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Gyroresonance of Kelvin-Helmholtz vortices with Na+ in Mercury's magnetotail

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Observations of Mercury's plasma environment by the MESSENGER spacecraft have revealed that the planet hosts a strongly asymmetric magnetosphere as a result of an off-axis internal magnetic field, and significant finite Larmor radius effects at the boundary layer between magnetospheric and solar wind plasma environments. Linear analysis and global hybrid simulations suggest asymmetric growth of the Kelvin-Helmholtz instability between the dusk and dawn flanks of the magnetopause, and indeed Kelvin-Helmholtz waves have been observed almost exclusively at the dusk flank during northward IMF. A previous study has shown that Kelvin-Helmholtz waves at the dusk flank are observed predominantly at scales associated with the gyration of hot sodium ions - a population originating at the dayside exosphere, and distributed preferentially at the dusk flank. This suggests that a resonance may occur between sodium ion gyration and Kelvin-Helmholtz vortex growth. Using two- and three-dimensional local hybrid simulations of dusk and dawn boundaries, with varying magnetospheric sodium ion density, we have reproduced the main observational features: we see a strong peak in the Kelvin-Helmholtz wave spectra at sodium gyro scales at the dusk boundaries, and suppression of the growth of vortices at the dawn boundaries. We examine the mechanism of the resonant interaction between counter-gyrating sodium ions and K-H vortices using test particle simulations. Finally, we discuss the effect of the sodium ion population on cross-boundary particle transport.