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Hybrid Simulations of Cosmic Ray Modified Shocks and Nonlinear Diffusive Shock Acceleration. COLBY HAGGERTY, DAMIANO CAPRIOLI, University of Chicago — We present simulations of collisionless plasma shocks performed with the first hybrid code to include relativistic ion dynamics (*dHybridR*). In these simulations, we show evidence of modifications to the fluid shock jump conditions caused by the cosmic ray (CR) pressure. The rapid transition to CR modified shocks occurs soon after the onset of the shock. CR modified shocks are expected to have a harder power law slope, however we find a significantly steeper spectral index of nearly p^-5 for early times and hardening as the simulation progresses to approximately p^-4.3 as the compression ratio saturates. To understand these simulation results we present a non-linear theory of diffusive shock acceleration (DSA) which includes considerations for both the magnetic field and the CR modified jump conditions. The steep spectra is shown to be caused by a larger fraction of CRs escaping downstream than predicted by DSA. The enhanced escape rate of CRs is facilitated by the compressed magnetic field just downstream of the shock. This magnetic field was originally generated from the CR streaming instability upstream of the shock, and thus the compressed/enhanced magnetic field acts to regulate the energetic run-away problem that CR modified shocks presents for DSA.

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