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Status and prospects of CDEX: the China Dark Matter Experiment

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Germanium detectors with sub-keV sensitivities [1, 2, 3] offer a unique opportunity to search for light WIMP Dark Matter and axion-like particles. We will highlight our results and status of CDEX dark matter experiment [4, 5, 6, 7, 8, 9] at the China Jinping Underground Laboratory (CJPL) [10] in China. The detector R&D programs which allow us to experimentally probe this new energy window will be discussed, especially the new bulk/surface events separation scheme. Recent results from axion searches, as well as results from dark matter searches [4, 5, 6, 7, 8, 9] will be described. Status of the construction of CJPL-II will be presented.

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1. Introduction

China Dark matter EXperiment (CDEX) ultilize point-contact Germanium detector (*p*Ge) to search for WIMP in China Jinping Underground Laboratory (CJPL). Cosmic ray rate at CLPJ is $<$0.2 muons/m^2/day at depth of 6720 m. w. e., making it the ideal location for WIMP searches and neutrinoless double-beta decay experiments.

For WIMP searches, *p*Ge is particular sensitive to WIMP mass at few to few tens GeV, ideal to probe the regions with positive dark matter signals suggested by DAMA/LIBRA and CoGeNT experiments.

A particular important feature of *p*Ge is bulk/surface events separation [1, 2, 3], which contribute to the largest uncertainties in analysis.

2. CDEX experiments

2.1 CDEX-1A & CDEX-1B experiments

The CDEX-1A and CDEX-1B experiments are two phases of the $\sim$1 kg targer mass CDEX experiment, with detection threshold of 450 eV and 160 eV, respectively. Both detector targets are $\sim$1 kg of mass with $\sim$1 mm of dead layers, shielded with 20 cm of copper, 20 cm of borated polyethylene and 20 cm of lead, from inside to outside. Both experiments are ran side-by-side inside a 6m(H)$\times$8m(L)$\times$4m(W) polyethylene room with wall thickness of 1 m [4, 6, 8].

Results on unmodulated spin-independent (SI) and spin-dependent (SD) cross-sections by the χN recoil spectral analysis were published in [4, 6] (CDEX-1A) and [8] (CDEX-1B), in particular both DAMA/LIBRA and CoGeNT positive claims are well excluded. Results of axion searches on CDEX-1A data were published in [7].

The data taking in CDEX-1B experiment is ongoing, 3 years live-time of data (till October of 2018) had been accumulated, annual modulation analysis is underway.

2.2 CDEX-10 experiment

Toward future ton-scale DM experiment, the second generation of CDEX experiment with a total detector mass of about 10 kg, called CDEX-10, has used three triple-element pPCGe strings directly immersed in liquid nitrogen (LN2), denoted as C10A (B,C), as shown in Fig. 1. Compared with cold finger cooling and high-Z material shielding systems, low-Z material shielding, such as with LN2 or liquid argon, provides better control of radiation background.

CDEX-10 focuses on the arraying technologies and background understanding of the prototype pPCGe detectors developed based on the CDEX-1 technique. The new CDEX-10 array detectors and dedicated data acquisition (DAQ) system started testing and data-taking inside a LN2 tank in 2016 at CJPL. C10A was returned to the CANBERRA factory in France for upgrades. Unmodulated spin-independent (SI) (Fig. 2) and spin-dependent (SD) cross-sections by the χN recoil results on one of the crystal (C10B-Ge1 detector) were published in [9].

3. Prospect

The CDEX experiment continues taking data at CJPL, expanding to Ge-detector arrays immersed in liquid nitrogen both as cryogenic coolant and shielding [9]. R&D efforts on acquisition

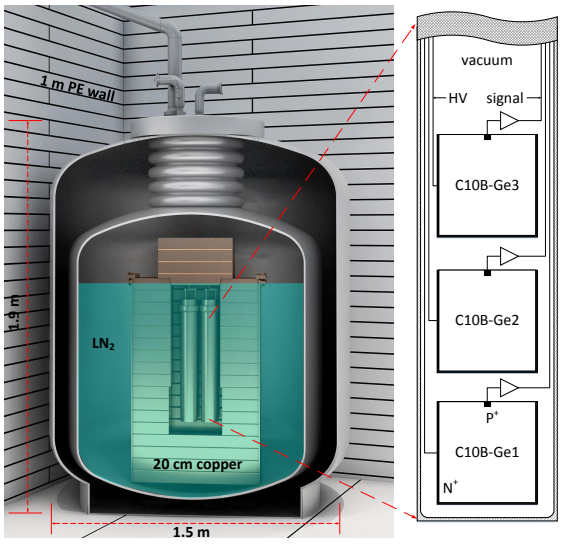

Figure 1: Configuration of CDEX-10 experimental setup (left) and C10B detector layout inside the string (right). C10B and C10C are running inside the LN2 tank which has an outer diameter of 1.5 m and a height of 1.9 m. Each detector string consists of three *p*Ge detectors tagged as Ge1 to Ge3 from bottom to top. The size of each germanium crystal is approximately 62 mm×62 mm.

of the Ge-detector fabrication technology, as well as further reduction of ambient and internal background, are being pursued. Scaled-up experiment towards target mass of 100 kg are being prepared at CJPL-Phase 2 [10].

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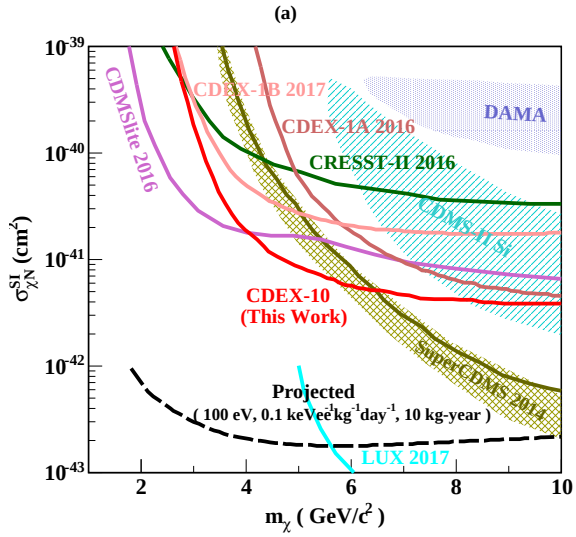

Figure 2: Exclusion plots of SI χ-N coupling at 90% confidence level, superimposed with results from other benchmark experiments ([9] for detail explanation).

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