Ion heating across the magnetic field in the solar corona

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Abstract

The perpendicular heating of the ions observed by SOHO in the solar corona has been mainly attributed to the ion-cyclotron damping of high-frequency Alfvén waves. We investigate an alternative possibility that the dissipation range is formed by the Alfvén waves that are short-wavelength across the magnetic field - kinetic Alfvén waves (KAWs). The energy reservoir is provided by low-frequency large-scale MHD waves that are launched in the corona by the photospheric motions or excited at the coronal base by magnetic restructuring. The short perpendicular wavelengths can be developed by phase mixing, converting MHD Alfvén waves into KAWs, or KAWs can be excited in situ linearly or nonlinearly. Dissipative mechanisms become significant for KAWs with sufficiently short perpendicular wavelength. Here we focus on the dissipative effects due to finite KAWs amplitude. We show that above a threshold value of the amplitude KAWs can stochastically accelerate ions in the direction perpendicular to the background magnetic field. In particular, KAWs with transversal wavelengths of the order of the proton gyroradius and with a wave/background magnetic field ratio larger than 0.005, are accessible for the stochastic heating of oxygen ions. We discuss advantages of this mechanism over the ion-cyclotron heating scheme for the intense transverse heating of ions observed by SOHO at 2-4 solar radii.