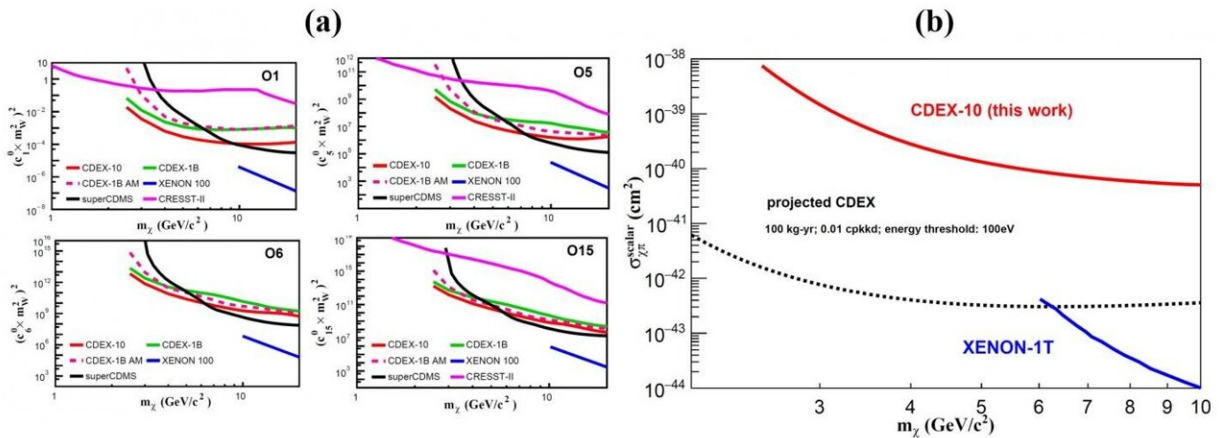


# CDEX listens to the sound of cosmology from a laboratory deep underground

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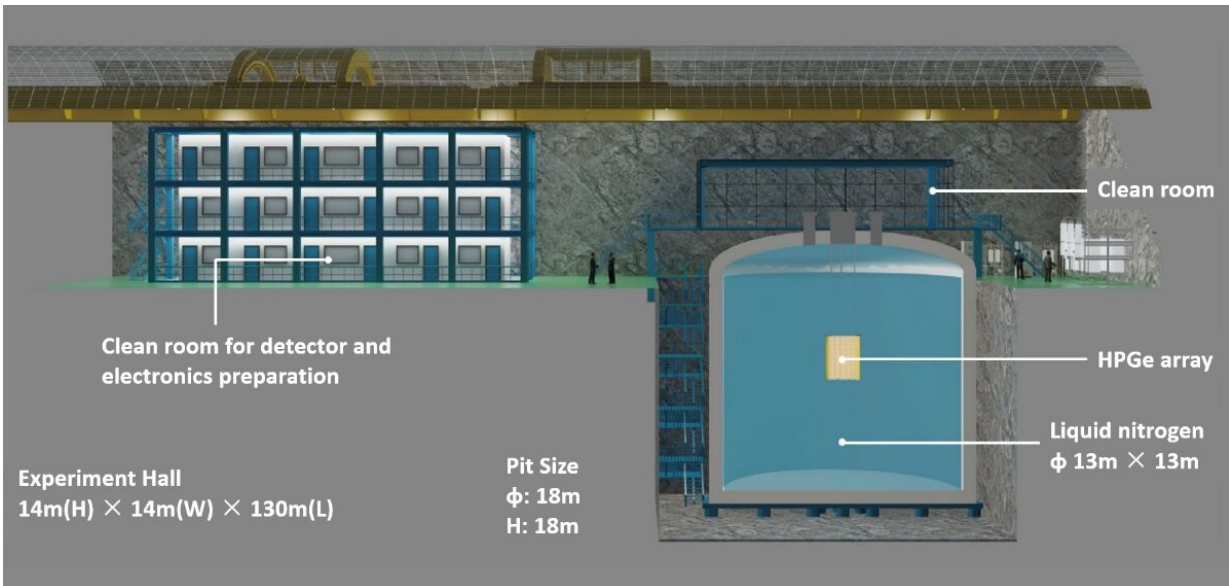


(a) Exclusion limits of different coupling coefficients of NREFT; (b) Exclusion limits of WIMP-pion scattering cross section. Credit: Science China Press

Much compelling evidence from astroparticle physics and cosmology indicate that the major matter component in the Universe is dark matter, accounting for about 85% with the remaining 15% ordinary matter. Nevertheless, people still know little about dark matter, including its mass and other properties. Many models predict dark matter particles could couple with ordinary particles at the weak interaction level, so it is possible to capture the signal of dark matter particles with direct detection experiment.

The scientific goals of the China Dark matter Experiment (CDEX) are on direct detection of light-dark matter and neutrino-less double beta decay with p-type point contact germanium (PPCGe) detectors at the China Jinping Underground Laboratory (CJPL). The measurable energy spectra induced by the elastic scattering between [dark matter particles](#) and target nucleons in the CDEX detector system could give us the information of dark matter mass, spin and other properties.

The analysis of current dark matter experiments is usually model dependent, and many models beyond the standard model have predicted the existence of dark matter, such as super-symmetry models and extra-dimension models. Due to the variety of physics models, the constraints obtained from same [experimental data](#) cannot be applied directly to other models, which brings complications to physical interpretations. Cosmology observations have verified that the major part of dark matter is the non-relativistic cold dark matter, and as a result, the momentum transfer in the scattering process between dark matter particles and nucleons is only about hundreds of MeV, much lower than the electroweak scale ( $\sim 250$  GeV). It is therefore suitable to use effective field theory to analyze the interaction between dark matter and [ordinary matter](#). Two alternative schemes have been proposed in recent years to study different possible interactions, namely non-relativistic effective field theory (NREFT) and chiral effective field theory (ChEFT). An effective theory contains all possible interactions allowed by given symmetric principles, so it can [model](#)-independently reduce the complicity of analysis.



The schematic setup of the next generation CDEX experiment in CJPL-II.  
Credit: ©Science China Press

In the dark matter direct detection experiments, what are mostly focused on are the spin-independent (SI) and spin-dependent (SD) scattering analysis, while EFT can give more momentum-dependent or velocity-dependent interaction which are not taken into consideration usually. Benefiting from the low electrical noise of PCCGe, the analysis threshold of CDEX-1B and CDEX-10 both reach 160 eV, which can largely improve the detection sensitivity for light dark matter.

Based on the data set of CDEX-1B and CDEX-10, CDEX collaboration presents new limits for the couplings of WIMP-nucleon arising from NREFT and ChEFT. In the nonrelativistic effective field theory approach, they improve over the current bounds in the low  $m\chi$  region. In the chiral effective field theory approach, they for the first time extended the limit on WIMP-pion coupling to the  $m\chi^2$  region.

Related results have been published online entitled "First experimental constraints on WIMP couplings in the effective field theory framework from CDEX" in *Science China-Physics, Mechanics & Astronomy*. Prof. Y. F. Zhou from the Institute of Theoretical Physics, Chinese Academy of Sciences wrote a review article for this publication.

The operation and analysis of CDEX-1B and CDEX-10 are coming to the end, and the next generation of experiments CDEX-100/CDEX-1T are under preparation now. The lower background level and improvement of PPCGe performance can raise the sensitivity of direct detection experiment. While the next generation experiment of CDEX can discover dark matter remains unknown, but the mystery of [dark matter](#) will encourage more and more researchers to pursue its studies until the day when this profound mystery of the Universe will be solved.

**More information:** First experimental constraints on WIMP couplings in the effective field theory framework from CDEX, *Science China Physics, Mechanics & Astronomy* (2021). [DOI: 10.1007/s11433-020-1666-8](#)

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