Development of an ion source of a mass spectrometer for observations of the hot oxygen density around Mars

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There are a number of lines of geological evidence supporting that liquid water once existed on Mars, while present Mars does not hold liquid water on its surface. One of possible mechanisms responsible for the loss of water is its escape to outer space. However, the quantitative contribution of such escape is still unclear. Understanding the mechanism and the escape rate of oxygen dissipation into outer space would provide an important clue to this problem. Since oxygen atoms are too heavy for thermal dissipation, non-thermal dissipation processes are considered. According to the previous models and the observational results, dissociative recombination may play a dominant role. However, the expected escape rate strongly depends on model assumptions. This is mostly due to the lack of the observations of the hot oxygen density profile that determines the escape rate. Although the altitude profile of the emission intensity of hot oxygen has been measured by an ultra-violet spectrometer, such remote sensing (column-density measurement) has difficulty in obtaining the density profile unambiguously. On the other hand, in-situ mass spectrometers have measured the oxygen profile in the Martian low altitude atmosphere. However, the sensitivity was insufficient to measure the hot oxygen in the exosphere. In order to measure the hot oxygen, the sensitivity should be higher than about 10 times of previous measurements.

In this study, we develop an ion source of a mass spectrometer for measuring the hot oxygen density. Since neutral particles are ionized by electrons emitted from cathodes before introduced into the mass spectrometer, higher emission leads to the higher sensitivity. We currently consider to install ~ 10 filaments to enhance the instrument sensitivity. We design the ion source so that ions, which distribute in a relatively wide range due to the multiple cathodes, are focused to the exit slit of the ion source. Since the power consumption increases by about 10 W in this case, this kind of observations would be conducted in a special operation mode.

Keywords: ion source, mass spectrometer, mars, hot oxygen

