

STEVE TRETTEL

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Positions

- 2019–Present **Stanford University**, Szegő Assistant Professor of Mathematics.
Fall 2019 **ICERM, Brown University**, Institute Postdoc.
Semester Program: [Illustrating Mathematics](#)

Education

- 2013–2019 **PhD, Mathematics**, University of California, Santa Barbara, Advisor: Darren Long.
Thesis: Families of Geometries, Real Algebras and Transitions
2008–2013 **B.S. Mathematics**, University of Minnesota, Twin Cities, GPA: 3.97.
Minors: Philosophy, Astrophysics, Linguistics. Addt'l Emphasis: Dakhóta Language

Publications

Accepted / Published Research Papers

- 2021 **The Heisenberg Plane**, Available at arxiv.org/abs/1805.04256.
Accepted at Algebraic and Geometric Topology
2021 **Vector-valued Distance and Gyrocalculus on the Space of Symmetric Positive Definite Matrices**, with Federico López, Beatrice Pozzetti, Michael Strube and Anna Wienhard.
[Accepted to NeurIPS \(Neural Information Processing Systems\)](#) arxiv.org/abs/2110.13475
2020 **Symmetric Spaces for Graph Embeddings: A Finsler-Riemannian Approach**, with Federico López, Beatrice Pozzetti, Michael Strube and Anna Wienhard, Available .
[Published in ICML \(International Conference on Machine Learning\)](#) arxiv.org/abs/2106.04941

Accept with Minor Revisions

- 2020 **Raymarching Thurston Geometries**, with Rémi Coulon, Sabetta Matsumoto and Henry Segerman, Available at arxiv.org/abs/2010.15801, Project Website: 3-dimensional.space.
With Experimental Mathematics

Other Published Mathematical Work

- 2020 **Non-Euclidean Virtual Reality III: Nil**, with Rémi Coulon, Sabetta Matsumoto and Henry Segerman, Available at arxiv.org/abs/2002.00369.
[Published in Bridges](#) 2020 Conference Proceedings
2020 **Non-Euclidean Virtual Reality IV: Sol**, with Rémi Coulon, Sabetta Matsumoto and Henry Segerman, Available at arxiv.org/abs/2002.00513.
[Published in Bridges](#) 2020 Conference Proceedings

Submitted Papers

- 2021 **Algebraic Number Starscapes**, with Edmund Harriss and Katherine E. Stange, Available at arxiv.org/abs/2008.07655, Project Website: algebraicstarscapes.com.

Preprints in Progress

An Intrinsic Formalism for Geometric Transitions.

Available at stevejtrettel.site/research/preprints/IntrinsicFormalism.pdf

Riemannian Limits of the Product Geometries.

Available at stevejtrettel.site/research/preprints/RiemannianLimits.pdf

The Space of Orthogonal Groups in $GL_n\mathbb{R}$.

Available at stevejtrettel.site/research/preprints/OrthogonalGroups.pdf

Research In Progress

The Kinematics of Deformable Bodies: Geometric Dynamics, Gauge Theory and Sub-Riemannian Geometry, with Brian Day and Sabetta Matsumoto.

Sub-Riemannian geometry and Stokesian Swimmers, with B. Day and S. Matsumoto.

A Transition of Complex Hyperbolic Space.

Teaching Experience

Stanford University

- Fall 2021 **Hyperbolic Geometry, Math 142**, Advanced Undergraduate Course.
Differential geometry of hyperbolic space in dimensions 2 and 3. Computations of isometries, lengths, areas, volumes. Introduction to hyperbolic structures on surfaces.
- Spring & Fall 2020 **Functions of a Real Variable, Math 115**, Undergraduate Math Major Course.
Construction of \mathbb{R} . Completeness, limits, sequences, series, differentiation, Riemman integration
- Fall 2020 & 2021 **Groups & Symmetry, Math 109**, Undergraduate Math Major Course.
An introduction to finite groups, discrete groups and Lie groups. Study of products, semidirect products, quotients, group actions, and representations.
- Winter 2021 **Integral Calculus, Math 21**, Introductory Undergraduate.
- Winter 2020 **Linear Algebra & Multivariable Calculus, Math 51**, Introductory Undergraduate.

University of California, Santa Barbara

- 2016, 2017 **Integral Calculus, Math 3B**, Introductory Undergraduate Course.

As A Teaching Assistant

- 2018 **Real Analysis**, UC Santa Barbara.
- 2017 **Advanced Linear Algebra**, UC Santa Barbara.
- 2015–18 **Multi Variable Calculus**, UC Santa Barbara.
- 2015 **Differential Equations**, UC Santa Barbara.
- 2013–16 **Linear Algebra**, UC Santa Barbara.
- 2013–16 **Single Variable Calculus**, UC Santa Barbara.
- 2011–12 **Precalculus**, University of Minnesota.

Select Invited Research Talks

- Spring 2021 **Cornell Topology Festival**, *Introductory Speaker*, [Video Link](#).
- Spring 2021 **McGill University**, *Geometric Group Theory Seminar*.
- Winter 2021 **University of Florida**, *Topology and Dynamics Seminar*.
- Winter 2021 **University of Arkansas**, *Mathematics Colloquium*.
- Summer 2020 **Weizmann Institute**, *Topology Seminar*.

- Spring 2020 **Stanford University**, *Topology Seminar*.
- Spring 2020 **UC Davis**, *Topology Seminar*.
- Winter 2020 **Arizona State University**, *Geometry and Topology Seminar*.
- Fall 2019 **UT Austin**, *Topology Seminar*.
- Fall 2019 **Brown University**, *Topology Seminar*.
- Fall 2019 **ICERM**, *Topology & Geometry Workshop*.
- Summer 2019 **Heidelberg University**, *Geometry & Dynamics Research Station*.
- Spring 2019 **UC Irvine**, *Topology Seminar*.
- Spring 2019 **Stanford University**, *Geometric Topology Seminar*.
- Winter 2019 **University of Virginia**, *Geometry Seminar*.
- Winter 2019 **Cornell University**, *Topology Seminar*.
- Fall 2018 **University of Minnesota**, *Topology Seminar*.

Invited Public Lectures

- Fall 2021 **Connecting the Young World International STEM Fair**, *Plenary Speaker*.
Geometry and Topology in Modern Mathematics
- Fall 2021 **76th Harry S. Kieval Lecture**, *Humbolt State University CA*.
Optics from Euclid to Einstein
- Winter 2021 **National Museum of Mathematics**, *New York, NY*, (Delivered Virtually).
Life in Curved Space: From Magnifying Glasses to General Relativity:
- Winter 2021 **Gathering for Gardner: Celebration of Mind**, (Delivered Virtually).
Visualization in low dimensional topology: differences in dimensions 2, 3 and 4.
- Fall 2020 **Bay Area Mathematical Adventures**, *San Jose, CA*, (Delivered Virtually).
When the shortest path doesn't look straight: geometry in optics, optimization and relativity.
- Summer 2019 **Santa Barbara Media Arts Show**, *UC Santa Barbara*.
Curved and twisted worlds: a Virtual Reality Exploration of 3-manifold topology.
- Spring 2018 **National Junior Science and Humanities Symposium**.
High dimensions in mathematics, computing and the "real world".
- Summer 2018 **Santa Barbara Media Arts Show**, *UC Santa Barbara*.
3-dimensional shadows of 4-dimensional objects

Invited Undergraduate Colloquia & Related Talks

- Fall 2021 **Humbolt State University**, *Mathematics Colloquium*.
What do 3-manifolds look like? Using the geometrization theorem to understand topology.
- Spring 2021 **Stanford Online High School**, *Invited Lecturer Series*.
A history of mathematical optics: from the Greeks to Einstein
- Spring 2021 **MAA Golden Sectional Meeting**, *Plenary Speaker*.
Ray Optics, Geodesics and Curved Space
- Spring 2019 **Cornell University**, *Undergraduate Math Club*.
Life in hyperbolic space: how a nonzero curvature tensor would screw up your daily routine.
- Winter 2019 **University of Virginia**, *Undergraduate Math Club*.
1,000 Ways to Die in Hyperbolic Space

Service & Outreach

- 2021 **Math & Computers Happy Hour**, *Stanford University*.
Ran an evening 'happy hour' crash courses in graphics programming to aid math/CS students to integrate knowledge from both tracts.
- 2021 **Stanford Postdoc Teaching Workshop**.
Gave presentations on teaching a wide variety of course types, recorded lectures from my live classes for future training material.
- 2021 **Topology beyond the Chalkboard: Speaker**, *NCNGTC Virtual Conference*.
Mini-course on creating teaching/outreach animations, session on writing outreach talks.
- 2020 **Department Technology Coordinator**, *Stanford Mathematics Department*.
Selected electronic tools to help move mathematics courses online during the pandemic, arranged for their approval through the university for department use. Worked individually with instructors to assist with all remote teaching needs.
- 2019–Present **oSTEM and Queer Postdocs**, *Stanford University*.
- 2018–19 **Directed Reading Program: Co-Founder**, *University of California, Santa Barbara*.
One of the co-founders and organizers of a directed reading program (DRP) pairing undergraduate students with graduate mentors. Successfully applied for & received a grant for its continuation.
- 2018–19 **Directed Reading Program: Mentor**, *University of California, Santa Barbara*.
- 2018–19 **SIMS: Tutor**, *University of California, Santa Barbara*.
Program pairing graduate students with undergraduates from underrepresented communities.
- 2015–18 **National Science Fair: Speaker, Judge**, (*Jr. Science & Humanities Symposium*).
Judge in mathematics category. Organizer of STEM outings, panel discussions. Invited speaker.
- 2016–19 **Graduate Topology Seminar: Organizer**, *University of California, Santa Barbara*.
Organized schedule, invited speakers, gave talks.

Fellowships & Awards

- 2018–19 **Bertelsen Dissertaton Fellowship**, *UC Santa Barbara*.
1-year fellowship. Awardee can be of any academic field, requires departmental nomination.
- 2018 **Outstanding Teaching Award**, *UC Santa Barbara Mathematics Department*.
Annual departmental award recognizing a graduate student's teaching.
- 2018 **Excellence in Teaching Nominee**, *UC Academic Senate*.
Nominations across all faculty and instructors directly by students to the Academic Senate.
- 2015–16 **UC Regents Fellowship**.
Fellowship from the UC Regents, awardees chosen from across all disciplines.
- 2015 **Excellence in Teaching Nominee**, *Graduate Student Association*.
Student nominated award for excellence in teaching.
- 2013–14 **UC Regents Fellowship**.
- 2013 **Excellence in Mathematics Award**, *University of Minnesota, Twin Cities*.
Annual award to the two top graduating seniors in the mathematics department.
- 2008–12 **University of Minnesota Gold Scholarship**, *University of Minnesota, Twin Cities*.
4-year merit based tuition scholarship.
- 2008 **Intel Scholarship**, *International Science and Engineering Fair, (ISEF)*.
1st place award, Intel International Science Fair. Project in Engineering.
- 2008 **Department of Defense Scholarship**, *National Science Fair, (JSHS)*.
1st place award, Junior Science and Humanities Symposium, project in Mathematics.

2006 **Department of Defense Scholarship, National Science Fair, (JSHS).**
1st place award, Junior Science and Humanities Symposium, project in Physics.

Mathematical Software

Open Source Projects

- 2019-Present **Raymarcher for the Thurston Geometries**, github.com/henryseg/non-euclidean_VR.
GPU accelerated calculation of the geodesic flow in homogeneous 3-manifolds and physically based shading to compute accurate 'inside views' of manifolds relevant to geometrization.
- 2020-Present **Path Tracer for Mathematical Illustration**, github.com/stevejtrettel/PathTracer.
Physically Based Renderer for producing photo-realistic images of mathematical objects (algebraic varieties, limit sets of hyperbolic groups, etc)
- 2021 **GPU - Accelerated Numerical PDEs**, github.com/stevejtrettel/ComputeMaterial.
Framework for computing and visualizing the results of highly parallelizable numerics in real time (Example: running mean curvature flow on surface, solving the 2D Schrödinger equation, etc)
- 2021 **GPU - Accelerated Parametric Surfaces**, github.com/stevejtrettel/ShaderMaterial.
Framework for computing real-time visualizations of functions defined on parametric surfaces. (Example: surfaces colored by mean curvature, domain coloring functions on Riemann surfaces, etc.

Selected Specific Programs

- Program **Geodesics in Sol**, For Rich Schwartz, stevejtrettel.site/code/SolGeodesics.
- Program **Spheres in Sol**, For Rich Schwartz, stevejtrettel.site/code/SolSpheres.
- Animation **Finding Lines on a Cubic**, For Benson Farb, Jesse Wolfson, vimeo.com/368051641.
- Animation **Braid Monodromy**, For Benson Farb, Jesse Wolfson, vimeo.com/368067023.
- Figures **Cubic Surfaces**, For Stephen McKean, vimeo.com/393580753, arxiv.org/abs/2002.10367.
- Animation **Approaching $\partial(\text{Teichmüller Space})$** , For Katie Mann, shadertoy.com/view/sdGGDV.
- Program **Phase of Complex Polynomials**, For Jon McCammond, Michael Dougherty.

Interactive Programs for Teaching

- Calculus**, Available at stevejtrettel.site/teaching.html#calc.
Riemann Sums, Volumes of Revolution, Parametric Curves, Surfaces, Vector Fields, Line integrals.
- Complex Analysis**, Available at stevejtrettel.site/teaching.html#cplx.
Projections of 4D graphs of z^n , $\exp(z)$. Domain coloring, series expansions and convergence.
- Differential Geometry**, Available at stevejtrettel.site/teaching.html#diffgeo.
Gauss curvature, geodesics, geodesic spheres for surfaces in \mathbb{R}^3 , conformal embeddings.
- Hyperbolic Geometry**, Available at stevejtrettel.site/teaching.html#hyperbolic.
Models of hyperbolic space, geodesics, Teichmüller space of surfaces.
- Fourier Analysis**, Available at stevejtrettel.site/teaching.html#fourier.
Partial sums, interpreting complex Fourier series, sinusoidal series for curves in \mathbb{R}^2 .
- Partial Differential Equations**, Available at stevejtrettel.site/teaching.html#pde.
Wave equations: numerics, eigenfunction expansion, fourier series. 2D Schrödinger equation.

Conferences Attended

- Spring 2021 **Cornell Topology Festival**, (*Virtual*).
- Spring 2021 **Nearly Carbon Neutral Geometry and Topology Conference**, (*Virtual*).
- Fall 2019 **Illustrating Algebra & Number Theory**, *ICERM, Brown University*.
- Fall 2019 **Illustrating Geometry and Topology**, *ICERM, Brown University*.
- Summer 2019 **Young Geometric Group Theory**, *Bilbao Spain*.
- Winter 2019 **Tech Topology Conference**, *Georgia Institute of Technology*.
- Summer 2018 **The Roots of Topology**, *University of Chicago*.
- Spring 2018 **Topology Student's Workshop**, *Georgia Institute of Technology*.
- Spring 2018 **Thin Groups in Geometry and Topology**, *Rice University*.
- Winter 2018 **Grad Student Topology Conference**, *UIC*.
- Summer 2017 **Lee Mosher Birthday Conference**, *Princeton University*.

Computer skills

- Javascript Proficient in THREE.JS, creation of 3D graphics both on the CPU and GPU.
- GLSL Proficient in writing GPU programs (vertex and fragment shaders) for graphics.
- Mathematica Long time user of the mathematica programming language for graphics.
- Other \LaTeX , HTML, CSS, Standard Office Software, etc

Languages

- English Native Speaker
- Dakhóta lápi 2nd language learner
- Deutsch 2nd language learner