ReMaSp: a Reflectron time-of-flight Mass Spectrometer. S. A. Livi[1], D. L. Domingue[1], W. B. Brinkerhoff[1], and P. Wurz[2] , [1]Johns Hopkins University Applied Physics Laboratory, [2]Physikalisches Institut, University of Bern.

Introduction: The ReMaSp (Reflectron Mass Spectrometer) is designed to analyze in situ the chemical and isotopic composition of the gaseous environment of planets and small bodies. Analysis of the local gas composition establish ground truth for remote observations, and can determine parameters that are otherwise difficult, if not impossible to obtain, like isotope ratios or abundance of noble gases and organic compounds.

The intrinsic high mass resolution ($\Delta m/m > 1000$), high sensitivity (10^{-3} A/torr), working pressure range (10^{-15} to 10^{-4} Torr), and radiation resistance (> 100 krad) of the proposed sensor are well suited to address several key questions regarding outer solar system bodies, from comets to planetary satellites.

This instrument placed on a cometary mission can address such issues as the presence of organics, the implied chemical composition of the solar protonebula, and the chemical mechanisms that contribute to the loss of materials from comets. This addresses our understanding of the origin and evolution of the early solar system and the transport of volatiles and pre-biotic material throughout the solar system.

The ability to measure the chemical composition of tenuous atmospheres allows for interesting studies of such planetary satellites as Europa and Triton. Measurements taken by this instrument can address such issues as the molecular composition of Europa's atmosphere (Is there water in the atmosphere? What radiation products from the interaction of the Jovian magnetosphere with the water ice surface are present in the atmosphere? Are pre-biotic materials present and being sputtered off the surface?), the chemical composition of the Triton plumes, the production rate of Europa and Triton's atmosphere (for Europa: how much surface material is loss at what rate due to magnetospheric interactions), and the spacial variability of the Europa's atmospheric composition and its relationship to the ion distribution relative to possible variations in surface composition. Such an instrument also has intrinsic applications for any probe of Titan's thick atmosphere and the measure of any organic materials.

Instrumental technique: Time of flight (ToF) instruments have the inherent advantage that the entire mass spectrum is recorded at once, without the need of scanning the masses through slits. With a storage ion source - a source that stores the continuously produced ions until their extraction into the ToF section -, with high transmission in the ToF section, and with a sensitive detector, it is possible to record a very large fraction (greater than 60%) of all ions produced. These factors contribute to the overwhelming sensitivity of ToF instruments. Another reason to use ToF instruments in space science is their simple mechanical design and easy operation. Their performance depends on fast electronics rather than on mechanical tolerances.

ReMaSp operates by simultaneous extraction of all ions from the ionization region into a drift space such that ions of a given m/q are time-focused at the first time focus plane. The very short m/q ion bunches are then imaged onto the detector by the isochronous drift section. Because different m/q bunches drift with different velocities, the drift length determines the separation of the bunches. The reflector incorporates the isochronity in the drift section. Mass resolution is determined by the drift time and the temporal spread of the ion packets.

ReMaSp will include two similar and independent source-detector systems, one optimized for ions and one for neutrals, using the same reflector. This configuration guarantees high reliability by almost complete redundancy.

Instrument heritage and future development: A reflectron-type instrument was successfully flown on the GIOTTO mission (COSIMA) to measure atoms and molecules ejected from a surface during impact of fast cometary dust particles. One explicitly design to measure gas and ions outgassing from the comet Wirtaanen (ROSINA) [1] is currently being built for the ROSETTA orbiter spacecraft. A miniaturized version of the same instrument (COSAC) is currently being tested for the lander of the same mission.

State of the art, flight-ready ToF spectrometers weight around 5 kilograms and use an average of 5 Watts of power. Development at various institutions aim at reducing those values while at the same time conserving the mass resolving capabilities, to enable flying this type of sensor in space mission. A prototype that uses the same detection technique [2] for analysis of surface and subsurface rock, ice, and fine samples is currently been developed at APL, and needs resources about a factor of two lower then today's state of the art. It is expected that further reduction, especially in weight and power of the associated electronics, will allow in near future to build a flight-unit ToF mass spectrometer that weights 1-2 kilograms and uses 1-2 watts of power.

[1] Balsiger, H., K. et al., (1997) Adv. Space Res., 21, 1527–1535
[2] Brinckerhoff W. et al. (2000) *Rev. Sci. Instrum., 71,* 536