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Pushing Boundaries of WIMP Detection with DarkSide-20k

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The Global Argon Dark Matter Collaboration (GADMC), formed to unite liquid argon–based dark matter experiments, is currently constructing its next-generation experiment DarkSide-20k. Located at the Laboratori Nazionali del Gran Sasso (LNGS), DarkSide-20k builds upon the success of previous argon experiments, including its predecessor, DarkSide-50, to continue the search for weakly interacting massive particles (WIMPs). The experiment introduces several new technologies and design improvements to reduce backgrounds and enhance sensitivity.

DarkSide-20k features a three-chamber design: a central dual-phase time projection chamber (TPC), an inner veto, and an outer veto. The TPC contains 50 tonnes of low-radioactivity underground argon (UAr). Surrounding the TPC, the inner veto, filled with 32 tonnes of UAr, provides efficient neutron tagging, while the outer veto, containing 650 tonnes of atmospheric argon (AAr), shields against cosmogenic backgrounds. The detectors are instrumented with novel photodetectors called silicon photomultiplier (SiPMs), small pixel-like detectors that can work under cryogenic temperatures. This design will allow the experiment to run nearly background free with a 200 tonne-year exposure.

With its large target mass and advanced instrumentation, DarkSide-20k is expected to probe WIMP–nucleon cross sections below $1\times10^{-42}\ cm^2$ for WIMP masses above 800 MeV. As its name implies, DarkSide-20k will look into unknown areas that have never been explored in search of dark matter, pushing closer to boundaries such as the neutrino floor than any experiment ever has.

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