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Nonlinear wave growth theory of coherent hiss emissions in the plasmasphere

OMURA, Yoshiharu[1*] ; NAKAMURA, Satoko[2] ; SUMMERS, Danny[3] ; HIKISHIMA, Mitsuru[4] ; KLETZING, Craig[5]

[1]Research Institute for Sustainable Humanosphere, Kyoto University, [2]GraduateSchool of Science, Kyoto University, [3]Memorial university of Newfoundland, [4]Solar-Terrestrial Environment Laboratory, Nagoya University, [5]Department of Physics and Astronomy, University of Iowa

Recent observations of plasmaspheric hiss emissions by the Van Allen Probes show that broadband hiss emissions in the plasmasphere comprise short-time coherent elements with rising and falling tone frequencies [1]. Based on nonlinear wave growth theory of whistler-mode chorus emissions [2], we examined the applicability of nonlinear theory to the coherent hiss emissions. We have generalized the derivation of optimum wave amplitudes for triggering rising tone chorus emissions for both falling and rising tone hiss elements. The amplitude profiles of the hiss emissions are well approximated by the optimum wave amplitudes for triggering rising or falling tones. Through formation of electron holes for rising tones and electron hills for falling tones, the coherent waves grow up to the optimum amplitudes. We find an excellent agreement between the optimum amplitudes and the observed amplitudes as a function of instantaneous frequency. We calculate nonlinear growth rates at the equator, and find that nonlinear growth rates for rising-tone emissions are much larger than the linear growth rates. The frequency sweep rates and time scales of observed hiss emissions also agree those predicted by the nonlinear theory. Based on the theory, we can infer properties of energetic electrons generating hiss emissions in the equatorial region of the plasmasphere.

[1] Summers, D., Y. Omura, S. Nakamura, and C. A. Kletzing (2014), Fine structure of plasmaspheric hiss, J. Geophys. Res. Space Physics, 119, 9134?9149,
doi:10.1002/2014JA020437.
[2] Omura Y., D. Nunn, and D. Summers (2012), Generation processes of whistler-mode chorus emissions: Current status of nonlinear wave growth theory, AGU Monograph ”Dynamics of the Earth’s Radiation Belts and Inner Magnetosphere”, 10.1029/2012GM001347.

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