Neutral and Ion Mass Spectrometers for the Ladee and Maven Missions. M. Benna[1], P. R. Mahaffy[1], D. Harpold[1], T. King[1], and the Science and Engineering Teams, [1]Planetary Environments Laboratory, NASA Goddard Space Flight Center, Greenbelt MD 20771 (Paul.R.Mahaffy@nasa.gov).

Introduction: Two similar quadrupole mass spectrometers, the **Neutral Gas and Ion Mass Spectrometer (NGIMS) [1]** on the Mars Atmosphere and Volatile Evolution Mission (MAVEN) and the **Neutral Mass Spectrometer (NMS) [2]** on the Lunar Atmosphere and Dust Environment Explorer (LADEE) mission are described. These were developed in the Planetary Environments Laboratory at NASA Goddard Space Center for use in two different planetary environments, the upper atmosphere of Mars and the tenuous exosphere of the moon.

Figure 1. Artist's representation of the LADEE spacecraft with its three instruments and an optical communication technology demonstration instrument.

Lunar Science with the NMS: The tenuous exosphere of the moon has a variety of sources. Some atoms or molecules on the surface of the moon such as radiogenic argon adsorb on the cold lunar surface at night but begin to evaporate from the surface at sunrise. The more volatile noble gas He sourced from the solar wind has a much shorter interaction times with the surface on average, a much shorter lifetime before it escapes, and an entirely different spatial distribution around the moon. Although the Apollo 17 mass spectrometer had detected both of these gases in the lunar atmosphere [3] these measurements were limited to the night time and to only 2 lunations. Other gases are released from the lunar surface by photons or micrometeoroid impacts. The task of the LADEE NMS in combination with a dust detector and an ultraviolet spectrometer was to determine the composition of the lunar atmosphere and to investigate their sources and sinks of its gas and to explore the dust environment. The NMS investigation was highly successful with the distribution of helium and argon mapped on a daily basis over more than three lunations to establish densities and scale heights and a number of new species detected [4]. The LADEE spacecraft was launched on September 7, 2013 and its mission ended on April 18, 2014 with formation of a new crater on the far side of the moon.

Science Objectives of the MAVEN Mission and the Role of the NGIMS: The ambitious MAVEN mission goals are to measure the rate and variability of the escape from the upper atmosphere of Mars. This loss over time must have substantially changed the surface environment and determined the duration of potentially habitable surface conditions. The role of the NGIMS investigation is to measure both thermal and suprathermal ions and neutral gas along the spacecraft track. A Remote Sensing Package and a Particles and Fields Package complement the NGIMS to provide both overlaping and complementary measurements. At the time of this abstract the NGIMS instrument had been successfully operated several times in space and planning is well underway for operations starting in October 2014.

NGIMS and NMS Description: Both instruments are built around a quadrupole mass analyzer with a mass range of 2-150 Da with unit mass resolution over this range. In each instrument a closed source enables a RAM density enhancement while an open source also enables the detection of surface active species. Redundant electon guns and detectors are employed. The instrument sensitivity is more than an order of magnitude higher than previous instruments of this type developed at Goddard. The NGIMS incorporates an in situ calibration gas tank to improve the precision of the measurement and understand any instrument changes over time. The quadrupole DC/RF control circuits enable flexible software control over mass scan parameters of the instrument. The focusing lens voltages were DAC controlled. Measurement sequences could be modified over the course of the LADEE mission to optimize the sampling for the gas environment encountered.

References: [1] Mahaffy, P.R. et al. (2014) Space Sci Rev accepted [2] Mahaffy, P.R. et al. (2014) Space Sci Rev accepted [3] Hodges, R.R. et al., (1974) Icarus 21, 415. [4] Benna, M. (2014) in preparation.