Searching for New Physics at the Quantum Technology Frontier

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Abstract

The discovery of the Higgs boson in 2012 at the Large Hadron Collider (LHC), was another remarkable success of the Standard Model (SM) of particle physics. However, despite its great success, the SM is falling short in explaining the origin of dark matter, dark energy, the neutrino masses and does not include gravity. Moreover, it seems to fail in providing an explanation of why we exist. In fact, after the Big Bang there should have been equal amounts of matter and anti-matter. However, today we live in a Universe dominated by matter. Why was there an asymmetry such that we (matter) could survive?
Those unsolved problems triggered vigorous theoretical and experimental activities seeking for their solution. New ideas Beyond the Standard Model (BSM) such as supersymmetry, large extra dimensions, and/or extended Higgs and Dark sectors attempt to address these open issues from the theoretical side. On the experimental one, searches at the high energy frontier, such as at the LHC, seek for the direct detection of new particles which would provide clear evidence of new physics. At the low energy frontier, precision measurements could also provide evidence for new phenomena beyond the Standard Model. For example, via effects manifesting themselves in potentially measurable quantities such as an electron or neutron electric dipole moment. Advances in atomic and molecular (AMO) physics, including quantum sensors and atomic and molecular clocks, open the door to new measurements that may indicate the existence of new physics well beyond the achievable energy of current colliders. This can be done either by improving the experimental precision of well predicted theoretical quantities, or by searching for a previously unobserved process.
On a worldwide scale, searches for new physics are one of the top research priorities in Europe, in the US in Japan, and in China. Switzerland with PSI and hosting CERN is playing a leading role in probing BSM physics. With this conference we will bring together different communities - particle physics, atomic and molecular physics, and quantum technologies - to foster new research projects and collaborations across Switzerland and internationally to advance in the search for new physics beyond the Standard Model exploiting emerging quantum technologies.

Key topics/focus

Atoms, molecules and ions, exotic atoms, anti-matter research, quantum sensors, interferometry, clocks, electric Dipole Moments (EDMs)