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Direct dark matter searches with argon detectors

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Dark matter constitutes one of the most compelling open questions in modern physics. One of the most compelling and theoretically-motivated candidates is the Weakly Interacting Massive Particle (WIMP), a hypothetical particle beyond the Standard Model with a mass typically ranging from a few GeV to several TeV. Direct WIMP searches are being actively pursued through a variety of experimental approaches, the most promising of which employ noble-element targets, such as argon and xenon. While xenon-based experiments presently set the most stringent exclusion limits over a broad WIMP mass range, future argon detectors are expected to achieve comparable sensitivity while offering enhanced potential for WIMPs with masses of a few GeV, commonly referred to as “low-mass WIMPs”. Interest in this mass region has grown significantly in recent years as increasingly stringent constraints have challenged conventional WIMP scenarios. This contribution presents an overview of past, current and future argon-based direct-detection experiments using both single-phase and dual-phase technologies. The main features and results of previous-generation detectors, such as DarkSide-50, are reviewed, followed by a discussion of ongoing efforts, including DEAP-3600 at SNOLAB (Canada) and DarkSide-20k at LNGS (Italy). Particular emphasis is placed on DarkSide-20k, which combines a multi-ton liquid-argon target with underground argon depleted in ^{39}Ar and a novel photodetection system based on cryogenic silicon photomultipliers (SiPMs). Finally, the prospects for the next-generation Argo experiment are presented.

Primary author(s) : PANDOLA, Luciano

Presenter(s) : PANDOLA, Luciano

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