radiative signatures of relativistic magnetic reconnection

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supporting Fermi
new flare in 3C 279

Fig. 2.— Gamma-ray light curve of 3C 279 around large flares with short time bins. Top panels: > 100 MeV (192 min). Lower panel: > 1 GeV. Flare 1, 2: 2 orbit (192 min) bin, Flare 3: 1 orbit (96 min) bin.

Fig. 3.— Gamma-ray spectral energy distribution of 3C 279 as measured by Fermi-LAT in each period. The plot include the spectra of 3C 279 during the 1st large flare and first two year averaged one (Hayashida et al. 2012).

Fig. 10.— The spectral energy distributions of 3C 279 during the brightest gamma-ray flares: Flare 1 (Period B, red) and Flare 3 (Period D, blue).

\[ t_{\text{var}} = 2h \]
\[ L_g = 6e48 \text{ erg/s} \]
\[ q = \frac{L_g}{L_{\text{syn}}} > 300 \]
\[ p = 1 \]

Hayashida et al. (2014?)
constraining blazars

- modeling blazars is ambiguous
- main unknowns: distance $r$, Lorentz factor $\Gamma$
- 3 constraints: $\Gamma \theta < 1$, $L_{SSC} < L_X$, $E_{cool} < 100$ MeV
- one can estimate: jet power $L_j$, magnetic field $B$

high Compton dominance $q \gg 1$ means low magnetization $\sigma \ll 1$
relativistic reconnection

- possible dissipation mechanism in relativistic jets and other environments
- efficient particle accelerator (L. Sironi)
- what are its radiative signatures?
relativistic reconnection

particle density and field lines

particle-in-cell code Zeltron
pair plasma
\[ \sigma = 16 \]
\[ kT = m_e c^2 \]

average particle energy

total synchrotron power
dense plasmoid cores are cold and dark

hot plasmoid shells dominate synchrotron emission

brief radiation enhancement during plasmoid mergers
light curves

observed flares can be located to plasmoid mergers
particle acceleration

- complete sample of tracked particles with $\gamma_{\text{max}} > 20$
- main acceleration phase: shortest time when $\Delta \gamma = (\gamma_{\text{max}} - \gamma_{\text{min}})/2$
- connection with emission towards $\pm x$

**color** — particle energy
**arrows** — main acceleration phases
**triangles** — emission along $\pm x$
particle acceleration

- acceleration sites identified by $z$ drift
- magnetic X-points
- merging plasmoids
- plasmoids
- other

main acceleration sites

**color** — mean $z$ velocity
**filled/open** — acceleration start/end
connection to radiation

- position of particles emitting towards +x
- high-energy emission produced mainly by particles accelerated at magnetic X-points and plasmoids (green/blue)
summary

• extreme gamma-ray flares may be produced by relativistic magnetic reconnection

• synchrotron radiation can be calculated self-consistently from kinetic simulations of reconnection

• radiation is produced mainly along hot plasmoid shells and enhanced (flaring) during mergers

• multiple sites of particle acceleration, not all contribute to high-energy flares