Generation of whistler mode waves at the boundary of the lunar wake

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At the boundary of the lunar wake, solar wind ions and electrons are thought to rush into the void region at different speeds, producing ambipolar electric field structure. When the solar wind magnetic field intersects the layers of the electric field, slow speed componets of the solar wind electrons are reflected back, and high speed (halo) components that penetrate through the electric field undergo electric field drift to obtain perpendicular speed and thus form a ring beam distribution in velocity space. Through the cyclotron resonance, the ring-beam electrons are thought to generate whistler mode waves propagating against the beam as observed by GEOTAIL in upstream region of the moon when it was magnetically connected with the lunar wake (Nakagawa et al., 2003).

In order to see that the whistler mode waves are generated by electron beam which has the ring distribution in velocity space, one-dimensional particle simulation was carried out by using the parameters as observed by GEOTAIL, i.e., cyclotron frequency of 174 Hz and the beam energy of 1keV. The velocity component perpendicular to the magnetic field was estimated to be 1.5 -2.5 times as large as that of the parallel component, according to the previous test-particle simulation. The whistler mode waves propagating against the beam was found to be generated by the ring beam electrons when the plasma density in the wake was estimated to be 10% of that in the solar wind.

Nakagawa et al., EPS 55, 569, 2003.