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Cyclotron Resonant Heating and Acceleration of protons, O VI & Mg X ions in the North Polar Coronal Hole

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Abstract: Ultraviolet Coronograph Spectrometer aboard Solar and Heliospheric Observatory (SOHO) has revealed the existence of temperature anisotropy of many minor ion species that populate the north solar polar coronal hole. In this study, we examined the propagation characteristics of ion-cyclotron waves which resonate with protons, O VI and Mg X ions. In our empirical model, radial variation of the magnetic field, electron and ion number densities, perpendicular and parallel temperature of protons, O VI and Mg X ions are adopted from the measurements of various instruments aboard SOHO. Since most of the measurements of SOHO instruments begin at 1.5 R (=r/$R_{\odot}$) where the collisionless plasma properties dominate towards the outer regions, we assumed bi--Maxwellian velocity distribution functions for protons, O VI and Mg X ions. Dispersion relation for the left circularly polarized ion cyclotron waves which are assumed to be generated at the bottom of the coronal hole is deduced. We do not consider the in situ generation of these waves. We found that ion cyclotron waves with frequency band 2.5 kHz - 10 kHz come into resonance with O VI ions between 1.5 R - 3.0 R . We also solved the dispersion relations for protons and Mg X ions in the same distance range and have shown that the waves of 2.5 kHz - 10 kHz frequency band preferentially heat the O VI ions. O VI ions come into resonance with ion cyclotron waves of certain frequency long before the protons and the Mg X ions. We do not know the evolution of the power spectrum of these waves. Therefore it is hard to tell if, after having been depleted partly (if not, totally) by O VI ions, any power is left over from ion cyclotron waves for either protons or Mg X ions. But if cyclotron resonance process is to be favored for the perpendicular heating, then we may hypothesize that ion cyclotron waves, after having heated the O VI ions first, have enough power left to heat protons and Mg X ions in the same distance range.

Key Words: Sun: solar corona: ion--cyclotron waves, heating.

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