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Detailed examination of ion distributions observed by Double Star during encounter with a slowly moving bow shock

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On 24 February 2004 the recently-launched Double Star spacecraft encountered the Earth's bow shock several times. Parks et al. [2004] examined the directly-transmitted protons and α particles during a crossing when the geometry was strongly perpendicular, and determined that the speed decreases were consistent with a cross-shock electric potential of $\sim$700 eV, approximately 80% of the solar wind proton bulk flow energy. The directly-transmitted proton beam speed reduced to $\sim$120 km s^{-1} just interior to the magnetic field overshoot – less than the bulk flow velocity observed further downstream. Some of the overall momentum was carried by the αs, which retained most of their initial anti-sunward velocity, as well as by energized secondaries which penetrated the shock following an initial sunward reflection at the shock. We examine in detail the momentum exchange by considering separately the contributions of populations from different parts of velocity space as the spacecraft stepped through the ramp/overshoot. Almost immediately after the encounter at $\sim$0931 UT, the shock reversed direction, re-encountering the spacecraft within $\sim$8 minutes. During this brief interval of very slow relative motion, Double Star had opportunity to sample the adjacent downstream region, which could be seen to consist of only partially thermalized ion distributions. We examine quantitatively the evolution of the distinct populations to establish a foundation for explaining the thermalization processes.