Ion Kinetics in the Solar Wind Generation Region

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The fast solar wind is generated in coronal holes by strong ion heating perpendicular to the large-scale magnetic field. The solar wind flow away from the Sun then results primarily from the mirror force acting on these anisotropic ion distributions in the decreasing coronal hole magnetic field. Solar wind behavior cannot be reliably modeled until the responsible heating mechanism is identified and understood. Fluid models do not provide sufficiently detailed information, so kinetic treatments are required. We have been investigating the radial evolution of the proton and minor ion distributions in a solar coronal hole by numerically solving the collisionless kinetic guiding-center equation including the large-scale forces due to gravity, charge-separation electric field, Alfvén wave pressure, and mirroring of the particles. We also include the kinetic scattering due to the resonant cyclotron wave-particle interaction, which will efficiently organize the ion distributions whenever velocity-space gradients appear along the quasilinear resonant surfaces. Turbulent heating and the large-scale forces will continually create these gradients, and the distributions evolve under the combination of these processes. We find that the resulting proton distributions become asymmetric along the radial direction, with different characteristic features in the sunward and anti-sunward portions of the distribution in the plasma frame. We will present results of these calculations and discuss further implications of this kinetic picture.