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Suppression of spontaneous oscillation of chorus wave emissions by artificial transmitter signals

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Whistler-mode chorus wave emissions play an important role in the acceleration of relativistic electrons in Earth's radiation belts through nonlinear gyroresonant interactions. In the nonlinear wave growth [1], a nonlinear resonant current from resonant electrons is characterized by an inhomogeneity factor, which indicates the shape of the phase trapping region in velocity phase space. In other words, if we can modify the inhomogeneity factor of the resonant electrons by stimulating them with external transmitter signals, we may be able to control the generation and suppression of chorus wave emissions. Here, we demonstrate computer simulations for the suppression of whistler-mode chorus wave emissions, a resonant wave driven by energetic electrons, by tuning an external space-borne transmitter signal located at the magnetic equator [2]. We set the wave frequency of the external transmitter signals to $0.4\Omega_{e0}$, where Ω_{e0} is the equatorial electron cyclotron frequency, relative to the maximum linear growth frequency of $0.2\Omega_{e0}$. The two nearby frequency waves essentially inhibit coherent interactions between the wave packets and phase-organized electrons, because the combined waves, which are resulting from the seed wave due to linear growth and the transmitter signals, become incoherent as seen by the electrons. Through the forcible modification of electron motions via phase trapping by the external transmitter waves, the nonlinear gyroresonant current is suppressed, along with the deformation of phase trapping region, resulting in an effective change in the inhomogeneity factor. Moreover, this can decrease the population of relativistic electrons due to the lack of coherent resonant whistler-mode waves seen by the phase-organized electrons. In this presentation, we will discuss the wave suppression mechanisms and a potential application for the active control of Earth's plasma environment.

1. Omura, Y. Nonlinear wave growth theory of whistler-mode chorus and hiss emissions in the magnetosphere. Earth Planets Space 73, 95 (2021). https://doi.org/10.1186/s40623-021-01380-w

2. Ozaki, M., Mizote, K., Kondo, T., Yagitani, S., Hikishima, M., & Omura, Y. (2024). Suppression of nonlinear chorus wave growth by active control of gyroresonant interactions with electron hole deformation. Geophysical Research Letters, 51, e2024GL112218. https://doi.org/10.1029/2024GL112218