Contribution ID: **869** Type: **Poster**

MoMoTarO-ISS feasibility studies of neutron measurements

We have developed a compact neutron and gamma-ray detector, Moon Moisture Targeting Observatory (MoMoTarO). The MoMoTarO project aims to utilize neutrons leaking from the lunar surface for water resource exploration, measure the neutron lifetime, and improve the localization accuracy of gamma-ray burst observations. MoMoTarO is planned to be installed in the external experiment site on the International Space Station (ISS) for six months in 2026 (MoMoTarO-ISS). The MoMoTarO-ISS will operate in space to evaluate its performance and demonstrate its technology readiness level, simultaneously providing scientific observations, for example, of solar neutrons and orbital neutrons.

Particle acceleration in stellar flares and supernova remnants remains unresolved, even solar flares, which are familiar to us, are still in mystery. Especially, hadrons acceleration in solar flares also has not been fully understood. It is difficult to constrain the generation time and the particle's initial energy of the charged particles because magnetic fields distributed unevenly in space disturb charged particles. On the other hand, the hadrons interact with the solar atmosphere and produce neutrons, solar neutrons. We can study the hadron acceleration effectively by observing the solar neutrons, which reach the Earth directly. In 2026, we expect high solar neutron fluxes around the Earth because solar activity is expected to be still active. The MoMoTarO can detect solar neutrons of X-class solar flares and we expect 5-10 X-class solar flares during the 6-month operation. There are few observed cases of solar neutrons, so MoMoTarO-ISS holds the potential for new discoveries. Additionally, it is possible to monitor thermal neutrons, epithermal neutrons, and fast neutrons outside the ISS, which enables a deeper understanding of the neutron environment in space.

We have environmental tests to evaluate the detector performance towards the launch of the MoMoTarO-ISS in 2026. We conducted proton irradiation tests and Geant4 simulations to study the radiation background and damage on the ISS orbit. We irradiated scintillators with 200 MeV protons and verified possible performance degradation due to radiation damage. As a result, the degradation in energy resolution and light output of scintillators was at most around 20% with the proton irradiation equivalent to 0.1-year exposure. The performance degradation of scintillators can be negligible because it is minimal and recovers over time. We simulated the orbital radiation environment of the MoMoTarO-ISS to confirm whether solar neutrons are observable in comparison to the background. We constructed MoMoTarO-ISS geometry and ISS experiment site in Geant4 simulation and irradiated them with background particles at the ISS altitude (Cumani et al. 2019) and solar neutrons, the neutron energy spectrum detected in November 2003 was used (Watanabe et al. 2006). When comparing the typical energy range of solar neutrons deposited in the scintillator (10 MeV) with the background, solar neutron detection is feasible with MoMoTarO-ISS because solar neutrons and the background are at similar levels. In this presentation, we report an overview of the MoMoTarO-ISS, the results of these environmental experiments, simulations, and the examination of various space observations with MoMoTarO-ISS.

Collaboration(s)

Author: Mr NAKAYAMA, Kazuya (Kyoto University)

Co-authors: Dr KUSANO, Hiroki (RIKEN); Dr TAKAHASHI, Hiromitsu (Hiroshima University); Dr NAGAOKA, Hiroshi (Ritsumeikan University); Dr NAKAZAWA, Kazuhiro (Nagoya University); Dr HOTOKEZAKA, Kenta (The University of Tokyo); Dr TANIGUCHI, Kentaro (RIKEN); Dr HAREYAMA, Makoto (St. Marianna Univeristy School of Medicine); Ms TSURUMI, Miwa (Kyoto University); Dr UENO, Munetaka (JAXA); Dr TSUJI, Naoki (Kyoto University); Dr OZAKI, Naoya (JAXA); Mr MAEDA, Ryota (Kyoto University); Dr KISAKA, Shota (Hiroshima University); Dr IKENAGA, Taichi (Soil and Rock Engineering Co., Ltd.); Dr KOBAYASHI, Taizo (Ritsumeikan University); Dr TAKANASHI, Takaoki (RIKEN); Dr HOSHINO, Takeshi (JAXA); Dr ENOTO, Teruaki (Kyoto University); Dr TAMAGAWA, Toru (RIKEN); Dr WAKABAYASHI, Yasuo (RIKEN); Dr KATO, Yo (RIKEN); Dr OTAKE, Yoshie (RIKEN); Dr TSUKAMOTO, Yushi (Soil and Rock Engineering Co., Ltd.); Dr NAKANO, Yuuki (Soil and Rock Engineering Co., Ltd.); Mr OMATA, Yuya (Kyoto University)

Presenter: Mr NAKAYAMA, Kazuya (Kyoto University)

Session Classification: PO-1

Track Classification: Solar & Heliospheric Physics