Electronstatic Solitary Waves observed by KAGUYA

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We observed electrostatic solitary waves (ESW) near the Moon by SELENE (KAGUYA) in the solar wind and in the lunar wake. SELENE is a lunar orbiter with an altitude of 100km and measured wave electric field, background magnetic field, and fluxes of ions and electrons. ESW observations are categorized into three types depend on the observed conditions: ESW generated by the electric in the wake boundary (Type A), strong ESW generated by the solar wind and bi-streaming electrons mirror-reflected over the magnetic anomaly (Type B), and ESW generated by the solar wind and counter-streaming electrons reflected back from the lunar surface (Type C). ESW of Type C often alternate with Langmuir waves.

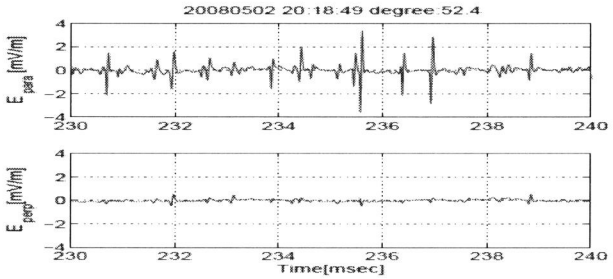

Figure 1. Electrostatic solitary waves observed above a magnetic anomaly.

Type A ESW at the wake boundaries are generated far from the Moon and they propagate along the magnetic field to the SELENE orbits. The energetic electrons accelerated by the strong electric at the wake boundary move along the magnetic field line, resulting in the bump-on-tail instability. A series of potentials due to the instability coalesce with each other to form larger and longer solitary potentials through propagation along the magnetic field. The longer distance of propagation in the wake boundary makes the magnitude of ESW comparable to those due to the strong bi-stream instability occurring in the short distance above the dayside magnetic anomalies. Total field strengths of magnetic anomalies at the surface of the Moon as derived from the Lunar Prospector electron reflectometer experiment reach more than 40 nT. Because of the strong magnetic field new the Moon surface, a substantial amount of electrons are reflected at mirror points above the anomalies, and they are observed by SELENE when the magnetic field are connected to the Moon. The Langmuir waves or ESW are alternately observed in Type C ESW events. Since the electron reflection over the surface without magnetic anomalies is relatively weak, a weak beam is formed. resulting in the weak-beam instability or the bump-on tail instability. Either Langmuir waves or ESW are generated depending on the background electron and ion thermal velocities.

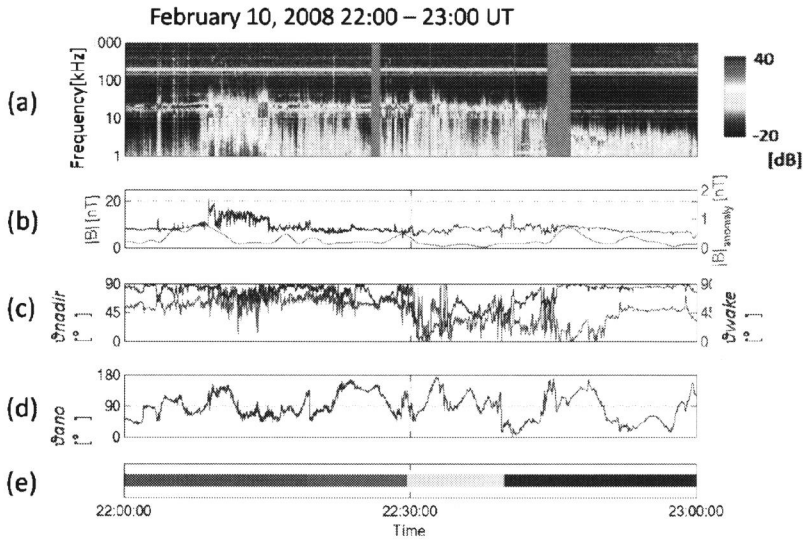

Figure 2. Plasma wave observation over a magnetic anomaly. (a) electric field spectra, (b) magnetic field intensity, (c) magnetic field intensity, (c) (d) magnetic field direction, (e) location of spacecraft.