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Dark matter search in DEAP-3600: results and prospects

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DEAP-3600 is the largest running dark matter detector filled with liquid argon, set at SNOLAB in Sudbury, Canada, 2 km underground. Since 2019 the experiment has held the most stringent exclusion limit in argon for WIMPs above 20 GeV/c^2. Such a result is a consequence of the large detector exposure and the extraordinary rejection power achievable in liquid argon against electron recoil backgrounds. DEAP-3600 demonstrated the discrimination power of pulse shape discrimination to the strongest precision to date, with a leakage probability as low as 10^{-10} for a nuclear recoil acceptance of 50 % at about 20 keV of deposited energy.

Recently, the WIMP analysis has been revised in terms of a non-relativistic effective field theory framework in correlation with non-standard velocity distributions in the halo, as suggested by the substructures observed with Gaia and the Sloan Sky Digital Survey. DEAP-3600 set the world's best exclusion limit for xenon-phobic dark matter scenarios. Moreover, a custom-developed analysis has recently pointed out the extraordinary sensitivity to ultra-heavy, multi-scattering dark matter candidates, resulting in world-leading exclusion limits on two composite dark matter candidates up to Planck-scale masses.

In parallel with ongoing analysis, involving both dark matter searches and measurements on the ^{39}Ar β decay spectrum and activity, the detector is undergoing upgrades with the aim to further mitigate the alpha-induced scintillation in the neck of the detector, which has limited the sensitivity to WIMPs up to now. Such R&D, including the pyrene coating of the flow guides and the external cooling system, will decrease this background and eventually enhance the detector sensitivity in the upcoming WIMP search.

Primary author: Dr LAI, Michela

Presenter: Dr LAI, Michela

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