

# Nicolas Allen Smoot

## Curriculum Vitæ

### Education

- 2020 **Ph.D.**, *Johannes Kepler University Linz, Austria, Computational Mathematics*
- 2016 **M.Sc.**, *Georgia Southern University, United States, Mathematics*
- 2014 **B.Sc.**, *Armstrong State University, United States, Mathematics (Graduated cum laude)*

### Employment

- 2023-current **Project Leader**, *University of Vienna, FWF Principal Investigator Project PAT 6428623*
- 2021-2023 **Project Leader**, *Johannes Kepler University Linz, FWF Stand-Alone Project P33933*
- 2016-2020 **Ph.D. Candidate/Research Assistant**, *Johannes Kepler University Linz*
- 2014-2016 **Graduate Teaching Assistant**, *Georgia Southern University*
- 2012-2014 **Undergraduate Research Assistant**, *Georgia Southern University (Armstrong Campus)*

### Funding

- November 2023–current: Principal investigator for Austrian Science Fund grant (ca. €187,000), Project PAT 6428623, “Towards a Unified Theory of Partition Congruences.”
- March 2021–2023: Principal investigator for Austrian Science Fund grant (ca. €145,000), Stand-alone Project P33933 “Partition Congruences by the Localization Method.”  
*I applied for this grant, and received it prior to completion of my Ph.D.*

### Awards and Honors

- 2021: Young Researchers' Award, Johannes Kepler University Linz.  
*Awarded in recognition for receiving my Stand-alone grant (P33933) before completing my Ph.D.*
- Graduated *cum laude* from Georgia Southern University (Armstrong Campus).
- President of the Armstrong (now Georgia Southern) chapter of Pi Mu Epsilon, 2013-2014.  
*Pi Mu Epsilon is the honor society for mathematics in the United States.*

### Cooperation Partners (Ongoing)

- Dr. Koustav Banerjee, postdoctoral researcher at RISC, JKU Linz
- Dr. Frank Garvan, professor of mathematics at University of Florida

- Dr. Paul Jenkins, chair of mathematics at Brigham Young University
- Dr. Michael Schlosser, associate professor of mathematics at University of Vienna
- Dr. James A. Sellers, professor of mathematics at University of Minnesota Duluth
- Dr. Balázs Szendroi, professor of mathematics at University of Vienna

## Cooperation Partners (Former)

- Dr. Silviu Radu, postdoctoral researcher at RISC, JKU Linz

## Main areas of research

- Analytic number theory
- Combinatorics
- Integer partition congruences
- Partition asymptotics
- Computer algebra
- Complex analysis

## Publications

1. "On the Classification of Modular Congruence Families," (submitted) (2024), <https://arxiv.org/abs/2403.10681>.
2. (with James A. Sellers) "Old Meets New: Connecting Two Infinite Families of Congruences Modulo Powers of 5 for Generalized Frobenius Partition Functions" (submitted) (2024), <https://arxiv.org/abs/2402.18509>.
3. (with Michael J. Schlosser) "A Finite-Bound Partition Equinumerosity Result Generalizing a Solution of a Problem Posed by Andrews and Deutsch" (submitted) (2024), <https://arxiv.org/abs/2312.09973>.
4. (with Koustav Banerjee) "The Localization Method Applied to  $k$ -Elongated Plane Partitions and Divisibility by 5" (submitted) (2022), <https://arxiv.org/abs/2208.07065>.
5. (with Koustav Banerjee) "2-Elongated Plane Partitions and Powers of 7: The Localization Method Applied to a Genus 1 Congruence Family" (submitted) (2023), <https://arxiv.org/abs/2306.15594>.  
*My latest manuscript on the localization method with K. Banerjee, currently submitted for publication.*
6. (with James A. Sellers) "On the Divisibility of 7-Elongated Plane Partition Diamonds by Powers of 8," *International Journal of Number Theory* Volume 20 (1), (2024), <https://doi.org/10.1142/S1793042124500131>.  
*This is a proof of a congruence family for powers of 2 that was originally conjectured by da Silva, Hirschhorn, and Sellers. The proof uses classical techniques.*
7. "A Congruence Family For 2-Elongated Plane Partitions: An Application of the Localization Method," *Journal of Number Theory* 242, pp. 112-153 (2023), <https://doi.org/10.1016/j.jnt.2022.07.014>.  
*This proves a congruence family conjectured by G.E. Andrews and P. Paule which was supposed by the two to be "especially challenging." I was able to supply the proof in this paper within a week using my*

*localization method.*

8. "A Single-Variable Proof of the Omega SPT Congruence Family Over Powers of 5," *Ramanujan Journal* 62, pp. 1-45 (2023), <https://doi.org/10.48550/arXiv.2004.03944>.

*This was the very first application of my localization method.*

9. (with Cristian-Silviu Radu) "A Method of Verifying Partition Congruences by Symbolic Computation," *Journal of Symbolic Computation*, Volume 104, pp. 105-133 (2021), <https://doi.org/10.1016/j.jsc.2020.04.008>.

*This very important paper details the experimental approach that I developed with S. Radu for verifying individual cases of congruence family. The computational ideas played a significant role in developing the more theoretical localization method.*

10. "On the Computation of Identities Relating Partition Numbers in Arithmetic Progressions with Eta Quotients: An Implementation of Radu's Algorithm," *Journal of Symbolic Computation*, Volume 104, pp. 276-311 (2021), <https://doi.org/10.1016/j.jsc.2020.05.003>.

*This is a description of my complete Mathematica implementation of S. Radu's algorithm for computing Ramanujan–Kolberg identities using the theory of modular functions. The software is extremely useful for verifying congruences and vanishing properties.*

11. "Divisibility Arising From Addition: The Application of Modular Functions to Infinite Partition Congruence Families," *Applied Mathematical Analysis and Computation - 1st SGMCC*, Statesboro, Georgia, U.S. (In preparation), Springer, April 2–3, 2021 (Conference Proceedings, to appear).

*This constitutes a survey of congruence families for various modular function Fourier coefficients with a partition-theoretic significance, together with the various techniques for proving them.*

12. "A Family of Congruences for Rogers–Ramanujan Subpartitions," *Journal of Number Theory*, Volume 196, pp. 35-60 (2019), <https://doi.org/10.1016/j.jnt.2018.09.025>.

*This is a proof of a conjecture by Choi, Kim, and Lovejoy, and constitutes an excellent example of the current proof techniques we currently have for proving congruences associated with a modular curve of cusp count 6. These techniques work, but we do not fully understand them.*

13. Solution 11908 II: "A Generalized Bijection for Partitions," *The American Mathematical Monthly*, Volume 125 (3), pp. 276–283, (2018), <https://www.jstor.org/stable/48661872>.

*The subject of this problem is an equality between different partition counting functions which can be proved in a straightforward manner by way of  $q$ -series manipulation. I generalized the bijection, and gave an entirely combinatorial proof in the manner of Franklin's proof of Euler's pentagonal number theorem.*

14. "A Partition Function Connected with the Göllnitz–Gordon Identities," *Harmonic Analysis, Partial Differential Equations, Banach Spaces, and Operator Theory*, Volume 2, Springer International, pp. 373-400, (2017), [https://doi.org/10.1007/978-3-319-51593-9\\_14](https://doi.org/10.1007/978-3-319-51593-9_14).

*This constitutes the core of my Master's thesis, in which an exact formula for the Fourier coefficients of a partition function (associated with the Göllnitz–Gordon Identities) was derived via the circle method.*

**Invited Talks**

1. (To be announced), The Legacy of Ramanujan: Celebrating the 85th Birthdays of George Andrews and Bruce Berndt, Penn State University, PA, 6–9 June, 2024.
2. “On the Classification of Modular Congruence Families,” International Conference on Modular Forms and q-Series, University of Cologne, Germany, 11–15 March, 2024.
3. “Partitions and Congruence Ideals,” Algebra and Number Theory Seminar, University of Vienna, 30 January, 2024
4. “Frobenius Partitions and New Congruence Families,” AMS Special Session on Partition Theory and q-Series, Joint Mathematics Meetings, San Francisco, CA, 4 January, 2024.
5. “Partitions and Their Surprising Arithmetic,” 19th Annual International Conference on Srinivasa Ramanujan, SASTRA Deemed to be University, Kumbakonam, Tamil Nadu, India, 20–22 December, 2023.
6. “Verifying Partition Congruences with Symbolic Computation,” AMS Special Session on Interactions Among Partitions, Basic Hypergeometric Series, and Modular Forms, Joint Mathematics Meetings, Denver, CO, 15–18 January, 2020.

### Contributed Talks

1. “Frobenius Partitions and Automorphisms,” Specialty Seminar in Partition Theory, q-Series and Related Topics, Michigan Technological University, Zoom Virtual Seminar, 21 March, 2024.
2. (with Michael J. Schlosser) “A Finite Extension of a Partition Bijection,” SFB Veterans’ Meeting, Schloss Roethelstein, Admont, 14 November, 2023.
3. “Partitions, Congruence Ideals, and the Localization Method,” Discrete Mathematics Seminar, University of Vienna, 24 October, 2023.
4. “Localization Applied to a Genus 1 Congruence Family,” Algorithmic Combinatorics Seminar, RISC, Hagenberg, 22 March, 2023.
5. “Provisional Results in the Localization Method,” Algorithmic Combinatorics Seminar, RISC, Hagenberg, 30 January, 2023.
6. “Congruence Kernels and the Localization Method,” Arbeitsgruppe Algebra und Zahlentheorie, MI Köln, 28 November, 2022.
7. “Additive Number Theory: An Introduction to Partition Numbers and Their Mysterious Laws,” DK “Computational Mathematics” Concluding Event, Strobl, October, 2022.
8. “Partitions, Kernels, and the Localization Method,” The 88th Seminaire Lotharingien de Combinatoire, Strobl, September, 2022.
9. “Some New Congruence Families and Unfamilies,” Algorithmic Combinatorics Seminar, RISC, Hagenberg, 15 June, 2022.
10. “k-Elongated Plane Partitions and Divisibility by 5” (Formerly “Computing Partition Identities Arising From Generalized Eta Quotients”), AMS Special Session on Modular Forms and Combinatorics, Joint Meetings of the AMS and MAA, Zoom Virtual Seminar, 9 April 2022.
11. “k-Elongated Plane Partitions and Divisibility by 5,” Algorithmic Combinatorics Seminar, RISC, Hagenberg,

6 April, 2022.

12. "The Localization Method Applied to Partition Congruences," Statusseminar, SFB F50 Algorithmic and Enumerative Combinatorics, Zoom Virtual Seminar, 1 December, 2021.
13. "Plane Partition Congruences and Localization," Specialty Seminar in Partition Theory, q-Series and Related Topics, Michigan Technological University, Zoom Virtual Seminar, 11 November, 2021.
14. "A Congruence Family For 2-Elongated Plane Partitions," Algorithmic Combinatorics Seminar, RISC, Hagenberg, 20 October, 2021.
15. "Partition Congruences and the Localization Method," Vanderbilt University Number Theory Seminar, Zoom Virtual Seminar, 8 September, 2020.
16. "Some New Identities From the Ramanujan–Kolberg Algorithm," Contributed Talk, Analytic and Combinatorial Number Theory: The Legacy of Ramanujan, University of Illinois at Urbana–Champaign, 7 June, 2019.
17. "A Family of Congruences for Rogers–Ramanujan Subpartitions," Contributed Talk, Combinatory Analysis 2018: A Conference in Honor of George Andrews' 80th Birthday, Pennsylvania State University, University Park, PA, 21 June, 2018.
18. "Enumerating the Partitions of the Göllnitz–Gordon Identities," Joint Meetings of the AMS and MAA, Baltimore, MD, 6 January, 2016.
19. "On the Stability of Ring Structures in Direct Limits," Joint Meetings of the AMS and MAA, Baltimore, MD, 17 January, 2014.
20. "The Structure of Consecutive Octic Residues," Joint Meetings of the AMS and MAA, San Diego, CA, 10 January, 2013.

## Teaching experience

2022W **Instructor for Analysis Exercise Course**, Johannes Kepler University Linz, Austria

2021W **Instructor for Analysis Exercise Course**, Johannes Kepler University Linz, Austria

2021S **Instructor for Special Topics in Symbolic Computation Exercise Course**, Johannes Kepler University Linz, Austria

2015–2016 **Instructor of the record (College Algebra)**, Georgia Southern University, United States

*I taught two courses in college algebra over the 2015–2016 academic year.*

2014–2015 **Teaching assistant (Calculus I)**, Georgia Southern University, United States

*As a first-year M.Sc. student, I assisted in teaching two calculus courses over the 2014–2015 academic year.*

## Conferences Organized

1. 28 November - 1 December 2021 (with Florian Aigner and Manfred Buchacher) Organizer for Statusseminar, SFB F50 Algorithmic and Enumerative Combinatorics, (Zoom Virtual Seminar).

*With F. Aigner and M. Buchacher, I organized the SFB Statusseminar in 2021. The seminar was originally to be held in person, but modified to a virtual seminar due to the COVID pandemic.*

2. 1-5 September 2025 (planned) (with Kathrin Bringmann) Organizer for the "Number Theory" session of

the Joint Meeting of the Österreichische Mathematische Gesellschaft and the Deutsche Mathematiker Vereinigung, to be held in Linz.

## Referee Contributions

I have refereed for the following journals:

1. *Advances in Mathematics*
2. *Journal of Number Theory*
3. *Ramanujan Journal*
4. *Journal of Mathematical Analysis and Applications*
5. *Journal of Symbolic Computation*
6. *Annals of Combinatorics*
7. *Journal of Integer Sequences*
8. *Publicationes Mathematicae Debrecen*
9. *Revista Matemática Iberoamericana*
10. *Discrete Mathematics*
11. *International Journal of Number Theory*
12. *Acta Arithmetica*