Energy transfer and electron dynamics in a kinetic Alfvén wave

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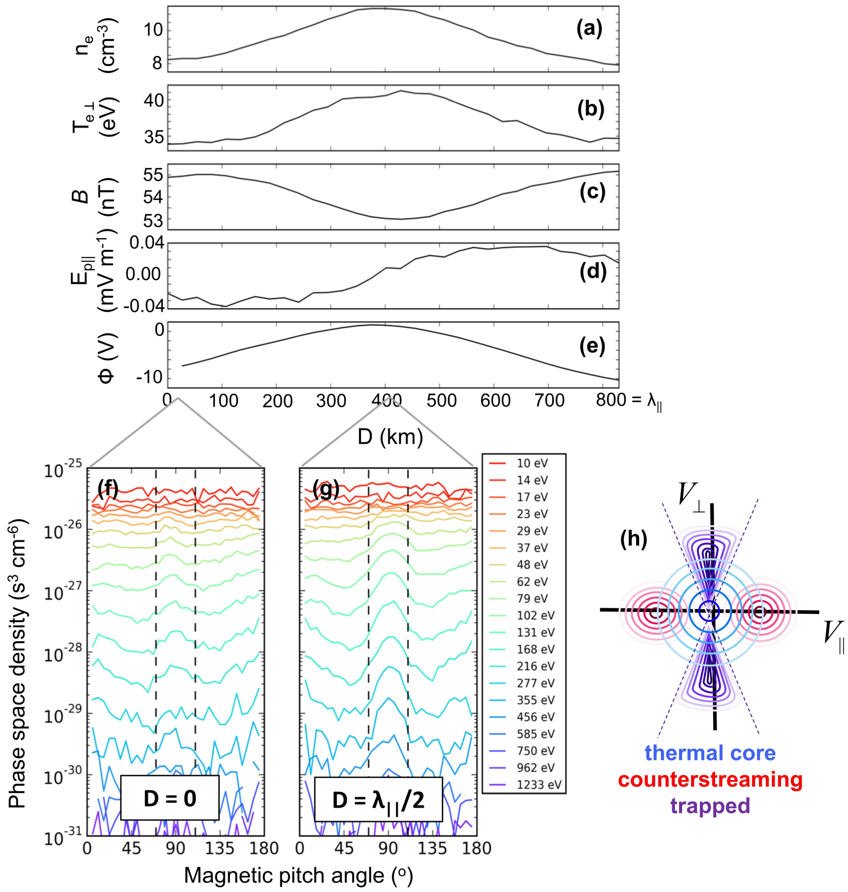
Kinetic Alfvén waves (KAW) provide a mechanism for the transfer of energy in plasmas throughout the universe. The detailed properties of these waves have been elusive due to limits on plasma instrumentation. However, NASA’s Magnetospheric Multiscale (MMS) mission provides high resolution particle and fields instrumentation suitable to resolve kinetic-scale physics. On 30 December 2015, MMS resolved a monochromatic KAW in a magnetopause reconnection exhaust. Through determination of the three-dimensional wavevector, particle currents, and pressure-gradient driven electric fields, we are able to observe the conservative energy transfer between the wave field and plasma particles for the first time.

In addition to resolving wave fluctuations, we identify a dynamically significant population of non-linearly trapped electrons. These electrons are trapped within a kinetic scale magnetic mirror formed by the parallel magnetic field fluctuations of the KAW. This population, which accounted for ~50% of the density fluctuations within the wave, may have inhibited Landau and transit-time damping of the KAW, enabling its stable propagation and transport of energy away from the reconnection X-line.

Keywords: kinetic alfven wave, plasma physics, plasma wave



(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
D (km)
800 = λ||
Phase space density (s3 cm-6)
Magnetic pitch angle (o)
D = 0
D = λ||/2
thermal core
counterstreaming
trapped