

Xiaoqian Michelle Chen

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**Strongly correlated electron systems, coherent x-ray scattering and imaging,
nanofabrication**

Education and Positions

Advanced Light Source, Lawrence Berkeley National Laboratory, Berkeley, CA 94720 and
University of Kentucky, Lexington, KY 40506

Postdoctoral Research Associate, Nov 2016 – Present

Research: Dynamics in frustrated magnetism, coherent x-ray scattering and imaging

Supervisor: Sujoy Roy, Steve Kevan, Todd Hastings

X-ray Scattering Group, Brookhaven National Laboratory, Upton, NY 11973

Postdoctoral Research Associate, Nov 2014 – Oct 2016

Research: Dynamics in complex oxides, coherent x-ray scattering and imaging

Supervisor: Stuart Wilkins, John Tranquada, Ian Robinson

University of Illinois Urbana-Champaign, Urbana-Champaign, IL 61801

Ph.D. in Physics, Dec 2014

Thesis research: ‘Magnetic domain formation and finite size effects in mesoscale LSMO nano island arrays using resonant soft x-ray scattering’

Advisor: Peter Abbamonte

Cornell University, Ithaca NY 14850

B.S. in Engineering Physics, May 2008

Minor in Computer Science

Awards

Drickamer Research Fellowship, Department of Physics, University of Illinois, 2013
SURGE Fellowship, College of Engineering, University of Illinois, 2008 – 2012

Skills

User of synchrotron radiation facilities (NSLSII, ALS, APS, SACLA, ESRF, CLS)

Characterization and Nanofabrication

SEM, AFM, MPMS, PPMS, E-beam evaporator, Ion Mill, Raith eLine, FIB

Computational

Programming Languages: Python, C++, Java, Matlab, Labview, Mathematica, Maple, Fortran

Others: Linux, AutoCad

Research Projects

Postdoctoral Research

Spontaneous domain wall fluctuation in artificial square spin ice

- Fabricated artificial spin ice (ASI) using e-beam lithography
- Used coherent resonant soft x-ray scattering (RSXS) and Photoemission Electron Microscopy to probe defect pinning and spontaneous dynamics of antiferromagnetic (AF) domain boundaries
- Observed an exponential slowing down of domain wall motion below the AF onset temperature, similar to the behavior of typical bulk antiferromagnet in nature

Return point memory of charge density wave (CDW) domains in $\text{La}_{2-x}\text{Ba}_x\text{CuO}_4$

- Innovated a procedure to attach a 2 μm -thick gold pinhole mask directly to bulk samples to define x-ray illuminated area
- Used coherent RSXS to study temperature hysteresis of CDW domain textures
- Speckle correlation showed that CDW pinning memory is defined by structures that form at the LTO transition rather than the LTT transition that appears alongside CDW order

Direct proof of static charge density wave correlations in $\text{La}_{2-x}\text{Ba}_x\text{CuO}_4$

- Used coherent RSXS to probe speckle dynamics representative of CDW domains
- X-ray photon correlation using one-time correlation function revealed static nature of CDW in $\text{La}_{2-x}\text{Ba}_x\text{CuO}_4$

Development of nanometer scale imaging using Bragg coherent diffraction imaging (Bragg CDI) in soft x-ray energy range

- Fabricated 5-10 μm pinhole masks on Au/silicon nitride membrane to define x-ray illuminated area
- Reconstructed the domain texture in TbCo thin films in transmission geometry to test the capability of CDI at CSX-1 beamline, NSLSII,
- Used square artificial lattice to demonstrate Bragg CDI and reconstructed lattice and magnetic

domains in square artificial lattice

Thesis Research

Magnetic domain formation and finite size effects in mesoscale $\text{La}_{1-x}\text{Sr}_x\text{MnO}_3$ nano-island arrays

- Fabricated nano-size magnetic wires and islands using e-beam lithography
- Used resonant soft x-ray scattering and MPMS to probe magnetic interaction among wires and islands
- Analyzed and modeled magnetization using Monte Carlo simulation, Least-squares surface fitting, and algorithmic phase retrieval

Other Projects

Impurity effect on the phase transition between IC and NC-CDW phases of Ti doped $1T\text{-TaS}_2$

- Used x-ray scattering and transport to study influence of Ti hole doping on the CDW in $1T\text{-Ta}_{1-x}\text{Ti}_x\text{S}_2$.
- Showed the CDW is most commensurate in the NC phase at $x \sim 0.08$, resembling pure TaS_2 because of their electronic structure

Two-dimensional dynamical reconstruction of the valence exciton in LiF

- Measured q-dependence of exciton excitation in LiF using inelastic x-ray scattering
- Reconstructed exciton electron density propagation in real space and time using phase retrieval technique

Mapping the magneto-structural quantum phases of Mn_3O_4

- Measured temperature and field dependence of structural phase transition of Mn_3O_4 using elastic and magnetic x-ray scattering
- Showed that the onset and nature of this structural transition can be controlled with both temperature and an applied magnetic field

Teaching Experience

Teaching Assistant, Department of Physics, University of Illinois 2009
PHYS 101 : College Physics: Mech & Heat

Teaching Assistant, Department of Applied and Engineering Physics, Cornell University 2008
AEP 1200 : Introduction to Nanoscience and Nanoengineering

Math Support Center, Department of Mathematics, Cornell University 2005 - 2008

Publications

1. **X. M. Chen**, B. Farmer, J. S. Woods, W. Hu, C. Mazzoli, S. B. Wilkins, I. K. Robinson, L. E. De Long, S. Roy, and J. T. Hastings
Spontaneous Magnetic Superdomain Wall Fluctuations in an Artificial Antiferromagnet
Under review: *PRL* (arXiv:1809.05656 [cond-mat.mes-hall])
2. **X. M. Chen**, C. Mazzoli, Y. Cao, V. Thampy, A. M. Barbour, W. Hu, M. Lu, T. Assefa, H. Miao, G. Fabbri, G. D. Gu, J. M. Tranquada, M. P. M. Dean, S. B. Wilkins, and I. K. Robinson
Probing Charge Density Wave Pinning in Cuprate High Temperature Superconductor $La_{1.875}Ba_{0.125}CuO_4$
Under review: *Nat. Commun.* (arXiv:1807.09066 [cond-mat.supr-con])
3. V Thampy, **X. M. Chen**, Y Cao, C Mazzoli, AM Barbour, W Hu, H Miao, G Fabbri, RD Zhong, GD Gu, JM Tranquada, IK Robinson, SB Wilkins, MPM Dean
Static charge-density-wave order in the superconducting state of $La_{2-x}Ba_xCuO_4$
Phys. Rev. B **95** (24), 241111 (2017)
4. **X. M. Chen**, V. Thampy, C. Mazzoli, A. M. Barbour, H. Miao, G.D. Gu, Y. Cao, J. M. Tranquada, M. P. M. Dean, and S. B. Wilkins
Remarkable stability of charge density wave order in $La_{1.875}Ba_{0.125}CuO_3$
Phys. Rev. Lett. **117** (16), 167001 (2016)
5. M. P. M. Dean, Y. Cao, X. Liu, S. Wall, D. Zhu, R. Mankowsky, V. Thampy, **X. M. Chen** et al.
Ultrafast energy- and momentum-resolved dynamics of magnetic correlations in the photo-doped Mott insulator Sr_2IrO_4
Nature Materials **15**, 601–605 (2016)
6. **X. M. Chen**, A. J. Miller, C. Nugroho, G. A. de la Peña, Y. I. Joe, A. Kogar, J. D. Brock, J. Geck, G. J. MacDougall, S. L. Cooper, E. Fradkin, D. J. Van Harlingen, and P. Abbamonte
Influence of Ti doping on the incommensurate charge density wave in $1T-TaS_2$
Phys. Rev B **91**, 245113 (2015)
7. Y. I. Joe, **X. M. Chen**, P. Ghaemi, K. D. Finkelstein, G. A. de la Peña, Y. Gan, J. C. T. Lee, S. Yuan, J. Geck, G. J. MacDougall, T. C. Chiang, S. L. Cooper, E. Fradkin, and P. Abbamonte
Emergence of charge density wave domain walls above the superconducting dome in $TiSe_2$
Nature Physics **10**, 421–425 (2014)
8. Chi-Cheng Lee, **X. M. Chen**, Yu Gan, Chen-Lin Yeh, H. C. Hsueh, Peter Abbamonte, and Wei Ku

First-principles method of propagation of tightly bound excitons: verifying the exciton band structure of LiF with inelastic x-ray scattering
 Phys. Rev. Lett. **111**, 157401 (2013)

9. **X. M. Chen**, E. M. Spanton, S. Wang, J. C. T. Lee, S. Smadici, X. Zhai, T. Naibert, J. N. Eckstein, A. Bhattacharya, T. Santos, R. Budakian, P. Abbamonte
Resonant soft x-ray scattering from $\text{La}_{1-x}\text{Sr}_x\text{MnO}_3$ quantum wire arrays
 arXiv:1109.0734
10. M. Kim, **X. M. Chen**, X. Wang, C.S. Nelson, R. Budakian, P. Abbamonte, S.L. Cooper
Pressure- and field-tuning the magnetostructural phases of Mn_3O_4 : Raman scattering and x-ray diffraction studies
 Phys. Rev. B **84**, 174424 (2011)
11. M. Kim, **X. M. Chen**, Y.I. Joe, E. Fradkin, P. Abbamonte, and S.L. Cooper
Mapping the magneto-structural quantum phases of Mn_3O_4
 Phys. Rev. Lett. **104**, 136402 (2010)

Conference Talks

1. "Thermally Induced Spontaneous AF Super-domain Wall Fluctuations in Artificial Spin Ice"
International Colloquium on Magnetic Films and Surfaces (ICMFS), Santa Cruz, CA (2018)
2. "Thermally Induced Spontaneous AF Super-domain Wall Fluctuations in Artificial Spin Ice"
Coherence 2018, Port Jefferson, NY (2018)
3. "Studying Dynamics using Soft X-ray XPCS at SR and FEL sources"
LCLS/SSRL users meeting, SLAC National Accelerator Laboratory, CA (2016)
4. "Direct Observation of Static Charge Density Wave Domains in $\text{La}_{1.875}\text{Ba}_{0.125}\text{CuO}_4$ "
Gordon Research Seminar, Correlated Electron Systems, South Hadley, MA (2016)

American Physical Society March Meeting Proceedings

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| Y24.00004 | Spontaneous Domain Wall Fluctuation in Artificial Square Spin Ice Studied with Soft X-Ray Photon Correlation Spectroscopy (2018) |
| Y24.00007 | Visualization of Spontaneous Domain Wall Fluctuation in Artificial Spin Ice using Bragg Coherent Diffraction Imaging (BCDI) (2018) |
| Y6.00009 | Direct proof of static charge stripe correlations in $\text{La}_{1.875}\text{Ba}_{0.125}\text{CuO}_4$ (2016) |
| W21.00011 | Influence of Ti doping on the incommensurate charge density wave in 1T-TaS ₂ (2015) |

- J17.00001 Mesoscale spin domain formation and their correlations in quasi-1D $\text{La}_{1-x}\text{Sr}_x\text{MnO}_3$ nanowires (2013)
- D13.00010 Magnetic x-ray scattering, transport and MFM study of strongly correlated $\text{La}_{1-x}\text{Sr}_x\text{MnO}_3$ nanowires (2012)
- J38.00006 Two-dimensional dynamical reconstruction of the valence exciton in LiF (2011)
- X38.00010 Mapping the magneto-structural phases of magnetodielectric Mn_3O_4 (2010)

Seminar Talks

1. "Probing Charge Density Wave Pinning in Cuprate High Temperature Superconductor $\text{La}_{1.875}\text{Ba}_{0.125}\text{CuO}_4$ "
CSE seminar, Argonne National Laboratory (2018)
2. "Nature of Charge Density Waves in $\text{La}_{2-x}\text{Ba}_x\text{CuO}_4$ "
Tsung-Dao Lee Institute, Shanghai Jiao Tong University (2018)
3. "Thermally induced spontaneous AF super-domain wall fluctuations in artificial spin ice"
LBNL-DGIST International Workshop, Lawrence Berkeley National Laboratory (2018)
4. "Direct Observation of Static Charge Density Wave Domains in $\text{La}_{1.875}\text{Ba}_{0.125}\text{CuO}_4$ "
The Myron Strongin Seminar, Brookhaven National Laboratory (2016)
5. "Direct Observation of Static Charge Density Wave Domains in $\text{La}_{1.875}\text{Ba}_{0.125}\text{CuO}_4$ "
ALS/CXRO Seminar, Lawrence Berkeley National Laboratory (2016)

Written and accepted beam time proposals

NSLSII:

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| May 2018 – current | Bragg coherent diffraction imaging (BCDI) of defect induced magnetic domain wall fluctuations in artificial lattice (May 2018 – current) |
| Sep 2017 – Apr 2018 | Effects of Topological Defects on Equilibration of ASI studied with Bragg CDI |
| Apr 2017 – Aug 2017 | Imaging domain wall dynamics in artificial spin ice using Bragg CDI |
| May 2016 – Aug 2016 | Nanometer scale imaging of magnetic domain formation and domain wall dynamics in TbCo alloy and manganites |
| Sep 2015 – Apr 2017 | Probing charge density wave dynamics in superconducting $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$ thin films using Bragg x-ray photon correlation spectroscopy |

ALS :

Jan 2018 – current

Searching for QSL-like excitation in ASI system by
introduction of disorders: studied with XMCD PEEM

Service activities

Referee:

Phys. Rev. Lett, Phys. Rev. B

Session Chair:

“Spin and Electronic Order in Functional Materials” workshop,
ALS User Meeting 2018