Electrostatic Solitary Waves (ESWs) observed by KAGUYA near the Moon

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Abstract

In KAGUYA (SELENE), a Japanese lunar orbiter, LRS/WFC-L [1] observed waveforms of plasma waves in 100Hz-100kHz and a lot of ESWs have been observed due to the interaction between the solar wind and the Moon. Some results have been reported [2]. Although orthogonal dipole antennas are generally used in the observations, sometimes a pair of monopole antennas were used. We reports observations mainly by the latter antennas.

ESWs were observed near the Moon by SELENE in the solar wind and in the lunar wake [2]. SELENE measured background magnetic field, and fluxes of ions and electrons as well as electric fields with an altitude of 100km. ESWs are categorized into three types depending on different regions of observations: ESWs generated by electrons reflected and accelerated by an electric field in the wake boundary (Type A), strong ESWs generated by bi-streaming electrons mirror-reflected over the magnetic anomaly (Type B), and ESWs generated by reflected electrons when the local magnetic field is connected to the lunar surface (Type C). ESWs of Type C often alternate with Langmuir waves.

SELENE can use Y1 antenna and Y2 antenna separately. The dipole antenna mode use the difference between the two and the noise of the main body of the satellite is canceled. In the monopole mode, each antenna measures change of the potential of a satellite main part and there is much noise. Since the monopole mode measures the potential difference of an antenna and a satellite, the polarity of positive/negative has reversed the wave of ESW observed with Y1 antenna and Y2 antenna on the same axis. This is different character from the bipolar wave by the moon dust which shows same sign in Y1 and Y2. When potential is one-dimensional structure, the wave observed with two antennas has a time difference, and a wave and amplitude become equal although polarity is reversed.

The velocities and spatial scales of ESWs are evaluated from waveforms observed in the monopole mode. Generally their velocities are from several 100 km/s to several 1000 km/s. Their spatial scales are several 10 m to several 100 m and the potential depths were several 10 eV to a few 100 eV. Both ion and electron holes are observed. The ESW waveforms have often components perpendicular to the background magnetic field and the potential structure has a component perpendicular to the background magnetic field. This means that these waves were observed close the source regions.

References

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978-1-4244-6051-9/11/$26.00