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First direct detection constraints on Planck-scale mass dark matter in DEAP-3600

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Several astrophysical observations suggest that about 25% of all the energy in the Universe is due to a non-luminous, non-relativistic kind of matter, the “dark matter”. Among all the possible models that can fulfill the observed abundance, one of the most promising are Weakly Interacting Particles (WIMPs), thermal relics with masses below 100 TeV. Despite the high number of attempts during the last two decades to directly detect WIMPs, no confirmed discovery has been made. Hence, the interest in other dark matter candidates has recently increased, even motivating the search for super-massive dark matter candidates. These dark matter candidates might have been produced non-thermally, as
radiation from primordial black holes, decay products of the inflaton, or as products of a dark sector with an extended thermal production mechanism.
DEAP-3600, with a target of 3.3 tonnes of liquid argon, is the largest running direct detection experiment. Even if it is designed for the WIMP search, it is also sensitive to candidates with masses above 10^{16} GeV and cross-sections in argon above 10^{-24} cm^2. Due to the high cross-section and the large area of the detector, the expected signal is a track of collinear nuclear recoils, resulting in a very peculiar signal, different from both WIMPs and most of the backgrounds. This motivated the development of a custom analysis, looking for a multi-scattering dark matter signal. Thanks to the quality of the selection cuts, four different Regions of Interests (ROIs) have been defined, each with a background level of much less than one event in three years of data taking. After the unblinding, no events were found, leading to world-leading constraints on two composite dark matter models, up to Planck-scale masses.

In-person participation

Yes

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