プラズマ圏ヒスの微細構造の理論解析

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Theoretical analysis on coherent elements of plasmaspheric hiss

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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. Based on nonlinear wave growth theory of whistler-mode chorus emissions, we have examined the applicability of the nonlinear theory to the coherent hiss emissions. We have generalized the derivation of the optimum wave amplitude for triggering rising tone chorus emissions to the cases of both rising and falling 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 the formation of electron holes for rising tones and electron hills for falling tones, the coherent waves evolve to attain the optimum amplitudes. An electromagnetic particle simulation confirms the nonlinear wave growth mechanism as the initial phase of the hiss generation process. We find very good agreement between the theoretical 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 time scales of observed hiss emissions also agree with 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.