# Shah Mohammed **Areeb**

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## Bibliography

### Master Thesis

**On a characterization of Higher Semiadditivity** — *Universität Regensburg*

Under the supervision of Prof. Dr. Denis-Charles Cisinski — *2022*

**Abstract**: In [HL13], M. Hopkins and J. Lurie introduce for $m \geq -2$, a notion of $m$-semiadditivity. This generalizes the classical notion of a semiadditive (infinity) category. Intuitively, $m$-semiadditive infinity categories are those in which limits and colimits of diagrams indexed by $m$-finite spaces (that is, $m$-finite infinity groupoids) are canonically equivalent.In [Har20], Y. Harpaz proves a universal property of the infinity category of spans of $n$-finite spaces with $m$-truncated wrong way maps. This is used to establish an equivalent characterization of $m$-semiadditivity in terms of a well behaved, essentially unique action of this category of spans. This approach has the advantage of not only providing a more succinct method of detecting $m$-semiadditivity, but also providing a versatile structure to work with $m$-semiadditive infinity categories. In this thesis, we survey this sequence of results.

### Expository Writing

**The Freyd-Heller group and the failure of Brown Representability** — *The University of Chicago*

The University of Chicago Mathematics REU — *Summer 2019*

**Abstract**: It is a classical result due to Edgar Brown that any set valued contravariant functor on the homotopy category of connected based topological spaces taking coproducts to products and weak pushouts to weak pullbacks is representable. This is however, false when we drop the assumption that our spaces and maps are based, or if we drop the assumption that the spaces under consideration are connected. We describe a construction due to Peter Freyd and Alex Heller, often called the "Freyd-Heller" group, that results in a counterexample in both cases.

URL: `http://math.uchicago.edu/~may/REU2019/REUPapers/Areeb.pdf`

## Talks

**Applied Category Theory 2023** — *University of Maryland*

Hidden Markov Models and the Bayes Filter in Categorical Probability — *31 July- 4 August 2023*

Delivered a talk on formulating hidden Markov models and Bayesian filtering in Markov categories.

URL: `https://www.youtube.com/watch?v=PwI3oOXWWe8`

## Experience

**Teaching Assistant** — *National Programme on Technology Enhanced Learning, India*

Teaching Assistant for the undergraduate Group Theory course at the National Programme on Technology Enhanced Learning — *Summer 2020*

- Responsibilities included checking exercise sheets and moderating the course forum, in particular answering student questions.

**Teaching Assistant** — *Chennai Mathematical Institute*

Teaching Assistant for the undergraduate Topology course at the Chennai Mathematical Institute — *Winter Semester 2019–20*

- Responsibilities included grading exercise sheets and conducting weekly tutorial sessions, as well as teaching when the instructor was unavailable.

**Student Mentor** — *Chennai Mathematical Institute*

Student mentor at the Chennai Mathematical Institute — *Academic Year 2019–20*

- Responsibilities included conducting weekly counseling sessions for first year students.

**Talk Host** — *Chennai Mathematical Institute*

Hosted a talk by Prof. Daniel Litt — *2020*

- Hosted a talk by Prof. Daniel Litt as part of the STEMS program at the Chennai Mathematical Institute.

**Workshop on Seshadri Constants** — *National Institute of Science, Education, and Research, Bhubhaneshwar*

National Centre for Mathematics Advanced Training in Mathematics Schools — *December 2019*

- Participated in workshop involving a series of talks by various speakers on topics related to Seshadri Constants.

### The University of Chicago Mathematics REU

*The University of Chicago*

Faculty Mentor: Prof. Peter May — *Summer 2019*

- Wrote an expository paper on the failure of the Brown Representability Theorem in both the Homotopy category of unbased, connected CW complexes and the Homotopy category of based CW complexes.
- Participated in lecture series on various topics by the University of Chicago faculty.

### Summer Internship in Algebraic Combinatorics

*Indian Institute of Technology Madras*

Mentor: Prof. Narayanan N — *Summer 2018*

- Completed a project under Professor Narayanan N of the Indian Institute of Technology, Madras on the topic of Algebraic Combinatorics, the application of algebraic methods to solving problems in combinatorics.

### Asian Science Camp 2018

*Manado, Indonesia*

Participant — *Summer 2018*

- Was one of 20 selected to represent India at the Twelfth Asian Science Camp 2018, where we were given the opportunity to interact with leading experts in the field of research, including some Nobel Prize winners such as Prof. Takaaki Kajita of the University of Tokyo.
- Completed a group project involving a presentation at the camp.

### Technical Internship

*Ducima Analytics*

Statistics and Data Analysis Intern — *Summer 2018*

- Performed statistical analysis of advertising revenue with the goal of optimizing the response to cost ratio of internet search advertisements.
- Preprocessed data, removed outliers, performed statistical tests and designed a regression model.
- Prepared a presentation for the clients.

### Vijyoshi National Science Camp

*Indian Institute of Science*

Participant — *2016*

- Attended lectures by various distinguished professors and multiple lab visits.

### Research Science Initiative – Chennai Summer Programme

*Indian Institute of Technology, Madras*

Intern — *Summer 2016*

- Attended daily lectures on various topics by the IIT Madras faculty, and visits to other labs and research facilities in and outside IIT Madras.
- Completed a project under the direct supervision of Professor Tripathy of the IIT Madras theoretical physics department.
- Analyzed dynamical systems via phase portraits and classified the nature of singularities to make local predictions.
- Delivered a presentation on the topic.

## Education

### Universität Regensburg

*Regensburg, Germany*

M.Sc. Mathematik — *2020–2022*

- **Year 1**
  1. **Semester 1 Coursework**
     - Higher Category Theory — *Grade: 1,0*
     - Cohomology of Sheaves 1 — *Grade: 1,0*
     - Algebraic Number Theory — *Grade: 1,0*
  2. **Semester 2 Coursework**
     - Seminar: Theta functions, complex abelian varieties and moduli spaces — *Grade: 1,0*
     - Higher Category Theory 2 — *Grade: 1,0*
     - Cohomology of Sheaves 2 — *Grade: 1,0*
- **Year 2**
  1. **Semester 3 Coursework**
     - Seminar: Introduction to Stable Homotopy Theory — *Grade: 1,0*
     - Derived Functors and Cohomology through Higher Categories — *Grade: 1,7*
  2. **Semester 4 Coursework**
     - Derived Categories — *No exam*
     - Seminar: Topoi, Logic and Forcing — *Grade: 1,0*
     - Seminar: Homotopical Algebra - Model Categories — *Grade: 1,0*

(Where the grades are on a scale from 1 to 4, 1 being the best)

**Chennai Mathematical Institute** *Chennai, India*

B.Sc. (Hons) in Mathematics and Computer Science *2017–2020*

- **Year 1**
  1. **Semester 1 Coursework**
     - Linear Algebra (Algebra 1)
     - Real Analysis (Analysis 1)
     - Functional Programming in Haskell
     - Classical Mechanics
     - English Literature

     *Semester 1 GPA: 10*
  2. **Semester 2 Coursework**
     - Group Theory (Algebra 2)
     - Multivariable Analysis (Analysis 2)
     - Probability Theory
     - Discrete Mathematics
     - Imperative Programming with Python

     *Semester 2 GPA: 10*
- **Year 2**
  1. **Semester 3 Coursework**
     - Rings, Fields and Modules (Algebra 3)
     - Analysis on Metric Spaces (Analysis 3)
     - Calculus
     - The Theory of Computation
     - Algorithms

     *Semester 3 GPA: 9.8*
  2. **Semester 4 Coursework**
     - Algebraic Topology (Graduate Topology 2)
     - Complex Analysis
     - Point-Set Topology (Topology)
     - Differential Equations
     - The Design of Programming Languages (PLC)

     *Semester 4 GPA: 9.8*
- **Year 3**
  1. **Semester 5 Coursework**
     - Algebraic Geometry 1
     - Introductory type-theory (Proofs and Types)
     - Introduction to Manifolds
     - Introduction to Formal Logic
     - Geometric Group Theory

     *Semester 5 GPA: 9.8*
  2. **Semester 6 Coursework**
     - Algebraic Geometry 2
     - Galois Theory (Algebra 4)
     - The Art of Short Fiction

     *Semester 6 GPA: 10*

(Where the GPA's are out of 10, 10 being the best)

## Skills

**Programming** Python, Haskell, GNU Octave, C, JAVA, LUA

**Scripting** LaTeX, HTML5, GNU Shell

**Languages** English (TOEFL 2019: 119/120), German (B1), Hindi, Tamil

## Honors & Awards

### Fellowships

2020 **CMI Medal of Excellence**, The CMI medal of excellence is awarded in recognition of outstanding performance in the National Undergraduate Programme in Mathematics and Computer Science.

2020 **Australian National University Future Research Talent Award**, The FRT is a competitive and prestigious program that attracts the very best international students from high-quality Indian institutions and provides them exposure to ANU research in the Science, Health, Medicine and Computer Science disciplines

Summer 2019 **SN Bose Scholars Program**, The Science and Engineering Board, Department of Science and Technology, Govt. of India, the Indo-U.S. Science and Technology Forum and WINStep Forward have partnered to develop a student exchange program between premier institutions in India and the United States.

2017–2020 **KVPY Fellowship**, The Kishore Vaigyanik Protsahan Yojana is a National Program of Fellowship in Basic Sciences, awarded by the Department of Science and Technology, Government of India.

## References


[Har20] Yonatan Harpaz. Ambidexterity and the universality of finite spans. *Proceedings of the London Mathematical Society*, 2020.

[HL13] Michael Hopkins and Jacob Lurie. Ambidexterity in $k(n)$-local stable homotopy theory. 2013. URL: https://www.math.ias.edu/~lurie/papers/Ambidexterity.pdf.