SELF CONSISTENT PARTICLE ACCELERATION IN 2D SUPERNOVA REMNANT SHOCKS

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In this paper we present a two-dimensional, self consistent model of cosmic ray modified, supernova remnant shocks developed by Zakharian (2000). The model incorporates anisotropic diffusion of the cosmic rays, including diffusion parallel ($\kappa_{\|}$), and perpendicular ($\kappa_{\perp}$) to the mean magnetic field, and the role of particle drifts due to the anti-symmetric diffusion coefficient κ_A. For the case of an initially uniform background magnetic field, the anisotropic diffusion of the cosmic rays, leads to an anisotropic spatial distribution of thermal plasma, cosmic rays and magnetic field. The shock is quasi-parallel over the poles ($\theta = 0^\circ$), and a quasi-perpendicular shock near the equator ($\theta = 90^\circ$), where $\theta = 0^\circ$ corresponds to the initial magnetic field direction. The equations of the model consist of the Parker transport equation for the energetic particle momentum distribution function, f, including convection, anisotropic diffusion, drifts, and adiabatic energy changes. The transport equation is coupled self-consistently, with the equations of ideal magnetohydrodynamics (MHD) describing the thermal plasma, but suitably modified to take into account injection at the shock, and with an extra force $-\nabla p_c$, exerted by the cosmic ray pressure p_c in the momentum equation for the system. The background state is initially taken to be a Sedov blast wave, with the same parameters used by Kang and Jones (1991). The evolution of the SNR shock, and the momentum distribution $f(\mathbf{r}, p, t)$ of the energetic particles are investigated. The dependence of the solutions and the acceleration rate at the shock on $\eta = \kappa_{\perp}/\kappa_{\|}$ and the shock obliquity θ_{Bn} are studied in detail. Numerical tests and validation of the code are also discussed.