

## Thermalization of electrons at quasi-perpendicular shocks

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The role of micro-instabilities in dissipation process in collisionless quasi-perpendicular shocks is investigated by a full-particle numerical code. It is well-known that an anomalous dissipation is necessary in the super-critical Mach number shock. The reflected ions are mainly considered to produce the dissipation. Recently, the contribution of electrons are also well discussed and many waves are listed-up for the candidate of the dissipation process: ion acoustic waves, upper hybrid waves, whistler waves, and so on. In the present study, we discuss the variation of the wave types depends on both the shock parameters (shock Mach number, upstream plasma beta) and time. Here, the reflected ions again act as an important role. The instability between the incoming ions and the reflected ions excites electrostatic waves in the ramp region. When the amplitude of the electrostatic wave is large, the incoming electrons are also reflected. This is the case that the Mach number is large, because the growth rate of the instability is large. The reflected electrons are also accelerated by the upstream motional electric field as reflected ions are accelerated. We can see another kinetic effect for electron heating process at collisionless shocks.