



**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

Figures 1 and 2 and the author photo are courtesy of Christina Sormani.

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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2020. Since the universities had been closed this meant moving everything online.

The first thing we realized was that everything related to the proceedings did not need any changes. For the submission and reviewing process we used EasyChair, and thanks to LaTeX and Springer's infrastructure around their series "Lecture Notes in Computer Science" everything was handled electronically.

All further plans, which we had made so far, were essentially useless. Luckily, we were able to cancel all reservations (rooms, etc.) with little to no cost. Unluckily, we had to replan everything within only three months.

If one gives it a quick thought, one realizes that classical conferences have one striking advantage: all participants meet at the same place at the same time. Our participants, however, were located all over the globe from west coast USA and Canada to Japan and Australia. Moreover, having all participants at the same place has the advantage of people actually talking to each other. This is obviously less likely to happen when being located in different time zones. Therefore, our first decision was that we would schedule a core time of only three hours—noon to 3 p.m. UTC—each day; only plenary talks and software presentations were broadcasted live, all other contributed talks had to be prerecorded. In hindsight this was a good decision, and it worked out pretty well. However, it created the issue that the videos had to be stored somewhere. Also, we learned that live talks broadcast from home can lead to new and interesting challenges as, e.g., Alan Edelman's dog was seeking his attention during his plenary talk and Alan's neighbor was insisting on continuing to mow the lawn during the presentation.

Structurally, we hence decided to organize the conference in three layers:

1. The *core layer*, being the three hours of live events during the days of the conference. Next to the plenary talks and the software sessions (both via Zoom), this layer included live parts of our 14 sessions. Each session was held in its own room using free software called BigBlueButton hosted at TU Braunschweig. The live part of a session covered only the discussions that would normally occur after a talk. That is, the participants were supposed to watch the offline talks before the sessions and then discuss them during the live part.
2. The *offline layer*, a virtual server donated by Amazon Inc., which was maintained there by Sebastian Gutsche, who had been a member of our community for many years and who volunteered to support us. On this server, we stored the prerecorded talks and the conference material like the booklet. All speakers were able to choose whether their talk would be available to the general public or to registered participants of the conference only.
3. The *interactive layer*, a Slack workspace we created having working groups for every one of our 14 sessions

and five software presentations, and other conference matters. It enabled a discussion among the participants about talks and content of the sessions at any time before, during, and after the conference. In consequence, "the conference never slept."

Indeed, this third layer contributed greatly to the social aspect of the conference. Joint with the live part of the sessions, which covered the discussions that would normally occur after a talk, ICMS 2020 became a conference full of actual discussions and exchanges of ideas as would normally happen in a classical conference format.

Despite using the three layers, we expected that a lot of the usual "conference feeling," that we all know and enjoy, would get lost. Thus, we decided to move the usual social parts online, too. We organized a virtual tour of the Pergamon Museum in Berlin. We also transferred the conference dinner into an online event. On Slack, we organized joint cooking and dining on one evening with the opportunity for the participants to upload a picture of their dinner and be elected the "Chef du Conference." The official conference photo was compiled from Zoom snapshots. These small things joint with the Slack environment, the timed schedule, and the change of rooms in-between helped, in our opinion, significantly to generate the conference feeling we referred to before.

This virtual version of ICMS 2020 was the result of a crisis and trying to solve the problem of how science can go on within the pandemic. The obvious downside of an online conference is that the participants do not actually meet. However, on the positive side, it is much cheaper, the carbon footprint is reduced dramatically, and people can attend who could not do so otherwise, e.g., for economical, visa, or health reasons. In fact, we had over 200 registered participants making ICMS 2020 the largest ICMS so far. Thus, we are very happy to conclude that, in the case of ICMS 2020, science *did* go on.



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