Contribution ID: **32** Type: **not specified**

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

Tuesday 28 June 2022 18:00 (15 minutes)

According to a wide range of astrophysical observations, about one-fourth of all the energy of the universe is due to "dark matter", a non-relativistic and non-luminous kind of matter, different from ordinary "baryonic" matter. While its present abundance is constrained, its mass and the way it interacts with baryonic matter and with itself is still unknown. A confirmed direct detection in a ground-based detector would allow the discovery of dark matter particles, together with the inference of their properties. One of the most promising candidates is the WIMP (Weakly interacting massive particle), thermal relic from primordial universe in the mass range of about (1-10ˆ5) GeV.
In the absence of any confirmed detection in the last two decades, the attention on other dark matter candidates, even up to Planck scale masses, has recently increased, motivating the search in the same experiments. These candidates are expected for instance in Great Unification Theories, as decays of particles out of thermal equilibrium or as dark monopoles. Alternatively, they can result from inflationary gravitational particle production or can be Hawking radiation from primordial black holes. DEAP-3600, with a target of 3.3 tonnes of liquid argon, is the largest running direct detection experiment, set at SNOLAB, in Ontario. Even though it is designed for the WIMP search, it is also sensitive to candidates with masses above 10ˆ{16} GeV and cross-sections in argon above 10ˆ{-24} cmˆ2. Due to the high cross-sectional area of the detector, the expected signal from these candidates is unique, as it consists of a track of collinear nuclear recoils. Such a change of paradigm motivated the development of a custom analysis of three years of data, looking for multi-scattering dark matter signals. After unblinding, no events were found, leading to world-leading constraints on two composite dark matter models, with masses up to the Planck-scale one.

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Session Classification: Parallel Session I.1