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Dissipation Mechanisms and Particle Acceleration at the Earth's Bow Shock

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NASA's Magnetospheric Multiscale (MMS) mission has four spacecraft equipped with identical state-of-the-art instruments that acquire magnetic and electric field, plasma wave, and particle data at unprecedented temporal resolution to study the fundamental physics of magnetic reconnection in the Earth's magnetosphere. During Phase 1a, MMS also encountered and crossed the Earth's bow shock more than $\sim$400 times. We use burst data during $\sim$2 bow shock crossings to shed new light on key open questions regarding the formation, evolution, and dissipation mechanisms at collisionless shocks. Specifically, we focus on two events that exhibit clear differences in the ion and electron properties, the associated wave activity, and, therefore in the nature of the dissipation. In the case of a quasi-perpendicular, low beta shock crossing, we find that the dissipation processes are most likely associated with field-aligned electron beams that are coincident with high frequency electrostatic waves. On the other hand, the dissipation processes at an oblique, high beta shock crossing are largely governed by the quasi-static electric field and generation of magnetosonic whistler waves that result in parallel temperature anisotropy for the electrons. We also discuss the implications of these results for ion heating, reflection, and particle acceleration.