# RELATIVISTIC PROTON ACCELERATION BY MAGNETOSONIC SHOCK WAVES

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Shock surfing acceleration of protons to relativistic energies by the magnetosonic shocks is analyzed. For relativistic energies, contrary to the non-relativistic case, the kinetic energy, with which the accelerated particle bounces in the direction of shock normal, decreases during the acceleration. Therefore the particle, being initially trapped in front of the shock, cannot overcome potential barrier at the shock front and may remain in the acceleration region indefinitely. Another danger for particle to escape upstream from acceleration is due to the presence at the oblique shock of magnetic field component in the direction of the shock normal. This component of the magnetic field causes cycloidal motion of accelerated ion in the shock plane. Due to this motion the normal component of the upstream Lorentz force changes sign. Since this force normally returns ion back to the shock, ion escapes upstream from the acceleration region. Analysis of the shock surfing acceleration at the relativistic energies yield a critical obliqueness of the relativistic shock below which the ion energy gain due to surfing acceleration is not limited by shock obliqueness.