RUSSELL JOSEPH MARTINEZ JR.

CURRICULUM VITAE

Contact Information

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Education

Bachelor's Degree in Mathematics Sep. 2021 – Present
Advisors: Prof. Yi Ni Caltech

GPA: 3.9/4.0. Relevant coursework: topological and smooth manifolds (Ma 109 ac); homology and homotopy theories (Ma 151 ab); Lie groups and their representations (Ma 157c); Morse theory and Floer homology (Ma 191b).

Research Interests

Low-dimensional topology: 3- and 4-manifolds, knot concordance, Khovanov homology, Heegaard/knot Floer homology.

Academic Experience

USS Participant [1] Expected: Jun. 2026
Mentors: To be determined PCMI

Student in the 2026 Undergraduate Summer School (USS) at the IAS/Park City Mathematics Institute (PCMI). Will explore knotted surfaces in 4-manifolds.

WWS Participant [1] Jan. 2026 – Jan. 2026
Mentors: Dugan Hammock, Prof. Zsombor Méder Wolfram

Student in the 2026 Wolfram Winter School (WWS). Explored S combinator arithmetic with a metamathematical basis using the Wolfram Language. Visually and symbolically defined the natural numbers using the n-tails of the 343-bird and introduced some dot notation for representing the combinator language.

SURF Fellow Jun. 2025 – Aug. 2025
Mentors: Prof. Yi Ni, Dr. Daren Chen Caltech

Student in the Geometry and Topology group at Caltech for the 2025 Summer Undergraduate Research Fellowship (SURF) program. Paper to be submitted online.

Abstract. Chen extended Bar-Natan homology to null homologous links in $\mathbb{RP}^3$. We consider the case of Bar-Natan homology for homologically essential links in $\mathbb{RP}^3$, defining the homology using a Bar-Natan deformation of the associated Khovanov chain complex and proving it is a link invariant. We then explore the geometric implications of this homology, namely in defining a Rasmussen-type s-invariant and proving some slice genus bound.

Undergraduate Researcher Apr. 2025 – Jun. 2025
Mentors: Dr. Matthew Gherman Caltech

Student in the Algebra group at Caltech for the SP 2024-25 term through Ma 97 (Research in Mathematics). Paper to be submitted online.

Abstract. The magic squares of squares problem is an open problem in recreational mathematics that asks whether a 3×3 magic square can contain nine distinct square entries. Using elementary mathematics, we exploit a series of magic square invariants to develop a single equation whose solutions are in correspondence with the collection of radical magic diamonds (RMDs), i.e., magic squares with six distinct square entries in a particular configuration. We then impose a second condition to create a system of equations whose solution, if it exists, would yield a non-Bremner magic square of seven distinct square entries; a lack of solution, however, would prove the nonexistence of a magic square of squares.

MSRI-UP Participant Jun. 2024 – Jul. 2024
Mentors: Prof. Candice Price, Prof. Erica Graham, Issa Susa SLMath

Student in the 2024 Mathematical Sciences Research Institute Undergraduate Program (MSRI-UP) at the Simons Laufer Mathematical Sciences Institute (SLMath). Expanded on Margolskee et al.'s 2013 model of the menstrual cycle and Arbelaez-Gomez et al.'s 2022 model of endometrium growth to develop a proposed mathematical model of the cyclic relationship between estradiol and endometriosis lesions. Used MATLAB and Simulink to simulate endometrium and lesion volume growth as well as demonstrate the increased estradiol-to-progesterone ratio in a person with endometriosis and the effectiveness of periodic exogenous estradiol suppression in preventing excessive endometrial tissue volume in the presence of lesions.

WELP:U Participant [2] Sep. 2023 – Mar. 2024
Mentors: Dr. Peter Barendse Wolfram

Student in the 2023 Wolfram Emerging Leaders Program: Undergraduate (WELP:U). Explored the 3×3 magic squares of squares problem with an educational basis using the Wolfram Language. Used a series of magic square invariants to prove the fundamental form of magic squares of squares, constructed several unique radical magic hourglasses of squares, and geometrically interpreted the hypothetical existence of a magic square of squares.

WSS Participant [3] Jun. 2023 – Jul. 2023
Mentors: Dr. Brad Klee Wolfram

Student in the New Kind of Science (NKS) and Ruliology track at the 2023 Wolfram Summer School (WSS). Explored methods of visualizing generalized Collatz functions with an experimental basis using the Wolfram Language. Observed numerous phenomena including structured distributions of prime number counts in iteration graphs, patterns in digit plots of different bases, and forced trajectories using truncated p-adic integers.

Undergraduate Researcher Apr. 2023 – Jun. 2023
Mentors: Prof. Nathan Lewis, Dr. Sean Byrne Caltech

Student in the Lewis Group for the SP 2022-23 term through Ch 80 (Chemical Research). Explored the effects of elemental substitution on cuprous oxide. Ran chronopotentiometry tests with a tri-potentiostat system at varying currents for pure and doped cuprous oxide solutions – specifically cobalt inclusions. Then, characterized the deposited electrode films via X-ray diffractometry (XRD) and scanning electron microscopy (SEM), and used the Wolfram Language to analyze the resulting data.

SURF Fellow Jun. 2022 – Aug. 2022
Mentors: Prof. Nathan Lewis, Dr. Sean Byrne Caltech

Student in the Lewis Group at Caltech for the 2022 Summer Undergraduate Research Fellowship (SURF) program. Explored the effects of elemental substitution on cuprous oxide. Ran chronoamperometry tests with a PAR 273 potentiostat at varying potentials for pure and doped cuprous oxide solutions – specifically iodine and bromine inclusions. Then, characterized the deposited electrode films via X-ray diffractometry (XRD), and used the Wolfram Language to analyze the resulting data.

Industry Experience

IN FOCUS Participant Jan 2024 – Jan 2024
Supervisors: N/A Jane Street

Student in the Trading track at the 2024 IN FOCUS program. Learned quantitative trading concepts, developed market making language, and simulated market interactions through games like Figgie.

MSP Fellow Jul. 2023 – Sep. 2023
Mentors: Dr. Regina Eckert NASA JPL

Student in the Imaging Spectroscopy group (382B) at NASA JPL for the 2023 Maximizing Student Potential in STEM (MSP) program. Produced synthetic time-series VSWIR data for next-generation algorithm development by creating a prototype image segment selection tool, RT-Finder, using Python. Used the Skimage library for image processing by applying a series of Felzenszwalb segmentation, simple linear iterative clustering (SLIC) segmentation, and regional adjacency graph (RAG) thresholding to a given image. Then, used the OpenCV library to create an interactive window for segment selection, with the generated image masks being converted into a single, integer array to be inpainted with data from the SHIFT campaign read along EMIT wavelengths.

Teaching Experience

Mathematics Tutor Jan. 2022 – June 2025
Supervisors: Liz Jackman Caltech Y

Mathematics tutor in the Rise Program. Demonstrated principles of math and their applications to K-12 students in local Pasadena, California. Assisted one student in particular through all four years of high school, helping them achieve self-proficiency in pre-college and International Baccalaureate (IB) mathematics.

Mathematics Tutor Jan. 2022 – Mar. 2023
Supervisors: Annice Jackson Caltech Y

Mathematics tutor in the Young Legends Tutoring Program. Demonstrated principles of math and their applications to K-12 students associated with the San Gabriel Valley Section of the National Council of Negro Women (SGV-NCNW).

Publications

[1] *Birdwatching: A tale of S combinator arithmetic*, Wolfram Community (2026), `https://community.wolfram.com/groups/-/m/t/3629162`

[2] *Exploring magic squares of squares*, Wolfram Community (2024), `https://community.wolfram.com/groups/-/m/t/3188586`

[3] *Exploring generalized Collatz functions*, Wolfram Community (2023), `https://community.wolfram.com/groups/-/m/t/2959684`

Talks

[1] *Birdwatching: A Tale of S Combinator Arithmetic*, presented at WWS, Wolfram, Jan. 2026

[2] *On Knot Floer Homology*, presented at Selected Topics in Mathematics: Morse theory and Floer homology (Ma 191b), Caltech, Mar. 2024

[3] *The Bunkbed Conjecture: How to Debunk a Bunkbed*, presented at Combinatorial Analysis (Ma 121a), Caltech, Dec. 2024

[4] *Proposed Mathematical Model Of The Cyclic Relationship Between Estradiol And Endometriosis Lesions*, presented at MSRI-UP, SLMath, Jul. 2024

[5] *Creating Synthetic Time-Series VSWIR Data for Next Generation Algorithm Development*, presented at MSP, NASA JPL, Sep. 2023

[6] *Effects of Elemental Substitution on Cuprous Oxide Crystallinity*, presented at SURF Seminar Day, Caltech, Oct. 2022

Awards

[1] *Featured Contributor*, awarded by Wolfram Community, Jan. 2026

[2] *Stanley and Chenmei Hsu SURF Fellow*, awarded by Caltech, Jul. 2025

[3] *Featured Contributor*, awarded by Wolfram Community, Jun. 2024

[4] *Featured Contributor*, awarded by Wolfram Community, Jun. 2023

[5] *Dr. and Mrs. Daniel C. Harris SURF Fellow*, awarded by Caltech, Jul. 2022