HUNTING FOR DARK MATTER WITH NEXT-GENERATION QUANTUM SENSORS

An innovative contribution in the search for dark matter could come from the development of devices based on quantum properties. Interesting progress, in which INFN is involved too, was recently achieved during the activities promoted by SQMS (Superconducting Quantum Materials and Systems Centre), the Fermilab centre funded by the US Department of Energy (DOE) and dedicated to research on new technologies for quantum computing and quantum sensing. A study, published on 9 May in the Physical Review Applied journal and led by INFN - SQMS's only non-US partner - shows how the performance of haloscopes - sensors dedicated to detecting a particular category of dark matter candidate particles, axions - can be enhanced through the use of new types of microwave resonant cavities with high sensitivity. Initially introduced in the '70s to tackle the problem of charge and parity symmetry violation in strong interactions, the axion also proved to be a good candidate for dark matter because of its extremely low mass and its limited ability to interact with ordinary matter. Exactly in order to probe the existence of these particles, in 1982, the theoretical physicist Pierre Sikivie devised and proposed a specific type of device called a haloscope, because it probes the halo of dark matter in our galaxy, which would later become widely used and is now being developed in various laboratories in Europe, the United States, South Korea and Australia. The strategy adopted by the Fermilab and INFN teams working on SQMS is to aim at increasing the efficiency of the axion-photon conversion process.