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M/Q=2 Ion Cyclotron Whistlers Observed by Akebono

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It is well known that lightning whistler wave is caused by lightning discharge, and propagates along geomagnetic field lines as R-mode plasma wave below several tens kHz. Ion cyclotron whistler wave, which is one of Electromagnetic Ion Cyclotron (EMIC) mode waves, has close relation to lightning whistler [1]. One of most important features is the lowest frequency of ion cyclotron whistler which denotes the local crossover frequency of the EMIC mode wave. R-mode lightning electron whistler is converted into L-mode ion cyclotron wave at local crossover frequency between electron whistler and ion cyclotron branches along the propagation path. Propagation characteristics of ion cyclotron whistler strongly depend on ion concentrations in plasma as well as nature of general EMIC waves. These facts suggest that we can estimate ion species and concentrations at observation point and/or along the propagation paths of the ion cyclotron whistlers.

Watanabe at al. [2] reported first observation of M/Q=2 ion cyclotron whistler measured by the ISIS-2 satellite. According to their analysis, M/Q=2 ion cyclotron whistlers were observed at an altitude region around 1,360 km. They suggested that these M/Q=2 ion cyclotron whistlers are caused by deuterons (D^+) from ionosphere of the Earth, and they named them ”deuteron whistlers”.

In the current study, we report M/Q=2 ion cyclotron whistlers observed by the Akebono satellite at an altitude region around 4,500 km, which is the highest altitude where M/Q=2 ion cyclotron whistlers were observed so far. We found that these events had obvious frequency gap near the cyclotron frequency at half of cyclotron frequency of H^+. Hence, these events are precious evidence that some amount of M/Q=2 ion exists in the inner magnetosphere.

In this paper, we study ion concentration in the inner magnetosphere estimated from crossover frequencies of ion cyclotron whistlers observed by Akebono. Recently, it is pointed out that wave-particle interaction is important process to control innermagnetospheric physics. Our results become prior information of future satellite mission such as ERG [3] in the inner magnetosphere and/or simulations such as ray tracing method.

[1]Gurnett, D. A., S. D. Shawhan, N. M. Brice, and R. L. Smith (1965), Ion cyclotron whistlers, *J. Geophys. Res.*, 70(7), 1665-1688, doi:10.1029/JZ070i007p01665.

[2]Watanabe, S., T. Ondoh (1975), Deuteron whistler and trans-equatorial propagation of the ion cyclotron whistler, *Planet. Space Sci.*, vol. 24, 359-364.

[3]Miyoshi, Y., Ono, T., Takashima, T., Asamura, K., Hirahara, M., Kasaba, Y., Matsuoka, A., Kojima, H., Shiokawa, K., Seki, K., Fujimoto, M., Nagatsuma, T., Cheng, C.Z., Kazama, Y., Kasahara, S., Mitani, T., Matsumoto, H., Higashio, N., Kumamoto, A., Yagitani, S., Kasahara, Y., Ishisaka, K., Blomberg, L., Fujimoto, A., Katoh, Y., Ebihara, Y., Omura, Y., Nose, M., Hori, T., Miyashita, Y., Tanaka, Y.-M. and Segawa, T. (2013) The Energization and Radiation in Geospace (ERG) Project, in *Dynamics of the Earth's Radiation Belts and Inner Magnetosphere* (eds D. Summers, I. R. Mann, D. N. Baker and M. Schulz), American Geophysical Union, Washington, D. C.. doi: 10.1029/2012GM001304

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