

Gilles Brassard, awardee in the Basic Sciences category (12th edition)

I am humbled and honoured to accept the prestigious BBVA Foundation Frontiers of Knowledge Award, especially when I read the list of luminaries who received it in the past. In particular, the very first Award in the basic sciences was given in 2008 to quantum information pioneers Ignacio Cirac and Peter Zoller. It is therefore clear that the Foundation recognizes the importance of quantum information. Indeed, it is no longer possible to doubt that the second quantum revolution is upon us and will define the 21st century as fundamentally as the computer ushered in the Information Age in the 20th century and the steam engine powered the Industrial Revolution one century earlier.

Quantum information has the potential to transform our lives for the better by offering unprecedented computational power, incomparably precise instruments, and unconditionally secure confidentiality. It also has the potential to cause substantial harm by wreaking havoc on the cryptographic infrastructure on which the security of the Internet currently relies. It is our collective duty, as a scientific community, to not let this happen. For this, new tools must be developed and deployed, such as quantum cryptography, which will be capable of withstanding the unleashed power of future quantum computers. All this is within our reach provided we are united and work together in the right direction.

Together with Charles Bennett, I was able to develop quantum cryptography, the ultimate defence against privacy intrusion, because we were standing on the shoulders of one giant, who sadly passed away last month. Therefore, I wish to pay tribute and dedicate this award to the memory of Stephen Wiesner, who single-handedly realized the potential of quantum information as early as the late 1960s at a time when the fragility and unpredictability of matter at the quantum scale would seem anathema to the needs for reliable computation. Later, quantum effects even appeared to be nefarious to the continued growth of computing since Moore's Law would clearly not be forever sustainable. But Wiesner understood already that one usually gets further ahead by working with Nature rather than trying to overcome it by brute force. He

21 de septiembre de 2021

imagined ways to harness quantum information that were so revolutionary that his main opus was rejected from a leading engineering journal, and nobody understood his genius. Nobody, that is, except Charles Bennett. And when Charlie told me about these crazy ideas a decade later, on the occasion of our first meeting, while swimming at the beach in San Juan, Puerto Rico, Wiesner's spark ignited the flame of this revolution. Actually, what I should have said earlier is that I was standing on the shoulders of *two* giants, that is on those of Charlie, himself standing on those of Wiesner, like an *enxaneta* at the top of a small Catalan *castells*. All counted, it took half a century after Wiesner's original inventions before his seminal work was finally recognized by a major international award, namely the 2019 Micius Quantum Prize. And now he is gone, but his memory will live forever in our hearts. Without him, our field would simply not exist. Thank you, Steve!

Of course, many other people throughout the years played an important part in the unfolding of the second quantum revolution, such as Ignacio Cirac and Peter Zoller, mentioned before, and perhaps most importantly David Deutsch, who was the first person to understand the potential power of quantum information for computing purposes, as well as our co-laureate Peter Shor, who discovered how awesome this power could actually be. However, I wish to pay particular homage to my former students, who helped me develop the theory for which the BBVA Foundation is honouring me today. Several of them have become major players in the field. Most of all, I think of Claude Crépeau, lifelong collaborator since the mid-1980s and co-inventor of quantum teleportation. Much more recently, Paul Raymond-Robichaud made me understand that Einstein was right in questioning the completeness of quantum theory in 1935. Being surrounded by bright students is the top blessing of a professorial career.

I wish to end with a passionate plea for the importance of curiosity-driven basic research, which is, of course, most appropriate when accepting an award in the basic sciences. When the fathers of quantum theory were busy developing the field in the early 20th century, they were doing it solely for the purpose of understanding Nature. They were blissfully unaware that their fundamental work was soon to change society forever. Most of contemporary technology relies on quantum theory in an essential way. Without it, there would be no transistors and therefore no computers (at least no efficient computers), no lasers, no intelligent telephones, the list goes on and on. Technology progresses because basic research took place decades earlier, driven by researchers who were not in search of applications for their work. Continued progress is contingent on encouraging fundamental research in all possible ways. We must accept that most



21 de septiembre de 2021

of this basic research will remain theoretical forever, and some will lead nowhere. But without it, the only possible outcome is stagnation followed by decline. You can never predict which crazy ideas of today will be at the very heart of the next technological revolution. And what better proof of this can I offer but to think again of how completely insane Wiesner's seminal ideas looked like to almost everyone at the time he was still the only one to have reached for the infinite potential of the quantum world? Fortunately in this case, Charlie Bennett was watching. But how many other great inventions were forever lost because they did not have their Bennett? I shiver to think of it. The best way to mitigate this risk is to foster Basic Sciences in all possible ways, which is precisely what the BBVA Foundation is doing with his Award. Thank you so much, not for me, but for the greatest benefit of humankind.