Production Mechanism of Lunar Sodium Atmosphere inferred from Spectroscopic Observation at Iitate Observatory

Shingo Umekawa[1]; Masato Kagitani[2]; # Shoichi Okano[2]

[1] Planet. Plasma Atmos. Res. Cent., Tohoku Univ; [2] PPARC, Tohoku Univ.

In order to identify physical mechanism(s) for producing tenuous sodium atmosphere on the Moon, spectroscopic observations of lunar sodium emission and Monte Carlo simulation study were carried out.

Observations were carried out at Iitate observatory using a 60-cm Coude telescope and a 1-m spectrograph in March-December 2004. Slit was placed perpendicular to the lunar surface to cover an altitude range from the surface to 0.3 Rm. Observations were made for a various combinations of lunar phase angles and at different latitudinal locations, which was made possible by the use of image rotator. Therefore, observational results for various solar zenith angles at the tangential point of the field of view were obtained. Observational results showed that the emission intensity is proportional to the square of cosine of solar zenith angle.

In the model simulation, photon stimulated desorption, micrometeorites evaporation, and solar wind sputtering were taken into account as source mechanisms. Also, the model incorporates adsorption and bouncing of ballistic atoms. Two kinds of model were prepared. One incorporates above mentioned processes completely independently, and in the other model, solar wind sputtering is regarded as a precursor of photon stimulated desorption, in a way of so-called gardening effect. From comparison between observational results and model simulation, following conclusions were obtained.

1. Only the model which incorporates solar wind sputtering as a gardening effect can explain whole dataset.

2. Lunar sodium atmosphere is produced by a combination of photon stimulated desorption, which contains solar wind sputtering as a gardening effect, and micrometeorites evaporation. Averaged production rate for photon stimulated desorption is 4.9 x 10ˆ6 atoms/cm2sec, and 0.219 x 10ˆ6 atoms/cm2sec for micrometeorites evaporation.

3. Considerably strong correlation was found between F10.7 index and production rate due to photon stimulated desorption.

4. Sodium atoms with low temperature are produced by energy exchange between sodium atoms with high temperature and the lunar surface.