

Perpendicular relativistic shocks in magnetized pair plasmas

I. Plotnikov^{1,2}, A. Grassi^{3,4,5}, M. Grech³

¹ *Institut de Recherche en Astrophysique et Planétologie, Toulouse, France*

² *Department of Astrophysical Sciences, Princeton, USA*

³ *Laboratoire d'Utilisation des Lasers Intenses, Paris, France*

⁴ *Dipartimento di Fisica Enrico Fermi, Pisa, Italy*

⁵ *Istituto Nazionale di Ottica, Pisa, Italy*

Perpendicular relativistic shocks in magnetized pair plasmas [1] are investigated using two-dimensional Particle-In-Cell (PIC) simulations. In a first part of this work, a systematic survey, from unmagnetized to strongly magnetized plasmas (upstream flow magnetizations from $\sigma = 10^{-6}$ to 10), is presented for an initial flow Lorentz factor $\gamma_0 = 10$. The mechanisms behind shock formation (from Weibel-mediated to magnetic-reflection), the global structure of the shock, and comparison to MHD predictions are discussed for the whole range of upstream magnetizations. The characteristic time of shock formation is also investigated focusing on both density compression and isotropization of the downstream plasma.

The second part of this work focuses on particle acceleration in the shock. It is found to be efficient at weak to intermediate magnetizations and fully suppressed for $\sigma > 10^{-2}$. The relative importance of diffusive shock acceleration and shock drift acceleration will be discussed, the spatial diffusion coefficients extracted from the simulations presented. A scaling of the accelerated particle maximum energy with the upstream flow magnetization $\gamma_{\max} \propto \sigma^{-1/2}$ for $10^{-3} < \sigma < 10^{-2}$ will be presented and the difference with that obtained by Sironi et al. [2] at lower magnetization will be discussed.

[1] Plotnikov, Grassi and Grech, [arXiv:1712.02883](https://arxiv.org/abs/1712.02883).

[2] Sironi, Spitkovsky and Arons, [ApJ 771, 54 \(2013\)](https://doi.org/10.1086/6688888).