Acceleration of the fast solar wind through minor ions

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Abstract

It is assumed that magnetic flux tubes are strongly concentrated at the boundaries of supergranule convection cells. A power law spectrum of high frequency Alfvén waves with a spectral index -1 originating from the sun is assumed to supply all the energy needed to energize the plasma flowing in such magnetic flux tubes. At the high frequency end, the waves are eroded by ions due to ion cyclotron resonance. The magnetic flux concentration is essential since it allows a sufficiently strong energy flux to be carried by high frequency ion cyclotron waves and these waves can be readily released at the coronal base by cyclotron resonance. The main results are: 1. The waves are capable of creating a steep transition region, a hot corona and a fast solar wind if both the wave frequency is high enough and the magnetic flux concentration is sufficiently strong in the boundaries of the supergranule convection zone. 2. By primarily heating alpha particles only, it is possible to produce a steep transition region, a hot corona and a fast solar wind. Coulomb coupling plays a key role in transferring the thermal energy of alpha particles to protons and electrons at the corona base. The electron thermal conduction then does the remaining job to create a sharp transition region. 3. Plasma species (even ions) may already partially lose thermal equilibrium in the transition region, and minor ions may already be faster than protons at the very base of the corona. 4. The model predicts high temperature alpha particles ($T_\alpha \sim 2 \times 10^7$K) and low proton temperatures ($T_p < 10^6$K) between 2 and 4 solar radii, suggesting that hydrogen Lyman lines observed by UVCS above coronal holes may be primarily broadened by Alfvén waves in this range.