

An Interview with Heekyoung Hahn

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A Math Club for Girls

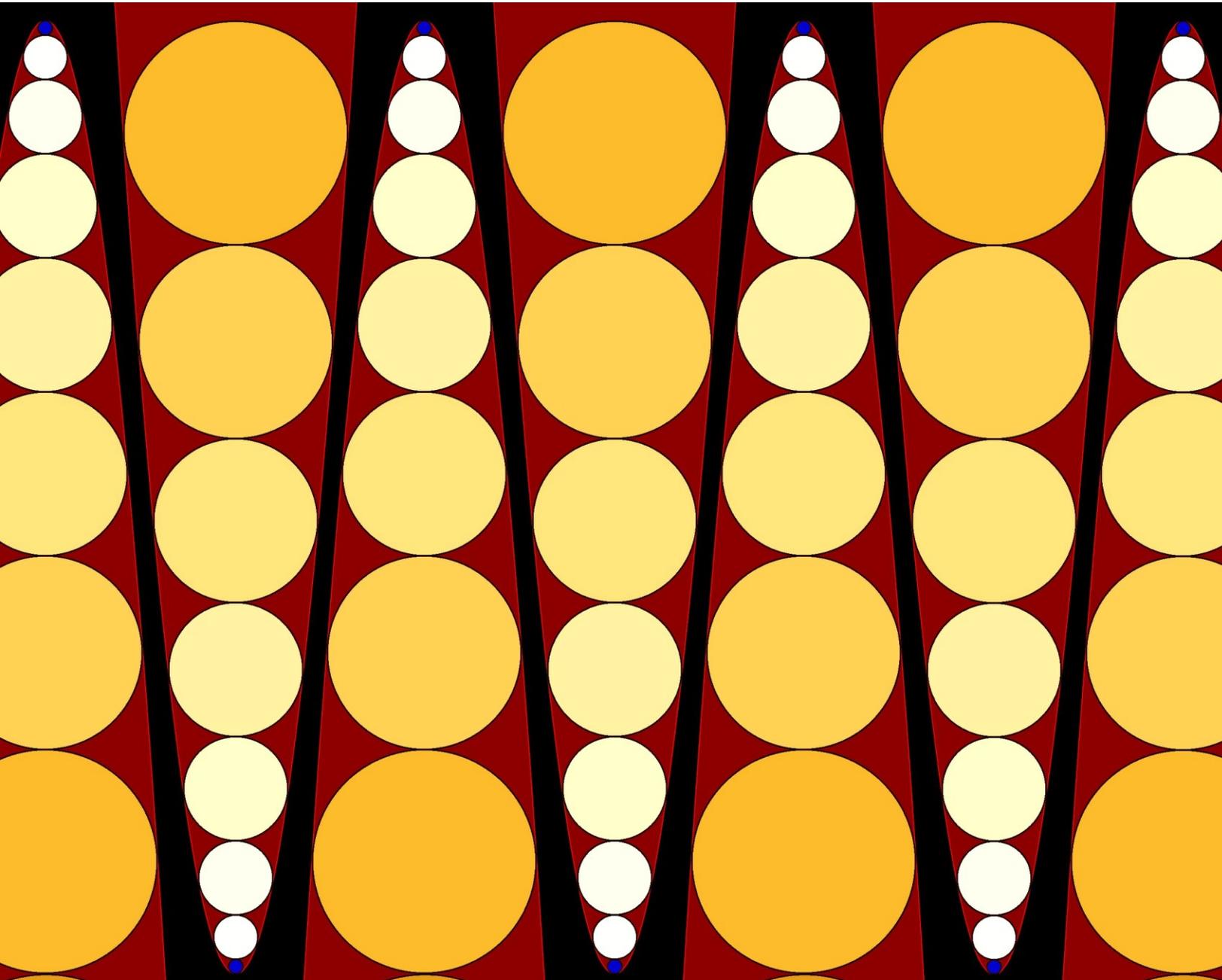
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Girls' *Angle* Bulletin

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To Foster and Nurture Girls' Interest in Mathematics



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From the Founder

The central focus of this Bulletin is doing math. That's the best way to improve and gain appreciation for the subject. What does it mean to do math? How does one go about doing math? How can I get started? Find answers to these questions in here! - Ken Fan, President and Founder

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Girls' Angle: A Math Club for Girls

The mission of Girls' Angle is to foster and nurture girls' interest in mathematics and empower them to tackle any field no matter the level of mathematical sophistication.

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On the cover: *Parabolic Pods* by C. Kenneth Fan and Amanda Galtman. Arithmetic progressions of circles – see *Stacked Circles, Part 2* on page **Error! Bookmark not**

An Interview with Heekyoung Hahn

Heekyoung Hahn is Assistant Research Professor in the Department of Mathematics at Duke University. She received her doctoral degree in mathematics from the University of Illinois at Urbana-Champaign under the supervision of Bruce Berndt.

Ken: What's an early memory of something that excited you to mathematics?

Heekyoung: From my big brother's friend (I had a big family, I am the youngest one) I heard that mathematicians can "count" all the natural numbers (yes, infinitely many numbers). Even more surprising to me, the number of all the natural numbers is equal to that of the integers. I was about a 4th or 5th grader at that time. At that time I knew, for sure, what the natural numbers and the integers were. I thought, if one could "count" them (which was crazy), the number of all the integers should be twice that of the natural numbers + 1 (because you have the positive numbers, negative numbers and zero). I really wanted to know if this is the case and wanted to study math more.

Ken: Could you please describe the journey you traveled to become a mathematician?

Heekyoung: I must say it is unbelievable that I am here. My husband (he is also a mathematician) often says that I should write a book about this.

I was born and raised in South Korea until I moved to the United States to pursue my PhD degree in Math. I grew up in a very small farm in a tiny village (about 70 households in total). There was no electricity available until the time of my 1st grade. I had to walk about an hour to school every day until my 8th grade. Bus service from my home town to the near city was available by then, but it was only twice a

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day. Even so, often I had to walk to school anyway, because I could not pay the bus fee (10 cents per trip). Back then, it was not mandatory in South Korea to send the kids to the school, so some of my friends did not go to school in order for them to help out their parents, especially female kids. I was lucky enough to have parents who were working hard to send their kids to school.

My parents are the people whom I respect most in my life. They were the hardest working people I have ever known in my entire life (they had to be in order to raise many kids in a very poor household). Back then, the whole country was very poor, especially in the country side. In fact, my dad was one of the young adults who had to fight in the Korean War. My dad had to stop his education when he was a 5th grader when my grandfather passed away. He and my grandmother had to figure out how to make ends meet and provide meals for his younger siblings. My mother never had a formal education, but she was quite a smart person who always desired to learn something. She always used to tell me that, even though I am a woman, I should move beyond high school education and should pursue professional careers.

As you can imagine, back then, almost all women stayed at home (even after their college degree). I am the youngest of all and a Daddy's girl. My father always supported me no matter what I did, although he first thought something was wrong with my brain when he heard about me going to the United States to pursue my PhD. He would never imagine such a thing could possibly happen to his own kid.

I always loved to go to school. There I can learn and sometimes, if I am lucky, I might get to read some story books. During my elementary school years, the only books available to me were almost

exclusively my “textbooks.” The few exceptions were when I could sometimes borrow a book from my homeroom teacher. We had no library. If I think back, there could be no way I would be good at literature or something like that. But to do math, in some sense, one may not need too many books. The math textbook explains the main concept. That was enough to me because I would play with that math all day long. After all, that is all I had, I had no toys. What’s funny is that the more you play with math, the better you understand it.

Ken: Yours is a remarkable story! What do you enjoy about being a mathematician? What is your life like as a mathematician?

Heekyoung: Many subjects, including most of science, can describe how things work (based on experimental tests, observations), but math is the one that can explain “why” things work in the way they do. Unlike much of humanity, we seek the simplest and easiest way to explain this “why”, permanently. Clean and simple. I like this. In math, we can even discuss infinite things, unbounded stacks of principles, and we often find the untouchable perfect truth behind them. This fascinates me. There has never been a subject that has beaten math, and there never will be one.

In my classroom, I always told my students that if God gave me a second chance at life, then I would certainly choose again to be a mathematician.

Ken: Does math come easily to you, or is it something you have to work hard at?

Heekyoung: I would say both. After reading articles or hearing lectures, I usually have some idea or some thoughts on a particular question. But those ideas always require very hard work on my part until all of my misunderstandings and confusions are cleared up. Only then will I have good questions to ask. It is like patching up the puzzle. One misstep could cause complete

nonsense. Sometimes, mathematicians have to fight the fear that what we are working on will completely blow up and not work.

Ken: Your research bridges many fields - algebra, geometry, analysis, number theory... Could you please explain some of the “big” questions that you are interested in and why you find these questions compelling?

Heekyoung: The Langlands functoriality conjecture is one of the deepest conjectures in number theory unifying the concepts in representation theory, algebraic geometry and the theory of automorphic forms. My current research is motivated by this conjecture. What is fascinating to me in my recent research is that I isolated a concrete question in algebraic group theory from this big conjecture. Moreover, the methods that I used to answer this question boiled down to representation theory and to computing concrete combinatorics problems. I like that because they are quite elementary.

Ken: What is one of your favorite results that you proved? How did you prove it?

Heekyoung: One of the main tools to study the relative Langlands functoriality conjecture of Sakellaridis and Venkatesh is via the theory of (relative) trace formulas. There has been so much great work done in this very important area. I am kind of new to this, though I was able to prove a simple twisted version of the relative trace formula over special subgroups. I am very happy that I was able to contribute to this area, although it may be only a little contribution. The proof comes down to integrating a kernel function over special subgroups; the key idea was to choose the subgroups in an interesting way so that one could mimic the twisted trace formula in this setting.

Ken: When you get stuck on a problem, what do you do to try to get unstuck?

Heekyoung: STOP thinking about the question for a few days! It is very important for me to undo my obsession on that problem. Do non-math activities, like hiking or taking kids to the children’s museum, and so on. When I come back, I restart the problem again from the very beginning. I revisit each step again to see if I am missing something. Sometimes, at each step, I ask myself, “What if this step were not true at all?” That way, I can confirm that I am at least walking along a right path.

Ken: You run a math program for high school girls called SWiM, which stands for Summer Workshop in Math. What inspired you to create this program? What is the program like?

Heekyoung: I have always been interested in promoting math in general. For example, at Duke, I have founded and organized the PLUM lecture series (Public Lectures Unveiling Math) aimed at a general audience and focused on promoting mathematics by presenting inspiring stories about mathematics.

Math is not something to be afraid of. Rather, it is something that you should enjoy playing with. It is important for us to think like this, and therefore we should inspire our kids to think this way. Parents’ influence on how their kids think about math and how to enjoy it are crucial.

One of the challenges with the SWiM program that Ingrid¹ and I were trying to overcome is to make it enjoyable as well as challenging. Just because something is difficult does not mean we can’t enjoy it. Math might be difficult, but that is okay, since we are capable of overcoming it. There is no reason to dumb Math down to make it look easy. In fact, many participants of the SWiM program get excited when they are challenged.

¹ “Ingrid” is Professor Ingrid Daubechies. There’s an interview with Professor Daubechies in this Bulletin, Volume 1, Number 6, and Volume 2, Numbers 1-4.

All SWiM participants attend two math courses, do afternoon group work, and attend SWiM lectures given by local professors at Duke, University of North Carolina, and North Carolina State University, as well as go on field trips. Participants in the program learn not only about exciting mathematics, but also about discovering new arguments, and explaining insights to their peers. The participants give a group presentation at the end of the program. All the presentations are broadcast in live stream video on the internet. Participants will also attend useful panel discussions as well as participate in social activities. For more information about the program, search for “Duke SWiM math” on the internet or visit the web page

services.math.duke.edu/SWIM/SWIM2018/index.html

Ken: What advice do you have for a teen who aspires to become a mathematician? What should she study? How should she spend her “math time”?

Heekyoung: Simply enjoy it. Personally, I found it a lot of fun to figure out how certain formulas are formed and why they should be true. To every single formula and a term, ask yourself why it has to be that way, or try to explain to your friends how it works, or perhaps think together to see if there is any room to negotiate, I mean, to make it better or different.

Ken: What do you like doing when you’re not doing math?

Heekyoung: Hiking. I love hiking. Walking around the trails in the woods and mountains makes me calm and helps me sort out my tangled thoughts and concerns.

Ken: Thank you for this interview!

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