Ion scale waves and kinetic instabilities in the inner heliosphere

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The coherent electromagnetic waves at ion scales have been frequently observed in the inner heliosphere during the first perihelion of Parker Solar Probe. It is expected that ion- scale waves, propagating preferentially quasi-parallel to the mean magnetic field, are locally driven by the ion velocity-space micro-instabilities that are closely associated with turbulent heating and thermodynamic processes in the expanding solar wind. In the present study, we discuss the underlying physical processes of how the ion-scale waves are generated in the inner heliosphere, where Parker Solar Probe has explored. Here we present a recently developed expanding box model based upon the velocity moment-based quasilinear kinetic analysis. This model incorporates the kinetic physics, such as plasma heating driven by Alfven-wave turbulence and micro-instabilities calculated by a self-consistent manner, into the large-scale fluid description. The theoretical results may help us understand the observational features, not only the presence of abundant ion-scale waves but also the solar wind thermodynamics, such as the evolution of temperature and its anisotropy.The coherent electromagnetic waves at ion scales have been frequently observed in the inner heliosphere during the first perihelion of Parker Solar Probe. It is expected that ion-scale waves, propagating preferentially quasi-parallel to the mean magnetic field, are locally driven by the ion velocity-space micro-instabilities that are closely associated with turbulent heating and thermodynamic processes in the expanding solar wind. In the present study, we discuss the underlying physical processes of how the ion-scale waves are generated in the inner heliosphere, where Parker Solar Probe has explored. Here we present a recently developed expanding box model based upon the velocity moment-based quasilinear kinetic analysis. This model incorporates the kinetic physics, such as plasma heating driven by Alfven-wave turbulence and micro-instabilities calculated by a self-consistent manner, into the large-scale fluid description. The theoretical results may help us understand the observational features, not only the presence of abundant ion-scale waves but also the solar wind thermodynamics, such as the evolution of temperature and its anisotropy.

Keywords: Parker Solar Probe, ion cyclotron wave, kinetic instability, turbulence

