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A Generalized Model of Nonlinear Diffusive Shock Acceleration Coupled to an Evolving Supernova Remnant

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Strong forward shocks found in SNRs are known to produce TeV particles, and are likely to be the predominant source of cosmic rays (CRs) in our Galaxy up to the 'knee' energy. If the CR production at SNR shocks is efficient, a number of nonlinear (NL) effects must be modeled appropriately to fully interpret broadband continuum observations and X-ray line emission. While a great deal of work has been done modeling SNRs, most work has concentrated on either the continuum emission from relativistic electrons or ions, or the thermal emission. However, the efficient production of CRs can have a significant impact on the SNR evolution and the properties of the shock-heated plasma, so these two processes have to be considered simultaneously. In a series of papers, Ellison et al. (e.g., arXiv:1109.0874) have modeled the coupling of efficient diffusive shock acceleration (DSA) with the non-equilibrium ionization calculation of thermal X-ray line emission using a semi-analytic, NL calculation of DSA developed by Blasi and co-workers. Here, we report on an extensive generalization of this cr-hydro code, based mainly on the recent work by Blasi and co-workers, which includes a number of additional effects related mainly to NL DSA. We believe our generalized cr-hydro code will provide a consistent modeling platform to improve interpretations of high-resolution Astro-H data and other multi-wavelength observations.