Geophysical Research Abstracts, Vol. 9, 10227, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-10227

Ion pick-up by finite amplitute Alfven waves

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Finite amplitude low frequency Alfv\'en waves are ubiquitous in the fast solar wind and the corona. Using test particle theory and simulations, we study situations when an Alfv\'en wave can lead to significant heating of ions. This can happen when such a wave is instantly introduced into a plasma, or when new ions are constantly created and the flow velocity of mother particles does not follow the disturbed velocity of an Alfv\'en wave. In both situations, ions will be picked up by the electromagnetic field of the Alfv\'en wave and a gyrospeed significantly larger than the original ion thermal speed may be generated. The wave field scatters ions in the phase space. When the wave amplitude is sufficiently large, a ring-like velocity distribution will be produced. The process yields a much stronger heating in the direction perpendicular than parallel to the background magnetic field and a temperature anisotropy. Ions also obtain a bulk acceleration along the background magnetic field during the heating process. The process may naturally lead to the dissipation of the Alfv\'en wave. Possible application of this mechanism in the solar atmosphere and the solar wind will be discussed.