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Laboratory experiments to understand the coronal heating problem[1]

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Coronal holes are regions of the Sun's atmosphere with open magnetic field lines that extend into interplanetary space. These regions are ≈ 200 times hotter than the underlying photosphere. Recent observations of damping of Alfvén waves in coronal holes suggest that a wave driven process may be responsible for the temperature rise. The mechanism of this wave damping is unknown. We have explored the effectiveness of a longitudinal gradient in Alfvén speed in reducing the energy of propagating Alfvén waves under conditions scaled to match those in coronal holes. The experiments were conducted in the Large Plasma Device located at the University of California, Los Angeles. Our results show that the energy of the transmitted Alfvén wave decreases as the inhomogeneity parameter, λ/L, increases. Here, λ is the wavelength of the Alfvén wave and L is the scale length of Alfvén speed gradient. For gradients similar to those in coronal holes, the waves are observed to lose a factor of ≈ 5 more energy than they do when propagating through a uniform plasma without a gradient. Contrary to theoretical expectations, this reduction in the energy of the transmitted wave is not accompanied by observation of a reflected wave. Nonlinear effects causing reduction in wave energy are ruled out as the amplitude of the initial wave is too small and the wave frequency well below the ion cyclotron frequency. Decrease of Alfvén wave energy due to mode coupling is unlikely, as we have not detected any other modes. Since the total energy must be conserved, it is possible that the reduced wave energy is being deposited in the plasma. These results pertaining to coronal holes are presented.

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