A new model of the boundary layer of the lunar wake

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Refilling of the tenuous lunar wake by solar wind plasma has been one of the fundamental phenomena of planetary plasma sciences. Because a portion of the solar wind electrons has much higher speed than protons, it has been widely accepted that suprathermal electrons precede protons to come into the wake along the interplanetary magnetic field. In this model, ambipolar (inward) electric fields around the wake boundary generated by the charge separation attract the surrounding solar wind protons into the central lunar wake. However, such treatment has implicitly assumed one-dimensional motion of the solar wind plasma along the magnetic field. Here we propose a new model of the wake boundary close to the Moon, taking into account the three-dimensionality of solar wind proton motions; Solar wind protons come into the lunar wake owing to their gyro motion and large inertia without help of suprathermal electrons, and those protons form an ion boundary layer between the surrounding solar wind and the tenuous region deeper inside the wake. We call this layer the wake ion boundary layer (WIBL). In this model, ambipolar electric fields would exist at the inner edge of the WIBL. This new model well explains electron signatures around the wake boundary detected by Kaguya (SELENE) at ~100 km altitude from the lunar surface. In addition, we suggest that the potential drop in the WIBL along the Kaguya orbit is several tens V, which is an order-of-magnitude smaller than the values previously reported as the wake boundary potential (400 V by Wind observation and 480 V by NOZOMI). We will discuss the reason of this discrepancy to obtain a comprehensive view of the lunar wake boundary.

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