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Upstream Shift of Generation Region of Rising-Tone Emissions Triggered by Whistler-mode Waves in the Magnetosphere

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The generation process of whistler-mode rising-tone emissions such as chorus has been a mystery for a long time, while its detailed nonlinear processes are being clarified by particle simulations in recent years. Although it is generally understood that chorus generation regions are close to the magnetic equator, the exact location and process of the wave generation have not been identified yet. It has been observed that a rising-tone chorus emission consists of many subpackets with gradually increasing frequencies. A new subpacket is generated by a foregoing wave packet, and the process is repeated. Instead of the naturally growing wave packet, we inject a wave with a constant frequency to trigger new emissions. We have performed a series of particle simulations for whistler-mode wave-particle interaction in a parabolic magnetic field with 12 different frequencies of triggering waves and three different plasma frequencies specifying cold plasma densities. Under a given plasma condition, a specific frequency range of the triggering wave exists that can generate rising-tone emissions. The generation region of rising-tone emission shifts upstream. The velocity of the wave generation region is dependent on duration of the subpacket, which is controlled by formation of the resonant current in the generation region. When the source velocity, which is a sum of the resonance and group velocities, is approximately the same as the velocity of the wave generation region, a long-sustaining rising-tone emission is generated [1]. When the spatial and temporal gap between subpackets exists due to damping phase of short subpacket generation, resonant electrons in the gap of the subpackets are carried at the resonance velocity to the upstream region, and the velocity of the wave generation region becomes large in magnitude. When formation of resonant currents is delayed, the velocity of the generation region becomes smaller than the source velocity in magnitude. Below one quarter of the cyclotron frequency, coalescence of subpackets takes place, suppressing formation of the resonant current in the generation region [2]. Since gradual upstream shift of the generation region is necessary for the wave to grow locally, the source velocity should be a small negative value.

References

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