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Dark matter search with liquid argon

A great number of astrophysical observations point to the existence of an abundant form of matter interacting almost exclusively through gravity. A potential candidate is a weakly interacting massive particle (WIMP) produced in the early Universe. Thanks to its excellent ionization response and unique scintillation light characteristics, Liquid Argon (LAr) detectors can provide great sensitivity for WIMP nuclear collisions and strong background suppression. DEAP-3600 single phase LAr detector has demonstrated, thanks to pulse shape discrimination, to reject the dominant beta/gamma background at the 10-7 level. DarkSide-50 has demonstrated a two-phase detection measuring direct light output together with electroluminescence from acceleration of electrons into a gaseous region above the liquid, providing excellent position resolution for fiducialization. By using low-radioactivity argon from underground wells, in 532 days run, a zero background has been obtained. The two-phase method also enables sensitivity for lower WIMP masses using the electroluminescence signal alone: a leading sensitivity below 10 GeV/c2 has been obtained by DarkSide-50. The next step forward is represented by the Darkside-20k experiment that, featuring 50 tonnes LAr, pursues a series of enabling technologies: target obtained with underground argon depleted in 39Ar; light detection via large-area cryogenic custom-designed silicon photomultipliers; active veto with atmospheric LAr.

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