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Boosted dark matter and directional direct detection

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We discuss a two-component dark matter model in which one component, heavier dark matter, annihilates into a lighter dark matter. The lighter dark matter is expected to generate detectable signals in detectors due to its enhanced momentum, enabling direct detection even for MeV-scale dark matter. We investigate the effectiveness of directional direct detections, especially the nuclear emulsion detector NEWSdm, in verifying these boosted dark matter particles through nuclear recoil. In particular, we focus on light nuclei, such as protons and carbon, as suitable targets for this detection method due to their high sensitivity to MeV-scale dark matter. By modeling the interactions mediated by a dark photon in a hidden U(1)D gauge symmetry framework, we calculate the expected dark matter flux and scattering rates for various detector configurations. Our results show that nuclear emulsions have the potential to yield distinct, direction-sensitive dark matter signals from the Galactic center, providing a new way to probe low-mass dark matter parameter spaces that evade conventional detection methods.

Presenter(s) : Prof. NOMURA, Takaaki (Sichuan University)

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