Study on the dynamics and structure of the lunar wake

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The moon directly collides with the solar wind plasma since it has no intrinsic magnetic field nor atmosphere. Therefore, very low density region called as lunar wake was clearly formed behind the moon body. In-situ observation of the lunar wake was carried out by a few satellite experiments. Explorer 35[Lyon et al., 1967], commander spacecraft of the Apollo mission[Schubert and Lichtenstein, 1974], Luna 2 and 10 are measurements carried out in the early period of studies of the lunar wake. However, their observation regions were close to the moon with several hundred km from the surface to 2-3 moon's radii(Rm). Observations in the region with several Rm, over 2-3 Rm, behind the moon body were needed to understand the whole wake structure of the moon. Theoretical study was started in 1960's by Al'pert(1963) by using kinetic approach. Recently, the WIND satellite observed the plasma density structure of the lunar wake when the satellite passed behind the moon with the distance of 6-8 Rm. The result showed that depletion of plasma density occurred widely behind the moon. In 2007, the SELENE satellite will be launched to achieve the comprehensive observation of plasma, material and gravity of the moon. Then, the observation results by the SELENE satellite will provide important facts to study on the physics of formation of the lunar wake.

The computer simulations of lunar wake have been carried out by many workers by using particle code simulation. Due to the limit of the resource of computer system at present, it is not practical to apply the three dimensional computer simulation for large area around the moon. In this paper, we calculated the density distribution based on analytical solution given by Al'pert(1965) which solved Boltzmann equation of solar wind plasma.

The structure of wake formed behind the fast moving the bodies in plasma with supersonic speed has been studied for a case of artificial satellites, space shuttles, and rockets. Though the basic understanding has already been given by Al'pert(1963), some open issue have been remained for detailed structure as well as the micro plasma instability possibly formed inside the wake. As the first step, we tried to calculated numerically the equation of Al'pert et al. (1965) in order to understand the plasma density structure of lunar wake. Al'pert derived an analytic solution of wake structure for the magnetized plasma in the case of rectangular obstacle cross-section. To obtain a realistic lunar wake structure, we approximate the moon's cross-section as a sum of segmentations of rectangular shape. By applying the formula derived by Al'pert et al. (1965), wavy nature of the wake structure was revealed inside the magnetized plasma medium. The present study has the purpose to realize the precise structure of wake, and to obtain micro processes by considering the electric field and energy dispersion of plasma depending on the velocity of particles.