Numerical investigation of auroral magnetospheric radio emission

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In recent years, there has been considerable published research and debate on an instability produced within an electron beam transported into an increasing magnetic field. Due to conservation of energy and magnetic moment, a velocity distribution is produced having a significant pitch spread and effective population inversion in perpendicular velocity. This distribution is unstable to cyclotron-maser emission and has been attributed to various planetary and stellar magnetospheric radio emissions. Although the generation mechanism is well established, a satisfactory explanation does not yet exist for the sporadic occurrence of these emissions and the observed field-aligned beaming of the radiation out of the source region. To address these issues, simulations have been conducted using the PiC code VORPAL to investigate the spatial growth of the instability in a sheet electron beam with background plasma whose density increases along the path of beam propagation. These simulations demonstrate a significant enhancement in spatial growth over the larger cross-section of the beam, and can simulate upward refraction of the generated radiation – consistent with recent theoretical predictions of enhanced emission / growth of terrestrial AKR tangential to the auroral cavity boundary and upward refraction of the resultant radiation due to an increasing background plasma density with decreasing altitude.