平成 30 年度共同利用研究・研究成果報告書

研究課題名	和文：XENONnT 実験の研究開発及び暗黒物質探索 英文：R&D for XENONnT and search for dark matter

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研究成果概要

nT-JP is the organizational framework for the Japanese members of the XENON collaboration. Several members of the XMASS collaboration working on direct dark matter detection underground at ICRR's Kamioka Observatory joined the XENON collaboration on Dec. 1, 2017 and organized themselves in this group we call nT-JP. Nagoya University, Kobe University, and The University of Tokyo are the participating institutions, represented by their respective principal investigators Yoshitaka Itow, Kentaro Miuchi, Shigetaka Moriyama, and Kai Martens. The group also contains all members working with their respective PIs at their respective universities here in Japan on upgrading the XENON collaboration's XENON1T detector (X1T) to the next generation XENONnT detector (XnT). Upon completion towards the end of 2019 XnT will have about four times the active target mass of its very successful X1T predecessor.

The upgrade from X1T to XnT started in Dec. of 2018. There are two major efforts in XnT that Japan critically contributes to: Liquid xenon (LXe) purification from electronegative contaminants, and the newly added neutron veto. LXe purification is using our XMASS experience, and new capabilities enabled by nT-JP contributions to XnT are the identification of new contaminant absorbers and a monitor for the resultant improvements that can ascertain performance throughout the experiment. A decidedly Japanese contribution to XnT is the unique neutron tagging technology proven in Kamioka for the Super-Kamiokande experiment: Gadolinium sulfate loading of a water Cherenkov detector. We are transferring and modifying this technology for use in XnT to enable

XnT to tag neutrons which can mimic single scatter dark matter nuclear recoils. This is achieved by surrounding the cryogenic containment vessel for the LXe target mass which since X1T is shielded by an XMASS-style water Cherenkov muon veto with an optically isolated nVeto region. Gadolinium loading into this water Cherenkov detector using the technology demonstrated by the EGADS experiment in Kamioka turns this optically isolated region surrounding the target mass into an efficient neutron veto.

Kyodo-Riyo support for nT-JP has allowed our students and PD to travel between the participating institutions and Kamioka and conduct dedicated measurements that became the basis for material choices and equipment tests that are now the foundation for the successful implementation of our ideas and contributions to the upgraded XnT experiment. A very important factor in enabling our successes so far was Kyodo-Riyo support in FY2018 for the first nT-JP face to face meeting at Kamioka, where we discussed strategy and organized its implementation in direct communication among ourselves – and with direct access to many of our Kamioka colleagues' specialist knowledge.

Most importantly this Kyodo-Riyo support has allowed our students and us to use the infrastructure available in Kamioka Observatory's Hall-C to test the equipment we design and build for XnT. We will continue to use in particular Hall-C's cryogenic systems, Xe, and analytic and monitoring equipment to teach our students, verify components, and try out new ideas. Having gotten our Japanese students started on such activities and involved in developing and using cutting edge technology here at the Kamioka Observatory is probably the most tangible benefit the Kyodo-riyo support has brought and continues to bring to nT-JP and through this to the XENON collaboration. Discovering the elusive particle nature of dark matter with XnT is our common goal in using this support.

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