

High-resolution spectroscopic observation of sodium atom emitted from the lunar surface using a Haleakala 40cm telescope

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The Moon has completely collision-free atmosphere with its surface pressure of about 10^{-17} times compared to that of the Earth. Previous studies showed that the lunar exosphere is consisted of He, Ar, Na, K, H, O. Among these constituents, Na and K have large resonant scattering cross sections, making ground-based observation of these atoms in the lunar exosphere relatively easy and a variety of observations has been made in the past.

Locality of Lunar sodium exosphere was suggested by observation of Lunar sodium atmospheric emission using Lunar circular orbit satellite Kaguya [Kagitani et al., 2010]. Lunar surface has Mare and Highland, those rock and telluric accidents are different. It is expected that these differences make locality of Lunar sodium exosphere. And, there are 4 source process mechanisms of Lunar exosphere, Photo-stimulated desorption (PSD), solar wind ion sputtering, vaporization by micrometeoroid impacts and thermal desorption, but contribution to quantitative source amounts and variety about time and space of each processes are not clear. From the above, purpose of our research is investigation into locality and time variance of Lunar sodium exosphere.

We observed at summit of Mt. Haleakala, Maui island, Hawaii, America, in the period of 18-25, 2011 and August 8-9, 2012 using our 40cm Schmidt-Cassegrain telescope and a high dispersion Echelle spectrograph. When we observed, we put on slit that length is 500 arcsec. at right angles to Lunar rim, made clear about distribution of sodium emission from surface to a height of 300km. On July 2011, we observed on Mare Orientale located at Long. 90 deg. W Lat. 20 deg. S, and Highland that located on a point of symmetry, Long. 90 deg. W Lat. 20 deg. N.. On August 2012, we focused on Oceanus Procellarum and expected to change amounts of Lunar sodium atmospheric emission from south to north, we observed on 5 points, Long. 90 W Lat. 50 deg. N, 20 deg. N, 0 deg., 20 deg. S, and 50 deg. S. From these observation, it was revealed that height distribution of sodium emission have thermal component (about 100K) and suprathermal component (about 1000K) in many cases.

About result of observation on July 2011, we investigated time variation of absolute emission intensity of suprathermal component, and saw brightening on July 19. At same time, number density of solar wind proton increased, so we thought that this brightening is result of contribution to PSD from gardening effect by solar wind ion sputtering. And, because this brightening is seen more at south hemisphere especially, it is suggested that gardening effect become intense especially at south hemisphere.

From result of observation on August 2012, about absolute emission intensity of both of suprathermal component and thermal component, that of south hemisphere is tend to be more than that of north hemisphere. About suprathermal component, from same discussion of observation of July 2011, we can interpret that gardening effect become more intense at south hemisphere. On the other hand, about thermal component, we take account of contribution of rebound particles of suprathermal component in source process, it is expected that encouragement of gardening effect to PSD of suprathermal component is reflected to thermal component. From this result, it is assumed that thermal component also has asymmetry of north and south.

South hemisphere has more area of highland than north hemisphere. So increase of absolute emission intensity at south hemisphere indicates that release rate of sodium at highland is higher than that of mare. Or, highland is more ups and downs and have large surface area per a unit surface, so it is thought that gardening effect with incidence of solar wind proton become more intense.

Kagitani et al., 2010, Planetary and Space Science, 58, 1660-1664, Variation in lunar sodium exosphere measured from lunar orbiter SELENE (Kaguya)