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A multi-turn time-of-flight isotope analyzer for space application

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In order to study terrestrial or planetary plasma environment in situ low-energy ion measurements are indispensable and thus have been done by a variety of ion analyzers. Detailed studies of plasma characteristics demand mass analyses as well as energy analyses. In case of measuring a variety of ions originating from planetary atmospheres, we need to measure the ion composition with high mass resolution. Although we have achieved the measurements of the ion composition by mass analyzers around planetary environment, higher mass resolution is now needed in order to distinguish heavy species and isotopes. For the future isotope measurements around moons, planets and asteroids, we are developing a high-mass-resolution mass analyzer. One of our scientific objects is to measure the Martian atmospheric escape and evolution. Mass resolution (m/dm) of 100 is generally needed for the isotope analysis of planetary particles. However the Martian atmospheric escape and evolution science requires m/dm>3,000 to discriminate N2 from CO.

Low-energy particle measurement group of ISAS has developed a time-of-flight(TOF) ion mass analyzer with mass resolution of about 20 for KAGUYA, which succeeded in measuring ions originating from the lunar exosphere and surface. It is also preparing a TOF mass analyzer with mass resolution of 40 for the BepiColombo mission. Multi-turn TOF mass spectrometers(MULTUM), where ions are stored in a fixed orbit within electrostatic sectors and allowed to propagate the same orbit numerous times, have been developed by Osaka Univ. mass spectrometry group. One of the MULTUM series achieves the mass resolution over 30000 with the size of 20cm x 20cm. We have prepared a test model of the ion optics of the isotope analyzer which employs the MULTUM technique. We are also developing a pulsive high voltage power supply(HVPS) for the test model of the ion optics. We will report test results of the MULTUM optics and the HVPS performance.

Keywords: mass analysis, isotope, planetary exploration