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The Women and Mathematics Program at the IAS

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A brief history

The Women and Mathematics (WAM) program at the Institute for Advanced Study (IAS) began in 1993 with a small NSF-funded workshop at MSRI that was an offshoot of the summer program at Park City. As Karen Uhlenbeck recalls,

I do not see the (WAM) program as having a "big picture." It grew and adapted. It was started because both women mathematicians and several institutions were concerned that in the 1990's, despite changes in admission and hiring practices, the numbers of women in mathematics did not grow as hoped and expected ...

My participation in the founding of the Park City Mathematics Institute (PCMI) was partially motivated by the fact that I had benefited from meeting other women at conferences, and I thought this would happen at Park City. During the first few years, the numbers of women attendees at PCMI were dismally small, except for the cadre of high school teachers. The NSF noticed and put some pressure on us. Also, my peer group of women professors at this time noticed that we were often the youngest women in our departments; the numbers of women entering the profession were still very small. We felt it was time we paid back some of the help we had received in succeeding. At that time, several (but certainly not all) institutions were concerned about the lack of women. Not everybody agreed that having a woman's program was the answer.

This first workshop was brilliantly organized on short notice by Antonella Grassi of the Mathematical Sciences Research Institute (MSRI), who was a postdoc at the time. Participants found it unexpectedly inspiring and invigorating. The question became: How can we sustain this energy?

Phillip Griffiths, then Director of the Institute for Advanced Study (IAS), offered to take over the administrative responsibility for PCMI. As part of this arrangement, Griffiths

approached Uhlenbeck, offering funding, housing, classrooms, and administrative support at the Institute for the workshop for women. Uhlenbeck then approached her friend Chuu-Lian Terng (at that time President of AWM) for help organizing it. They did co-organize together for many years, with very significant administrative help from Anne Humes at IAS.

That women were underrepresented in mathematics, especially at the highest levels, was obvious; before the Women and Mathematics program began, the number of female postdocs in the Institute's School of Math each year could usually be counted on one hand. The Institute had been in discussions about assuming responsibility for the Park City Mathematics Institute (PCMI) when Karen Uhlenbeck had the inspired idea of inviting groups of women mathematicians to Park City for two weeks of intensive mathematical talks on the PCMI research theme prior to the summer sessions. The objective would be to help them prepare for the formal program; there would be no talks on the challenges for women in the profession, which could be addressed informally outside of the sessions, but rather a laser focus on mathematical research. Coupling PCMI with WAM in this way struck me as a brilliant concept, and I was pleased to be able to provide administrative support and modest discretionary funding for the first year; and later, when Princeton University also became involved through the leadership of Alice Chang, to help bring in additional funding.

—Phillip Griffiths, former IAS Director

One of the guiding principles of WAM has been to involve as many senior women as possible. Over the years this help has included reading application files, coordinating visits from senior faculty to the program, and organizing panel discussions on a wide variety of topics. Many people contributed at different times, but Nancy Hingston and Antonella Grassi have remained dedicated to WAM throughout its existence.



Photo Credit: Andrea Kane, Institute for Advanced Study.

Past and present Women and Mathematics committee members. First row (from left) Alice Chang, Lisa Traynor, Chuu-Lian Terng, Christine Taylor, Michelle Huguenin. Back row: (from left) Margaret Readdy, Antonella Grassi, Nancy Hingston, Dusa McDuff, Karen Uhlenbeck.

In time, this group coalesced into a local committee formed by women faculty at colleges and universities near Princeton. The committee is now one of the essential elements in the running of the program. It meets twice a year, discusses and decides on the main theme of the programs, chooses participants, and suggests workshop topics and lecturers. When possible, its members also attend the program as senior mentors.

In its beginnings, the program was simply part of the Park City Institute, supported by both NSF funds and the generosity of IAS and its donors, which included the Starr Foundation and the Geraldine Dodge Foundation. Gradually WAM grew more independent of PCMI, partly because it was difficult for women to commit to attending both programs. As a sign of further independence, WAM applied for and obtained its own NSF grant.

When Shirley Tilghman became President of Princeton University, as part of her concern for the status of women at Princeton University, Princeton began to sponsor the program with the IAS and participants spent a day at the Princeton University Mathematics Department.

At present, the majority of funding comes from the NSF with additional support from IAS, Lisa Simonyi, and Princeton University. An important factor in its longevity is that throughout its existence all three IAS directors, as well as several IAS mathematics faculty, have been staunch supporters.

Women doing math together

The main aim of the program is to prepare women to enter the world of research mathematics. As an unexpected bonus, it created an environment for women to do mathematics together. In the early 1990s this was a fairly radical idea, partly because many women had internalized the prevailing prejudice against female mathematicians. Being among a large group of female mathematicians is still a revealing and refreshing experience for many. Here are some reactions from some current members of the WAM committee.

I was somewhat ambivalent about the "all female" aspect of the program, but I was easily won over when I saw how beautifully it worked, and the positive and lasting impact it had on so many.

—Nancy Hingston, long-time member of the WAM Committee

One year while I was still an undergraduate (at Princeton), the WAM program came to Fine Hall for a day. I saw a talk given there by a distinguished speaker invited by WAM. I was a math major, and I loved math "best" of all the subjects I was studying, but I had been preparing to go to medical school. During the talk, I looked around the room, filled with women. I remember thinking, "Here we all are, thinking with our individual brains about the same abstract concepts, which we can't see in any literal sense, but are all thinking about together." I felt at that moment like I was part of a community, and I let go of applying to medical school, and fully accepted my choice that I would become a mathematician.

—Lillian Pierce

My first impression was a realization that I could "let my guard down" being surrounded only by women. That this was a completely different social and professional dynamic than being with colleagues of both genders. This was quite a revealing experience for

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Photo Credit: Andra Kane, Institute for Advanced Study.

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me. It wasn't clear if it was a better or worse environment for learning, but I certainly felt much more relaxed and that I could open up to faculty and students in ways that I usually don't.

—Lisa Carbone

These reflections capture the powerful effect of the atmosphere of WAM. The lectures and colloquia are open to all, and a few non-participants do attend sometimes, especially the colloquia. However, the working groups, seminars, and most of the dinners are for participants only.

The range of participants

One special feature of WAM is that it is “vertically integrated”—it involves women at all stages of their careers, from undergraduates who are not yet sure of their future career paths, through graduate students at various stages, to postdocs and faculty at all levels. The goal is for the participants to meet successful role models at all levels, and to see the successful transition from one level to the next. The participants learn from one another professionally and personally, and all get a sense that the field is progressing and renewing itself with new members and professional contacts. The precise mix changes from year to year in response to the pool of applicants, which largely depends on that year's subject area. The current aim is to have sixty participants, roughly fifteen advanced undergraduates, thirty graduate students split between beginning and advanced, and fifteen postdocs and junior/senior faculty. Since around fifteen percent of participants return to WAM in a different role at different stages of their careers, this makes it possible for WAM to build a real community with many connections to mathematicians working in the US and abroad. WAM is now building on this strength with its Ambassador program, described in detail below. The program obviously affects participants at each career stage differently, but it does affect everyone involved, with the generations educating each other through the power of tiered mentoring.

The biggest lesson I learned is that the senior women benefited even more than the participants. It is quite an experience to lecture to a room full of women and to follow the women you meet at WAM as they progress through their careers. It gives insight into your own life.

—Karen Uhlenbeck

Of all the math conferences I have been to, the Women and Mathematics program was probably the most influential on my career path. I attended WAM the summer before starting graduate school and was a bit nervous about what I was getting myself into. Coming from a small undergraduate institution, the WAM program was my first real introduction to the world of math research. Even more important, however, were the connections I made with the other participants and mentors. I can remember one of the organizers told us on the last day that she expected all of us to get our PhD. Hearing someone so confident in my ability was empowering. I keep in touch with many of the people I met at the program, including the woman who became my academic advisor.

—2012 participant

I attended the Women and Mathematics Program at IAS at the end of my last year of graduate studies in 1998 ... Besides great mathematics, what I remember most was

meeting, for the first time, so many female mid-career researchers in my field. I'd developed the impression that the women all disappeared after graduation, so this was a perfectly-timed boost as I contemplated my own academic career. —Current Professor

I've developed a pile of course materials, inspired and supported by my time at WAM. And that enthusiasm and newly developed "expertise" really helped me win over the computer science students in my cryptology class. These students really don't tend to enjoy mathematics and don't have a lot of respect for mathematicians—but oh, wow, did the students really show a lot of interest and appreciation for the mathematics behind the modern cryptosystems that we discussed. This was a big difference over the last time I taught the course. —Senior Participant at the Cryptography program

The mathematics

WAM has always invited women at the very top of their fields to deliver the weeklong lecture series and colloquia, and has been surprisingly successful in persuading them to come. Karen Uhlenbeck's presence and the fact that it takes place at IAS undoubtedly plays a role. All the participants in the 2018 program appreciated the fact that Toni Bluher managed to persuade her bosses at NSA to let her bring a real Enigma machine to examine. Not so tangible, but equally impressive, was the contribution of Claire Voisin, for example, who lectured in 2015 on her most recent work on birational geometry in an amazingly accessible way.

The theme for each year's program is usually chosen to be closely related to the topic of that year's special program at IAS. However, WAM also aims to cover a very wide range of topics in order to give as many women as possible a chance to participate in the program. Encouraged by the recent presence of Linda Ness on the organizational committee, WAM has also been branching out into some more applied areas. For example, the 2018 program focused on the Mathematics of Cryptography, and the 2022 program will focus on the Mathematics of Machine Learning. The members of the organizational committee play an important role in guiding the selection of topics and lecturers, while the academic manager Margaret Readdy liaises with the lecturers and TAs, explaining how the program works and what is needed from them to ensure its success. Sometimes programs are particularly well-timed, as in the following case.

In 2005, we taught the advanced mini-courses for the IAS Women in Mathematics Program on the Geometry of Groups. Geometric group theory was a relatively new area at the time and was attracting many young people. In retrospect, the program had an amazing impact on the field. The community of young women created at the IAS program has remained a strong and cohesive network to this day and several of the women we first encountered there have become leaders in the field. Moreover, the innovative structure of the workshop, with problem sessions and mentoring events, has influenced the way we, and many others, have designed subsequent workshops aimed at young people. As a result, the field has maintained a welcoming atmosphere for young people, both male and female, and continues to attract a strong and diverse cohort.

—Ruth Charney and Karen Vogtmann

Participants often form lasting relationships that are reinforced when they meet each other later at conferences. This can be especially valuable for graduate students. One attendee reported how lucky she was that the program came just at the beginning of her work on her thesis. When she started going to meetings a few years later, she discovered that she knew people there from WAM. This helped her instantly feel at home and welcomed in her math community. For others, the program may simply (but powerfully) provide a place where they find their mathematical voice:

The WAM program has shown me that algebraic geometry can be very enjoyable when lecturers explain the material in a user-friendly way. For the first time, I found myself not only asking people math questions, but also answering. —2015 participant

The second part of my thesis is based on an idea that I first had the courage to say out loud to Nathalie during the WAM. My engagement with this project was fueled by her interest at that time. —2016 participant

The program also includes one or two colloquium talks, and short research seminars given by advanced graduate students (two to three years to PhD) and postdocs. The colloquium talks often give a wonderful new perspective on the topic at hand, while the research seminars allow each graduate and postdoc speaker to present her work to experts and receive feedback. These opportunities can create useful professional connections.

Other program elements

The program also includes a great variety of workshops and panel discussions, including how to apply to and survive graduate school, applying for NSF grant support, and a discussion of careers with panelists from a wide variety of different mathematical occupations. We also have discussions about family/life issues, the two-body problem, having children—and these are not all theoretical; sometimes lecturers and participants bring their children—and these are now facilitated by the Institute's new Child Care program (see below). Often a colloquium speaker eats dinner with the participants and then answers informal questions about her life and career. A great deal of informal discussion and mentoring takes place during the lunches and dinners.

When I was a Member at the Institute in 2010–11 I was invited to attend an evening dinner for WAM. I sat down at one of the long tables and was surrounded by about fifteen young women. I asked them to introduce themselves. They were very happy and excited about being able to chat about themselves, their interests, and ask me questions about my life as a mathematician. I realized pretty quickly how much attention each one of the participants craved and that this sort of program was needed.

—Margaret Readdy

One year ... I gave a seminar about "How to say it" for female mathematicians. This was a talk designed to give suggestions to participants on how to use language that would facilitate their experiences interacting with male colleagues. I had done some self-training on this topic while I was an assistant professor and I wanted to pass on this advice to participants. The feedback was excellent, and I felt that I was able to

communicate something really valuable. I also enjoyed follow-up discussions with students and faculty after this event.

—Lisa Carbone

New developments

Christine Taylor joined the WAM program committee in 2012 and over the next five years organized a wide variety of events; for example, a live showing of Gioia De Cari's play *Truth Values*, a public lecture (organized by IAS) given by Tadashi Tokieda, tours by WAM participants of the Princeton Plasma Physics Lab and of the NYC museum MOMATH, WAM participation in a local 5K run accompanied with a math outreach table, and a visit to a Trenton after-school program with a plethora of intriguing math activities. She also worked very hard to update our alumni list and, in 2016, started compiling the yearbooks. They appear on the WAM website at IAS (www.ias.edu/math/wam) and form a wonderful and informative record of what happens each year. These efforts help sustain WAM's commitment to forge a lasting community among the WAM alumni. Most of the lectures are now videotaped, which makes the mathematics more widely available.

IAS Director Robbert Dijkgraaf was very interested in helping to support such activities because they align with his vision of connecting the IAS to both the local and global communities. His office also helped arrange a connection with Johnson & Johnson. Two senior female executives who were originally trained in math gave a presentation one year, and now there is an internship program at J&J for WAM students and alumnae.

When it became time to reapply for NSF funding, it seemed prudent to redesign the program. It now lasts seven days, running from Saturday to Sunday, instead of the previous, more leisurely, ten days. This means that there are now two lecture courses instead of four and there is no longer a two-day weekend break. However, the key elements remain—in particular, time for students to work on problems together, rather than just listen to talks. Organizers also highlight the possibilities for prolonging the connections made at WAM by joining one of the AWM-sponsored Women in ... networks or by taking part in one of the many summer research opportunities for small groups that are now sponsored by several of the Mathematics Institutes. The Ambassador program, described below, is another way to take advantage of the connection with WAM.

Other new features of WAM

Computer workshop A new component of Princeton Day is a two-hour computer workshop designed to introduce WAM students to software that is relevant to the subject of that year's WAM program. The difficulty of designing such a workshop varies depending on the field: sometimes it works really well and sometimes not so well, depending on how well-integrated computations are with a particular area of mathematics. However, students planning a career in mathematics need to gain familiarity with the use of programs such as Sage, Maple, or Mathematica, so this effort seems worthwhile. Feedback shows that students appreciate the focus.

Outreach In the past few years, WAM had small-scale outreach in a local school as part of their after-school and Science Day enrichment activities. Beginning in 2019, WAM organized a successful Math Carnival at the Princeton Public Library. The ease with which

low-income and underrepresented students can participate in an event that is walking distance from their homes, coupled with many activities that capture the interest of a wide variety of local K–12 students, resulted in WAM attracting over 120 students on a Sunday afternoon. This is not only an opportunity for the participating children and teens, but also very instructive and enjoyable for the WAM participants who volunteer to run the activities tables with a minimal amount of instruction. We also aim to give WAM participants the inspiration and tools to try similar initiatives at their home institutions, which feeds into the WAM Ambassador Program.

WAM Ambassadors A key new feature of WAM is the Ambassador program, which was designed by Dusa McDuff and Christine Taylor and is supported financially by Lisa Simonyi. As the following reflection shows, WAM participants can have a powerful impact when they return to their home institutions.

Yes, I told everyone how amazing it is and hopefully more students at my institution will participate and be inspired. I once mentored a younger student and sent her to a women in math [WAM] conference and she went from having no aspirations to completing the Honors program with goals to pursue graduate school. These events have major impacts.

—Recent Participant

WAM was looking for ways to formalize and extend this effect. Christine Taylor had learned from graduate students in large state universities about the lack of funding even for basic stationery supplies. Thus WAM realized that funding for women- and math-related initiatives at places with limited resources would be truly appreciated and impactful.

The Ambassador program allows WAM alumni to apply for small grants to organize local or regional outreach, whether it be a reading course, tutoring, a community event or regional conference, in order to bring the ideas and energy of WAM to other parts of the country.

Being a WAM ambassador was something I'm very proud of since it allowed me to create spaces for female undergraduate and graduate students to connect and empower each other.

—WAM Ambassador

The previous year's ambassadors receive travel funding to return to the WAM program to report on their activities. This also contributes to the cohesiveness of the program from year to year.

Child Care program This new development evolved slowly, from practical necessity. Christine Taylor reported that in 2014, one of the colloquium speakers, Nalini Anantharaman, could only come if there was child care for her daughter. Luckily she had been to IAS before, so the IAS nursery, Crossroads, agreed to take her daughter for a week because they knew her. However, this was not a general solution to the problem.

Lillian Pierce and Christine Taylor contacted the Simons Foundation in summer 2014 to explore the possibility of a child care related travel grant for women mathematicians with young children, but they were uninterested. The next case occurred in 2016, when one of the undergraduate participants would have difficulty attending the program without some financial subsidy to care for her ten-year-old. Christine Taylor talked to Robbert Dijkgraaf, and Dijkgraaf was immediately on board with providing a child care subsidy

for WAM participants. The 2014 proposal was revived, revised, and successfully submitted to the IAS Human Resources office, thus securing child care funding for future WAM participants.

Even more striking, the child care program is now in place for all programs at IAS. WAM and IAS program initiatives have also influenced other research institutes to follow suit. For example, MSRI now has private funds in place to support child care for its members, as well as a summer research program for women mathematicians similar to the Summer Collaborators program initiated by the IAS School of Mathematics.

Funding: a public/private partnership

The funding of WAM has been both a public and private partnership. On the public side, the National Science Foundation has provided funding for the WAM program through its Infrastructure and Workforce in the Mathematical Sciences Programs. On the private side, there are IAS and Princeton University, as well as Lisa Simonyi and past private foundations. The IAS has provided substantial private funding. The IAS does not simply give WAM money. Instead, the IAS raises funds specifically for the program through private donors. So unlike core research in pure mathematics, there are sources of money for programs for women.

The past years have been harder with respect to funding for a good reason. There are many other programs for women, and schools and departments have their own ways of encouraging women, so WAM has a lot of competition. This is a good reason to have to struggle!

—Karen Uhlenbeck

Conclusion

This brief description should give some idea of the various elements that make up the WAM program. Bringing them all together requires a great deal of work and patient organization, as well as enthusiasm and new ideas both for the mathematical program and the associated workshops/evening events. The strong support from IAS coupled with the enthusiasm and knowledge of the members of the WAM organizing committee continue to provide inspiration for the WAM program.

The climate for women in mathematics and other sciences has improved, but there are still barriers preventing talented individuals from achieving their life goals. The WAM program has enabled me to take my love of mathematics to the national level and encourage women at critical life stages to soar over these barriers.

—Margaret Readdy

In the years since its establishment, WAM has been copied but to the best of my knowledge never really equaled, and it is one of the initiatives I was involved with as IAS director of which I am most proud.

—Phillip Griffiths, former IAS Director

Lillian Pierce's insights capture the far-reaching influence of the WAM program:

Of course the WAM programs are excellent and beneficial because of the technical expertise they develop in participants. But I think there is something else about the WAM program that is precious and irreplaceable: it allows women in math to find out what

it means to be relaxed in a mathematical atmosphere. To breathe fully and freely, and to think "ah, this is how it can be, to do math among people who naturally assume I am good at this." The fact that WAM takes place at the IAS is also part of this message: this is an investment in new generations of mathematicians, and a welcoming, a boost, to say "we think you can be great."

—Lillian Pierce



Michelle Huguenin has over twenty years of professional experience in higher education, and is the Program Manager for the IAS School of Mathematics.

Dusa McDuff was born in London to an academic family with a long tradition of activism. Now at Barnard College after many years at Stony Brook University, she is a Fellow of the Royal Society, a member of the National Academy of Sciences, and was awarded the Sylvester medal in 2018.

Margaret Readdy works in algebraic combinatorics. She is the first person in her maternal family to go to college, the first PhD in her family, and the first woman to be promoted to Full Professor of Mathematics at the University of Kentucky.

Karen Uhlenbeck is Professor Emerita at the University of Texas in Austin and Distinguished Visiting Professor at the Institute for Advanced Study, Princeton. She is the recipient of many awards including a MacArthur Fellowship, the National Medal of Science, and the 2019 Abel Prize.