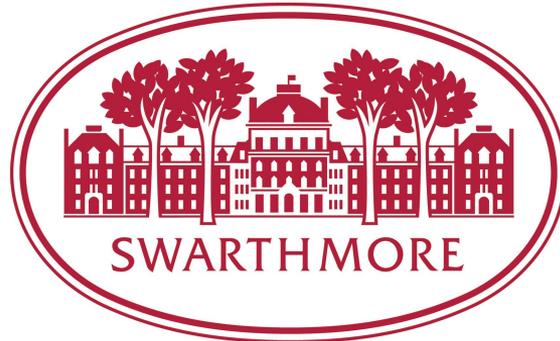


Swat Math/Stat Summer Opportunities

Summer 2024



Our Awesome Panelists!

- **Daniela Padron Castillo '24**
- **David Yang '24**
- **Joyce Ben '25**
- **Michael Eddy '24**
- **Olivia McClammy '25**

How to use this document:

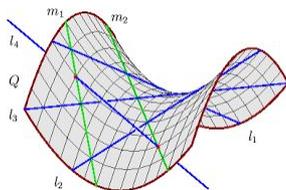
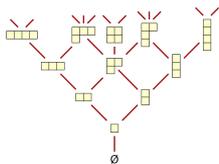
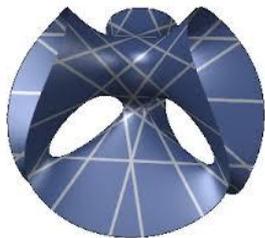
Faculty members in the math/stat department who may have Summer 2024 research projects have each made a slide or two to give you a short overview of their work and potential ideas for what students could work on. Some have also included further reading and next steps for potential research assistants.

Take a look at the following slides, check out the linked resources, and reach out to any professors that you might be interested in working with!

The last slides have links to some outside opportunities. If you know of more, let me know and I'll add them to the list!

(Note: demand for math/stat summer research far exceeds the supply of positions available, and most funding will be through the college's funding application, which happens in February or later)

Algebraic Combinatorics and/or Algebraic Geometry -- Prof. Linda Chen



My research is at the interface of complex algebraic geometry, algebraic combinatorics, and representation theory:

- the translation of problems in geometry to problems in algebra and combinatorics,
- combinatorial structures such as partitions and permutations,
- families of symmetric polynomials.



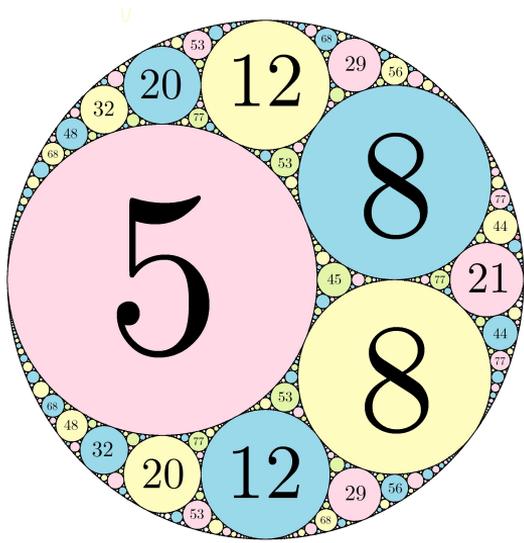
I *might* supervise undergraduate research this summer. If interested, email lchen@swarthmore.edu with a paragraph about your background and potential interest.

Ideal background: at least two of Math 67/Math 69/Math 102.

Bonus background: programming experience, any math seminar (Math 101/102/103/104/105).

Quick [reference](#) and [video](#).

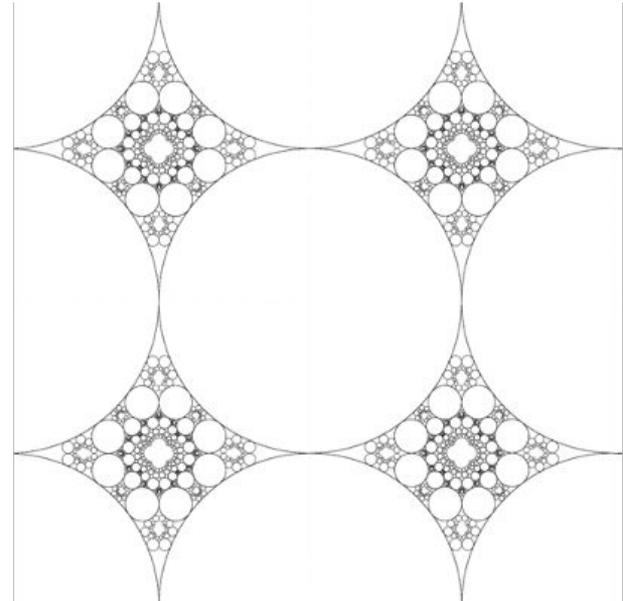
Number Theory -- Prof. Ian Whitehead



The image at left is an Apollonian circle packing. Each new circle is tangent to three circles surrounding it. Each circle is labeled with one over its radius. Interesting questions about these numbers include:

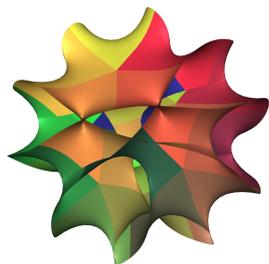
- Given a (large) integer X , how many numbers less than X appear in the picture?
- Given a (large) integer X , can you predict whether X appears without searching for it?

My own research uses analysis techniques to study these questions. With Swarthmore students, I've been studying generalizations of the Apollonian packing. We've computed fractal dimensions, discovered new packings, and found integer patterns like the one above. This summer, we'll explore the number theory and geometry of these new packings. References [here](#) and [here](#). Past projects [here](#) and [here](#).



Geometry and Physics-Prof. Ralph Gomez

Research Project: The universe might very well be 10 dimensional (4 space-time plus 6 extra dimensions) although there is not yet any experimental evidence for this. However, there is a fascinating symmetry associated to these 6-dimensional spaces. That symmetry is called *mirror symmetry*. I would like to use some computational techniques and ideas from mirror symmetry to explore the creation of new mathematical spaces in odd dimensions for which the curvature of these spaces is very specific. We will likely specialize to dimensions five, seven and nine.



Ideal background: A course in multivariable calculus (34 or 35) and if possible and upper level proof-based math class. No physics background needed!

Contact: Please email me at rgomez1@swarthmore.edu if you are interested or stop by my office if you have any questions!

Statistical Paleontology — Prof. Steve Wang

I develop statistical methods for analyzing data from paleontology, mass extinctions, evolution, and conservation biology.

I am not yet sure what specific projects we'll be working on this summer, but you can read brief descriptions of work by previous students here:
<http://paleo.domains.swarthmore.edu/personnel.html>

The most important qualities I am looking for are curiosity, persistence, perseverance, attention to detail, and skill in debugging. My work mainly involves computer programming, so you should have taken CS 21 or the equivalent. (CS 35 is helpful but not necessary.) The ideal statistical preparation would be Stat 51, but Stat 11 could work as well. No experience in paleontology is expected.

If you're interested, please send a resume/CV to swang1@swarthmore.edu.

You can find more information on my research here:
<http://paleo.domains.swarthmore.edu/research.html>

Feel free to ask if you have any questions!



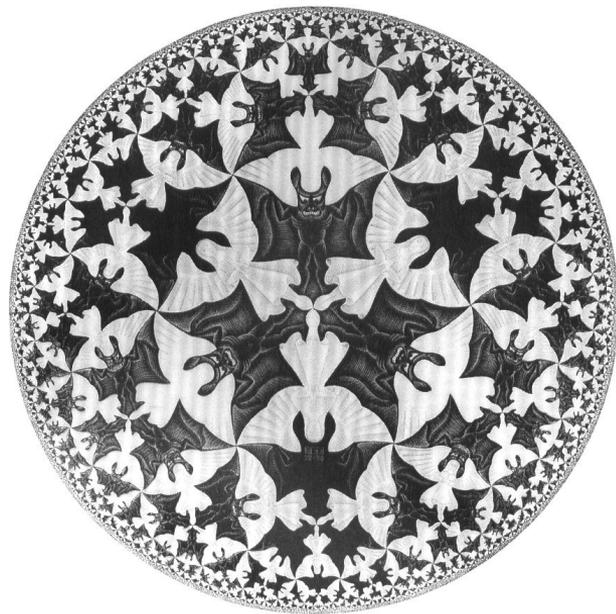
Quantitative Aspects of Hyperbolic Geometry

The hyperbolic plane is a 2-dimensional space whose volume grows exponentially as a function of the distance from the origin. Hyperbolic geometry is essential in my research and geometric group theory at large.

I am interested in questions about how we can get numerical estimates for constants that control the geometry of the hyperbolic plane and test their optimality either through computer simulation or proof.

Prereq: Math 34/35 Pluses: Math 63 and/or 67.

Email eeinste1@swarthmore.edu or drop by Singer 303 if you're interested and/or have questions



Escher's tessellation of the hyperbolic plane with bats

Applied Math and Brain Modeling– Prof. Victor Barranca

Overview:

I study the relationship between the [structure of a network and its function](#), particularly for high dimensional systems with nonlinear dynamics. Much of my research uses mathematical approaches to investigate the [neural computations underlying sensory processing](#) and the role of neuronal network connectivity in facilitating brain function. More information can be found [here](#).

This year's project will likely study how "what we see" can change from a single percept to alternating percepts, depending on the stimulus, and how this potentially helps us understand autism.

Projects Involve: *Nonlinear dynamics, modeling, signal processing, numerical computing, and binocular rivalry*

Prerequisites: Differential Equations (Math 43/44) and Programming Ability (CS 21 or equivalent)

Helpful, But Not Required, Additional Coursework Includes any of the Following:

Modeling (Math 56), Probability (Stat 51), Stochastic and Numerical Methods (Math 66)

No neuroscience experience needed: only interest in applications of math to biology is required

If Interested:

Contact Prof. Barranca at vbarran1@swarthmore.edu for more information. Please send along a short message explaining your interest in the research and relevant background. Feel free to reach out with any questions!



Spectral Graph Theory

Prof. Carolyn Reinhart



Overview- Given a matrix associated with a graph, what can the eigenvalues of the matrix tell us about the structure of the graph?

Consider the graph and matrix to the right. The number of times 0 is an eigenvalue of the matrix corresponds to the number of isolated vertices in the graph (vertices in orange).

$$A = \begin{pmatrix} 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

Our Problem- Ideally, the spectrum of a matrix would differentiate between different graphs, but this is not always the case. When two graphs are not the same, but they have the same spectrum for a matrix M defined in terms of a graph, they are called cospectral graphs. Our summer research will involve the study of cospectral graphs.

Requirements- Math 28 or Math 27 + at least one proof heavy course. Math 39 or some other experience with graph theory is preferred but not required. Experience writing in LaTeX is preferred but not required. Python programming experience is a plus. If interested, email creinha1@swarthmore.edu or stop by my office (Sci 155).

Swarthmore Summer Scholars Program Math Mentor

As we have learned in the 9 years of the Program, the Student Mentors are the 'secret sauce' to the S³P recipe for a successful program. **The job is a combination of teaching assistant and resident assistant, and includes a full summer stipend.** Please direct any questions to

Professor Ben Geller, S³P Director bgeller1@swarthmore.edu
<https://www.swarthmore.edu/summer-scholars-program/mentor-information>

Two student Math Mentors will be hired (along with 4 others who will support Writing and Astronomy) and will work closely with Professor Joseph Towles (Engineering). Math Mentors should have completed Math 15 and Math 25 and do not need to be STEM majors or minors. Feel free to apply for Astronomy and/or Writing as well!

Responsibilities: Support 16 summer scholars during the 4 weeks of the summer Program: serve as subject matter teaching assistants (TAs) to support the faculty who will be teaching; run the 5 study hall sessions each week; serve as RAs, providing tours, talking about resources on campus to support academics, physical and mental health, social activities; undergo 2 weeks training before the Program formally begins; attend and report at weekly S³P staff meetings during the summer; follow up with the Director in the week following the summer Program

Strong candidates: have demonstrated knowledge in the subject area that they will support; have strong commitment to inclusive diversity in the Swarthmore community; are dependable team members with strong communication skills; have awareness of first-gen/low-income (FLI) student challenges and opportunities



External Math/Stat Research Opportunities

The NSF funds a number of REU's in the [mathematical sciences](#) and [other fields](#) across the US. (Note that NSF-funded positions are restricted to US citizens or permanent residents). The AMS also has a list of possible summer programs: <https://www.ams.org//opportunities>.

Students have told us they have found the following links helpful for finding REUs:

- <https://sites.google.com/view/mathreu>,
- <https://reufinder.com/> or
- <https://www.mathprograms.org/db/program>

[Summer@ICERM](#) program at Brown University

The [Summer Institute in Biostatistics and Data Science](#) is an NIH-funded program across six different universities

[Stanford Population Health Summer Research Program](#) is a virtual program for under-represented and historically excluded students in the health sciences with a focus on quantitative methods for population health

** Feel free to leave a comment with any other opportunities, and I will add them to the document 😊

Career Services can help too!

- [Resumes](#), [Cover Letters](#), [Interviews](#), [Make Connections](#)
- [Handshake](#) - internships, employers, appointment scheduling, events and programs.
- [SwatWorks](#) - Winter and Summer
- [Summer Funding](#) options - Summer Opportunities Fair (January 16)
- Consortia - Fairs and Recruiting Days
 - [TCCF](#) - January 26
 - [Inclusive Hiring Meet Up](#) - January 25
 - [LAUNCH](#) - January 3 (application deadline); January 18 & 19 (virtual interviews)
 - [Government, Education, Non-Profit Fair](#) - February 4