Radiative signatures of Fermi acceleration at relativistic shocks

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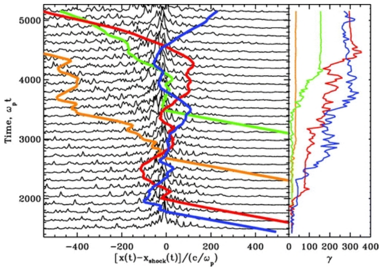
Steady Jets and Transient Jets
Max-Planck-Institut für Radioastronomie
7-8 April, 2010

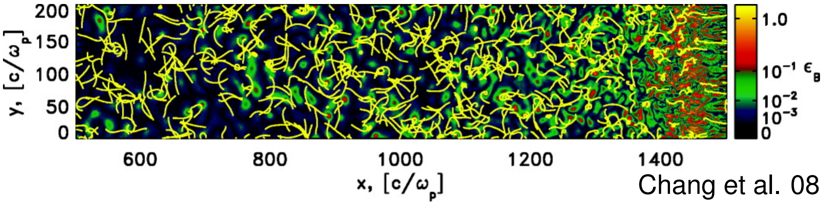
Fermi acceleration at relativistic shocks

- PIC simulations now clearly showing self-consistent acceleration at relativistic shocks
- so far only for unmagnetised plasmas or subluminal shocks

$$\sigma = \frac{B^2}{4\pi\Gamma nmc^2} \ll 1$$



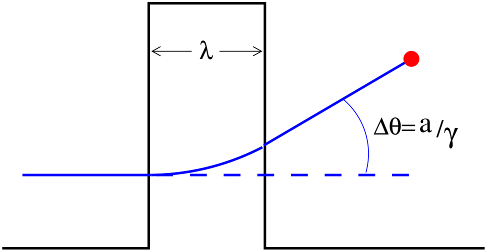
Spitkovsky 2008



Chang et al. 08

Radiation spectra in turbulent fields

Consider a structure with strength parameter $a = eB\lambda/mc^2$



2 transport regimes

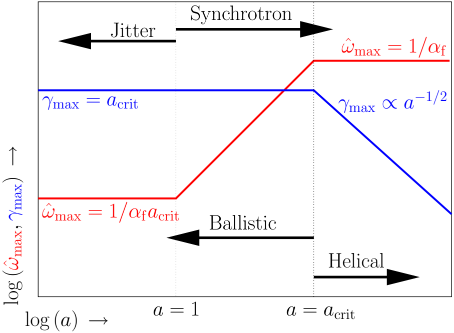
- $a \ll \gamma$: Ballistic
- $a \gg \gamma$: Helical

2 radiation regimes

- $a > 1$: Synchrotron
- $a < 1$: Jitter

Summary

For $e^{\pm}$ Weibel mediated shocks $a_{\mathrm{crit}} \approx 10^6 \bar{\gamma}^{1/6} \left(n/1\,\mathrm{cm}^3\right)^{-1/6}$

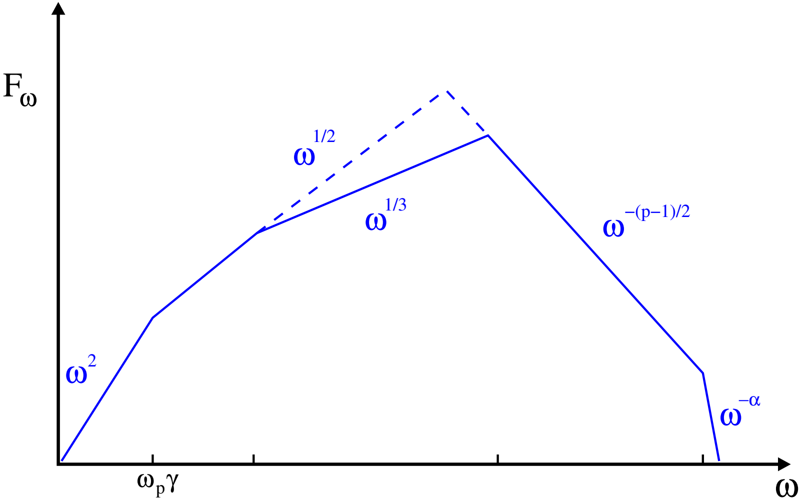


Kirk & Reville (2010)

Current PIC simulations suggest $a \sim \bar{\gamma}$, $\hbar\omega_{\max} \approx 30 \sim 300$eV
$\Rightarrow$ no γ-rays

Radiative signatures of small scale turbulence

Power-law of electrons $\mathrm{d}n/\mathrm{d}\gamma \propto \gamma^{-p}$



Summary

- First order Fermi at relativistic shocks requires strong short wavelength turbulence
- synchrotron in the UV/optical waveband. γ-rays produced via inverse Compton scattering
- low/high frequency spectrum depends on structure of turbulence