning of May and the award/prize nomination for McGroddy, Adler and Dresselhaus is usually the beginning of June. DMP and APS encourage nominations of women and members of under-represented minority groups for these prizes, awards, and fellowships.

DMP is also heavily invested in recognizing junior members of our community. We would like to remind you of the September 1 nomination deadline for the Richard L. Greene Dissertation Award in Experimental Condensed Matter Materials Physics. The 2023 awardees are:
Suraj Cheema, University of California, Berkeley, "For atomic-scale design of ferroelectricity and negative capacitance in ultrathin HfO$_2$-ZrO$_2$ films on Si" and

Tiarnan Doherty, University of Cambridge, “For characterizing nanostructure and understanding its influence on phase stability and performance in Halide perovskites"

See https://www.aps.org/programs/honors/prizes/greene.cfm for full details.

I would also like to remind everyone about the DMP travel awards for students and post-docs. Student presenters at the March Meeting are invited to apply for a Stanford and Iris Ovshinsky Student Travel Award. Postdoctoral presenters are also invited to apply for a DMP Postdoctoral Travel Award. These highly competitive and prestigious awards are available to students and postdocs whose abstracts are submitted to DMP-sponsored contributed sessions. The awards provide travel support and the awardees will be publicly recognized at our Reception at the 2024 March Meeting. Applications must be completed by November 13, 2023. Advisors will be asked to complete a letter of support by November 28, 2023.

I would also like to encourage you to nominate colleagues or self-nominate for DMP nominating committee, executive committee and chair-line as described below.

Finally, I would like to recognize the members of the DMP Executive Committee who have recently completed their service. Rachel S. Goldman (University of Michigan) completed her four years in the chair line, while Peter Fischer and Anand Bhattacharya completed their terms as Members-at-Large. We appreciate all their time and effort to better our community and their contributions have been invaluable.

I look forward to seeing you all in Minneapolis next March!

Yuri Suzuki, DMP Chair

The DMP Executive Committee

Chair: Yuri Suzuki, Stanford University (03/23 - 03/24)
Chair Elect: James M. Rondinelli, Northwestern University (03/23 - 03/24)
Vice Chair: Junqiao Wu, University of California, Berkeley (03/23 - 03/24)
Past Chair: Vivien Zapf, Los Alamos national Laboratory (03/23 - 03/24)

Councilor: Peter E. Schiffer, Princeton University (01/21 - 12/24)
Secretary/Treasurer: Ni Ni, University of California, Los Angeles (03/23 - 03/26)

Members-at-Large:
   Judy J. Cha, Cornell University (03/21 – 03/24)
The Division of Materials Physics March Meeting Postdoctoral Travel Awards

To recognize innovative materials physics research by post-doctoral researchers, the Division of Materials Physics will again be sponsoring March Meeting Postdoctoral Travel Awards for those presenting at the APS March Meeting.

We anticipate that there will be an increase in the number of Travel Awards from 2023 to support participation in DMP Focus Topic sessions at the APS March Meeting sessions. The selection will be based on the research quality, the impact of the research at the March Meeting and the innovative contribution of the postdoctoral researcher. The selection committee will consist of members of the DMP Executive Committee.

Postdoctoral researchers interested in being considered for an award must apply online. The application deadline is November 13, 2023; a link to the application site will be available on the DMP website closer to this deadline. Nominations of members belonging to groups traditionally underrepresented in physics, such as women, LGBT+ scientists, scientists who are Black, Indigenous, and people of color (BIPOC), disabled scientists, and scientists from outside the United States are especially encouraged.

The Division of Materials Physics Ovshinsky Student Travel Awards

The Ovshinsky Student Travel Awards were established to assist the career of student researchers. The Awards are named after Stanford and Iris Ovshinsky, who had a very strong interest in, and commitment to, scientific education. The awards have been endowed by the Ovshinsky family, their colleagues at Energy Conversion Devices (ECD) companies and all their numerous friends from many social, intellectual and business relationships.

We anticipate that there will be an increase in the number of Travel Awards from 2023 to enable students to participate in the APS March Meeting sessions that are sponsored by DMP. The selection will be based on merit and the selection committee will consist of members of the DMP Executive Committee.
Students interested in being considered for an award must apply online, and information can be found on the Division of Materials Physics pages under ‘Prizes and Awards’. The application deadline is **November 13, 2023**; a link to the application site will be available on the DMP website closer to this deadline. Nominations of members belonging to groups traditionally underrepresented in physics, such as women, LGBT+ scientists, scientists who are Black, Indigenous, and people of color (BIPOC), disabled scientists, and scientists from outside the United States are especially encouraged.

The recipients of the 2023 Ovshinsky Student Travel and Honorable Mention Awards as well as the 2023 Post-Doctoral Travel Awards were listed in the 2023 Winter DMP Newsletter.

**The Richard L. Greene Dissertation Award**

The Richard L. Greene Dissertation Award in Experimental Condensed Matter or Materials Physics was established in 2013 to honor the scientific and administrative contributions of Richard L. Greene to experimental condensed matter and materials physics. This award recognizes doctoral thesis research of exceptional quality and importance in experimental condensed matter or experimental materials physics. The annual award consists of $3000, a certificate, travel reimbursement up to $1000, and a registration waiver to attend to give an invited talk and accept the award at APS March Meeting.

Nominations will be accepted for doctoral dissertations written in English and submitted to any college or university, worldwide. Nominees must have submitted their dissertations after January 1, two years prior to the award year. For example, if submitting a nomination for the award to be presented in 2019, the nominee must have submitted their dissertation after January 1, 2017. Nominations may be considered for up to two consecutive review cycles if they continue to meet these criteria and the nominator re-certifies the nomination before the next deadline.

More information about the award can be found at [https://www.aps.org/programs/honors/prizes/greene.cfm](https://www.aps.org/programs/honors/prizes/greene.cfm). The application deadline is **September 1, 2023**.

**Nominations for DMP Officers and Executive Committee Members**

The DMP Officer election will be held late in 2023 to elect a Vice-Chair, a Councilor, and two new Member-at-Large Executive Committee Members. According to the Bylaws, the Nominating Committee shall nominate at least two candidates for the ballot for each office. We are inviting your suggestions for candidates, which should be emailed to the DMP Past
Chair, Vivien Zapf (vzapf@lanl.gov) and copied to the DMP Secretary, Ni Ni (nini@physics.ucla.edu) by September 15, 2023.

It is important to remember the membership of APS is diverse and global, so the Executive Committees of the APS should reflect that diversity. Nominations of women, members of underrepresented minority groups, and scientists from outside the United States are especially encouraged.

In addition, candidates can be directly nominated by petition of five percent of the membership of the Division. Such petitions must be received by the DMP Secretary/Treasurer, Ni Ni (nini@physics.ucla.edu) by October 1, 2023.

**DMP Focus Topics for the 2024 APS March Meeting**

The Division of Materials Physics is delighted to announce the program of DMP Focus Topics for the 2024 APS March Meeting (March 4 – March 8, 2024) in this Newsletter. A Focus Topic generally consists of a series of sessions, each of which is typically seeded with one invited talk, the remainder of the session being composed of contributed presentations.

For the 2024 March Meeting, DMP is the lead organization unit on 21 different Focus Topics and is the co-sponsoring unit for an additional 10 (see lists below).

You have all received an email from Chair-elect James M. Rondinelli soliciting nominations for invited speakers for the Focus Topics sessions and may have also received an email from individual topic organizers.

Finally, note that the contents of this Newsletter will be available electronically on the DMP website at [https://engage.aps.org/dmp/home](https://engage.aps.org/dmp/home). Corrections or updates will also be posted at this location.

**List of DMP-Sponsored Focus Topics and Sorting Categories for the 2024 APS March Meeting**

**07.01.01 Topological Materials: Synthesis, Characterization and Modeling**
Organizers: Dr. Trithep Devakul, Stanford University, tdevakul@mit.edu, Dr. Linda Ye, Caltech, lindaye@caltech.edu
There has been explosive growth in the field of topological materials in which band structure anomalies give rise to novel gapless states in the bulk and on the boundaries of 3-dimensional (3D), 2D, and 1D systems. Moreover, the field has expanded to include topological phases in more complex materials such as Kondo systems, magnetic and superconducting materials, and complex heterostructures capable of harboring exotic topologically nontrivial states of quantum matter. The realization of theoretical predictions and understanding of observed phenomena, however, depends greatly on sample quality. As such, there remain significant challenges in identifying and synthesizing materials that have properties amenable to the study of the bulk, thin films, surface and interface states of interest. This topic will focus on fundamental advances in the synthesis, characterization, theoretical modeling, and predictions of candidate topological materials aimed at guiding synthesis efforts. This will encompass all forms including single crystals, exfoliated and epitaxial thin films and heterostructures, and nanowires and nanoribbons. Of equal interest is the characterization of these materials using structural, transport, magnetic, optical, scanning probe, photoemission and other spectroscopic techniques, and related theoretical efforts to model key experimental observations.

07.01.02 Dirac and Weyl Semimetals
Organizers: Dr. Suyang Xu, Harvard University, suyangxu@fas.harvard.edu, Dr. Maia Vergniory, MPI for Chemical Physics of Solids, Maia.Vergniory@cpfs.mpg.de, Prof. Dr. Silke Buehler-Paschen, Vienna University of Technology, paschen@ifp.tuwien.ac.at

The field of topological semimetals has developed dramatically over the past few years. After the initial prediction and discovery of Dirac and Weyl semimetals – materials whose low energy excitations can be described by the Dirac or Weyl equation of high-energy physics – the field has now expanded to include new low-energy excitations not possible in a high-energy setting. Semimetals with different degeneracy at crossing points or lines have been predicted. Theories and experiments have been predicted and proposed in order to measure a small subset of the topological characteristics of semimetals (such as Chern numbers). Furthermore, semimetals whose existence is guaranteed by filling constraints derived from the presence of certain orbitals at certain points in specific lattices have also been mentioned in the literature.

Distinct from conventional low carrier density systems, Dirac, Weyl, and other semimetals are expected to possess exotic properties due to the nontrivial topologies of their electronic wave functions. A subset of the novel properties predicted include Berry phase contributions to linear and nonlinear transport properties, chiral anomaly, quantized nonlinear transport under circularly polarized light, protected Fermi arc surface states, suppressed scattering, optical control of topology, landau level spectroscopy, and superconductivity. Another exciting development is the discovery of Dirac and Weyl semimetal in ferromagnetic, antiferromagnetic and charge density wave materials. The interplay between symmetry breaking phases and topological band structure leads to even richer phenomena. While promising candidate materials exist for many but certainly not all of the topological semimetals, many phenomena have yet to be clearly resolved.

This focus topic aims to explore Dirac, Weyl and other new semimetals and the novel phenomena associated with them. We solicit contributions on predictions, new materials synthesis and characterization, and new phenomena in topological semimetals both in the
bulk and on the surfaces of samples that accentuate the non-trivial topological character of the new semimetals.

07.01.03 Topological Superconductivity: Materials and Modeling
Organizers: Dr. Nicholas Butch, NIST Center for Neutron Research, nicholas.butch@nist.gov, Prof. Daniel Agterberg, University of Wisconsin Madison, agterber@uwm.edu, Prof. Javad Shabani, New York University, jshabani@nyu.edu

Topological superconductors are characterized by nontrivial topological invariants associated with the energy dispersion of Bogoliubov quasiparticles. This Focus Topic covers topological superconductivity, as well as noncentrosymmetric and triplet superconductivity in various physical systems, including bulk and layered crystals, engineered heterostructures, lower-dimensional interfaces, and wires. Studies of interest include experimental probes of superconductivity, characterization of host materials, theory and calculations of superconductivity and materials, the role of electronic correlations, heavy fermion phenomena, and strategies for quantum information processing using topological superconductivity.

07.01.04 Magnetic Topological Materials
Organizers: Dr. Huibo Cao, Oak Ridge National Lab, caoh@ornl.gov, Prof. Jennifer Cano, SUNY- Stony Brook University, jennifer.cano@stonybrook.edu, Prof. Sheng Ran, Washington University in St. Louis, rans@wustl.edu

The intersection of magnetism and topological electronic states is an exciting and rapidly advancing field of research in condensed matter materials and physics. A variety of exotic quantum phenomena and states have been predicted in magnetic topological materials, such as the quantum anomalous Hall effect, Weyl semimetals, and axion insulators. Experimental development has also been rapid with several candidate materials having been proposed or synthesized very recently. However, only a few experimental realizations have been found to date, leaving many open questions that are inspiring rapid developments in both theoretical and experimental research. This will be a focus session on theoretical predictions, experimental methods that are sensitive to the topological nature of magnetic materials, and the discovery of magnetic topological materials in single-crystal, thin film, and heterostructure morphologies.

08.01.01 Dopants and Defects in Semiconductors
Organizers: Prof. Rachel Goldman, University of Michigan, rsgold@umich.edu, Prof. Anderson Janotti, University of Delaware, janotti@udel.edu

Defects profoundly affect electronic, optical, and other properties of semiconductors. They control charge carrier concentration, transport, and recombination rates. They also regulate mass-transport processes involved in migration, diffusion, and precipitation as well as energy level alignment and charge transfer at interfaces. The success of electronic and optoelectronic semiconductor devices has relied on the optimization of beneficial defects while mitigating unwanted ones. Understanding, characterizing, and controlling dopants and defects is essential for technologies such as light sources, detectors, power electronics, quantum devices, logic devices, memory, and solar cells. The focus of this topic is on the physics of dopants and defects in existing and emerging semiconductors, from bulk to atomic scales, encompassing point, line, and planar defects, including surfaces and interfaces. We
solicit abstracts on experimental, computational, and theoretical investigations of the electronic, structural, optical, magnetic, and other properties of dopants and defects in elemental and compound semiconductors, whether in bulk crystals, polycrystals, or nanoscale structures and across applications. We especially encourage submissions on (1) defect management in wide-band-gap materials such as diamond, group-III nitrides, and group-III oxides; (2) defects in inorganic semiconductors for photovoltaics, and (3) Defects in emerging memory materials and devices such as spintronic and magnetic materials, ferroelectrics, phase change materials, resistive random-access memory devices. In addition, we welcome abstracts on relevant techniques such as materials processing and advanced characterization.

08.01.02 Metal Halide Perovskites – From Fundamentals to Applications
Organizers: Prof. Mahshid Ahmadi, The University of Tennessee, Knoxville, mahmadi3@utk.edu, Dr. Joey Luther, National Renewable Energy Laboratory, Joey.Luther@nrel.gov, Prof. Peijun Guo, Yale University, peijun.guo@yale.edu

The scientific community has shown significant interest in metal halide perovskites due to their impressive optoelectronic properties and outstanding performance in electronic devices such as solar cells, light-emitting diodes, photodetectors, and neuromorphic devices. Despite the progress made in understanding their fundamental physical and chemical properties, many aspects of these materials remain controversial, such as their defect physics and the extent of their defect tolerance. Furthermore, the role of microstructure and grain boundaries is not yet well-understood. These unresolved issues highlight the need for further research to advance the field of perovskite semiconductors. Recent efforts have been focused on overcoming challenges associated with the application of perovskite materials in electronic devices, including stability, sustainability, and reproducibility. Developing effective mitigation strategies to address these challenges is crucial for the future of this technology. To advance the field, this Focus Topic welcomes contributions on experimental or modeling studies of the optical, electronic, structural, and defect properties of metal halide perovskites, as well as advancements in materials engineering and practical applications. In addition to their remarkable optoelectronic properties, metal halide perovskites are unique due to their wide compositional space and structural variability, making them ideal for designing and discovering new materials for various functionalities. Moreover, this Focus Topic seeks to explore the novel physics of lower dimensional perovskites. Despite the extensive research in this field, much remains to be discovered, making it an exciting area of study for both experimentalists and theorists. Contributions that shed light on the fundamental physical and chemical properties of these materials, as well as their potential applications, are highly encouraged.

08.01.03 Multiferroics, magnetoelectrics, spin-electric coupling, and ferroelectrics
Organizers: Dr. Suguru Yoshida, The Pennsylvania State University, sgy5298@psu.edu, Dr. Takuya Aoyama, Tohoku University, aoyama@tohoku.ac.jp, Dr. Tong Zhu, Kyoto University, zhu.tong.4e@kyoto-u.ac.jp

This focus topic covers the challenge of coupling magnetic and electric properties in diverse materials as well as ferroelectricity in different materials classes. Topics include:
- Ferroelectricity in inorganic, organic and hybrid-inorganic-organic materials
- Novel and unconventional routes to induce ferroelectricity
- Bulk multiferroic and magnetoelectric oxides
- Bulk multiferroic and magnetoelectric non-oxide materials
- Multiferroicity and magnetoelectricity in emerging low-dimensional systems such as two-dimensional materials and van der Waals heterostructures.
- Heterostructured magnetoelectrics such as thin film, pillar and nanostructured materials.
- Metal-organic frameworks, organometallics, molecule-based materials, organic thin films and other soft materials that can exhibit magnetoelectric properties
- Spin-electric coupling in single molecule magnets
- Coupling of spin crossovers and spin state ordering to electric and strain properties of materials
- Magnetoelectric domains and domain walls and coupling at surfaces
- Magnetoelectric coupling at surfaces
- Band-filling and bandwidth control in complex oxides (a prerequisite to harnessing charge/orbital order, magnetic transitions and metal insulator transitions)
- Other novel theoretical and experimental routes to multifunctional cross coupling of magnetic, electric and strain properties.

09.01.01 Fe-based Superconductors
Organizers: Dr. Elena Gati, Max-Planck-Institute for Chemical Physics of Solids, elena.gati@cpfs.mpg.de, Prof. Andreas Kreisel, Niels Bohr Institute, Copenhagen University, kreisel@itp.uni-leipzig.de

More than a decade after their discovery, Fe-based superconductors (FeSCs) continue to fascinate the materials and condensed matter physics communities, not only due to their potential to lead to higher superconducting transition temperatures, but also as a platform to investigate the complicated interaction(s) of correlated quantum matter and new techniques. Considerable synthesis, experimental, and theoretical progress has been made in elucidating the defining properties, including the role of electron-electron interactions in shaping their normal state; the intertwining between different ordered states involving spin, orbital, charge, and lattice degrees of freedom; the relevance of nematicity, magnetism, and quantum criticality to the pairing interaction; and the symmetry effects associated with the multi-orbital nature. At the same time, there is progress in understanding the unifying principles causing superconductivity and finding connections with other unconventional superconductors such as cuprates, heavy fermions and organic charge-transfer salts. In recent years, topological phenomena in the normal state and the superconducting state have been explored in the FeSCs such that these systems allow additional insights into the role of different degrees of freedom for topological phases. In addition to advancing our fundamental understanding of superconductivity and correlated electron systems, the unique material parameters of FeSCs (relatively high Tc, low anisotropy, high critical fields) offer new approaches to the design of applications such as superconducting wires, magnets and thin-film devices. This focus topic will cover the pertinent recent developments in the materials growth, experimental measurements, and theoretical approaches, and survey the potential for discovering new applications and new superconducting systems.

11.01.01 4d/5d Transition Metal Systems: Spin-orbit Driven Emergent Phases and Phenomena
Organizers: Dr. John Mitchell, Argonne National Laboratory, mitchell@anl.gov, Prof. Patrick Woodward, The Ohio State University, woodward.55@osu.edu, Prof. David Mandrus, The University of Tennessee, dmandrus@utk.edu

Transition metal compounds with 4d/5d orbitals exhibit rich exotic phenomena resulting from the complex interplay between spin-orbit coupling, electron interactions, and noncubic crystal electric field. With different filling of d orbitals, a rich variety of spin-orbit-entangled states are being experimentally and theoretically investigated. This Focus Topic explores the nature of various exotic states of such spin orbit entangled matter and how the interplay between spin orbit coupling, electron correlations, and crystal fields leads to rich novel phenomena. These include unusual magnetic phases, topological behavior, spin liquids, unconventional superconductivity, and insulator-metal transitions. Contributions are solicited in areas that reflect recent advances in synthesis, experiment, theory, and simulation covering new materials in single-crystal, thin film, and heterostructure morphologies. Specific topics of interest include, but are not limited to:
- Rhodates
- Ruthenates
- Iridates
- Osmates
- Kitaev materials
- Anomalous and topological Hall effects
- Tunability with external stimuli

11.01.02: Light-Induced Dynamical Control of Electronic Phases
Organizers: Prof. Fahad Mahmood, University of Illinois, Urbana-Champaign, fahad@illinois.edu, Prof. Liuyan Zhao, University of Michigan, lyzhao@umich.edu, Prof. Yao Wang, Clemson University, yaowang@g.clemson.edu

The novel electronic properties of strongly correlated materials typically arise due to complex interactions between various degrees of freedom (charge, spin, orbital and lattice). Controlling these interactions at various length- and timescales is thus key to understanding unconventional material properties and establishing routes to functionalize their physical states. New light sources, ultrafast probes, and the achievement of strong light-matter coupling have made it possible to directly induce changes in the electronic, magnetic, or crystal structure with light, enabling the control and examination of non-equilibrium states in a wide range of materials. Examples range from driving phase transitions by nonlinear phononics, the observation of coherent dressed states, to the demonstration of effects from pure vacuum fluctuations of light on material properties in light-matter hybrid systems. This focus topic aims to create a platform for communicating high-impact developments in light-induced dynamical control of novel phases to a broad audience, involving theorists and experimentalists. Particular emphasis is placed on topics such as ultrafast dynamics in correlated and low-dimensional materials, light-induced phase transitions and metastable phases, non-thermal nonequilibrium states and band-engineering, nonlinear response and mode-selective control.

12.01.01: 2D Materials: Formation Pathways and Mechanisms, Heterostructures, and Defects
The multitude of two-dimensional (2D) materials in regard to composition, crystal structure and layer thickness leads to a variety of material properties, including semiconducting, metallic, insulating, superconducting and magnetic, covering all of the components necessary to address voltage, interconnect, energy, and dimensional scaling issues for a plethora of future applications and technology. Their structural anisotropy provides new pathways to the controlled formation and interfacing of atomically thin crystals and layers. The underlying mechanisms remain, however poorly understood, which manifests itself in limited control and scalability, when it comes to integration with industrial process flows. This focus topic will concentrate on the science of scalable and controlled synthesis and tuning of 2D materials and their heterostructures, covering both experimental and computational approaches. This comprises reaction design, crystal and amorphous layer formation, phase engineering, confined growth phenomena, post-growth transformation, defect engineering (structural and chemical), in-plane and out-of-plane heterostructures, approaches to clean interfacing, 2D-3D interfacing, substrate preparation for large scale synthesis and area-select approaches.

12.01.02 2D Materials: Frontiers of Van der Waals Assembly and Moiré Materials
Organizers: Prof. Hugh Churchill, University of Arkansas, hchurch@uark.edu, Prof. Diana Qiu, Yale University, diana.qiu@yale.edu, Prof. Andrew Mannix, Stanford University, ajmannix@stanford.edu

2D layered materials provide a unique platform to assemble heterostructures without the typical constraints of epitaxial interfaces, providing exciting opportunities for the discovery of emergent interfacial phenomena unique to these non-covalently bonded interfaces. A prime example concerns moiré patterns emerging at twisted and/or strained interfaces, which may simultaneously modify the momentum-space registry, interlayer hybridization, and/or shape and period of the periodic potential superlattice. Recent advances have highlighted unique electronic, optical, topological, and magnetic properties that emerge from the interfaces of bilayers involving two otherwise trivial materials. The exciting opportunities to translate these emergent properties into new functional devices require concurrently: (i) enhanced processes for assembling and modifying layered material heterostructures; and (ii) an improved understanding of interfacial device physics, including the role of strain and atomic relaxation effects in the emerging electronic and optical interfacial properties, the physics of beyond-bilayer systems, the coupling and engineering of quantum defects, the engineering of thermal coupling in heterostructures, and beyond. This focus topic will cover experimental and theoretical/computational work related to devices based on the growing array of 2D materials that exhibit a wide variety of behaviors. Our focus section invites contributions on topics including theory, computation, synthesis and device fabrication, and experimental characterization covering the wide-ranging library of 2D materials and their heterostructures.

12.01.03 2D Materials: Advanced Characterization
Organizers: Prof. Dong Yu, University of California, Davis, dony@ucdavis.edu, Dr. Alex Weber-Bargioni, Molecular Foundry, afweber-bargioni@lbl.gov

The ever-increasing class of 2D materials, with their various polymorphs, distinct electronic phases, and 2D heterostructures, require sophisticated characterization methods to both
understand their emergent electronic and magnetic phases as well as establish structure-property relationships. This focus topic will concentrate on advanced and novel characterization methods to probe structural, optical, electronic, magnetic, and other properties of 2D materials and heterostructures. Characterization methods include but are not limited to advanced electron microscopy and spectroscopy (ex: 4D STEM, in situ techniques, ARPES, and momentum-resolved EELS), advanced optical microscopy and spectroscopy (nanoscale imaging, ultrafast time-resolved, non-linear), and various scanning probes, and multi-modal characterization methods. Theory development for data interpretation, treatment of large data sets, and machine learning approaches applied to 2D material characterization are also relevant to this focus topic.

12.01.04 2D Materials: Correlated States: Superconductivity, Density Waves, and Ferroelectricity
Organizers: Dr. Biao Lian, Princeton University, biao@princeton.edu, Dr. Yu He, Yale University, yu.he@yale.edu, Dr. Qiong Ma, Boston College, maqa@bc.edu

The low-dimensional nature of 2D materials alters bulk crystalline symmetries, weakens screening effects, boosts interactions, promotes fluctuations, and facilitates exceptional physical tunability, thereby introducing many novel states of matter. The interconnection between spontaneous symmetry breaking and emerging orders in low-dimensional systems, such as superconductivity, density waves, and ferroelectricity, is a fascinating topic for both fundamental physics and applications. This focus topic will cover theoretical and experimental studies of the emerging correlated states in 2D stacked or epitaxial systems, including:
- Unconventional superconductivity in naturally occurring and engineered materials and interfaces
- Emergent charge, spin or pair density wave orders and nematicity
- Ferroelectricity arising from engineered lattice or electron structures
- Emergent phenomena as the above effects couple, such as multiferroicity
- Related novel device engineering and applications

13.01.01 Nanostructures and Metamaterials
Organizers: Prof. Cheng-Wei Qiu, National University of Singapore, chengwei.qiu@nus.edu.sg, Prof. Yongmin Liu, Northwestern University, y.liu@northeastern.edu, Prof. Andrea Alu, City University of New York, aalu@gc.cuny.edu

Metamaterials are artificially designed structures with subwavelength, atomic- or molecular-level constituents that exhibit exotic properties not occurring in nature. Because of advances in state-of-the-art nanofabrication technologies, we could realize sophisticated metamaterials and structures precisely at the nanoscale. Metamaterials research merged with nanophotonics and physics, which further leads to metaphotonics. These concepts have also been extended to acoustic, mechanical, elastic, phononic metamaterials. The transition from three-dimensional nanostructures and metamaterials to planar two-dimensional metasurfaces further facilitates structure fabrication, material integration, novel functionality, and system miniaturization, thereby finding a wide range of potential applications. This focus topic will include, but are not limited to: nanophotonics, plasmonics, near-field and quantum optics, optoelectronics, energy harvesting, reconfigurable/flexible/dynamically tunable structures, inverse designs, and machine-learning metastructures, acoustic/mechanical meta-devices.
13.01.02: Electron, Exciton, and Phonon Transport in Nanostructures
Organizers: Prof. Mandar M. Deshmukh. Tata Institute of Fundamental Research, deshmukh@tifr.res.in, Prof. Aditya Sood, Princeton University aditya.sood@princeton.edu

Flow of energy in nanoscale devices is often the key to their performance. Energy can be carried by a variety of quasiparticles like electrons, phonons, plasmons and excitons. The efficiency of energy transport depends on the interaction of the quasiparticles with the lattice in solids and the nanoscale substructure within such a lattice. Such interactions with the lattice can lead to coupling between different quasiparticles, resulting in novel emergent phenomena. Contributions are solicited in areas that reflect recent advances in measurement, theory, and modeling of transport mechanisms of quasiparticles in nanoscale materials and across interfaces. This includes, but is not limited to, studies of classical and quantum scaling effects, electron-phonon coupling in low-dimensional materials, emergent electronic and thermal phenomena in heterostructures, nanoscale phonon transport, quasiparticle-defect interactions, strong light-matter coupling, and related areas.

13.01.03 Complex Oxide Interfaces and Heterostructures
Organizers: Prof. Lior Kornblum, Technion, Israel, liork@technion.ac.il, Senior Researcher Felix Trier, Technical University of Denmark, fetri@dtu.dk, Prof. Lucas Caretta, Brown University, lucas.caretta@brown.edu

Emergent electronic and magnetic states at complex oxide interfaces raise exciting prospects for new fundamental physics and technological applications. These novel properties arise as a result of interfacial charge transfer, exchange coupling, orbital reconstructions, proximity effects, dimensionality, and mechanical and electric boundary conditions. This Focus Topic is dedicated to progress in the fabrication, methodologies, and knowledge in the field of complex oxide thin films, membranes, heterostructures, superlattices, and nanostructures. Synthesis, characterization, theory, and novel device physics are emphasized. Specific areas of interest include but are not limited to: the growth of novel oxide thin films and heterostructures; creation of complex oxide membranes, the control of magnetic, electronic, ordering, ionic conduction, phase transitions, interfacial superconductivity, multiferroicity, magnetotransport, spin-orbit coupling properties; and developments in theoretical prediction and materials-by-design approaches. Advances in techniques to probe and image electronic, structural, and magnetic states at heterostructure interfaces are also emphasized. Note that some overlap may exist with other DMP and GMAG focus sessions. As a rule of thumb, if complex oxides and their heterostructures are at the core of the investigation, then the talk is appropriate for this focus topic.

13.01.04 Discovery and Design of Enhanced Physical Qubits: From Electrons to Devices
Organizers: Dr. Sinead Griffin, Lawrence Berkeley National Laboratory, SGriffin@lbl.gov, Prof. Geoffroy Hautier, Dartmouth College, geoffroy.hautier@dartmouth.edu, Prof. Danna Freedman, Massachusetts Institute of Technology, danna@mit.edu

To fully unlock the potential of quantum-based sensing, communication, and computation, new strategies are required to protect, control, and scale quantum coherence in qubits. The diverse nature of these applications necessitates tailored quantum properties for qubits, prompting advancements in computational and theoretical tools for predicting quantum
properties, as well as innovative synthesis and characterization techniques for tailoring and measuring quantum phenomena. These advances are now enabling ‘qubits by design’ where physical qubits ranging from solid-state defects and molecular qubits to trapped ions and topological systems can potentially be designed with desired properties such as improved coherence or optimized interactions with initialization and readout schemes. This focus topic invites scientists exploring the intentional design of qubits, focusing on the control of coherence, entanglement, and functionality. It also welcomes contributions focusing on the understanding of physical mechanisms in qubits in view of their rational design. This focus topic welcomes submission for any qubit platforms and materials except superconducting materials and devices which should be submitted elsewhere.

**13.01.05 Design and Synthesis of New Bulk and Thin-Film Quantum Materials**  
Organizers: Prof. Gang Cao, University of Colorado Boulder, gang.cao@colorado.edu, Prof. Sang Cheong, Rutgers University, sangc@physics.rutgers.edu, Prof. Yuri Suzuki, Stanford University, ysuzuki1@stanford.edu

The persistent failure to realize many predicted, important quantum phases/materials (e.g., quantum spin liquids, accessible p-wave superconductors, etc.) is a stark reminder that existing synthesis techniques may be inadequate. This Focus Topic exclusively addresses the materials synthesis challenges in the following key areas: (1) Design of new quantum materials exhibiting exotic states, such as strong frustration/quantum spin liquids, novel superconductivity, correlated topological states, heavy fermion states without f-electrons, etc. (2) New synthesis techniques, such as high-temperature synthesis under extreme conditions of high pressures or magnetic/electric fields, laser floating-zone techniques. (3) Thin film and heterostructure synthesis, such as heterostructures via hybrid pulsed laser deposition, advanced layer-by-layer growth methods, etc. (4) Precision synthesis of interfacial materials. (5) Theoretical design of materials and machine learning approaches to materials discovery that include synthesizability.

**13.01.06 Superconducting Qubits: Linking Surfaces, Interfaces, and Defects to Decoherence**  
Organizers: Dr. Akshay Murthy, Fermilab, amurthy@fnal.gov, Dr. Josh Mutus, Rigetti Computing, jmutus@rigetti.com, Dr. Tobias Lindstrom, National Physical Laboratory, tobias.lindstrom@npl.co.uk

With massive improvements in device coherence times and gate fidelity over the past two decades, superconducting quantum devices have emerged as a leading technology platform for next generation quantum computing. While much of these improvements has been driven through optimized device designs and geometries, the constituent materials continue to limit performance and present a critical barrier in achieving scalable quantum systems with long coherence times. As a result, groups around the world are using a wide variety of experimental techniques to identify structural defects and chemical inhomogeneities in superconducting qubits. Through this effort, researchers have identified surfaces, interfaces, impurities, and defects that may potentially serve as sources of two-level system (TLS) or non-TLS dissipation in superconducting quantum systems. This Focus Topic brings together the materials characterization, superconductivity theory, and device physics communities in an effort to systematically and intelligently improve the coherence times of superconducting qubits. Suitable talks for this focus topic should focus on the use of experimental techniques to gain an understanding of the underlying physical interactions limiting performance in these
superconducting quantum devices. Contributions on Trapped ion systems; Solid-state artificial atoms (quantum dots, quantum wells); Solid-state quantum defects; and 2D materials should be submitted elsewhere.

13.01.07 Ultrawide-Bandgap Semiconductor Materials: Growth, Characterization, Theory, and Devices
Organizers: Dr. John Lyons, US Naval Research Laboratory, john.lyons@nrl.navy.mil, Dr. Mahesh Neupane, US Army Research Laboratory, mahesh.r.neupane.civ@army.mil, Prof. Mary Ellen Zvanut, University of Alabama-Birmingham, mezvanut@uab.edu

Ultrawide-bandgap semiconductors (UWBGS) represent an emerging new area of materials that are engaging researchers in material science and condensed-matter physics to devices and applications. This new class of semiconductors, all of which have band gaps in excess of 3.5 eV, has promising applications for future generations of RF and high-power electronics, as well as for deep-UV optoelectronics, quantum information science, and harsh-environment applications. This focus topic will cover broad research subtopics, including (but are not limited to) UWBG bulk crystal growth, film deposition, and substrate development, the electronic and optoelectronic properties of UWBG crystals, films, and interfaces, the science of defects and dopants in UWBGS, doping and carrier dynamics for quantum information science, related low-dimensional structures and devices, applications in power electronic and RF electronic devices, and UV light emitting diodes and detectors. Theoretical, computational, and experimental contributions are all sought, and this Focus Topic also welcomes researchers investigating a wide variety of materials, including (but not limited to) diamond, gallium oxide (Ga2O3), aluminum nitride (AlN), aluminum gallium nitride (AlGaN), cubic and hexagonal boron nitride (BN).

List of DMP-Co-Sponsored Focus Topics led by other APS Units for the 2024 March Meeting

Please submit invited talk nominations through primary sponsoring Unit

05.01.07 First Principles Modeling of Excited-State Phenomena in Materials (DCOMP, DMP, DCP) [same as 16.01.03]

10.01.03 Spin Transport and Magnetization Dynamics in Metals-Based Systems (GMAG, DMP, FIAP) [same as 22.01.07]

12.01.05 Computational Design, Understanding and Discovery of Novel Materials (DCOMP, DMP, DCMP) [same as 16.01.13]

16.01.01 Matter at Extreme Conditions (DCOMP, DMP, GCCM) [same as 18.01.01]

16.01.03 First Principles Modeling of Excited-State Phenomena in Materials (DCOMP, DMP, DCP) [same as 05.01.07]

16.01.04 Machine Learning for Electronic Structure, Properties and Dynamics of Molecules and Materials (DCOMP, GDS, DMP) [same as 23.01.19]
16.01.19 Computational Design, Understanding and Discovery of Novel Materials (DCOMP, DMP, DCMP) [same as 12.01.05]

18.01.01 Matter at Extreme Conditions (DCOMP, DMP, GCCM) [same as 16.01.01]

22.01.07 Spin Transport and Magnetization Dynamics in Metals-Based Systems (GMAG, DMP, FIAP) [same as 10.01.03]

23.01.19 Machine Learning for Electronic Structure, Properties and Dynamics of Molecules and Materials (DCOMP, GDS, DMP) [same as 16.01.04]