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Simulation of chorus generation using the DAWN code

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Chorus waves play an important role in energetic electron dynamics in the inner magnetosphere. Because of the complex nonlinear dynamics involved, numerical simulations are normally used to study the detailed excitation process and properties of chorus. In this work, we present a new hybrid code, DAWN, to simulate the generation of chorus waves. The DAWN code is unique in that it models cold electrons using linearized fluid equations and hot electrons using particle-in-cell techniques. The simplified fluid equations can be solved with robust and simple algorithms. We demonstrate that discrete chorus elements can be generated using the code. Waveforms of the generated elements show amplitude modulation or "subpackets". Also frequency sweep rates of the generated elements are compared with a chorus generation theory by Helliwell. We then investigate the variation of wave intensity ($\propto B_w^2$) with respect to linear growth rates at the equatorial plane. Previous observations showed a puzzling fact associated with whistler wave intensity modulation in the inner magnetosphere; i.e., the change in linear growth rates modulated by external processes such as density modulations is usually small ($\mathcal{O}(10^{-1})$), while the variation of the wave intensity is large $\mathcal{O}(10^1 - 10^2)$. We define two instability regimes, the broadband whistler wave regime and the chorus wave regime, according to the generated wave field, to simplify discussions. Using a chosen set of background plasma parameters, we demonstrate that a small change ($\mathcal{O}(10^{-1})$) in linear growth rates can lead to significant variation ($\mathcal{O}(10^1)$) of wave intensity only in the transition from the broadband whistler wave regime to the chorus wave regime. Our results should be helpful to understanding variation of whistler wave intensity associated with chorus generation in the inner magnetosphere.