# Curriculum Vitae

### Toby Sanders

## Contact Information

Email: toby.sanders@lickenbrocktech.com

Phone: 314-376-5298

Website: tobysanders.com

Lickenbrock Technologies, INC.

1034 S. Brentwood Blvd, Suite 525

Saint Louis, MO, 63117

## Education

- 2015, Ph.D. in Mathematics (focus in Applied and Computational), The University of South Carolina

- 2010, B.S. in Mathematics, Georgia Southern University

## Research and Experience

- **General areas:** Image and signal processing, inverse problems, nonlinear optimization, harmonic analysis, learning and data based regularization models, statistical signal processing.

- **Application experience:** electron tomography, synthetic aperture radar, microscopy, image inpainting, super resolution, image registration, image feature detection and classification, blind deconvolution, compressed video restoration, automated parameter estimation, image sharpening, terrain classification of overhead imagery.

## Employment

- **2019-present, Senior R&D Engineer at Lickenbrock Technologies, INC., Saint Louis, MO**

  - solutions to complex imaging problems for industry, defense, and medicine
  - some specific tasks include sparse coding for defect detection in radiography images, conebeam computed tomography, multi-frame blind deconvolution, support vector machine learning for classification, blind deconvolution of noisy and compressed drone imagery, automated terrain classification with random forests.
  - software and GUI development for above mentioned projects
  - high performance computing
  - grant proposal writing

- **2015-2018, Postdoc at Arizona State University, Tempe, AZ, USA**

  **2015-2016: *AFOSR Funded Postdoc***

  - research funded in synthetic aperture radar (SAR) imaging
  - novel algorithm development and design for SAR from scratch
  - taught differential equations each semester

  **2016-2018: *NSF Funded Research Training Group Postdoc***

  - research duties include data-oriented math and stat sciences

- focus in computational math, harmonic analysis, and statistics
- specific project included:
    * Bayesian methods for inverse problems
    * optimal data acquisition methods for scanning beam microscopies
    * continued research in SAR
    * automated hyper-parameter selection for regularized inverse problems
    * automated alignment methods of tomography data
- organizer of the graduate student data-oriented seminar
- taught one undergraduate course each calendar year

- **2014, Pacific Northwest National Laboratory, Richland, WA, Ph.D. Intern**

    - research and development of algorithms for electron tomography, particularly pertaining to regularization, discrete tomography, and image alignment

- **2010 - 2015, University of South Carolina, Graduate Teaching Assistant**

# Undergraduate and Graduate Teaching at ASU

- MAT 591, Organizer of our Data-Oriented Math and Stats RTG Graduate Seminar
- Differential Equations, 80 students per class, 2 semesters
- Vector Calculus, 80 students per class, 1 semester
- Probability, 50 students, 1 semester

# Invited Talks

- Summer 2020, Efficient and Effective Automated Parameter Selection for $\ell_2$ and $\ell_1$ Regularized Deconvolution, *SIAM Imaging Conference (Virtual)*
- Winter 2019, Model Fitting and Optimal Data Acquisition for Inverse Problems, *Los Alamos National Laboratory.*
- Fall 2017, Novel Imaging and Regularization Techniques for Synthetic Aperture Radar, *Argonne National Laboratory.*
- Fall 2017, Robust Data Registration Techniques for Electron Tomography, *SIAM Pacific Northwest Regional Conference*
- Fall 2017, Techniques for Data Alignment and Image Reconstruction for Electron Tomography, *COMBIRS Event: Mathematical Advances in Electron Microscopy*
- Summer 2017, Multiscale Higher Order TV Operators for L1 Regularization, *Dartmouth College ACM Seminar.*
- Spring 2017, Multiscale Higher Order TV Operators for L1 Regularization and Autofocusing Techniques for SAR, *HRL Laboratories, Malibu, CA.*
- Summer 2016, Inverse Methods for Noisy and Incomplete Data with Applications to Tomography and SAR, *USC-IMI Applied and Computational Math Seminar, Columbia, SC.*
- Spring 2015, Electron Tomography - Recent Reconstruction and Alignment Methods, *NIST, Gaithersburg, MD.*
- Spring 2015, Recent Advances in Mathematical Methods for Electron Tomography, *ASU Computational and Applied Math Seminar*
- Spring 2014, Advanced 3-D Reconstruction Techniques for Electron Tomography, *Imaging and Modeling in Microscopy - Recent Advances, Banff, Canada*

# Public Speaking/Talks/Posters

- Fall 2020, Real Time Deconvolution of Adaptive Optics Ground Based Telescope Imagery, *AMOS Conference (Virtual)*
- Fall 2019, Leveraging Image Denoising Engines for Image Reconstruction and Blind Deconvolution, *ASU Computational and Applied Math Seminar*
- Spring 2019, Shrinkage Formulas, L1 optimization, and Alternating Direction Method of Multipliers (ADMM), *At Lickenbrock Technologies*
- Fall 2018, Some Thoughts on Data-Oriented Math and Stats Through a Parameter Selection Problem, *ASU Research Training Group Seminar*
- Fall 2018, Poster: Automated Parameter Selection for Regularized Inverse Problems, *IMA Workshop on Recent Advances in Machine Learning and Computational Methods for Geoscience.*
- Fall 2018, Model Fitting and Optimal Data Acquisition for Inverse Problems, *ASU Postdoc Seminar Series.*
- Summer 2018, Inpainting versus denoising for dose reduction in STEM, *Microscopy & Microanalysis, Baltimore, MD.*
- Spring 2018, An Introduction to Inverse Problems and Synthetic Aperture Radar, *ASU Research Traning Group Seminar*
- Fall 2017, Multiscale Higher Order TV Operators for $\ell_1$ Regularization, *ASU Postdoc Seminar Series*
- Fall 2017, Robust Data Registration Techniques for Inverse Problems, *ASU Computational and Applied Math Seminar*
- Fall 2017, More data with more noise, or less data with less noise? In the context of image reconstruction and electron microscopy, *ASU Research Training Group Seminar*
- Summer 2017, Poster: Phase Based Autofocusing for Electron Tomography, *Microscopy & Microanalysis, St. Louis, MO.*
- Summer 2017, Poster: Higher Order Total Variation, Multiscale Generalizations, and Applications to Inverse Problems *Foundations of Computational Mathematics, Barcelona, Spain.*
- Spring 2017, Combination of correlated phase error correction and sparsity models for SAR, *SPIE Commercial + Scientific Sensing and Imaging*
- Spring 2017, Series on Inverse and Imaging Problem: Imaging Techniques for Synthetic Aperture Radar, *ASU Research Training Group Seminar*
- Spring 2017, Multiscale Higher Order TV Operators for $\ell_1$ Regularization, *ASU Computational and Applied Math Seminar*
- Spring 2017, Series on Inverse and Imaging Problem: Alternating Direction Method of Multipliers, *ASU Research Training Group Seminar*
- Fall 2016, Imaging Techniques for Synthetic Aperture Radar, *ASU Postdoc Seminar Series*
- Fall 2016, An Introduction to the Mathematics of Computed Tomography, *ASU Research Training Group Seminar*
- Summer 2016, Special Regularization Techniques for Synthetic Aperture Radar, *SIAM Conf. on Imaging Science*
- Spring 2016, Robust Image Reconstruction Techniques for Tomography and SAR, *ASU Postdoc Seminar Series*
- Fall 2014, Electron Tomography - Approximating Functions from Line Integrals, *USC SIAM Student Chapter Seminar, Columbia, SC*
- Fall 2014, Introduction to Wavelets and Shearlets, with Application to Denoising and Segmentation, *Graduate Seminar on Image and Surface Processing, Columbia, SC*
- Fall 2014, Image Registration and Alignment Arising from the Radon Transform, *Graduate Seminar on Image and Surface Processing, Columbia, SC*
- Spring 2014, Advanced 3-D Reconstruction Techniques for Electron Tomography, *Microscopy & Microanalysis Conference, Hartford, CT*

- Spring 2013, Electron Tomographic Reconstruction, *USC SIAM Student Chapter Seminar, Columbia, SC*
- Spring 2013, Electron Tomographic Reconstruction, *Georgia Southern University, Graduate Student Conference, Statesboro, GA*

# Funding Awards

- NGA Phase II SBIR (Co-PI, funding pending): "Improved still frames and denoised motion imagery from distressed full motion video," 2021.

- Army Phase I SBIR (PI): "Rapid Terrain/Map Generation for Robotic and Autonomous Vehicle," 2021

- NGA Phase I SBIR (Co-PI): "Improved still frames and denoised motion imagery from distressed full motion video," 2020.

# Miscellaneous Awards and Notable Achievements

- 2017, ASU Computing PostDoc Best Practices Fellow
- 2017, NSF Travel Award: Foundations of Computational Mathematics, Barcelona, Spain
- 2016, Research Training Group Postdoc Fellowship at ASU
- 2015, Postdoc Fellowship at ASU
- 2014, PhD Intern at the Pacific Northwest National Laboratory
- 2012, ACM Fellow for HPC training at USC.
- 2010, AMS Unites States National Collegiate Mathematics Championships Participant

# Community Service

**Journal Referee for:**

- IOP Inverse Problems
- SIAM Journal of Scientific Computing
- Applied Numerical Mathematics
- Review of Scientific Instruments
- IEEE Trans. on Computational Imaging
- IEEE Trans. on Image Processing
- IEEE Trans. Geosci. Remote Sens.
- Structural Dynamics

**Ph.D. Committees:**

- Dr. Dennis Denker
- Dr. Theresa Scarnati

# Peer Reviewed Articles

1. T. Sanders, R. Platte, R. Skeel. Effective new methods for automated parameter selection in regularized inverse problems. *Applied Numerical Mathematics* (2020).

2. T. Sanders, C. Dwyer. Image inpainting vs denoising in the presence of Poisson noise. *IEEE Transactions on Image Processing* (2019).

3. T. Sanders, R. B. Platte. Multiscale Higher Order TV Operators for $L_1$ Regularization. *Advanced Structural and Chemical Imaging.*, 4(1), 12.

4. Toby Sanders. Phase-based alignment and improved projection matching of parallel beam tomography data. *IEEE Trans. Computational Imaging*, 4(3):395-405, 2018.

5. T. Sanders. "Parameter selection for HOTV regularization." Applied Numerical Mathematics 125 (2018): 1-9.

6. Sanders, Toby, and Ilke Arslan. Improved Three-Dimensional (3D) Resolution of Electron Tomograms Using Robust Mathematical Data-Processing Techniques. *Microscopy and Microanalysis* (2017): 1-9.

7. Ramos, M., Galindo-Hernández, F., Arslan, I., Sanders, T., & Domínguez, J. M. (2017). Electron tomography and fractal aspects of MoS2 and MoS2/Co spheres. *Scientific reports*, 7(1), 12322.

8. T. Sanders, and C. Dwyer. "Subsampling and inpainting approaches for electron tomography." *Ultramicroscopy* 182 (2017): 292-302.

9. T. Sanders, A. Gelb, and R.B. Platte. Composite SAR imaging using sequential joint sparsity. *Journal of Computational Physics* 338 (2017): 357-370.

10. M. Mandal, C. Liu, T. Sanders, F. Haso, V. Bhadram, I. Arslan, T. Liu, Y. Fei, K. Landskron. Periodic Mesoporous Hexagonal Boron Nitride at High Pressure: A Route to Cubic Boron Nitride Nanocrystals and Mesoporous Cubic Boron Nitride. *ChemistrySelect* 2017, 2, 740.

11. T. Sanders, A. Gelb, R.B. Platte, I. Arslan, K. Landskron. Recovering fine details from under-resolved electron tomography data using higher order total variation $\ell_1$ regularization. *Ultramicroscopy* 174 (2017): 97-105.

12. T. Sanders. Discrete Iterative Partial Segmentation Technique (DIPS) for Tomographic Reconstruction, in *IEEE Transactions on Computational Imaging*, vol. 2, no. 1, pp. 71-82, March 2016.

13. T. Sanders, H. Wang. Colonel Blotto's Combinatorial Decisions - A Resource Allocation Problem. *Advances and Applications in Discrete Math,* vol. 15, no. 2, (2015) pp. 145-152.

14. T. Sanders, C. Akatay, M. Prange, P. Binev, Physically Motivated Global Alignment Method for Electron Tomography, *Advanced Structural and Chemical Imaging* vol. 1, no. 1, (2015)

# Preprints/Submitted/Other

1. T. Sanders. Fourier Analysis, Computing, and Image Formation For Synthetic Aperture Radar. *arXiv preprint arXiv:1910.10236* (2019).

2. T. Sanders. MATLAB Imaging Algorithms: Image Reconstruction, Restoration, and Alignment, with a Focus in Tomography., `http://www.toby-sanders.com/software`, `https://doi.org/10.13140/RG.2.2.33492.60801`, Dec. 2016

3. T. Sanders, "Image Processing and 3-D Reconstruction in Tomography," PhD Dissertation, Major Professor: Dr. Peter Binev, University of South Carolina, May 2015.

# Conference Proceedings

1. T. Sanders, R. Hedges, T. Schulz, M. Abijaoude, J. Peters, M. Steinbock, and T. Holmes, Real-time deconvolution of adaptive optics ground based telescope imagery, in *Proceedings of the Advanced Maui Optical and Space Surveillance Technologies Conference*, 2020

2. T. Sanders, The potential for Poisson image reconstruction models for electron tomography, *SPIE Optics + Photonics 2018*

3. T. Sanders, C. Dwyer, Inpainting versus denoising for dose reduction in STEM, *Microscopy and Microanalysis 2018*

4. T. Sanders, T. Scarnati, Combination of correlated phase error correction and sparsity models for SAR, *SPIE Commercial + Scientific Sensing and Imaging*, 2017.

5. T. Sanders, M. Prange, P. Binev, C. Akatay and I. Arslan. Robust Physical Alignment Models for Electron Tomography. *Microscopy and Microanalysis*, 21 (Suppl. 3) , pp 2335-2336. doi:10.1017/S1431927615012453, 2105

6. T. Sanders, J.D. Roehling, K.J. Batenburg, B.C. Gates, A. Katz, P. Binev, I. Arslan, Advanced 3-D Reconstruction Algorithms for Electron Tomography, *Microscopy and Microanalysis (M&M 2014)*, #397

7. T. Sanders, P. Binev, I. Arslan, Practical 3-D Reconstruction Techniques for Electron Tomography, *invited speaker, BIRS workshop* #14w5048, 2014