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SLAMS-ENHANCED PARTICLE ACCELERATION AT HIGH-MACH NUMBER ASTROPHYSICAL SHOCKS: TeV IN A BLINK OF SUPERNOVA

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Abstract. The shocks of supernova remnants are known as the nature's most efficient particle accelerators. By the mechanism of diffusive shock acceleration (DSA) particles can reach cosmic-ray (CR) energies over a life time period of the supernova remnant. The DSA is able to produce a power law particle distribution $f(p) \sim p^{-q}$ with the momentum index q=4. However, the radio-synchrotron emission observed at young supernovae implies steeper electron spectra with the slopes $5<q<6$. Since the shocks of young supernova remnants are fast, having Alfvènic Mach numbers > 100, the CR-driven waves in the upstream evolve into short large-amplitude magnetic structures (SLAMS). The periodically amplified magnetic field inside SLAMS represents a superluminal barrier for magnetized electrons. However, the subluminal gaps in the SLAMS structure enable extremely fast electron acceleration by a recently found mechanism of quasi-periodic shock acceleration (QSA). I present the results of our particle-in-cell simulations and theory of electron acceleration at high-Mach number quasi-parallel collisionless shocks. The simulations show that electrons are able to reach TeV energies by QSA in a matter of hours. The good agreement between the slopes of simulation spectra and those observed at young supernova remnants strongly highlights QSA as the main electron acceleration mechanism up to TeV energies where we expect electrons to become unmagnetized and continue to accelerate via DSA.