Rafael Ceja Ayala

Presidential Postdoctoral Fellow
Arizona State University

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Employment/Academic Positions

Arizona State University July 2024 – Present
Presidential Postdoctoral Fellow *Mentor: Dr. Malena Español*

Education

Ph.D in Applied Math, Purdue University Aug 2018 – May 2024
Thesis: Analysis and Computation for the inverse scattering problem with conductive boundary conditions. *Advisor and Mentor: Dr. Isaac Harris*

M.S. in Applied Math, Purdue University May 2022

B.A. in Math, California State University, Sacramento Aug 2014 – May 2018

Current Research Interests

My research interests are in **Direct and Inverse Problems** for *Partial Differential Equations.* I work with shape reconstruction problems arising in **Inverse Scattering** and **Electrical Impedance Tomography** for **second and fourth order equations**. These problems focus on developing *computationally inexpensive*, yet *rigorous algorithms* to reconstruct the region(s) of interest. In addition, I work with **transmission eigenvalues** that correspond to scattering problems where there is no scattering. These problems arise in many physical applications such as **nondestructive testing** and **detecting defects** in complex structures in medical imaging and engineering.

Publications

1. **R. Ceja Ayala, I. Harris, and A. Kleefeld**, "Inverse parameter and shape problem for an isotropic scatterer with two conductivity coefficients". *Analysis and Mathematical Physics,* 14, No. 90, DOI:10.1007/s13324-024-00950-x (arXiv:2402.07880) (2024).
2. **R. Ceja Ayala, I. Harris, and A. Kleefeld** , "Direct sampling method via Landweber iteration for an absorbing scatterer with a conductive boundary," *Inverse Problems and Imaging*, DOI:10.3934/ipi.2023051 (arXiv:2305.15310) (2023).
3. **R. Ceja Ayala, I. Harris, A. Kleefeld, and N. Pallikarakis**, "Analysis of the transmission eigenvalue problem with two conductivity parameters," *Applicable Analysis*, DOI: 10.1080/00036811.2023.2181167 (arXiv:2209.07247) (2023).
4. **R. Ceja Ayala, S. Farrand, and V. Pigno**, "Using a Geometric View of Relatively Prime Integers to Associate Fractions to Decimals," Published in the McNair 2016-Journal at CSU-Sacramento.

Submitted and/or Under Review

1. **C. Borges, R. Ceja Ayala, and P. Nekrasov,**, "On Sampling Methods for Inverse Biharmonic Scattering Problems in Supported Plates," *Submitted for publication*, (arXiv:2603.21477).

2. **R. Ceja Ayala, I. Harris, and T. Sanchez-Vizuet**, "Well Posedness for the biharmonic scattering problem for a penetrable obstacle," *Submitted for publication*, (arXiv:2506.10176).
3. **R. Ceja Ayala, I. Harris, and A. Kleefeld**, "Analysis of a transmission eigenvalue problem for biharmonic scattering considering penetrable scatterers," *Submitted for publication*, (arXiv:2510.08444).
4. **R. Ceja Ayala, I. Harris, P. Li, and G. Ozochiawaeze**, " Factorization method for the biharmonic scattering problem for an absorbing penetrable obstacle," *Under Review in Communications on Analysis and Computation*, (arXiv:2511.05711).
5. **R. Ceja Ayala, G. Granados, and M. Español**, "Qualitative reconstruction methods for imaging interior Robin interfaces in EIT from Robin-to-Dirichlet data," *Under Review in Inverse Problems*, (arXiv:2601.10839) .

Publications Under Preparation

1. **V. Bokil, C. Carvalho, R. Ceja Ayala, M. Fabien, R. Maity, V. Obieke, and C. Scheid**, "Comparison of Structure Preserving Discretizations for the Nonlinear Schrodinger Equation with Applications to Nonlinear Optics," *Under preparation.*
2. **R. Ceja Ayala and G. Granados**, "Analysis of the anisotropic transmission eigenvalue problem considering a Neumman-to-Dirichlet map," *Under preparation.*
3. **R. Ceja Ayala, G. Granados and M. Español**, "Global uniqueness and lipschitz-stability for the inverse Robin-to Dirichlet transmission problem," *Under preparation.*

Selected Presentations

1. "Well-Posedness and Transmission Eigenvalues for Penetrable Biharmonic Scattering," AMS Sectional Meeting at North Dakota State University, Fargo, North Dakota, April 2026 *(Invited to the "Recent Developments in Inverse Problems: Theory and Applications" session).*

2. "Well-Posedness and Transmission Eigenvalues for Penetrable Biharmonic Scattering," SIAM Annual Meeting, Cleveland, Ohio, July 2026 *(Invited to the "Research Highlights from The Southwest Section of SIAM" session).*

3. "Factorization method for the biharmonic scattering problem for an absorbing penetrable obstacle," California State University, Sacramento, Sacramento, California, April 2026 *(Invited to Department's Colloquium).*

4. "Inverse shape problem for an isotropic scatterer with conductivity coefficients," SIAM Annual Meeting, Montreal, Canada, August 2025 *(Invited).*

5. "Inverse shape problem for an isotropic scatterer with conductivity coefficients," SIAM Conference on Computational Science and Engineering (CSE25), Fort Worth Texas, March 2025 *(Organized).*

6. "Inverse shape problem for an isotropic scatterer with conductivity coefficients," SACNAS, Phoenix, Arizona, October 2024 *(Organized).*

7. "Inverse shape problem for an isotropic scatterer with conductivity coefficients," Modeling and Computation seminar at the University of Arizona, Tucson, Arizona, October 2024 *(Invited).*

8. "Inverse shape problem for an isotropic scatterer with conductivity coefficients," PDE seminar at Arizona State University, Tempe, Arizona, October 2024.

9. "Analysis of the Transmission Eigenvalue Problem with two Conductivity Parameters," Inverse Problems for Partial Differential Equations, New Brunswick, New Jersey, May 2024.

10. "Analysis of the Transmission Eigenvalue Problem with two Conductivity Parameters," SACNAS, Portland Oregon, October 2023.

11. "Analysis of the Transmission Eigenvalue Problem with two Conductivity Parameters," Mathematics Seminar, Virginia Tech, October 2023.

12. "Analysis of the Transmission Eigenvalue Problem with two Conductivity Parameters," Great Lakes Mathematical Physics Meeting, Oberlin Ohio, June 2023.

13. "Analysis of the Transmission Eigenvalue Problem with two Conductivity Parameters," Ohio River Analysis Meeting, Cincinnati Ohio, March 2023.

14. "Analysis of the Transmission Eigenvalue Problem with two Conductivity Parameters," SIAM Conference on Computational Science and Engineering (CSE23), Amsterdam Netherlands, February 2023.

Selected Teaching & Mentoring Experiences at Arizona State University

- **TEACHING:**
  - Spring 2026: MAT 343 (lecture)*Applied linear algebra* (1 section).
  - Fall 2025: MAT 343 (lecture)*Applied linear algebra* (1 section).
  - Summer 2025: MAT 342 (lecture)*Linear algebra* (1 section).
  - Spring 2025: MAT 343 (lecture)*Applied linear algebra* (1 section).
  - Spring 2025: MAT 343 (lecture)*Applied linear algebra* (1 section).
  - Fall 2024: MAT 265 (lecture) *Calculus for engineers* (1 Section).

- **MENTORSHIP:**
  - **Barret Honors College project with William Slingland in Spring 2026.** Here I supervised a student project investigating the role of linear algebra in cryptography, focusing on matrix-based encryption schemes. Guided the implementation of a program that encodes messages as matrices, applies invertible transformations for encryption, and incorporates a user interface with input validation and error handling.
  - **Barret Honors College project with Ram Bhatnagar in Spring 2026.** I supervised a student project investigating low-dimensional structures in high-dimensional facial data via linear algebra techniques. Directed the use of PCA/SVD to derive eigenfaces and eigenshapes, enabling efficient representation and reconstruction of 2D images and 3D meshes, and conducted comparative analysis of dimensionality, spectral decay, and approximation error.
  - **Serving in an honors thesis committee to co-advise Naman Vaibhav Gandhi in Spring 2025 and Fall 2025.** He succesfully defended his thesis in Fall 2025. Thesis title: Deep Learning Enhancement of Electrical Impedance Tomography Reconstructions Using Transformer Neural.
  - **Barret Honors College project with CJ Cate in Spring 2025.** We worked on quantum mechanics and the main idea of having qubit. We tried to understand the role in linear algebra in quantum mechanics and generalizations of the concepts in MAT343.
  - **Barrett Honors College project with Ayaan Mansoori in Fall 2024.** We connected basic understanding of calculus to financial mathematics. We answered the different ways the derivative can be used to understand rates of change in financial mathematics.

Selected Teaching & Mentoring Experiences at Purdue University

- **TEACHING:**
  - Fall 2023 and 2022: MA 16010 (lecture) *Applied Calculus I* (2 Sections).
  - Summer 2023: MA 51100 (TA) *Graduate Linear Algebra with Applications* (3 Sections).
  - Spring 2023: MA 16010 (Forum Moderator) *Applied Calculus I* (All Sections).
- **MENTORSHIP:**
  - *Association for Women in Mathematics Mentor to* Eric J. Pabón Cancel (2023 – 2024)
  - *Louis Stokes Alliances for Minority Participation program Purdue Program Mentor to:*
    - Prinitha Senthil and Kyndahl Bishop (Spring 2023),
    - Loahni Hernandez (Fall 2022),
    - Jessica Soleto and Gabriel Muzio (Spring 2022),
    - and Santiago Lopez and Oliver Bonilla (Fall 2021)

Selected Awards, Grants & Honors

- Arizona State University Presidential Fellowship . . . . . 2024 – 2027
- MGB-SIAM Early Career (MSEC) Fellowship . . . . . 2025 – 2027
- 2025-26 Project NexT Cohort ($3000) . . . . . 2025 – 2026
- PDE Mini School at UNC-Chapel Hill, North Carolina . . . . . February 2026
- 2025 SACNAS Postdoc Leadership Institute (PLI) . . . . . October 2025
- Summer School on Analysis, Partial Differential Equations, and Applications, University of Wyoming ($600) . . . . . Summer 2025
- 2025 SIAM Travel Award to attend SIAM-CSE25 ($650) . . . . . Spring 2025
- Attended the Blackwell-Tapia 2024 Conference . . . . . Nov 2024
- Attended the Math Modern workshop . . . . . Oct 2024
- Attended SACNAS/NDiSTEM . . . . . Oct 2024
- Attended ICERM-Empowering a Diverse Computational Mathematics Community . . Aug 2024
- Honorary mentioned NSF Postdoctoral Fellowship . . . . . Feb 2024
- Bilsland Dissertation Fellowship . . . . . Spring 2024
- Gates Millennium Fellowship/Scholarship . . . . . 2018 – 2024
- Alliance for Graduate Education and the Professoriate (AGEP) Scholar . . . . . 2021 – 2024
- Oregon State University Pre-Doctoral Scholar 2023
- Virginia Tech Future Faculty Diversity Program Scholar . . . . . Fall 2023

- Purdue Doctoral Fellowship . . . . . 2018 – 2022
- Math Alliance Scholar . . . . . Grad School
- Gates Millennium Scholarship . . . . . 2014 – 2018
- Gates Millennium Scholarship . . . . . 2014 – 2018
- Louis Stokes Alliances for Minority Participation Program Scholar . . . . . 2017 – 2018
- Math Alliance Scholar . . . . . 2017 – 2018
- McNair Scholar . . . . . 2016 – 2018

Professional Activities

- **Editorial Reviewer,** for *Applicable Analysis,* as of . . . . . January 2025
- **Editorial Reviewer,** for *La Matematica,* as of . . . . . December 2025
  - **Co-organizing,** mini-session titled "Computational and Numerical Methods for Inverse Problems and Imaging," at the 2026 Fall Western Sectional Meeting . . . . . November 2026
  - **Co-organizing,** mini-session titled "Spectral Theory and Scattering Phenomena in PDE and Inverse Problems," at the 2026 Fall Western Sectional Meeting . . . . . November 2026
  - **Co-organizing,** mini-session titled "Rhythms of Rest and Responsibility: Managing Commitments in the Early Career," at MathFest 2026 conference . . . . . August 2026
  - **Co-organizing,** mini-session titled "Inverse problems and applications: ideas from early-career researchers," at 2026 SIAM Annual Meeting . . . . . July 2026
  - **Co-organized,** mini-session titled "Recent Advances in Modeling and Numerical Methods for Inverse Problems for Partial Differential Equations," at 2025 SIAM PD25 conference November 2025
  - **Co-organized,** mini-session titled "Hispanic Voices in Applied Mathematics," at the 2026 Joint Mathematics Meeting . . . . . January 2026
  - **Co-organized,** mini-session titled "ICERM-SIAM Empowering a Diverse Computational Mathematics Research Community," at 2025 SIAM Annual Meeting (SIAM AN25) July 2025
  - **Affinity Group Leader,** for the Guided affinity group in Inverse Problems and data assimilation at the Building Engagement Program happening at SIAM CSE25 . March 2025
  - **Co-organized,** mini-session titled "Recent Advances in Modeling and Numerical Methods for Inverse Problems," at the 2025 SIAM Conference on Computational Science and Engineering (CSE23) . . . . . March 2025
  - **Co-organized,** mini-session titled "Diverse Perspectives: Interdisciplinary Research in Applied Mathematics," at NDiSTEM . . . . . Oct 2024

Selected Academic Activities, Service & OUTREACH

- **Lathisms Judge,** in charge of reviewing applications for the Lathisms Scholarship program April 2025

- **Panel Speaker,** Fields of Success: Math Alliance Scholars Tell their Stories from Undergraduate to Graduate and Beyond . . . . . August 2025
- **Lathisms Judge,** in charge of reviewing applications for the Lathisms Scholarship program April 2025
- **Writer,**SIAM news article focused on the "ICERM-Empowering a Diverse Computational Mathematics Community" workshop . . . . . Feb 2025
- **Broader Engagement Judge,** in charge of reviewing applications for the Broader Engagement Program happening at SIAM CSE (25) . . . . . Dec 2024
- **Lathisms Judge,** in charge of reviewing applications for the Lathisms Scholarship program Oct 2024
- **Invited Speaker,** Graduate Student Panel at Career Paths in the Mathematical Sciences an IMSI/IMA/Math Alliance Workshop . . . . . June 2024
- **Co-organizer,** Basic Skills Seminar at Purdue University . . . . . Fall 2023 – Spring 2024
- **Co-organizer,** Graduate Student Analysis Seminar at Purdue University Fall 2023 – Spring 2024
- **Mathematics Screening Judge,** Mathematics Department at Purdue University Aug 2023
- **Poster Judge,** Graduate Bridge Program at Purdue University . . . . . August 2023
- **Panel Speaker,** Summer Research Opportunities Program at Purdue University . June 2023
- **Panel Speaker,** Conexiones Retreat at Purdue University . . . . . Fall 2022
- **Writer,** for the Al Punto Newspaper in Ukiah California . . . . . 2012 – 2020
- **Panelist,** for the Science Equity Education (SEE) Program at CSU-Sacramento Spring 2022
- **Co-Organizer,** Diversity Statement Virtual Workshop Hosted by AGEP . . . . . Fall 2021