

Joel A. Sotelo Flores

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Education

Washington and Lee University

Lexington, VA

B.S. Physics; B.S. Earth and Environmental Geoscience

Expected June 2027

- Honors Thesis: *PyRo-FOAMS: An open-source workflow for automated vesicle segmentation and stereological analysis.*
- Relevant coursework: Volcanology; Modeling and Simulation of Physical Systems; Earth and Environmental Geochemistry; GIS and Remote Sensing; Petrology & Crystallography; Hydrology; Geomorphology; Classical Mechanics; Electricity and Magnetism; Statistical Physics; Quantum Mechanics.
- Study abroad: Big Science in 21st Century Europe, including CERN and VIRGO Gravitational Wave Detector; Korean language study at Yonsei University.

Research Experience

NSF REU – Computer Vision in Physical Volcanology

June 2026 – Present

University of Hawai'i at Mānoa

Honolulu, HI

Advisor: Natalia Gauer Pasqualon

- Developing a computer vision pipeline to segment Kilauea lava fountain video and support quantitative extraction of eruption parameters from field footage.
- Trained U-Net segmentation models to identify lava-fountain regions across changing lighting, viewing geometry, and field conditions.
- Built a Python-based labeling and dataset-preparation system for selecting frames, generating masks, tracking video metadata, and organizing model-ready training data.
- Collected field footage for Kilauea Episodes 49 and 50 and documented camera settings, viewing conditions, and observational notes.

Machine Learning for Micro-CT in Physical Volcanology

June 2025 – Present

Washington and Lee University

Lexington, VA

Advisor: Nicholas Barber

- Conduct computational volcanology research on pyroclastic micro-CT volumes to quantify vesicularity, pore connectivity, permeability, and eruption-related textural characteristics of the 1817 Kawa Ijen eruption to reconstruct eruptive history.
- Train and evaluate U-Net-based deep learning models for 3D pore-space segmentation of volcanic clasts, enabling quantitative analysis of connected pore networks.
- Built PyRO-FOAMS, a Python-based stereometric analysis program inspired by Shea et al. (2010), to support automated vesicle analysis from 2D thin-section imagery through classical and machine learning computation.
- Used Dragonfly and OpenPNM to quantify porosity, permeability, pore connectivity, and anisotropy from segmented pyroclast volumes.
- Integrated electron microprobe and scanning electron microscope data to connect textural observations with mineral chemistry, fractionation trends, and pressure-temperature constraints.

Pulsating Star Astronomy

March 2025 – April 2026

Washington and Lee University

Lexington, VA

Advisor: David W. Sukow

- Conducted multi-band observational analysis of the RR Lyrae variable star V0499 Centauri.
- Analyzed robotic telescope data from the Las Cumbres Observatory global telescope network to construct folded light curves and measure pulsation behavior.
- Contributed to period determination using multiple algorithms, including phase dispersion minimization, string length minimization, harmonic analysis of variance, and Lomb-Scargle periodograms.

- Supported photometric distance analysis using period-luminosity-metallicity relations, extinction corrections, and comparison with Gaia DR3 parallax measurements.

Double Star Astrometry

Washington and Lee University

Advisor: David W. Sukow

October 2024 – April 2025

Lexington, VA

- Conducted astrometric analysis of the binary star system WDS 03575-0110 using robotic telescope observations from Las Cumbres Observatory.
- Used AstroImageJ to measure separation and position angle from observational image data.
- Compared new measurements with historical observations and Gaia DR3 data to evaluate common proper motion and refine orbital parameter estimates through novel techniques.

Nanotechnology and Particle Physics

Washington and Lee University

Advisor: Irina Mazilu

January 2024 – March 2024

Lexington, VA

- Assisted with laboratory research on electric-field-driven self-assembly of nanoparticles and magnetic dipole systems.
- Investigated how dipoles interact, align, and form larger-scale structures under applied electric fields.
- Designed experimental apparatuses to observe, measure, and record magnetic dipole interactions.

AIM Research Scholar – Computational Number Theory

Washington and Lee University

Advisor: Carrie Finch-Smith

June 2023 – August 2023

Lexington, VA

- Developed an algorithm in R to identify Riesel-Sierpiński numbers within recursive sequences.
- Applied computational methods to explore problems in number theory and mathematical pattern recognition.

Publications and Manuscripts

Peer-Reviewed Publications

Sotelo Flores, J., Acevedo, S., Pickens, A., & Sukow, D. W. (2025). “New Measurements and Proposed Orbital Parameters for WDS 03575-0110 using Desmos Fitting.” *Journal of Double Star Observations*, 21(2), 182–189.

Manuscripts Under Review

Sukow, D. W., **Sotelo Flores, J.**, Nagy, J., & Freed, R. (under review). “BViz Photometric Distance to the RR Lyrae Star V0499 Centauri.” Submitted to the *Journal of the American Association of Variable Star Observers*.

Manuscripts in Preparation

Sotelo Flores, J., Barber, N. D. “PyRo-FOAMS: An open-source workflow for automated vesicle segmentation and stereological analysis” Planned submission to *Volcanica*.

Sotelo Flores, J., Gauer Pasqualon N., Patrick M. R., Anderson K., Tisdale C. M., Forshaw R. E. L. , Houghton B. F., Llewellyn E. W., Santos I. “Computer Vision Segmentation of Kilauea Lava Fountain Video for Physical Eruption Parameter Extraction.” Planned submission to *Journal of Applied Volcanology*.

Software and Research Products

Sotelo Flores, J. (2026). “Kilauea Lava Fountain Segmentation and Labeling Pipeline.” Research software. Computer-vision and labeling workflow for segmentation and quantitative analysis of Kilauea lava-fountain video.

Sotelo Flores, J. (2026). “PyRo-FOAMS” Research software. Python workflow for vesicle segmentation and stereological analysis, built as an evolution of Shea et. al’s FOAMS (2010) work.

Presentations

Sotelo Flores, J., Barber, N. D., Berlo, K., Handini, E., Buono, G., Pappalardo, L., & van Hinsberg, V. (2025). “Textural and Chemical Reconstructions of the 1817 Kawah Ijen Eruption: 3D Deep Learning Segmentation and Chemical Depictions of Pyroclasts.” Poster presentation, American Geophysical Union Fall Meeting.

Barber, N. D., **Sotelo Flores, J.**, Surya, G. P., Handini, E., Berlo, K., van Hinsberg, V., Buono, G., Pappalardo, L., Ratdomopurbo, A., & Ayuningtyas, T. R. (2026). "A field-based and 2D/3D stereological analysis of pyroclasts from the Ijen Caldera Complex: new insights into eruptive history and processes." Oral presentation, Palais des congrès de Montréal, Montréal, Canada.

Conference Abstracts Submitted

Sotelo Flores, J., Gauer Pasqualon N., Patrick M. R., Anderson K., Tisdale C. M., Forshaw R. E. L. , Houghton B. F., Llewellyn E. W., Santos I. (2026). "Computer Vision Segmentation of Kilauea Lava Fountain Video for Physical Eruption Parameter Extraction." Abstract submitted to the American Geophysical Union Fall Meeting.

Sotelo Flores, J., Barber N. D., Handini E., Berlo K. (2026). "PyRo-FOAMS: An open-source workflow for automated vesicle segmentation and stereological analysis" Abstract submitted to the American Geophysical Union Fall Meeting.

Awards, Fellowships, and Scholarships

R. Preston Hawkins IV Geology Field Research Award	April 2026
Samuel J. Kozak–Odell S. McGuire–Edgar W. Spencer L. Schwab Geology Lab Research Award	April 2025
U.S. Department of State Gilman Scholar	January 2024
QuestBridge Scholar	March 2023

Research Training and Scientific Programs

Green Bank Observatory ERIRA Program August 2025
Green Bank Observatory *Green Bank, WV*

- Gained hands-on experience in pulsar data analysis, radio telescope operations, and radio astronomy research methods.
- Built PyTorch machine learning models for detection and classification of galaxy images.

Michigan State Nuclear Science Summer School May 2025
Facility for Rare Isotope Beams, Michigan State University *East Lansing, MI*

- Participated in nuclear science workshops focused on rare isotope research, nuclear physics techniques, and data analysis.
- Gained exposure to experimental methods and computational workflows used in isotope experiments.

Teaching and Mentoring

Physics and Astronomy Teaching Assistant September 2024 – December 2025
Washington and Lee University *Lexington, VA*

- Assisted students in observational astronomy and introductory physics laboratories through hands-on support with data collection, analysis, and interpretation.
- Guided students in the use of the Skynet Robotic Telescope Network and Afterglow image-processing software.
- Helped students connect astronomical image processing, telescope observations, and physical interpretation of laboratory results.

AIM Program Advisor June 2025 – July 2025
Washington and Lee University *Lexington, VA*

- Served as a residential and academic mentor for incoming students participating in the AIM Scholars Program.
- Supported students during their transition to college by helping build community, encouraging academic confidence, and connecting students with campus resources.
- Facilitated group activities and informal advising focused on belonging, collaboration, and navigating university life.