

than usual. In addition to pausing frequently to allow students to ask questions, we sent an email after the first day asking students about the experience. In response to the feedback, we adjusted how much guidance we gave during the problem sessions. On a few occasions we changed problem session group compositions on the fly to support participants who didn't feel their current group was a good fit for them. *We felt it important to get feedback on potential problems midsession while we could still do something to fix them.* After the summer school ended, we sent out a survey to ascertain how the participants felt about the school as a whole. Some of the questions specifically asked for feedback on the online organization of the school.

The responses to the surveys were mostly positive: participants enjoyed the school, were happy with its organization, except for the necessary requirement that they spend many hours in front of a computer. Importantly, they did not feel that their learning was impacted and said they were able to get their questions answered easily in our format.

We sent out a concluding email pointing out additional resources and what further steps could be taken to continue learning about ergodic theory and continued fractions. Our lecture notes also pointed to further results.

5. Conclusions

Our experience indicates that technology makes it possible to run a summer school such as ours online, and that students will participate enthusiastically. While the possibilities we lost—such as working together at the board, informal one-on-one chats, and external social activities—are valuable, we gained by being able to hold the school at all given the current situation, not having to spend very much money to run the workshop, and not needing to travel away from home to be together. With a few tweaks to the technology, and broad access to it, there is no reason why online summer schools shouldn't play a prominent role in promoting and disseminating mathematics. Be it by choice or necessity, we wish you the best in organizing a similar meeting online.

As a service to those who would like to organize a similar event, we have collected a list of helpful technology tips and tricks here: go.uncg.edu/ergodictheory.



Daniel Glasscock



Claire Merriman



Donald Robertson



Clifford Smyth

Credits

Photo of Daniel Glasscock is courtesy of Daniel Glasscock.

Photo of Claire Merriman is by Noelle Sawyer.

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Virtual Workshop on Ricci and Scalar Curvature Draws Unexpected Attendance

Christina Sormani

Every year or two my collaborators and I co-organize a workshop about the convergence of manifolds. Sometimes the event is held at CUNY but we've held them also at IAS and SCGP and in Canada, Mexico, and Italy. Each event drew a group of 20–40 participants after an open call for participants on the geometry listserv. Postdocs would fly in from around the world for an opportunity to present their work and collaborate. However, due to rising concerns about the cost of air travel and its contribution to global warming, we decided that in the summer of 2020 we would hold a virtual workshop.

We had no idea there would be a pandemic and that our workshop would be one of the few conferences in geometric analysis that wasn't canceled completely. In the end our Virtual Workshop on Ricci and Scalar Curvature in honor

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of Misha Gromov attracted over 250 participants and 50 speakers from Asia to Africa, Europe to South America, and a few from Canada and Mexico as well. Due to the success of the event, Frank Morgan suggested that I should write about how the workshop was designed and implemented.

In some respects the workshop was quite typical: we chose a topic and we chose to honor Misha Gromov because his recent conjectures have led to significant activity in geometric analysis. We brought together a team of co-organizers who were experts on various aspects of Gromov's conjectures: Guofang Wei, Lan-Hsuan Huang, Pengzi Miao, Paolo Piazza, Hang Chen, Blaine Lawson, and Richard Schoen.

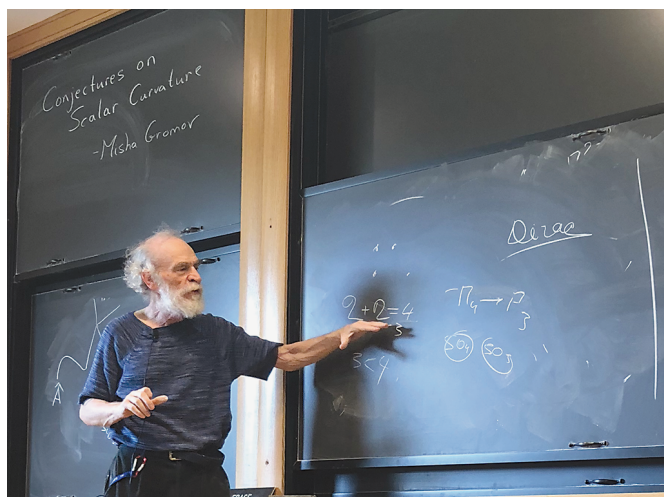


Figure 1. Misha Gromov presents his conjectures at the IAS Emerging Topics on Scalar Curvature and Convergence in 2018.

Together with Misha Gromov, we chose an initial plenary speaker to advertise the meeting. We had an open call for participants who might get to speak if they had a relevant result to present. We advertised internationally using not only Conrad Plaut's geometry listserv⁷ but also contacting mathematicians around the world by email. We were hoping that people who might not ordinarily be able to afford the travel might attend a virtual event.

Funding that usually went to travel was budgeted instead as salaries or research stipends for about 20 postdocs. We paid extra for those who had daycare costs or needed to purchase equipment. By paying stipends and salaries we avoided collecting receipts.

We chose to run the workshop asynchronously because we didn't want to impose a preferred time zone on the participants. It also allowed us to avoid dealing with technical problems during a talk. We had an open call for submission of prerecorded talks, leaving the speaker to handle logistics of recording and posting the videos themselves on YouTube, bilibili, or on their university server.⁸

⁷geometry@listserv.utk.edu

⁸Note that bilibili could be viewed by participants in China while YouTube is not available there.

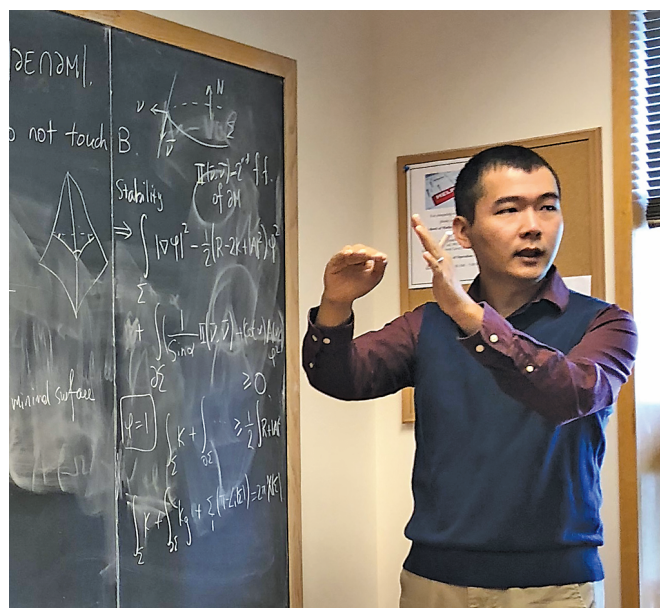


Figure 2. Chao Li at IAS in 2018.

We designed guidelines to ensure all the talks covered the relevant background and were generous in citing others before presenting their own results. Each selected talk would be linked to the workshop webpage and also have a link to an online discussion board where questions and ideas could be exchanged among participants. We then reviewed the videos of the submitted talks to choose the most exciting to be listed as additional plenary addresses.

The workshop began with four of the initial plenary speakers, all young mathematicians chosen for exciting results directly related to Gromov's Conjectures on Scalar Curvature. Chao Li (Princeton University) presented new geometric comparison theorems for scalar curvature. Paula Burkhardt-Guim (University of California at Berkeley) defined new pointwise lower scalar curvature bounds for C^0 metrics via regularizing Ricci flow. Brian Allen (University of Hartford) presented his work contrasting different notions of convergence in geometric analysis. Raquel Perales (UNAM Oaxaca) presented new techniques involving convergence with controls on volumes from above and distance from below, applying the method to Gromov's Scalar Torus Stability Conjecture in the graph setting.

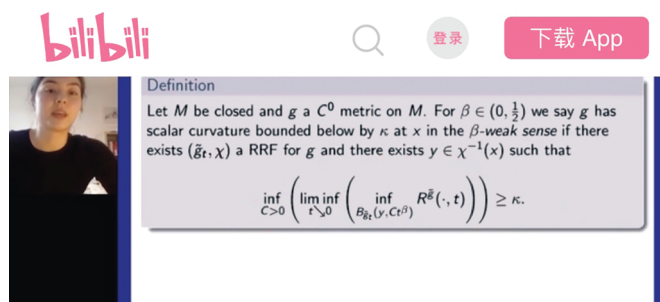


Figure 3. Paula Burkhardt-Guim presents her new definition at VWRS 2020 on a video posted to bilibili.

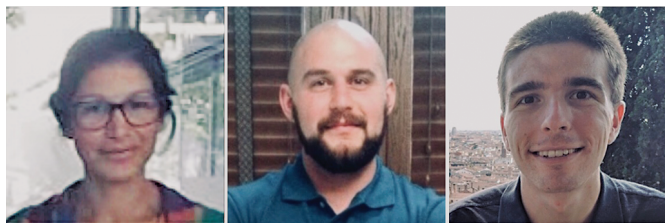


Figure 4. Raquel Perales, Brian Allen, and Daniel Stern were plenary speakers at VWRS 2020.

Soon the discussion board was filled with an incredible conversation trying to combine the results to develop a deeper understanding of scalar curvature and convergence. In the same week we released a group of invited talks on Ricci curvature. The second week had only one of our original invitees, Yuguang Shi (Peking University), and three young people selected from among the submissions. Martin Lesourd was selected for submitting a beautiful talk on his new joint results with Ryan Unger and Shing-Tung Yau. Thomas Richard was selected for his exciting new work on systoles. Perhaps most surprising of all was Daniel Stern's new approach to studying scalar curvature using harmonic maps to circles. At this point new collaborations among participants moved off the discussion board and into private email exchanges.

After the first two weeks the workshop grew incredibly with over a hundred applications to participate and many beautiful talks submitted. We ended up extending the original three-week program to five weeks with a break in the middle. For a complete list of all the talks with links to their videos and to the subsequent discussions, the reader can go to the website of the workshop: <https://sites.google.com/site/professorsormani/2020-virtual-workshop-on-ricci-and-scalar-curvature>. We hope that this website and its mirrors will persist as a resource for those who would like an introduction to the field for years to come.



Christina Sormani

Credits

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Figure 3 is courtesy of Paula Burkhardt-Guim.

Figure 4 is courtesy of Brian Allen, Raquel Perales, and Daniel Stern.

The International Congress on Mathematical Software Goes Virtual: Experience from Organizing an Online Conference in Times of COVID-19

Michael Joswig and Timo de Wolff

We have been the General and the Local Chair, respectively, of the 7th International Congress on Mathematical Software (ICMS). This was meant to take place at Technische Universität Braunschweig, Germany, in July 2020. Instead, it took place as an online conference. Here we report on the transition and our experience.

The history of the conference series starts in 2002, when the first ICMS was organized in Beijing, China, as a satellite event to the International Congress of Mathematicians. ICMS' topic is the development and use of software in all areas of mathematics. The conference traveled the continents, and the initial four-year rhythm was shortened to a biannual cycle in 2016. The last traditional ICMS so far was located at the University of Notre Dame, South Bend, Indiana, in 2018.

Organizing a conference is about a lot of things. The scientific program comprises a program committee, its chairs, invited speakers, and proceedings to be published as a book. Additionally ICMS features topical sessions which are largely organized by session chairs, who are also members of the program committee. However, for a conference to occur physically there is also a need for lecture halls, accommodations, catering and/or guides to restaurants, a guided tour or excursion, and more. It is worth mentioning that some of the above actually require money. So, for our summer 2019 started with sketching the budget for three plenary talks and about 120 invited or contributed talks distributed over about a dozen sessions, possibly with a total of 150 participants.

The global pandemic caused by the Sars-Cov-2 virus arrived in Germany, much like everywhere else in the western hemisphere, in March 2020. Evaluating our options, we quickly decided neither to postpone nor to cancel ICMS

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