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Physicists have established that the natural world obeys quantum mechanics, which underlie a wide range of remarkable phenomena in materials, atomic nuclei, or even astrophysics. However, describing and understanding quantum systems comprising many particles is an immensely challenging and often insurmountable task. In the last twenty years, a new approach known as quantum simulation has emerged to tackle the complexities of quantum systems. In this approach, a quantum machine is programmed to replicate the behaviour of these systems, offering a level of control akin to a computer simulation while using the quantum nature of the machine to capture the underlying complexity.

Jean-Philippe Brantut's laboratory at EPFL has developed innovative platforms for quantum simulation, leveraging a unique combination of gases of lithium atoms cooled a millionth of degree above absolute zero, and photons trapped between high- reflectivity mirrors. A notable achievement of his team is the discovery a new type of optical excitations called Fermion-pair polaritons, where two atoms and one photon form hybrid compounds. Moreover, the control over light-matter interactions achieved in Brantut's laboratory allows for the synthesis and exploration of new phases of matter where atoms interact over long distances by exchanging photons.

Beyond these examples, these platforms demonstrate a high degree of control over the quantum properties of matter. This has broader implications for the field of quantum technologies, which seek to leverage quantum systems to perform tasks beyond the capabilities of classical machines. Brantut's work contributes to the ongoing development of these technologies.