Form 8

Research Result Report
ICRR Inter-University Research Program 2024

Research Subject: Novel Probes of Fundamental Physics with Nucleon Decays in Neutrino Experiments
Principal Investigator: Volodymyr Takhistov
Participating Researchers: Volodymyr Takhistov
Summary of Research Result : Following my earlier work published in Phys. Rev. D Lett. (Phys. Rev. D 110, L031701, 2024), which introduced a broad new class of nucleon decay channels sensitive to light new physics that can be probed in Super-Kamiokande and Hyper-Kamiokande, I have systematically identified and classified relevant effective field theory operators up to dimension-9 that can mediate such decays. The publication is currently in preparation and lays the theoretical groundwork for targeted searches at neutrino experiments. My proposal further motivated new Super-Kamiokande data re-analysis updating the constraints from my 2014 Physical Review Letters publication Takhistov et al., (Super-Kamiokande Collaboration) Phys. Rev. Lett. 115, 121803, , which established the first world limits on the decay modes $p \to eX$ and $p \to \mu X$, where X is a new massless invisible particle. In a complementary direction for exploring new physics in neutrino experiments, I have also demonstrated a novel method by which Super-Kamiokande and Hyper-Kamiokande can probe a new proposed early population of stars known as dark stars, powered by dark matter annihilation. This is achieved through new analyses of diffuse supernova neutrino background signals beyond conventional searches. This study has been accepted for publication in Astrophysical Journal Letters (arXiv:2412.18654).

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