Results from DarkSide-50 high-mass WIMP search: upper limits at the 90% CL for the binomial fluctuation model (red solid line, continued as dotted) and the model with zero fluctuation in quenching (red solid line, continued as dashed) on spin-independent dark matter-nucleon cross sections from DarkSide-50 in the range above 1.8 GeV/c².

Gravitational effects that cannot be explained by visible matter are well documented, though their source remains deeply mysterious. One hypothesis about the nature of the so-called "dark matter", motivated by considerations in elementary particle physics, is that it consists of as-yet undiscovered elementary Weakly Interacting Massive Particles (WIMPs). WIMPs in random orbits make up the dark matter halo that pervades our galaxy, and their motion should result in WIMP-nucleus elastic collisions of sufficient energy to be detected directly by a sensitive detector on Earth.

Liquid argon double-phase TPCs play a major role in this search, especially if they take advantage of ultra-low background underground argon (UAr) extracted from deep wells in Colorado, featuring a specific activity in the cosmogenic $^{39}$Ar three orders of magnitude lower with respect to the atmospheric argon.
The DarkSide Collaboration at *Laboratori Nazionali del Gran Sasso* (LNGS) has a broad physics program, which includes the continuous operation since 2013 of a double-phase 50 kg TPC, DarkSide-50, and the construction of a 20-tonne UAr experiment (DarkSide-20k). DarkSide-50 recently completed a major milestone of its program by publishing results from a 532-day campaign. The outcome of the dark matter search is a null result. The discrimination between events induced by natural radioactivity and nuclear recoils – the potential candidate dark matter events – is outstanding, confirming once more that a future generation of DarkSide detectors will also be able to operate completely free of background and in a real discovery mode.

The extremely low background of DarkSide-50 reached since the start of the run with the UAr target has allowed to obtain an extremely significant result in the search for WIMPs. The analysis of very-low energy events, characterized by the presence of the sole ionization events, has led to the world-best limits for masses below 6 GeV/c$^2$. The improvement with respect to competing experiments is of one order of magnitude, thus bringing DarkSide into the lead.

Learn more about: 1, 2, 3