

# Ali Siahkoohi

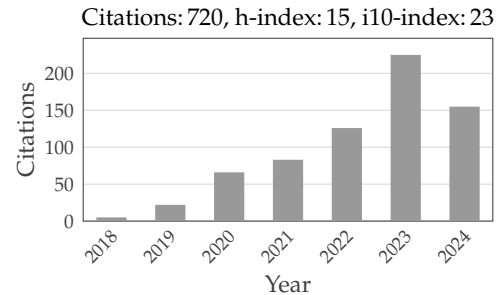
Simons Postdoctoral Fellow  
Dept. of Comp. Applied Math. & Operations Research  
Rice University

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Last updated: June 26, 2024

## Research Interests and Highlights

My research in scientific machine learning aims to overcome barriers to fully unlocking AI's potential in computational science. I develop scalable, data-driven methods that integrate strengths from both fields to tackle challenging problems in computational science and engineering. Keywords defining my current research include: generative models, scientific machine learning, computational imaging, and uncertainty quantification.

Over the past years, I have published 38 peer-reviewed articles, including 17 first-author papers in high-impact journals and conference proceedings, such as *NeurIPS*, *ICML*, *ICLR*, *Interspeech*, *MIDL*, *SPIE*, *TMLR*, and *Geophysics*.



## Academic Appointments

**Rice University**  
Simons Postdoctoral Fellow  
Department of Computational Applied Mathematics & Operations Research  
Jointly hosted by Maarten V. de Hoop and Richard G. Baraniuk

August 2022 – Present  
Houston, TX, USA

## Education

**Georgia Institute of Technology**  
Ph.D. in Computational Science and Engineering (minor in Applied Math.)  
Advised by Felix J. Herrmann

August 2022  
Atlanta, GA, USA

**University of Tehran**  
M.Sc. in Geophysics

March 2016  
Tehran, Iran

**Sharif University of Technology**  
B.Sc. in Electrical Engineering

August 2013  
Tehran, Iran

## Publications

Google Scholar profile: <https://scholar.google.com/citations?user=sxRMqYIAAAAJ&h>

## In Preparation & Under Review

- P5. P. M. Mayer, L. Luzi, A. Siahkoohi, D. H. Johnson, and R. G. Baraniuk. Removing bias from maximum likelihood estimation with model autophagy. Preprint arXiv:2405.13977; under review by *NeurIPS*, 2024
- P4. L. Baldassari, A. Siahkoohi, J. Garnier, K. Sølna, and M. V. de Hoop. Taming score-based diffusion priors for infinite-dimensional nonlinear inverse problems. Preprint arXiv:2405.15676; under review by *NeurIPS*, 2024
- P3. R. Orozco, A. Siahkoohi, M. Louboutin, and F. J. Herrmann. ASPIRE: Iterative amortized posterior inference for Bayesian inverse problems. Preprint arXiv:2405.05398; under review by *Inverse Problems*, 2024

- P2. [A. Siahkoohi](#), R. Morel, R. Balestrieri, E. Allys, G. Sainton, T. Kawamura, and M. V. de Hoop. Martian time-series unraveled: A multi-scale nested approach with factorial variational autoencoders. Preprint arXiv:2305.16189, 2024
- P1. R. Orozco, P. Witte, M. Louboutin, [A. Siahkoohi](#), G. Rizzuti, B. Peters, and F. J. Herrmann. InvertibleNetworks.jl: A Julia package for scalable normalizing flows. Preprint arXiv:2312.13480; under review by *Journal of Open Source Software*, 2023

## Journal Publications

- J6. L. Luzi, P. M. Mayer, J. Casco-Rodriguez, [A. Siahkoohi](#), and R. G. Baraniuk. Boomerang: Local sampling on image manifolds using diffusion models. *Transactions on Machine Learning Research*, 2024
- J5. M. Louboutin, Z. Yin, R. Orozco, T. J. Grady II, [A. Siahkoohi](#), G. Rizzuti, P. A. Witte, O. Møyner, G. J. Gorman, and F. J. Herrmann. Learned multiphysics inversion with differentiable programming and machine learning. *The Leading Edge*, 42(7):474–486, 2023
- J4. Y. Zhang, Z. Yin, O. López, [A. Siahkoohi](#), M. Louboutin, R. Kumar, and F. J. Herrmann. Optimized time-lapse acquisition design via spectral gap ratio minimization. *Geophysics*, 88(4):A19–A23, 2023
- J3. [A. Siahkoohi](#), G. Rizzuti, R. Orozco, and F. J. Herrmann. Reliable amortized variational inference with physics-based latent distribution correction. *Geophysics*, 88(3):R297–R322, 2023
- J2. [A. Siahkoohi](#), G. Rizzuti, and F. J. Herrmann. Deep Bayesian inference for seismic imaging with tasks. *Geophysics*, 87(5):S281–S302, 2022
- J1. [A. Siahkoohi](#), M. Louboutin, and F. J. Herrmann. The importance of transfer learning in seismic modeling and imaging. *Geophysics*, 84(6):A47–A52, 2019

## Peer-Reviewed Conference Proceedings

- C32. S. Alemohammad, J. Casco-Rodriguez, L. Luzi, A. I. Humayun, H. Babaei, D. LeJeune, [A. Siahkoohi](#), and R. G. Baraniuk. Self-consuming generative models go MAD. In *The Twelfth International Conference on Learning Representations*, 2024
- C31. L. Luzi, D. LeJeune, [A. Siahkoohi](#), S. Alemohammad, V. Saragadam, H. Babaei, N. Liu, Z. Wang, and R. G. Baraniuk. Titan: Bringing the deep image prior to implicit representations. In *IEEE International Conference on Acoustics, Speech and Signal Processing*, pages 6165–6169, 2024
- C30. L. Baldassari, [A. Siahkoohi](#), J. Garnier, K. Sølna, and M. V. de Hoop. Conditional score-based diffusion models for Bayesian inference in infinite dimensions. In *Advances in Neural Information Processing Systems*, volume 36, pages 24262–24290, 2023
- C29. [A. Siahkoohi](#), R. Morel, M. V. de Hoop, E. Allys, G. Sainton, and T. Kawamura. Unearthing InSights into Mars: Unsupervised source separation with limited data. In *Proceedings of the 40th International Conference on Machine Learning*, volume 202, pages 31754–31772, 2023
- C28. R. Orozco, M. Louboutin, [A. Siahkoohi](#), G. Rizzuti, T. van Leeuwen, and F. J. Herrmann. Amortized normalizing flows for transcranial ultrasound with uncertainty quantification. In *Medical Imaging with Deep Learning*, volume 227, pages 332–349, 2023
- C27. R. Orozco, [A. Siahkoohi](#), M. Louboutin, and F. J. Herrmann. Refining amortized posterior approximations using gradient-based summary statistics. In *5th Symposium on Advances in Approximate Bayesian Inference*, 2023
- C26. R. Orozco, [A. Siahkoohi](#), G. Rizzuti, T. van Leeuwen, and F. J. Herrmann. Adjoint operators enable fast and amortized machine learning based Bayesian uncertainty quantification. In *Medical Imaging 2023: Image Processing*, volume 12464, page 124641L, 2023
- C25. Y. Zhang, Z. Yin, O. Lopez, [A. Siahkoohi](#), M. Louboutin, and F. J. Herrmann. 3D seismic survey design by maximizing the spectral gap. In *Third International Meeting for Applied Geoscience & Energy*, 2023
- C24. [A. Siahkoohi](#), M. Chinen, T. Denton, W. B. Kleijn, and J. Skoglund. Ultra-low-bitrate speech coding with pretrained Transformers. In *Proceedings of Interspeech*, pages 4421–4425, 2022

- C23. A. Siahkoohi, M. Louboutin, and F. J. Herrmann. Velocity continuation with Fourier neural operators for accelerated uncertainty quantification. In *Society of Exploration Geophysicists Technical Program Expanded Abstracts*, pages 1765–1769, 2022
- C22. M. Louboutin, P. Witte, A. Siahkoohi, G. Rizzuti, Z. Yin, R. Orozco, and F. J. Herrmann. Accelerating innovation with software abstractions for scalable computational geophysics. In *Society of Exploration Geophysicists Technical Program Expanded Abstracts*, pages 1482–1486, 2022
- C21. Z. Yin, A. Siahkoohi, M. Louboutin, and F. J. Herrmann. Learned coupled inversion for carbon sequestration monitoring and forecasting with Fourier neural operators. In *Society of Exploration Geophysicists Technical Program Expanded Abstracts*, pages 467–472, 2022
- C20. Y. Zhang, M. Louboutin, A. Siahkoohi, Z. Yin, R. Kumar, and F. J. Herrmann. A simulation-free seismic survey design by maximizing the spectral gap. In *Society of Exploration Geophysicists Technical Program Expanded Abstracts*, pages 15–20, 2022
- C19. A. Siahkoohi, R. Orozco, G. Rizzuti, and F. J. Herrmann. Wave-equation based inversion with amortized variational Bayesian inference. In *EAGE Deep learning for seismic processing: Investigating the foundations workshop*, 2022
- C18. R. Orozco, A. Siahkoohi, G. Rizzuti, T. van Leeuwen, and F. J. Herrmann. Photoacoustic imaging with conditional priors from normalizing flows. In *NeurIPS Workshop on Deep Learning and Inverse Problems*, 2021
- C17. A. Siahkoohi, G. Rizzuti, M. Louboutin, P. Witte, and F. J. Herrmann. Preconditioned training of normalizing flows for variational inference in inverse problems. In *3rd Symposium on Advances in Approximate Bayesian Inference*, 2021
- C16. A. Siahkoohi and F. J. Herrmann. Learning by example: Fast reliability-aware seismic imaging with normalizing flows. In *Society of Exploration Geophysicists Technical Program Expanded Abstracts*, pages 1580–1585, 2021
- C15. R. Kumar, M. Kotsi, A. Siahkoohi, and A. Malcolm. Enabling uncertainty quantification for seismic data preprocessing using normalizing flows (NF)—An interpolation example. In *Society of Exploration Geophysicists Technical Program Expanded Abstracts*, pages 1515–1519, 2021
- C14. G. Rizzuti, A. Siahkoohi, P. A. Witte, and F. J. Herrmann. Parameterizing uncertainty by deep invertible networks, an application to reservoir characterization. In *Society of Exploration Geophysicists Technical Program Expanded Abstracts*, pages 1541–1545, 2020
- C13. M. Zhang, A. Siahkoohi, and F. J. Herrmann. Transfer learning in large-scale ocean bottom seismic wavefield reconstruction. In *Society of Exploration Geophysicists Technical Program Expanded Abstracts*, pages 1666–1670, 2020
- C12. A. Siahkoohi, G. Rizzuti, and F. J. Herrmann. Weak deep priors for seismic imaging. In *Society of Exploration Geophysicists Technical Program Expanded Abstracts*, pages 2998–3002, 2020
- C11. A. Siahkoohi, G. Rizzuti, and F. J. Herrmann. Uncertainty quantification in imaging and automatic horizon tracking—A Bayesian deep-prior based approach. In *Society of Exploration Geophysicists Technical Program Expanded Abstracts*, pages 1636–1640, 2020
- C10. A. Siahkoohi, G. Rizzuti, and F. J. Herrmann. A deep-learning based Bayesian approach to seismic imaging and uncertainty quantification. In *European Association of Geoscientists & Engineers Conference and Exhibition Extended Abstracts*, 2020
- C9. F. J. Herrmann, A. Siahkoohi, and G. Rizzuti. Learned imaging with constraints and uncertainty quantification. In *NeurIPS Deep Inverse Workshop*, 2019
- C8. A. Siahkoohi, R. Kumar, and F. J. Herrmann. Deep-learning based ocean bottom seismic wavefield recovery. In *Society of Exploration Geophysicists Technical Program Expanded Abstracts*, pages 2232–2237, 2019
- C7. A. Siahkoohi, D. J. Verschuur, and F. J. Herrmann. Surface-related multiple elimination with deep learning. In *Society of Exploration Geophysicists Technical Program Expanded Abstracts*, pages 4629–4634, 2019

- C6. G. Rizzuti, A. Siahkoohi, and F. J. Herrmann. Learned iterative solvers for the Helmholtz equation. In *European Association of Geoscientists & Engineers Conference and Exhibition Extended Abstracts*, 2019
- C5. A. Siahkoohi, M. Louboutin, R. Kumar, and F. J. Herrmann. Deep convolutional neural networks in prestack seismic—two exploratory examples. In *Society of Exploration Geophysicists Technical Program Expanded Abstracts*, pages 2196–2200, 2018
- C4. A. Siahkoohi, R. Kumar, and F. J. Herrmann. Seismic data reconstruction with generative adversarial networks. In *European Association of Geoscientists & Engineers Conference and Exhibition Extended Abstracts*, 2018
- C3. A. Siahkoohi and A. Gholami. Sparsity promoting least squares migration for laterally inhomogeneous media. In *7th EAGE Saint Petersburg International Conference and Exhibition*, 2016
- C2. M. S. Ebrahimi, M. H. Daraei, J. Rezaei, and A. Siahkoohi. A novel utilization of wireless sensor networks as data acquisition system in smart grids. In *Materials Science and Information Technology*, volume 433-440, pages 6725–6730, 2012
- C1. A. Najafi, A. Siahkoohi, and M. B. Shamsollahi. A content-based digital image watermarking algorithm robust against JPEG compression. In *IEEE International Symposium on Signal Processing and Information Technology*, pages 432–437, 2011

## Theses

- T2. A. Siahkoohi. *Deep generative models for solving geophysical inverse problems*. PhD thesis, **Georgia Institute of Technology**, 2022
- T1. A. Siahkoohi. *Sparsity promoting least-squares migration for laterally inhomogeneous media*. Master’s thesis, **University of Tehran**, 2016

## Technical Reports

- R3. M. Louboutin, A. Siahkoohi, R. Wang, and F. J. Herrmann. Low-memory stochastic backpropagation with multi-channel randomized trace estimation. Technical Report arXiv:2106.06998, Georgia Institute of Technology, 2021
- R2. A. Siahkoohi, G. Rizzuti, P. A. Witte, and F. J. Herrmann. Faster uncertainty quantification for inverse problems with conditional normalizing flows. Technical Report arXiv:2007.07985, Georgia Institute of Technology, 2020
- R1. A. Siahkoohi, M. Louboutin, and F. J. Herrmann. Neural network augmented wave-equation simulation. Technical Report arXiv:1910.00925, Georgia Institute of Technology, 2019

## Talks

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### Invited Talks

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| <p>T22. <b>CNRS, Université Montpellier</b><br/>         Low-cost uncertainty quantification for large-scale inverse problems<br/>         RhEoVOLUTION Group (Dr. Andréa Tommasi)</p>                                                                                                                         | <p>January 2023<br/>         Virtual oral presentation</p> |
| <p>T21. <b>Workshop on Subsurface Uncertainty Description and Estimation</b><br/>         Reliable amortized variational inference with conditional normalizing flows via<br/>         physics-based latent distribution correction<br/>         International Meeting for Applied Geoscience &amp; Energy</p> | <p>August 2022<br/>         Oral presentation</p>          |
| <p>T20. <b>Intelligent illumination of the Earth Workshop</b><br/>         Fast and reliability-aware seismic imaging with conditional normalizing flows<br/>         King Abdullah University of Science and Technology</p>                                                                                   | <p>June 2021<br/>         Virtual oral presentation</p>    |
| <p>T19. <b>Advances in Seismic Imaging and Inversion Mini-symposium</b><br/>         Unsupervised data-guided uncertainty analysis in imaging and horizon<br/>         tracking</p>                                                                                                                            | <p>October 2020<br/>         Virtual oral presentation</p> |

## Contributed Talks

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|------|-------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| T18. | <b>International Conference on Machine Learning</b>                                                                                       | July 2023                           |
|      | Unearthing InSights into Mars: Unsupervised source separation with limited data                                                           | Poster presentation                 |
| T17. | <b>Symposium on Advances in Approximate Bayesian Inference</b>                                                                            | July 2023                           |
|      | Refining amortized posterior approximations using gradient-based summary statistics                                                       | Poster presentation                 |
| T16. | <b>Geo-Mathematical Imaging Group Partners Meeting, Rice University</b>                                                                   | May 2023                            |
|      | Martian time-series unraveled: A multi-scale nested approach with factorial variational autoencoders                                      | Oral presentation                   |
| T15. | <b>Geo-Mathematical Imaging Group Partners Meeting, Rice University</b>                                                                   | May 2023                            |
|      | Unearthing InSights into Mars: Unsupervised source separation with limited data                                                           | Oral presentation                   |
| T14. | <b>International Meeting for Applied Geoscience &amp; Energy</b>                                                                          | August 2022                         |
|      | Velocity continuation with Fourier neural operators for accelerated uncertainty quantification                                            | Oral presentation                   |
| T13. | <b>Chrome Media Team, Google</b>                                                                                                          | December 2021                       |
|      | Low-bitrate speech coding with Transformers                                                                                               | Virtual oral presentation           |
| T12. | <b>ML4SEISMIC Partners Meeting, Georgia Institute of Technology</b>                                                                       | November 2021                       |
|      | Multifidelity conditional normalizing flows for physics-guided Bayesian inference                                                         | Virtual oral presentation           |
| T11. | <b>ML4SEISMIC Partners Meeting, Georgia Institute of Technology</b>                                                                       | November 2021                       |
|      | Uncertainty quantification in imaging and automatic horizon tracking—A Bayesian deep-prior based approach                                 | Virtual oral presentation           |
| T10. | <b>Society of Exploration Geophysicists International Exposition and Annual Meeting</b>                                                   | September 2021                      |
|      | Learning by example: Fast reliability-aware seismic imaging with normalizing flows <a href="#">[Link to video]</a>                        | Virtual oral presentation           |
| T9.  | <b>Symposium on Advances in Approximate Bayesian Inference</b>                                                                            | January 2021                        |
|      | Preconditioned training of normalizing flows for variational inference in inverse problems <a href="#">[Link to video]</a>                | Prerecorded short oral presentation |
| T8.  | <b>European Association of Geoscientists &amp; Engineers Annual Conference &amp; Exhibition</b>                                           | December 2020                       |
|      | A deep-learning based Bayesian approach to seismic imaging and uncertainty quantification                                                 | Virtual oral presentation           |
| T7.  | <b>Society of Exploration Geophysicists International Exposition and Annual Meeting</b>                                                   | October 2020                        |
|      | Uncertainty quantification in imaging and automatic horizon tracking—A Bayesian deep-prior based approach <a href="#">[Link to video]</a> | Virtual oral presentation           |
| T6.  | <b>Society of Exploration Geophysicists International Exposition and Annual Meeting</b>                                                   | October 2020                        |
|      | Weak deep priors for seismic imaging <a href="#">[Link to video]</a>                                                                      | Virtual oral presentation           |
| T5.  | <b>Society of Exploration Geophysicists Student Chapter, Georgia Tech</b>                                                                 | February 2020                       |
|      | A deep-learning based Bayesian approach to seismic imaging and uncertainty quantification                                                 | Oral presentation                   |
| T4.  | <b>HotCSE Seminar, CSE Department, Georgia Institute of Technology</b>                                                                    | November 2019                       |
|      | Learned imaging with constraints and uncertainty quantification                                                                           | Oral presentation                   |
| T3.  | <b>Society of Exploration Geophysicists International Exposition &amp; Annual Meeting</b>                                                 | September 2019                      |
|      | Deep-learning based ocean bottom seismic wavefield recovery                                                                               | Oral presentation                   |
| T2.  | <b>Society of Exploration Geophysicists International Exposition &amp; Annual Meeting</b>                                                 | September 2019                      |
|      | Surface-related multiple elimination with deep learning                                                                                   | Oral presentation                   |
| T1.  | <b>Society of Exploration Geophysicists International Exposition &amp; Annual Meeting</b>                                                 | October 2018                        |
|      | Deep convolutional neural networks in prestack seismic—two exploratory examples                                                           | Poster presentation                 |

## Professional Service

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### Editorial Service

- ▶ **Journal of Mathematics** 2023 – Present  
Guest Editor  
Special issue on Applied Mathematics in Inverse Problems and Uncertainty Quantification

### Conference Organization

- ▶ **Deep Learning and Inverse Problems Workshop (NeurIPS)** 2024  
Workshop Organizer
- ▶ **International Meeting for Applied Geoscience & Energy** 2022  
Session Chair

### Technical Program Committee Member and Reviewer

- ▶ Neural Information Processing Systems (NeurIPS) 2023 – 2024
- ▶ Advances in Approximate Bayesian Inference (AABI) 2023 – 2024
- ▶ Structured Probabilistic Inference & Generative Modeling (ICML workshop) 2023 – 2024
- ▶ International Conference on Machine Learning (ICML) 2024
- ▶ International Conference on Learning Representations (ICLR) 2024
- ▶ Artificial Intelligence and Statistics Conference (AISTATS) 2024
- ▶ International Speech Communication Association (Interspeech) 2023
- ▶ Deep Generative Models for Health (NeurIPS workshop) 2023
- ▶ International Meeting for Applied Geoscience & Energy 2023

### Journal Reviewer

- ▶ IEEE Transactions on Neural Networks and Learning Systems
- ▶ IEEE Geoscience and Remote Sensing Letters
- ▶ IEEE Transactions on Geoscience and Remote Sensing
- ▶ Notices of the American Mathematical Society (AMS)
- ▶ Remote Sensing
- ▶ Journal of Geophysical Research – Solid Earth
- ▶ Geophysical Prospecting
- ▶ Geophysics
- ▶ Geosciences
- ▶ Entropy

## Teaching Experience

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**Rice University** Fall 2022  
Instructor for 18 lectures Houston, TX, USA  
Numerical Analysis I

**Georgia Institute of Technology** Spring 2022  
Teaching Assistant Atlanta, GA, USA  
Computational Foundations of Machine Learning

**Georgia Institute of Technology** Fall 2019  
Teaching Assistant Atlanta, GA, USA  
Imaging with Data-Driven Models

**Georgia Institute of Technology**  
Teaching Assistant  
Numerical Analysis I

Fall 2018  
Atlanta, GA, USA

**Sharif University of Technology**  
Teaching Assistant  
Digital Signal Processing

Spring 2011  
Tehran, Iran

**Sharif University of Technology**  
Teaching Assistant  
Signals and Systems

Spring 2011  
Tehran, Iran

**Sharif University of Technology**  
Teaching Assistant  
Linear Algebra

Spring 2010  
Tehran, Iran

## Internship

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**Google**  
Research Intern (cf. publication C24)  
Chrome Media Team

August 2021 – December 2021  
San Francisco, CA, USA