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The SWIM-family of miniature ion mass analyzers

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Over the last 15 years the Swedish Institute of Space Physics developed and mastered a line of miniaturized ion mass analyzers for space plasma studies with masses of 400 – 600 g and highly compact and dense design to minimize the volume. The sensors cover an energy range few eV and up to 15 keV, reach the coverage up to hemispherical (depending on application), and mass resolution up to 8. The experience with this line of sensors demonstrates that a sensor mass of 400 – 600 g is a limit in a trade-off between scientifically valuable performance and the sensor weight. The small size and mass of these sensors make them ideally suited for small spacecraft or other applications where resources are very limited.
The Solar Wind Monitor (SWIM), one of the sensors of the Sub-keV Atom Reflecting Analyzer (SARA) on board of the Indian Chandrayaan-1 mission to the Moon (2005), was the first sensor in the line. A number of instruments derived from SWIM were built, each using the same basic architecture but adapted for the needs of the corresponding mission:
a) the Miniature Ion Precipitation Analyser (MIPA) on ESA's Bepi Colombo mission to Mercury (2017) with an entrance system capable to withstand direct sun exposure at Mercury (operation temperatures up to 450° C) and near hemispherical coverage.
b) the Detector for Ions at Mars (DIM) on the Russian Phobos-Grunt mission (2011) to Mars and the Yinghuo Plasma Package Ion sensor (YPPi) built for the Chinese Yinghuo-1 spacecraft (2011) for Mars, both modified for hemispherical coverage and different thermal environments.
c) the Prisma Ion Mass Analyzer (PRIMA) on the Swedish technology mission PRISMA (2010), adapted for low energy measurements and higher mass resolution measurements using electrical gater and micto mechanical (MEMS) shutter.
d) the eXtra Small Analyzer of Neutrals (XSAN) for the Russian Luna-Glob lander (2018), modified with a charged particle deflection system and a change conversion surface to measure energetic neutral atoms at the lunar surface.
e) the Laboratory Ion Scattering Analyzer (LISA) built for the laboratory investigation of ions scattered from surfaces (2015).

We review and compare performance and fields of application of the instruments in this family and give an outlook on further developments.