



# Initiatives in the Quantum Technologies Pillar of the CNRS-USP International Research Center

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## Abstract

Quantum Science and Technology is an strategic area in the development plan of countries all around the world summing an investment up to U\$ 55 billion [1]. France and Brazil have a long history of collaboration in the field of Quantum Science, including important physicists of the two countries as the Brazilian Luiz Davidovich and the Moroccan-French Serge Haroche, 2012 Nobel Laureate in Physics. In 2024, the French public agency of research, the CNRS, has inaugurated an International Research Center (IRC) at the University of São Paulo (USP), in Brazil, focused in seven main pillars with one of them being Quantum Technologies. By taking advantage in already established France-Brazil collaborations, the CNRS-USP IRC aims to promote the creation of joint research laboratories that will contribute to state-of-the-art research on quantum science and technology. Here, we describe the first initiatives related to the Quantum Technologies pillar of the CNRS-USP IRC “*Transitions*”.

**Keywords** Quantum physics · Quantum technologies · CNRS · USP · French-Brazil collaborations

## 1 Introduction

Quantum Science and Technology is considered an strategic area in many countries around the world. The resources devoted to deeper our understanding of its fundamental laws and to the development of quantum technologies 2.0, from which quantum computers are the biggest example, summed now more than U\$ 55 billion. For 2040, this number is expected to reach U\$ 106 billion [2]. Countries such as the United States, the United Kingdom and China have already invested U\$ 7.6 billion, U\$ 5.5 billion and U\$ 15.3 billion, respectively. Following these initiatives, it is mandatory to think about a national developing plan if one aims to be one of the actors in the next quantum revolution that will take place in the following years.

France has started its quantum initiatives a few years ago. In 2021, it was announced a five-year national investment

plan of U\$ 1.8 billion in quantum technologies [3]. In 2024, the French government launched the PROQCIMA program [4] aiming to develop a French quantum computer with 128 logical qubits by 2030, combining academic initiatives with companies and start-ups, by the selection of five French companies to accelerate the development of their prototypes. Brazil has started direct investments on quantum technologies a little later and summing a more modest budget (~ U\$ 79 million), which comprehend the programs funded by the *Empresa Brasileira de Pesquisa e Inovação Industrial* (Embrapii) and by the Quantum Technologies Initiative (QuTia) from FAPESP [5], the São Paulo state funding agency. However, the high level of researchers working in different areas connected with quantum science can still place Brazil in a good position if more programs started to be promoted in the public and private level. Another strategy is to search for collaborations creating an active network with constant exchange of knowledge, technologies and personal resources.

In 2024, the French public agency of research, the *Centre National de la Recherche Scientifique* (CNRS), has created an International Research Center (IRC) at the University of São Paulo (USP), in Brazil, the CNRS-USP IRC “*Transitions*”. It is organized around seven fundamental pillars, with one of them

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devoted to Quantum Technologies<sup>1</sup>. This choice is not only motivated by the individual national interests of France and Brazil in developing its quantum environment, but and more importantly, it focus on strengthen the history of the France-Brazil collaboration in Quantum Science. Collaborations that go back more than 50 years and include important physicists such as José Roberto Rios Leite, one of the responsible for the foundation of the Optics Group at Federal University of Pernambuco (UFPE) in the 70s which strongly collaborated with Martial Ducloy, researcher director from the *Laboratoire de Physique des Lasers* (LPL) and former president of the European Physical Society (EPS); Nicim Zagury, Moysés Nussenzveig and his former PhD student, Luiz Davidovich, all emeritus professors of the Federal University of Rio de Janeiro (UFRJ) and pioneers of quantum optics in Brazil with Claude Cohen-Tannoudji, Serge Haroche, both professors at *Collège de France* (CdF) and Nobel Laureates in Physics in 1997 and 2012, respectively, and Michel Brune, director of research at *Laboratoire Kastler Brossel* (LKB); and many others.

These names were responsible for putting together the building blocs of the French-Brazil networks we have nowadays with important representations from UFPE, UFRJ, USP, with the *Instituto de Física* (IF), at the campus of Butantã, and with the *Instituto de Física de São Carlos* (IFSC), at the campus of São Carlos, and the Federal University of São Carlos (UFSCar)<sup>2</sup>. In the next Section, we describe the recent initiatives inside the Quantum Technologies pillar of the IRC *Transitions*.

## 2 Initiatives in the Quantum Technologies Pillar

The Quantum Technologies pillar of the CNRS-USP IRC *Transition* is being built taking advantage on already established France-Brazil collaborations to promote the creation of new joint research groups that will contribute to state-of-the-art research on quantum science and technologies. It is coordinated by Paulo Alberto Nussenzveig (IF-USP), in the Brazilian side, and by Robin Kaiser (*Institut de Physique de Nice* - INPHYNI at the *Université Côte d'Azur*), in the French side. Apart from having an expressive research work on quantum science, focusing in quantum optics [6, 7] and quantum statistics of light [8–10], respectively, they share strong interest in quantum applications such as quantum sensors, single-photon sources, etc. Their role in the IRC is to facilitate the

initiatives of collaborations between the two countries and define the development plan for the pillar itself.

Within the establishment of the Quantum Technologies pillar, we have conducted two scientific workshops in the past year: the 1<sup>st</sup> Workshop CNRS-USP on Quantum Technologies and the 1<sup>st</sup> Quantum Pillar Meeting at the “French-Brazilian Workshop on Quantum transport of Light and Cold matter” (QuaLiCo 2025).

The first scientific workshop took place online on December 4<sup>th</sup> and 6<sup>th</sup> 2024. In that occasion, researchers from France and Brazil presented short seminars introducing their research field and focusing on recent projects and results that could foster new collaborations. Experiments with ultracold atomic gases were present during the two days of the workshop with the participation of Vanderlei S. Bagnato (IFSC-USP), Raul C. Teixeira (UFSCar), Hélène Perrin (LPL), Raphael Lopes (LKB), Sebastián Gleyze (LKB) and Robin Kaiser (INPHYNI), covering topics such as low dimensionality [11], out-of-equilibrium systems [12], quantum sensing [13] and light-matter interactions [14]. There were also different topics in photonics and quantum materials with Gustavo Wiederhecker (*Universidade estadual de Campinas* - Unicamp), Yara Galvão (UFSCar), Sebastien Plissard (*Laboratoire d'analyse et d'architecture des systèmes* - LAAS) and Clement Faugeras (*Laboratoire National des Champs Magnétique Intenses* - LNCMI) [15–18]; metrology and quantum sensors with Sergio R. Muniz (IFSC-USP), Loïc Rodin (*Université Paris-Saclay*) and Carlos L. Garrido Alzar (*Observatoire de Paris* - SYRTE) [19]; quantum optics with Paulo Nussenzveig (IF-USP) and Rafael Barros (IF-USP) [20]; and quantum computing with Julien Laurat (LKB) [21]. The two-days folder of the event is displayed in Fig. 1 and the complete program can be find at [22].



**Fig. 1** Folder of the 1<sup>st</sup> Workshop CNRS-USP on Quantum Technologies with the list of the participants during the two days of the event

<sup>1</sup> The other pillars of the CNRS IRC *Transitions* are Human Sciences, Agriculture/Decarbonation, Biology, Computing Methodologies and Applications, Oceans/Climate/Atmosphere and Ecology & Environment

<sup>2</sup> Other French-Brazil collaborations related to quantum science are probably active during the time of the writing of this article, but our focus here is to mention the ones related to the development of the CNRS-USP IRC *Transitions*.



**Fig. 2** Left: All participants of the QuaLiCo 2025 workshop. Right: Some of the Brazilians participants of the QuaLiCo 2025 workshop

The second scientific workshop took place in Peyresq between July 21st and 25th 2025 and it was a joint event with the “French-Brazilian Workshop on Quantum transport of Light and Cold matter” (QuaLiCo 2025), a kickoff event of the French-Brazil network funded by an International Research Project (IRP-CNRS), coordinated by Mathilde Hugbart (INPHYNI), and by the Brazilian *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq), coordinated by Romain Bachelard (UFSCar). These two projects are big joint research consortiums that combines the São Carlos group on cold atoms hosted in IFSC-USP and UFSCar with the quantum optics group of UFPE, in the Brazilian side, and the group at INPHYNI with the LPL and ISIS-Strasbourg, in the French side. The focus of the consortium is to explore quantum transport phenomena of matter and light and the possibilities for quantum sensing among different experimental platforms. The idea to merge these events was again to take advantage of the existing French-Brazil network in the field of quantum science and explore new collaboration partnerships. In that occasion, apart from researchers that had already participated on the previous workshop, there were Barbara Amaral (IFUSP), who works with the foundations of quantum mechanics [23], and Xin Zhou (*Institut d’Electronique, Microélectronique et Nanotechnologie - IEMN*) presenting her research on nanoelectromechanics and quantum circuits [24]. The book of abstracts of the full event can be download at [25]. In Fig. 2, we show two pictures taking during the event with all participants, in the left, and all the Brazilians attending the workshop, in the right.

In addition to the two events presented so far, the Quantum pillar of CNRS-USP IRC also benefited from a call for joint PhD program. The idea was to combine a French and a Brazilian group into a single project with one PhD student from each side funded by CNRS and FAPESP, respectively, that would develop their thesis in strong collaboration and with planned missions to the collaborating partner. In that occasion, the selected joint PhD project was proposed by Philippe Courteille (IFSC-USP) and Mathilde Hugbart

(INPHYNI) and focused on light-matter interaction effects with the title “ICorQuant: Intensity correlations to probe light diffusion within a dense atomic cloud”.

### 3 Conclusions

The Quantum Technologies pillar of the CNRS-USP International Research Center is an initiative motivated by the historical collaboration background on quantum science that goes back to more than 50 years old. Important Brazilian physicists, such as José Roberto Rios Leite, Luiz Davidovich and Moyses Nussenzveig, are a few examples of the importance of such collaboration: all of them spent relevant research time during their careers in France and kept strong collaborations with leading researchers in the field, such as Martial Ducloy, Serge Haroche and Michel Brune. The possibility to foster new collaboration initiatives within the Quantum Technologies pillar strengthening personal and knowledge exchange between the two countries will surely have a positive impact in the years to come promoting the realization of disrupting and leading research in the field of quantum science that will influence the younger generations to continue to search for French-Brazilian partnerships.

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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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