A reconsideration of the lunar wake boundary based on Kaguya observations

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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 perpendicular to the solar wind flow. Here we propose a new model of the wake boundary close to the Moon, based on Kaguya observations in orbit around the Moon; 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 positively charged regions and outward electric fields around the wake boundary that should attract surrounding solar wind electrons. This new model well explains electron signatures around the wake boundary detected by Kaguya at ~100 km altitude from the lunar surface.

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