

# Xiaoqian Michelle Chen

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U.S. citizen

**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, Fourc

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 $\mu\text{m}$ -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 $\mu\text{m}$  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  $\text{TaS}_2$  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 $\text{Mn}_3\text{O}_4$

- Measured temperature and field dependence of structural phase transition of  $\text{Mn}_3\text{O}_4$  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. Fabbris, 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 Fabbris, 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  $La_{1-x}Sr_xMnO_3$  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  $La_{1.875}Ba_{0.125}CuO_4$ "  
**Gordon Research Seminar**, Correlated Electron Systems, South Hadley, MA (2016)

## American Physical Society March Meeting Proceedings

- 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  $La_{1.875}Ba_{0.125}CuO_4$  (2016)
- W21.00011 Influence of Ti doping on the incommensurate charge density wave in 1T-TaS<sub>2</sub> (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  $\text{Mn}_3\text{O}_4$  (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:

- |                     |   |
|---------------------|---|
| 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