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# A "Trap-Release-Amplify" Model of Chorus

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## 1 Extended Abstract

Whistler mode chorus waves are quasi-coherent electromagnetic emissions with frequency chirping. Various models have been proposed to understand the chirping mechanism, which is a long-standing problem in space plasmas. Based on analysis of effective wave growth rate and electron phase space dynamics in a self-consistent particle simulation, we propose a phenomenological model called the "Trap-Release-Amplify" (TaRA) model for chorus. In this model, phase space structures of correlated electrons are formed by nonlinear wave particle interactions, which mainly occur in the downstream of equator. When released from the wave packet in the upstream, these electrons lead to selective amplification of new emissions which satisfy the phase-locking condition to maximize wave power transfer, resulting in frequency chirping. The phase-locking condition at the release point gives a chirping rate that is fully consistent with the one by Helliwell in case of a nonuniform background magnetic field. The nonlinear wave particle interaction part of the TaRA model results in a chirping rate that is proportional to wave amplitude, a conclusion originally reached by Vomvoridis et al. Therefore, the TaRA model unifies two different results from seemingly unrelated studies. This model shows reasonable agreement in terms of frequency chirping rate when compared with MAVEN observation of chorus elements at Mars, whose crustal magnetic field has a relatively extreme field inhomogeneity compared with planets such as Earth, Saturn and Jupiter. Finally, we suggest that this model could be applied to explain other related phenomena, including frequency chirping of chorus in a uniform background magnetic field and of electromagnetic ion cyclotron waves in the magnetosphere.