Whistler waves and magnetotail bursty bulk flows as a source for earth's diffuse aurora

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Electron cyclotron harmonic (ECH) and whistler chorus waves are the two primary mechanisms underlying the resonant wave-particle interactions that precipitate plasma sheet electrons into the Earth's ionospheric diffuse Aurora. Previous work has demonstrated that ECH waves dominate scattering of plasma sheet electrons further from Earth (at L shells > 8), while whistler chorus emissions dominate scattering closer to the Earth (at L shells L < 8). However, we find from the THEMIS (Time History of Events and Macroscale Interactions) constellation of spacecraft at L = 12 that, during substorms in the magnetotail, bursty bulk flows produce oblique whistler chorus emissions that surpass the scattering efficiency of parallel whistler waves and the local ECH waves. Previously, researchers have observed that betatron acceleration in the magnetotail creates the electron temperature anisotropy $T_{e,\perp}/T_{e,||} > 1$ that serves as the free energy source for whistler-mode waves. Here, however, we find parallel electron beams and $T_{e,\perp}/T_{e,||} < 1$. The parallel electron beams are produced by Fermi acceleration at magnetic dipolarization fronts in the bulk flows. The parallel electron beams provide an effective energy source for oblique whistler chorus waves, and the whistler waves' oblique propagation direction enhances the efficient scattering of lower-energy electrons into the diffuse aurora. We conclude that Fermi acceleration of electrons provides one important free-energy source for the wave-particle interactions responsible for coupling plasma sheet electrons into the diffuse aurora during magnetotail substorm conditions. It is likely that the Fermi acceleration results from magnetotail magnetic reconnection.