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Paraty Quantum Information: How a Conference Helped Foster a Research Field in Brazil

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Abstract

There are many scientific conferences around the world, but some of them play special roles. Paraty Quantum Information is one of these. In this article we present the story of how it was dreamt up and how it became a reality. We emphasize the conference's key role in fostering a community in this field, by creating and reinforcing bouds between different research groups inside Brazil, within South America and around the globe. A high-quality and low-stress international school, at an attractive place, with the costs of a national event proved to be a very efficient mechanism for this.

1 Introduction

Quantum Information is a relatively young research field. As in most cases, it is difficult to choose a particular scientific result or statement that clearly marks its birth date. One could argue in favor of the suggestion of quantum money by Stephen Wiesner in 1969, Paul Benioff's proposal of a quantum Turing machine in 1980 or Yuri Manin's or Richard Feynman's statements about efficient quantum simulation in 1980 and 1981. It is safe to say, however, that the proposals of quantum cryptography by Bennett and Brassard in 1984 and Ekert in 1991, the teleportation protocol designed by Bennett, Brassard, Crépeau, Jozsa, Peres, and Wootters in 1993, and the factorization algorithm by Shor in 1994 form the set of first significant results in the field and mark the beginning of its acceleration into what is nowadays one of the largest worldwide funding efforts in physics.

These works revealed that, more than being just philosophical curiosities, quantum properties such as entanglement and non-locality could be turned into resources for the development of new and enticing technology. This attracted the attention of different communities of physicists to the field, in particular those used to exploring, theoretically or experimentally, the behavior of small quantum systems under finely tuned control. Areas such as quantum optics, nuclear magnetic resonance, superconductors and the like quickly started to learn the language of quantum information and to connect its most basic elements to their day-to-day setups and calculations. Two-level atoms and spin-1/2 systems were recognised as qubits and Jaynes-Cummings or Ising time evolutions became entangling gates. Well-established conferences and graduate schools began to include seminars, mini-courses or even sub-sessions dedicated to the new field. By the end of the 1990's, most leading countries in the physical sciences were already building research groups and organizing conferences and meetings dedicated specifically to the development of quantum information and quantum technology.

The scientific community in Brazil was quick to react to this international movement. By the end of the 1990s, many groups in the country, both theoretical and experimental, had also turned their attention to the field and the first MSc and PhD theses featuring quantum informational analysis were produced. Moreover, a large group of senior researchers gathered together in 2001 under an umbrella-like initiative launched by Brazil's Ministry of Science and Technology, the Millennium Institute of Quantum Information. After being renewed in 2005, this was followed by two further consecutive initiatives in 2008 and 2014, the National Institutes for Science and Technology in Quantum Information (INCT-IQ), resulting in an effort that has guaranteed investments to build laboratories and research networks in the field for the last 25 years [1].

In the early 2000s, the efforts of this group led to the first conferences in Brazil specifically dedicated to the field, notably

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2002's IUPAP International Conference on "Quantum Entanglement, Complexity and the Physical Basis for Quantum Computation" at CBPF in Rio de Janeiro [2] and 2003's Pan American Advanced Studies Institute (PASI) on the Physics of Information in Búzios [3]. While these meetings successfully attracted some important foreign researchers, they were both one-off instances of international event series, and were organised largely with foreign funding. For example, PASI was a pan-American integration effort largely funded by the USA's National Science Foundation, under the rule that half of each event's participants had to come from North America.

In contrast, at nationally funded conferences and meetings, quantum information was still being featured as a subsession of other areas of physics well into the mid-2000s. This had two deleterious consequences for the development of the topic in Brazil: researchers and students approaching the subject from different angles had little chance to meet and discuss their advances and specific challenges, and the contact with foreign experts in quantum information was mostly limited to those working in older, more established research areas that had strong prior connections to the well-established Brazilian research groups.

The beginning of the century was also marked by the first hirings by Brazilian universities of young researchers directly trained in quantum information. A new generation of physicists with PhDs and/or postdocs supervised abroad by quantum information experts found a place in the Brazilian scientific system, not only reinforcing the local interest in the area but also establishing direct connections between the country and those experts. These connections, plus the perception that local students could benefit from a more focused exposure to leading researchers in the field, prompted a group of these young scholars to design and create a new national[1] event dedicated to quantum information: the Paraty Quantum Information School and Workshop. Starting in 2007, the conference has been held biennially ever since, with the exception of 2021 (due to the Covid-19 pandemic), and has become one of the main focal points of the Brazilian quantum information community.

This note is an attempt to record just how exactly this process occurred, from the conference's initial conception and planning, to the people and sometimes fortuitous circumstances that made it a reality, and finally to the event's enduring success and impact on the quantum information landscape in Brazil. It is our hope that, in this way, we may not only leave a record of interest to the current and future generations of Brazilian researchers in this community, but also inspire young scholars in other burgeoning fields, both within physics and beyond.

[1] We mean, international in scope, national in flavor and to the community building aspect, in which we focus here. Even more important, national in terms of costs for participants living in Brazil.

2 The Birth of the Paraty Quantum Information School and Workshop

In late 2005, former UNICAMP undergraduate classmates Marcelo França Santos, Daniel Jonathan and Marcelo Terra Cunha, at the time all recently hired young lecturers, got together to discuss how to grow the quantum information community in Brazil. Their view was that there was a need for a locally funded conference, in order to attract young researchers, especially students, to the field. They set about designing it, following a very simple guiding principle: it should be an event that they themselves would have loved to attend when they were students. The model for this project was based on their combined previous experience with two very particular conferences: the aforementioned PASI series, especially the year 2000 edition in Ushuaia, Argentina, under the leadership of Juan Pablo Paz, and the then recently created Benasque Quantum Information workshop, directed by Artur Ekert and Ignacio Cirac [4].

The PASI conferences featured a two-week graduate school split in half by a workshop for senior researchers, held from the middle of the first week to the middle of the second. This format had the great advantage of allowing the students of the graduate school to get in contact with the senior researchers attending the workshop, while also giving those same researchers free time to discuss physics in between the workshop talks. It was, however, still a standard conference, namely one with pre-scheduled activities throughout the day, held in a conference hotel where most of the participants were hosted, and rotating to a different location in each edition.

The Benasque series presented an entirely different proposal: First, it was, and remains to this day, strongly tied to the small mountain town of Benasque, Spain. Participants were hosted in small hotels or apartments spread around the town, with offices provided for them to work in if desired. Most importantly, the conference featured only two pre-scheduled talks per day. Instead, attendees were left free to discuss physics in their significant available free time. Larger discussions of common interest were self-organized, as were daily sports and social activities. The whole conference was based on a simple idea: given enough free time to get together, chill out, relax and talk to each other, scientists end up producing excellent work. The vast amount of relevant scientific results born or developed at Benasque in the last 25 years is a testament to this concept's success. (Nowadays, the workshop has no scheduled talks at all; the only official program is a daily meeting for introducing newcomers and announcing discussions and activities).

Although, conceptually, the Benasque style was particularly attractive to the Brazilian trio, there were two main concerns that prevented its full adoption: Benasque was basically a conference for people already initiated in the

topic, whereas the main target of the new event in Brazil was graduate students willing to enter the field. The second reason was more provincial: funding agencies in Brazil would never understand the concept of a scientific conference where the scientists were basically brought together and let loose to do whatever they felt like.

At the same time, even though the graduate school was the priority, there was also a feeling that a workshop, in the mold of the PASI conferences, would also benefit the emerging Brazilian community in quantum information, giving them a place to meet and to talk to foreign researchers that approached the area from different perspectives. Moreover, students participating in the School would have the opportunity to interact not only with the selected group of lecturers, but also with many other participants of the Workshop. Combining both concepts, the chosen design for the event was the PASI format but with fewer classes and talks, allowing plenty of free time for the students and researchers to meet, relax, discuss science and engage in other social activities. Unfortunately, the main Brazilian agency supporting graduate schools did not allow such events to be split into two different half-weeks. Therefore, the organizers had to settle for a two-week-long event, with the School in the first week and the Workshop in the second one. This format has remained to this day.

3 Paraty: The Perfect Location

When discussing the advantages of the Benasque model, a few aspects stood out, all related to the influence of the place itself on the overall spirit of the participants. Perhaps counterintuitively, the fact that they were free to choose from a long list of possible housing options, rather than being concentrated in a single hotel, was pivotal for the formation of a sense of community. Being spread around a small and cozy *pueblo* gave participants the opportunity to self-organize various social gatherings and small discussion meetings that, together with the fantastic scenery of the Pyrenees, fostered a relaxed, creative environment perfect for the innovation required when developing new science.

While Brazil also has many attractive, tourist-friendly small towns where similar conditions could be replicated, not all could provide the necessary infrastructure for such a conference. Furthermore, for logistics and cost-saving reasons it was also advantageous to choose somewhere relatively close to the locations of the main quantum information groups that existed in Brazil at the time, most of which were clustered around the major cities of Rio de Janeiro, São Paulo and Belo Horizonte.

Paraty, a scenic village located halfway along a beautiful coastal road connecting Rio de Janeiro and São Paulo, and roughly twice that distance to Belo Horizonte, met all these conditions. Facing a bay with 365 islands, surrounded by hills covered in tropical rainforest and featuring a preserved Portuguese-colonial-style historical center, Paraty is certainly one of the most precious hidden gems in the world, as recognized by UNESCO in 2019 [5]. This combination had made it one of Brazil's most relevant tourist sites, providing the village with an excellent infrastructure including plenty of housing and food options at all price levels. All the elements from the Benasque setting were there: a cozy and beautiful place where participants could stay wherever they liked, circulate freely enjoying each other's company and relaxing to the point where learning and developing new science became almost natural.

Paraty also had another fortuitous advantage: Luiz Guilherme Lutterbach, a former PhD colleague of França Santos', had been living in the village for some time, and had all the local knowhow necessary to help set up the event. In fact, the idea of holding a scientific event in the village, with potential outreach activities targeting the local community, had already been discussed by the pair a couple of years earlier.

The only caveat concerning Paraty was the limited availability of suitable conference venues. At the time, only one or two local hotels possessed conference halls large enough to host the target size of 100 students for the school. Unfortunately, these hotels were relatively isolated and far from the picturesque historical city center, undermining the idea of a freely circulating, self-organized conference atmosphere. Fortunately, a solution was found in the form of the *Casa da Cultura*, a public cultural facility. Located in an elegant colonial mansion with an internal open courtyard, occupying roughly half a block of the historical city center, and boasting an auditorium with 120 seats, a raised stage and a giant screen, it was a perfect venue. Luckily, its administrators agreed to host the scientific event for the two whole weeks.

The next step was to choose a date. Since the main existing quantum optics events in Brazil and Latin America were held in even years, an odd year seemed to be the more reasonable choice. Furthermore, waiting until 2007 would give the organizers enough time to put the whole operation together. Moreover, August or September seemed the best choices of month, being the less rainy months in the region, while still warm enough to attract foreign visitors, and also overlapping with the Northern hemisphere's summer holidays. They also contained gaps in Paraty's very busy tourist calendar. Thus, August 2007 became the chosen target for the first event.[2]

[2] Unbeknownst to the Paraty team, while their plans were coming together another group of pioneering Brazilian researchers - coming from the computer science end of the spectrum - was also setting up a quantum information and computation (QIC) conference. This was the *Workshop Escola de Computação e Informação Quântica*, or WECIQ, whose first edition was held in Pelotas, Rio Grande do Sul, in October 2006, making it the first genuinely Brazilian QIC meeting [6]. Though it has been repeated less regularly than the Paraty meeting, WECIQ is also still going strong, with its eighth edition held in late 2025.

Picture taken at Paraty 2007. Along one side of Casa da Cultura, from right to left, the real part of the organizing committee: Ernesto Galvão, Steve Walborn, L.G. Lutterbach, Daniel Jonathan, Marcelo Terra Cunha, and Marcelo Fança Santos. Around the corner, along the imaginary axis, Luiz Davidovich. At the corner, the origin of the Argand-Gauss Cartesian system, Barbara Amaral, representing the students, the origin of all the efforts.

4 The Paraty 2007 Organizing Committee

Having settled on the overall concept and the venue, the now quartet started planning the details of the event. The first consideration was that engaging in such an endeavor, novel for all of them, was a task that required more help. Two more friends thus joined the crew: Ernesto Galvão and Stephen Walborn, then also young lecturers recently hired by Brazilian universities who shared the same goals for the next generations.

The next challenge was, of course, obtaining funding. The preexistence of the already mentioned Brazilian Millennium Institute for Quantum Information was critical in this regard. The conference concept was presented to the co-heads of the Institute, prominent Brazilian physicists Luiz Davidovich and Amir Caldeira. Both gladly agreed to fund the idea, not least because a new generation was stepping up to the task of promoting the field. Nevertheless, more funding was still necessary. Davidovich and Caldeira thus also agreed to join the organizing committee, adding the necessary *gravitas* to an otherwise very young team. Having them on board certainly helped secure financial aid from other public sources - as in most countries, Brazilian funding agencies are not necessarily kind to younger scientists, especially when available resources are limited. However, as Davidovich quipped at the time: 'Organizing conferences is complex - it has real and imaginary parts'. In other words, the senior researchers' presence was confined to the 'imaginary axis' of the committee, leaving all the real organizing to the core team of six youngsters: França Santos and Terra Cunha from UFMG, Jonathan and Galvão from UFF, Walborn from UFRJ, and Lutterbach, who no longer had an academic affiliation, but had all the essential local connections to make the event happen.

5 The School

It was a consensus amongst the organizers that the graduate school had to be the centerpiece of the event, due to its potential to help grow the Brazilian quantum information community. Careful consideration was therefore paid to all of its aspects. Its overall format, for example, comprised six mini-courses over a week, each composed of three hour-and-a-half long lectures. Since the event was the first of its kind, and in a very young field to which many students would likely be having their first exposure, it was decided that the course topics should cover the broad fundamentals of several sub-fields of quantum information. The final choices were: introductory quantum information theory, quantum open systems and decoherence, quantum computation, quantum cryptography, quantum error correction, and entanglement theory.

Half-hour breaks were left in between lectures, and long (four-hour long) lunch breaks were also provided. A poster session was also scheduled for one of the evenings, during which a small cocktail party was held. Finally, instead of a standard conference dinner, the main social event was an afternoon boat trip exploring Paraty's lush bay and tropical islands. All these ingredients were designed to encourage bonding between students and lecturers, to give the students time to absorb the knowledge transferred during the classes and to stimulate creativity.

The last, but most important step was to put together an exciting lineup of lecturers, who would not only deliver high quality courses, but also embrace the conference's intended informal, relaxed spirit. Another important goal was to foster or reinforce bonds amongst the broader South American community and to demonstrate that good research in the field was also being developed in the region. The organization thus decided to invite one researcher working in Brazil, one in another South American country and four others working in the rest of the world. Last but not least, in order to make the conference's limited funding go as far as possible, the organizers leveraged their personal connections, inviting sympathetic colleagues who would agree to at least partially self-fund their trip to Brazil. This generosity would allow, for example, the provision of financial aid to several students from Brazil and South America.

A stellar team of lecturers with all the necessary attributes was identified, and fortunately all accepted immediately. The final lineup (after one last-minute replacement) featured Luiz Davidovich (Rio de Janeiro), Juan Pablo Paz (Buenos Aires), Artur Ekert (Oxford and Singapore), Antonio Acín (Barcelona), Daniel Gottesman (Perimeter Institute, Canada) and Jacob Dunningham (Leeds).

Classes began on a Monday afternoon, with two lectures (the morning was used for buses to come from Rio and Sao Paulo to Paraty). This was followed by two relatively intense days on Tuesday and Wednesday (four lectures, two in the morning and two in the afternoon), a more relaxed day on Thursday with just a pair of morning lectures (and the boat trip), another intense day on Friday, followed by the round table discussion, and finally two lectures on Saturday morning. This somewhat unconventional ending time allowed students to cut costs, while ensuring the important "no squeezing" principle to which the organization adhered.

The 2007 School was really memorable. Students were able to bond with each other, with the lecturers (many of whom were, up till then, only "names in important papers" to the majority of them), and also with the organizers and some participants of the Workshop who had arrived early. The six courses were all very well received, from the very basic and instructive one by Artur Ekert all the way to the very abstract course on quantum-error correction codes by Daniel Gottesman.

Another very important point was the international character of the event. Participants came from many different countries and continents, some visiting Brazil for the first time. This really allowed the local participants to contrast their own experiences with an interesting sample of international students, from countries like Argentina, Chile, Ecuador, Iran and Israel.

6 The Workshop

The philosophy adopted for the Workshop was simple: it should be as horizontal as possible, encouraging young researchers to join; it should value quality over seniority; and it should stimulate collaborations and profitable scientific discussions rather than serve as a publicity platform for well-established groups. In order to achieve all this, the following set of informal rules was created: first, inspired by the Benasque model, the schedule was kept as uncluttered as possible, with only a relatively small amount of 25-minute talks spread over five days, in two daily sessions separated by a large lunch break. This allowed participants enough free time to roam around the town, meet each other and discuss science wherever they felt comfortable. As had been done during the school, the only other scheduled events were poster sessions accompanied with a simple cocktail, and a boat trip in the middle of the week, replacing the traditional conference dinner.

Second, there should be no formal hierarchy among speakers. Although, in the 2007 edition, there were a small number of national and international invited speakers (both to ensure a quality workshop and also to help attract interest in the event), all accepted speakers were assigned an equal 25-minute slot. From the 2009 edition onwards, this

'horizontality' principle has been extended even further, with a complete absence of invited speakers. Everyone wishing to take part in the Workshop is advised to apply and submit their work, regardless of seniority, with a selection committee being responsible for assigning the relatively few talking slots. The only exceptions are the lecturers from the School who, as a courtesy, are invited to stay on for a further week and also give a 25-minute talk at the Workshop if they so wish.

Third, all participants would be entitled to present their work, either as a talk or in one of the poster sessions.

Finally, the conference would not pay for anyone to come. The exceptions, again, were those lecturers of the school who were not able to self-fund their presence in Brazil, and a small number of students with financial difficulties.

These rules have largely held true for all the subsequent editions.

7 The Outreach Event

In parallel to the school, the conference also included an outreach event for the local community of Paraty, as originally planned by França Santos and Lutterbach. This was comprised of several activities, including a week-long exhibition of physics experiments, and a public lecture by Luiz Davidovich about Quantum Information. The exhibition, called "Física em Paraty" (Physics in Paraty), took place at the main local public school and also at *Casa da Cultura*. It was curated by França Santos and Lutterbach and presented by a team of undergraduate students from the Federal University of Minas Gerais, who also provided the experiments. Over the course of the week, the exhibition welcomed around 800 schoolchildren from public and private schools from around the region.

Since 2007, all but one edition of the Paraty Quantum Information event has included outreach activities, ranging from public lectures to artistic exhibitions, using different spaces, from public schools to public squares.

8 A Success Case

It is safe to say that, despite its uncommon format and philosophy, the first edition of the conference was a huge success.

The testimonies of all attendees and professors by the end of the conference were so encouraging that there was little doubt that a second edition was a must. The format was considered particularly enticing by the participants and the engagement of the students was encouraging for the organizers. The event also created bonds with local businesses providing services such as transportation, internet access, sound equipment, etc., that have remained firm ever since.

The format has remained basically the same, with a few eventual adaptations due to changes in the venue. Nowadays, the *Casa da Cultura* has found a new and exciting agenda throughout the year which cannot accommodate such a long event for two entire weeks. As a result, since 2019 the event has been hosted at a local hotel close to the historic center. This has concentrated some of the participants and part of the social activities in one single location. However, the long lunch breaks and the fact that most students and some researchers still stay in other locations help preserve a significant part of the original characteristics of the 2007 conference.

More importantly, the Paraty Quantum Information meeting has established a worldwide reputation as a high level event where senior researchers from many different, highly active countries in the topic have stimulated the participation of their graduate students, especially those who have been involved with the conference in the past, either as a professor of the school or a participant of the workshop. It is also, together with WECIQ, the longest lasting continuous quantum information event in the whole of South America and one that has definitely put Brazil on the World map of relevant graduate schools in the field.

The outreach event has also had an impact on the local society with an increasing number of schools applying for it and a vast number of children who have in it their first contact with physics experiments.

The list of professors who have visited and lectured at the School is also a testament to Brazil's successful insertion within the wider quantum information community. From a Nobel Prize winner to founders of the field, the large number of prominent scientists that have accepted the invitation to visit the Paraty conference and teach its students shows the enthusiasm that the international community demonstrates towards the physics developed in the country (for a complete list, please check the end of this paper). Incidentally: by examining this list, it is plain to see that four of the first five editions of the School only featured male lecturers (although in reality some women were in fact invited for those editions but could not make it). It is important to note that the last four editions have all featured at least two women giving courses.

Another significant outcome of the event has been the equally large number of collaborations started or enhanced during the workshops, as well as the opportunities for PhD students and post-docs initiated by contacts made during the coffee-breaks. Furthermore, a natural by-product of the format of the Workshop is that it attracts many young researchers who receive there their first opportunity to present a talk at a high level event.

Finally, a large number of Brazilian quantum information researchers currently holding permanent positions have either had their first contact with the broader community during the

school and/or have found PhD or post-doc supervisors and collaborators during the two weeks of the event. The relevance of the conference to their training and career can be estimated by the fact that many former student participants have returned in later editions either as professors of the School or as organizers of the event after being permanently integrated into the national quantum information community, which has grown into a healthy interconnected network [1].

9 The Latest Edition (2025)

This year, 2025, witnessed the ninth edition of the Paraty Quantum Information School and Workshop. As already mentioned, since 2007 the event has been repeated every second year, with the sole exception of 2021 (an online edition was briefly considered that year, but discarded, as the organizers agreed that the Paraty experience could not be reproduced with an online mode).

Confirming the resilience of the event, the School and the Workshop continue to attract students and researchers from all over the world. The 2025 edition had 71 participants solely in the School, 75 solely in the Workshop and 53 attending both, for a total audience of 199 scientists over both weeks. Out of this total, around 27% came from 20 different countries (9% from other South American countries and 18% from other continents). This is a significant number when one considers that the conference still does not have invited speakers, and that traveling to Brazil is quite expensive for most of the World. This relative presence has been consistent throughout the years.

10 The Future

By and large, the event has successfully achieved its original aims. The next edition, in 2027, will celebrate its 20th anniversary and also its 10th edition, two important milestones. With the present text, we just want to convey some of the event's guiding principles, as well as a few hopefully interesting first-hand stories. We wish a long life to Paraty Quantum Information, and hope that it can keep its community spirit and continue to help the field develop as it matures.

11 List of Lecturers of The School

2007: Antonio Acín, Artur Ekert, Daniel Gottesman, Jacob Dunningham, Juan Pablo Paz and Luiz Davidovich.

2009: Adan Cabello, Alain Aspect, Jens Eisert, Paulo Nussenzveig, Raymond Laflamme and Werner Vogel.

2011: Barbara Terhal, Carlton Caves, David DiVincenzo, Juan Pablo Paz (x2), Robert Spekkens and Stephen Walborn.

2013: Artur Ekert (x2), Atac Imamoglu, Gerardo Adesso, Ivan Deutsch, Marcelo França Santos and Miles Padgett.

2015: Ernesto Galvão, Fernando Brandão, Leandro Aolita*, Matthew LaHaye, Philip Walther and Richard Jozsa.

2017: Alexia Auffèves, Časlav Brukner, Elham Kashefi, Emile Hoskinson, Marcelo Terra Cunha and Michal Lipson & Alexander Gaeta.

2019: Alejandro Perdomo-Ortiz, Antonio Zelaquett Khoury, Daniel Cavalcanti*, Olivier Pfister, Sabrina Maniscalco and Yelena Guryanova.

2023: Fernando Brandão (x2), Glaucia Murta*, Nadja Bernardes*, Richard Kueng and Esteban Sepulveda* & Stephen Walborn (x2).

2025: Amir Caldeira, Anna Sanpera, Carmem Gilardoni, Christian Schmiegelow*, Eugene Polzik and Otfried Guehne.

(x2) indicates the few people to have taught twice in the history of the Paraty School;

* indicates former students of the School who went on to give courses.

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Data Availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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