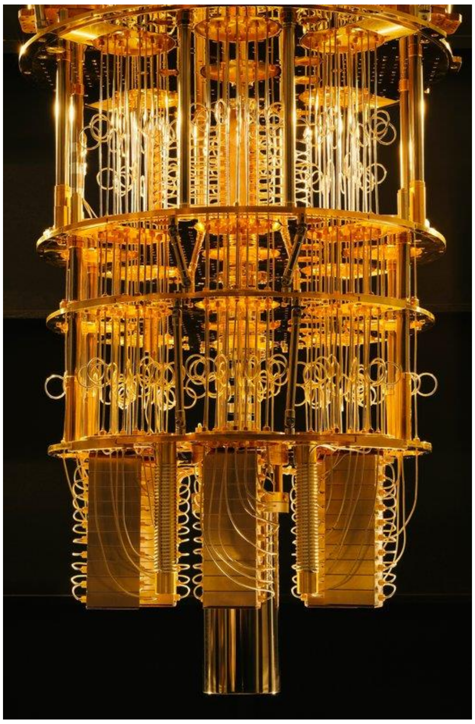
QC & Research in Science and Technology



Some definitions:

- ***Quantum simulator***: a controllable quantum system used for the simulation of other quantum systems, as it is possible to control some parameters.
- ***DQS (digital quantum simulator)***: a system that can reproduce a quantum algorithm for simulating another system. Quantum computers are an example: they are universal simulators, as they can *potentially* reproduce any kind of quantum system.
- ***AQS (analogue quantum simulator)***: tangible quantum systems that can replicate other ones. They can simulate a limited class of systems or phenomena. Because they are tangible, one can directly make measurements on them, contrary to DQSs, where states are manipulated through algorithms for obtaining results. In the recent years, different types of AQS models were implemented, and the development of some of them is based on the principles of physics of condensed matter—neutral atoms in optical lattices, cooled and trapped ions, superconducting circuits, et cetera.
- ***Quantum sensors:*** devices that use the superposition principle and/or entanglement in order to obtain higher sensibility and resolution for measurements of gravitational and magnetic fields, time intervals, and fundamental physical constants.

Quantum simulation applies to various scientific and technological fields, from atomic physics and solid-state physics, to high-energy physics and cosmology, and beyond.

Moreover, as it will allow to analyse the properties of certain systems, to select systems with desired properties, and to realise new compounds with desired properties, it will also allow to design new drugs or materials with important features (such as superconductors at high temperatures) that could be used in different fields, such as the energy or the transport ones.

As far as the environment is concerned, one of the so-called *world's critical problems* is the design of an efficient system for capturing carbon in the atmosphere.
A wide accessibility to quantum computers on one hand and to scientific knowledge on the other is necessary to avoid the creation of monopoles within pharmaceuticals companies, multinational corporations and governmental institutions. It is for tackling these new challenges that we need to educate new generations of technicians and scientists.

Links	Descriptions
https://www.youtube.com/watch?v=qarc7AA4-wM	Short introductive video on the challenges of quantum simulation
https://www.microsoft.com/en-us/research/blog/problems-will-solve-quantum-computer/	Article showing that a QC can be used to reveal the reaction dynamics within a complex chemical system. For example, the analysis of the nitrogenase (an enzyme), which is beyond the capacity of any supercomputer today, will have important consequences on the production of fertilisers
https://qt.eu/discover/applications-of-qt/fertilizer-and-other-quantum-computer-chemistry/	Website showing the objectives of computational chemistry in the development of mathematical models that simulate the behaviour and the properties of complex chemical systems
https://home.cern/news/news/computing/exploring-quantum-computing-high-energy-physics	QC for the challenges in high-energy physics
https://www.cnr.it/it/news/8292/sensori-quantistici-superconduttivi-per-comprendere-la-progressione-della-sla	Use of quantum superconductive sensors in the functional study of the brain
https://qt.eu/app/uploads/2018/04/93056_Quantum-Manifesto_WEB.pdf	Quantum Manifesto