Observation of Hamiltonian phase space structure in geospace plasmas

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We consider Hamiltonian dynamics of charged particles in a sharp magnetic feild reversal (a current sheet), modeling a broad region in the geomagnetic tail region of the magnetosphere. Theory and simulations have predicted an energy resonance related to the symmetry of the particle phase space partitions (into regular, chaotic, and transient regions). The resonance manifests itself a series of peaks in the ion velocity distribution function, which have been observed in in-situ data from two different spacecraft during periods of low to moderate magnetic activity. The observed peaks scale as the fourth root of the normalized particle energy, in agreement with the theoretical resonance structure. In this paper, we summarize these results and present new results from the multi-spacecraft Cluster mission, which allow us to better utilize the resonances to remote sense properties of the magnetotail current sheet that are difficult to determine otherwise.