AKASH SUDHANSHU

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ABOUT

I am a fifth-year B.S.-M.S. (Research) student at the Indian Institute of Science, Bangalore, majoring in Mathematics. My primary interest lies in differential geometry and topology. More specifically, I am interested in Teichmüller theory, Riemann surfaces, and complex geometry.

EDUCATION

Indian Institute of Science, Bangalore — Bengaluru, India
B.S.- M.S. (Research) dual degree — 2021 - 2026(Expected)
Majoring in Mathematics
CGPA: 9.1/10 (Overall), 9.4/10 (Mathematics)

PROJECTS

Bounded Distortion Conjecture for Once-punctured Torus
(Master's Thesis) — July - Ongoing
Mentor: Prof. Subhojoy Gupta — IISc, Bangalore

- The *Bounded Distortion Conjecture* proposed by R.C. Penner for (punctured) oriented surfaces relates a combinatorial method (convex-hull construction) with a complex analytic method (using Jenkins-Strebel differentials) which partitions the Teichmüller space into ideal cells.
- Currently, we are near completing our calculations to conclude the conjecture for a once-punctured Torus. We are using extremal lengths to lower bound the distortion and easy-to-compute models of marked-Riemann surfaces for calculations. Using branched covers, we can also conclude the conjecture for all once-punctured surfaces, if it turns out to be false for the once-punctured torus.
- This is an extension of my bachelor's thesis in which I presented an overview of this conjecture.

Two perspectives at the Weil-Petersson metric on the Teichmüller space — May-July 2025
Mentor: Prof. Sumio Yamada — Gakushuin University, Tokyo

- The goal was to learn about how the Weil-Petersson (WP) metric is defined on the Teichmüller space of closed oriented surfaces and Wolpert's Formula. Currently, I'm writing a report to summarise my understanding and explain how the two perspectives are interrelated.
- I learnt about two *equivalent* ways to define the WP metric using two models of the Teichmüller space: as the space of isotopic complex structures and the space of hyperbolic metrics up to isotopy. These two are equivalent in the sense that one can go back and forth from one description to another during each step, showing their equivalence.
- I mainly read Tromba's book textit Teichmüller theory in Riemannian Geometry for the metric model and N. Campo's book *Topological, Differential and Conformal Geometry of Surfaces* for the complex structures model description of the WP metric.

Decorated Teichmüller Theory: Towards the Bounded Distortion Conjecture
(Bachelor's Thesis) — Jan-April 2025
Mentor: Prof. Subhojoy Gupta — IISc, Bangalore

- In my Bachelor's thesis, I presented an overview of this conjecture and described it through an algorithmic perspective.
- The *Bounded Distortion Conjecture* proposed by R.C. Penner for (punctured) oriented surfaces concerns the distortion during the translation from one model to another model of an ideal cell decomposition of the Teichmüller space. One decomposition is obtained from a combinatorial construction (convex-hull construction) and the other from a complex analytic method (using Jenkins-Strebel differentials)..

- I started by learning about hyperbolic geometry, Teichmüller space, Strebel differentials from Hubbard's book *Teichmüller Theory*, Imayoshi & Taniguchi's book *Introduction to Teichmüller Theory*. I studied the setup of the conjecture from RC Penner's book *Decorated Teichmüller Theory* and quasiconformal maps from L. Ahlfors' *Lectures on Quasiconformal mappings*.

Complex Geometry (Summer project) May-Aug 2024
Mentor: Dr. Purvi Gupta IISc, Bangalore

- The aim was to learn the foundations of Complex geometry.
- I read the first five sections of *Principles of Algebraic Geometry* book by Griffiths and Harris, supplemented with other standard books for learning specific topics. I learned about analytic varieties, sheaf cohomologies, de Rham and Dolbeault's theorem, Poincaré duality for de Rham cohomology and a bit about geometry of complex vector bundles.
- Alongside, out of interest, I worked on an idea to generalize the surface of revolution via Lie group actions on embedded submanifolds. Eventually, I found necessary and sufficient conditions for the resulting manifold to be embedded. [report]

Introduction to Algebraic Topology (Winter Project) Dec 2023
Independent reading IISc, Bangalore

- Studied about fundamental groups, covering spaces and simplicial complexes. I primarily followed *Algebraic Topology* book by Hatcher. This was a prerequisite for the graduate-level Algebraic Topology course that I credited in the following semester.

Multivariable Calculus and Basic Fourier Analysis (Summer Project) May-July 2023
Mentor: Prof. Arka Mallick IISc, Bangalore

- The aim was to learn multivariable calculus and study Fourier analysis.
- I studied multivariable calculus from Rudin's *Principles of Mathematical Analysis* and Tao's *Analysis II*. I learned about wave and heat equations, Fourier and Plancherel's theorems, Dirichlet & Poisson kernels and convergence theorems from Stein and Shakarshi's *Introduction to Fourier Analysis*

PRESENTATIONS

1. **Hyperbolic LEGO to Teichmüller space** April, 2025
   Introduced hyperbolic geometry and presented Fenchel-Nielsen coordinates of Teichmüller space. Slides
2. **Algebraic structure of Analytic sets** (Finals, Complex Manifolds) April,2025
   Presented how algebraic structure of $\mathcal{I}_{A,x}$ and $\mathcal{O}_{A,x}$ differ at regular and singular points. (Board talk)
3. **Abel's Theorem on Riemann Surfaces** (Finals, Riemann Surface) Nov, 2024
   Presented the proof of Abel's theorem, which tells when a divisor is a principle divisor arising out of a meromorphic function. (Board talk)
4. **Mittag-Leffler Problem** Aug, 2024
   Presented the $\check{C}$ech method to solve the Mittag Leffler's problem on Riemann surfaces. Slides
5. **Fourier Series** Aug, 2023
   Presented the basic theory of Fourier series and a C^2 convergence theorems. Slides

RELEVANT COURSEWORK

Geometric Analysis (Ongoing)
Introduction to Complex Dynamics (Ongoing)
Complex Manifolds
Riemann Surfaces
Riemannian Geometry
Introduction to Several Complex Variables
Functional Analysis (Ongoing)
Complex Analysis
Ordinary Differential Equations
Multivariable Calculus
Measure & Integration
Topology

Algebraic Topology
Introduction to Differential Manifolds

Algebra II
Algebra I
Design and Analysis of Algorithms

CONFERENCES ATTENDED

1. **New Trends in Teichmüller theory** Feb 2025
   I got overview of various areas of ongoing research in Teichmüller theory. I read more about Weil-Petersson metric and Higher Teichmüller Theory, motivated by talks of Prof. Sumio Yamada and Prof. John Parker.
2. **Lean for the Curious Mathematicians** April 2025
   This was a workshop on Lean formalisation with talks about ongoing lean projects to formalise many big results like Fermat's Last Theorem. I solved the provided exercises and learnt about the ongoing projects and research in this area.
3. **Geometric Analysis and PDE** (upcoming) Feb 2026
4. **Geometric Structures and stability** (upcoming) Feb 2026

ACADEMIC ACCOMPLISHMENTS

- **Qualified Alibaba Global Math Competition, Stage 1** 2024
  It is an global mathematics competition for all age groups modelled on the International Mathematics Competition with participants from top universities in US, China and Asia.
- **Placed in top Quartile in Simon Marais Mathematics Competition, Pair category** 2023
  It is an undergraduate mathematics competition modeled on the Putnam mathematics competition with participants from top universities in Australia, New Zealand and Asia.
- **Mimamsa Physics Subject Topper** 2023
  It is a science olympiad competition for undergraduate teams across India with participants from top Indian mathematics institutes like IITs, ISIs and CMI.
- **KVPY-SX Fellowship** 2021- present
  Awarded a five-year fellowship by Department of Science and Technology, Government of India for higher education in pure science. KVPY (now discontinued) was a prestigious exam for 11th and 12th graders (junior and senior year) who are interested in studying pure sciences in college.

COMMUNITY SERVICE AND VOLUNTEER EXPERIENCE

- **Chess Coordinator, Pravega** 2023
  Organised and managed online Chess tournaments for Pravega(IISc's UG Fest).
- **Notebook Drive (NBD), Volunteer** 2022 -23
  NBD is a student-run group to support and mentor children from underprivileged backgrounds.
  Visited local schools in Bangalore, distributed stationery items, food & interacted with children.
- **IISc's Open Day** 2023-25
  Demonstrated the Gambler's Ruin concept through the game of Roulette in 2022, mathematical puzzles in 2023 and Reinforcement Learning though matchboxes. On this day, the student community at IISc showcases its activities and puts presentations for the general public.

TECHNICAL SKILLS

LaTeX: Intermediate proficiency
Python: Intermediate proficiency
Lean: Basic proficiency