The Advanced Composition Explorer Shock Database and Application to Particle Acceleration Theory

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The theory of particle acceleration via diffusive shock acceleration (DSA) has been studied in depth by Gosling et al. (1981), van Nes et al. (1984), Mason (2000), Desai et al. (2003), Zank et al. (2006), among many others. Recently, Parker and Zank (2012, 2014) and Parker et al. (2014) using the Advanced Composition Explorer (ACE) shock database at 1 AU explored two questions: does the upstream distribution alone have enough particles to account for the accelerated downstream distribution and can the slope of the downstream accelerated spectrum be explained using DSA? As was shown in this research, diffusive shock acceleration can account for a large population of the shocks. However, Parker and Zank (2012, 2014) and Parker et al. (2014) used a subset of the larger ACE database. Recently, work has successfully been completed that allows for the entire ACE database to be considered in a larger statistical analysis. We explain DSA as it applies to single and multiple shocks and the shock criteria used in this statistical analysis. We calculate the expected injection energy via diffusive shock acceleration given upstream parameters defined from the ACE Solar Wind Electron, Proton, and Alpha Monitor (SWEPAM) data to construct the theoretical upstream distribution. We show the comparison of shock strength derived from diffusive shock acceleration theory to observations in the 50 keV to 5 MeV range from an instrument on ACE. Parameters such as shock velocity, shock obliquity, particle number, and time between shocks are considered. This study is further divided into single and multiple shock categories, with an additional emphasis on forward-forward multiple shock pairs. Finally with regard to forward-forward shock pairs, results comparing injection energies of the first shock, second shock, and second shock with previous energetic population will be given.