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低マッハ数衝撃波による相対論的電子加速
Relativistic electron acceleration in a low Mach number shock

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An extreme case of a shock (gradient) drift acceleration process of reflected electrons at low Mach number collisionless shocks is investigated by utilizing one-dimensional electromagnetic full particle simulation. A relativistic shock drift acceleration occurs even in a low Mach number (< 10) moderate quasi-perpendicular shock if a ratio of electron plasma to cyclotron frequencies is small and a plasma beta is high. Such a condition may be realized in some astrophysical environments like a large scale shock in a galaxy cluster, a cosmic ray modified subshock of a supernova remnant, etc. For an almost perpendicular shock with a Mach number of 7.8, a plasma beta of 3, and the frequency ratio of 3, the shock drift acceleration leads to upstream relativistic reflected electrons forming a local relativistic ring-beam distribution function. Additional periodic simulations with a local approximation indicate that the reflected electrons may be possible to self-generate upstream oblique waves, and further be back-scattered toward a downstream by those waves. Coherent wave packets play an important role in the process of back-scattering of the reflected electrons.

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