Imaging observation and Monte-Carlo simulation of lunar sodium atmosphere

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On small bodies in the solar system like Mercury, Moon, and asteroids, their exobase coincides with the solid surface. Therefore, their tenuous atmosphere is different from an atmosphere in its classical meaning and understanding of such tenuous atmosphere on a small body is important. Production mechanisms of such tenuous atmosphere are thought to be a combination of photon stimulated desorption (PSD) caused by solar radiation, thermal desorption, solar wind sputtering, and vaporization of micro meteoroids. Observation of lunar atmosphere is expected to give a higher accuracy compared to other small bodies and is useful for understanding the production mechanism of the tenuous atmosphere.

We have carried out observation of lunar sodium atmosphere and Monte-Carlo simulation in order to clarify the production mechanism of the lunar atmosphere. Observation was made at our Iitate observatory using a wide FOV (5.7 degree) monochromatic imager. Distribution of sodium emission of lunar sodium atmosphere was obtained by observations using interference filters centered at NaD lines and at background wavelength (620nm). In our simulation, PSD by solar radiation and vaporization of micro meteoroids were assumed as production mechanisms. The ratio of production of these two mechanisms, the temperature of sodium atoms emitted by PSD, and solar zenith angle dependence of production were varied independently as free parameters in the calculation. By fitting cosine functions to calculated intensity distribution of sodium emission along dayside semi-circles centered at the lunar center, solar zenith angle dependence of the emission was obtained. It was found that the structure of sodium emission can not be determined by a single parameter given in the calculation, but a combination of parametrs is important to represent a certain structure of sodium emission.The simulation was compared with an observed image data of lunar sodium emission and it is concluded that the PSD by solar radiation contributes at least 85% of the production mechanism of lunar sodium atmosphere.