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Consequences of electron reflection back upstream in oblique shocks

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Astrophysical shocks are believed to efficiently accelerate charged particles, yet electrons need to undergo pre-acceleration to be energetic enough to cross the shock and join the game of acceleration. Understanding the mechanisms responsible for electron pre-acceleration is crucial to solving the shock injection problem. Here, we present PIC simulations of Oblique shocks of varying obliquity angle, θ_{Bn}. Our analyses focus on the reflection of incident electrons back upstream, with these particles capable of generating upstream turbulence and transferring energy away from the shock itself and to the upstream plasma. In this work, we demonstrate that electron reflection occurs in the foot region of the shock, and discuss the cause of this phenomenon. We quantify the dependencies of the rate at which electrons are reflected and the amount of energy carried upstream as functions of shock parameters, showing the electron spectra vary as a function of θ_{Bn} and for which parameter ranges the upstream is significantly modified by the reflected particles. We show that some electrons lose energy after their initial reflection and can be caught up to by the shock, where they either cross into the downstream, or are again reflected. We assess how these energy losses, when significant, could compromise the efficiency of electron injection at the shock.

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Collaboration

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Primary authors: MORRIS, Paul (DESY); BOHDAN, Artem (Z_THAT (Theoretische Astroteilchenphysik)); POHL, Martin (Z_THAT (Theoretische Astroteilchenphysik))

Presenter: MORRIS, Paul (DESY)

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