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Kinematic Transformation of MHD Alfvén Waves Into Kinetic Alfvén Waves and its Consequences in the Solar Wind

Yuriy Voitenko and Viviane Pierrard
Belgian Institute for Space Aeronomy, Brussels, Belgium (voitenko@oma.be / +3223748423)

Recent observations suggest that wave-particle interactions in the solar wind are dominated by finite ion gyroradius effects rather than finite ion-cyclotron effects envisaged earlier. The same follows from recent turbulent theories where the nonlinear Alfvénic spectral transport is dominated by the perpendicular cascade towards short cross-field wavelengths, in which case the dissipation range in the solar wind is constituted by kinetic Alfvén waves (KAWs). We consider linear alternatives for the KAWs production in the solar wind and their observed consequences. In particular, we show that MHD Alfvén waves with finite cross-field wavelengths can transform into KAWs kinematically in the course of their propagation in the solar wind. When the cross-field wavelength becomes of the order 100 ion gyroradii, kinetic effects come into play initiating wave-particle interactions. Since KAWs carry a field-aligned electric potential well propagating with super-Alfvén velocity, the protons trapped in this potential well build up isolated super-Alfvénic proton beams or extended tails. The Cherenkov resonant interaction of KAWs with electrons results in a local heating/flattening of the anti-sunward part of electron distribution function. These processes can explain the origin of the proton beams and flattened electron distributions that are often observed in the fast solar wind.