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Non-linear combined MHD- Monte Carlo simulations of proton acceleration in colliding wind binaries

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In colliding-wind binary (CWB) systems, the supersonic winds of two stars collide, forming a wind-collision region (WCR) delimited by two shocks. Such systems are expected to produce a nonthermal distribution of energetic particles via diffusive shock acceleration (DSA) at the collisionless shocks. Interacting with the environment, relativistic electrons and/or protons are in turn expected to produce γ-rays. Test-particle Monte Carlo simulations suggest that the energy put into nonthermal protons is non-negligible. Their backreaction on the shock itself therefore has to be taken into account. We perform Monte Carlo simulations of particle acceleration, obtaining the background from MHD simulations of an archetypal CWB system. We further take into account the feedback of the accelerated protons on the local shock structure, where the particles are injected. Global changes to the system are neglected here. Our approach allows the injection efficiency of DSA in the considered system be obtained from the simulations in a locally self-consistent way, thus contributing to improve γ-ray flux predictions for CWB systems. We present the results of our simulations, including a comparison of the injection efficiencies and of the spectral energy distributions of the accelerated particles injected close to the apex of the WCR.

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