Ion Dynamics During Magnetospheric Compression at Mercury

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Because of the small planetary magnetic field as well as proximity to the Sun that yields enhanced solar wind pressure as compared to Earth, the magnetosphere of Mercury is very dynamical and at times subjected to prominent compression. We investigate the dynamics of magnetospheric ions during such compression events. Using three-dimensional single-particle simulations, we show that the electric field induced by the time-varying magnetic field can lead to significant ion energization (up to several keVs) in regions where the gyroperiod is comparable to the field variation time scale. This energization occurs in a nonadiabatic manner, being characterized by large magnetic moment enhancement and bunching of the particles in gyration phase. At Mercury, the above resonance between the ion gyromotion and the time-varying field may be achieved at various latitudes, because of both small field variation time scales (smaller by about a factor 20 than those at Earth) and large ion gyroperiods (small planetary magnetic field). This contrasts with the terrestrial case where similar features are obtained essentially in the equatorial region. We show that, during compression events, ion species originating from Mercury's exosphere can be subjected to prominent energization upon transport into the lobes ; hence, a different magnetospheric response depending upon mass loading.