

月周辺で観測される電子サイクロトロン高調波 Electron cyclotron harmonic waves observed around the moon

片山 由美子¹, 小嶋 浩嗣^{1*}, 斎藤 義文², 笠原 禎也³, 大村 善治¹, 山本 忠輝⁴, 横田 勝一郎², 西野 真木², 橋本 弘藏¹, 小野 高幸⁵, 綱川 秀夫⁶

Yumiko Katayama¹, Hirotsugu Kojima^{1*}, Yoshifumi Saito², Yoshiya Kasahara³, Yoshiharu Omura¹, Tadateru Yamamoto⁴, Shoichiro Yokota², Masaki N Nishino², Kozo Hashimoto¹, Takayuki Ono⁵, Hideo Tsunakawa⁶

¹ 京都大学生存圏研究所, ² 宇宙航空研究開発機構, ³ 金沢大学, ⁴ 総研大, ⁵ 東北大学, ⁶ 東工大

¹RISH, Kyoto university, ²JAXA, ³Kanazawa university, ⁴Sokendai, ⁵Tohoku university, ⁶Tokyo TECH

The present paper discusses the generation of Electron Cyclotron Harmonic (ECH) waves observed around the Moon. Plasma wave data obtained by the KAGUYA satellite show the existence of two kinds of ECH waves. They are: the

ECH waves with lower order harmonics and ones with higher order harmonics which frequencies are close to the upper hybrid resonance frequency. ECH waves can be observed only when the moon is inside the terrestrial magnetosphere. They never appear in the solar wind. The configuration of local magnetic fields is also important. KAGUYA observes the both types of ECH waves along the magnetic field lines which are connected with magnetic anomalies which are scattered on the moon surface. Furthermore, while the lower order harmonics are observed in the nightside of the Moon in the plasma sheet and lobe regions, the higher order harmonics are observed in the dayside in the lobe region. The correlation studies between waves and particles show that the existence of two components of electrons is essential for the observation of the both types of ECH waves. Two components of electrons mean hot electrons with the loss cone velocity distribution and cold electrons. On the other hand, the generation of cold electrons is classified into two mechanisms. One is the acceleration over the nightside moon surface which is negatively charged and the other is the emission of photo electrons while the spacecraft gets sunlight. In order to make sure the relation of ECH waves and electron distribution, we conducted the linear dispersion relation analysis and particle simulation using the realistic plasma parameters of electromagnetic environment based on the KAGUYA observation. The results clearly showed the parametric dependence of the ECH wave growth under the co-existence of the loss cone distribution of hot electrons and cold electrons. We discuss the generation of ECH waves consulting the parametric dependence and explain the relation of the ECH waves with the moon location in the magnetosphere.

キーワード: 電子サイクロトロン高調波, プラズマ波動, かぐや, 月

Keywords: Electron cyclotron harmonic waves, Plasma waves, KAGUYA, moon