Modelling of blazar SEDs with the nonlinear SSC cooling process

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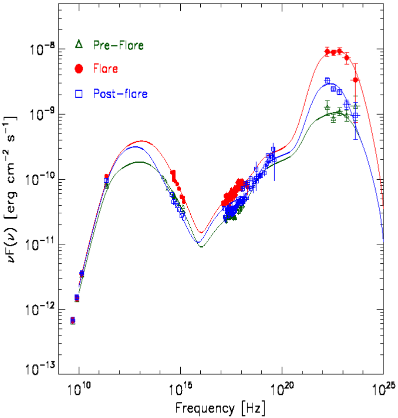

Figure 1: SED of 3C 454.3 during a large outburst in November 2010 (Vercellone et al. 2011)

- Numerical calculations of SEDs implement time-dependent nature of SSC cooling
- Most modeling attempts fail to recognize the important effects

Kinetic equation

- Electron kinetic equation:

$$\frac{\partial n(\gamma, t)}{\partial t} - \frac{\partial}{\partial \gamma}\left[|\dot{\gamma}|_{\mathrm{TOT}} n(\gamma, t)\right] = Q(\gamma, t)$$

- Source term:

$$Q(\gamma, t) = q_0 \delta(\gamma - \gamma_0)\delta(t)$$

  - Description of flares, i.e. single injection of relativistic ($\gamma_0 \gg 1$) particles
  - Not useful for steady-state sources

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  - SSC cooling depends on electron distribution (i.e. time-dependent) $\Rightarrow$ synchrotron cooling dominates after some time

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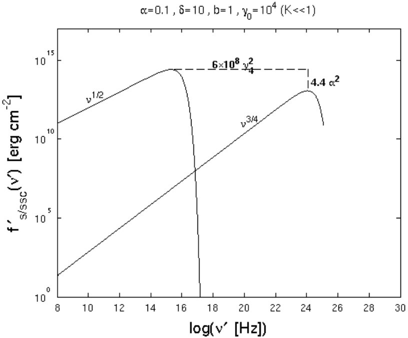


Figure 2: Model-SED for $\alpha \ll 1$ in the Thomson-limit

- Compton dominance depends strongly on α as predicted

Results

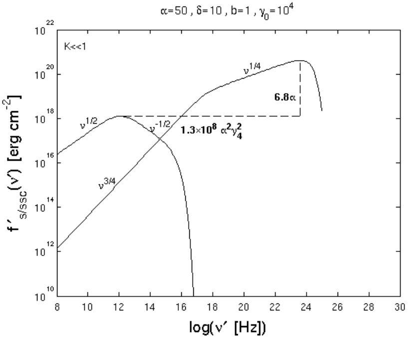
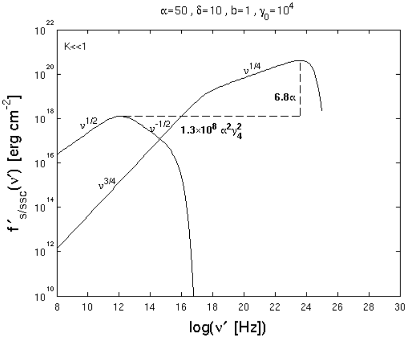


Figure 3: Model-SED for $\alpha \gg 1$ in the Thomson-limit

- Compton dominance depends strongly on α as predicted
- The synchrotron peak shows a characteristic feature for $\alpha \gg 1$ (without the need for fancy electron distributions)
- Different electron distributions affect only the high-energy end of the peaks (MZ & RS 2010)



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A new chain of reasoning

Standard scenario:

- Efficient accretion disk
- $\Rightarrow$ Strong BLR and torus
- $\Rightarrow$ Lots of seed photons
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$\Rightarrow$ Potentially both processes are equally important

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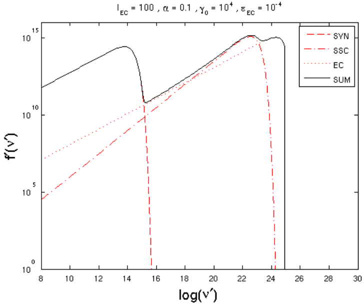
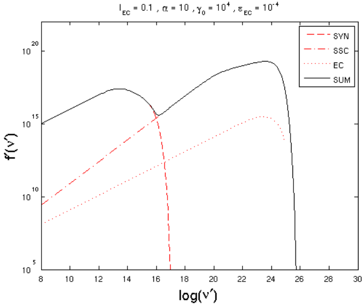


Figure 4: Model-SED for $\alpha_{ec} \ll 1$ and $l_{ec} \gg 1$ in the Thomson-limit

- Inclusion of external Compton requires new parameters:
  - Relative strengths $l_{ec} = u_{ec}\Gamma_b^2/u_B$
  - Injection parameter $\alpha_{ec}^2 = \gamma_0^2 q_0 A_0 \,/\, D_0(1 + l_{ec})$
- For $\alpha_{ec} = \alpha$
  $\Rightarrow$ q_0 increases
  $\Rightarrow$ SSC luminosity increases with $(1 + l_{ec})$



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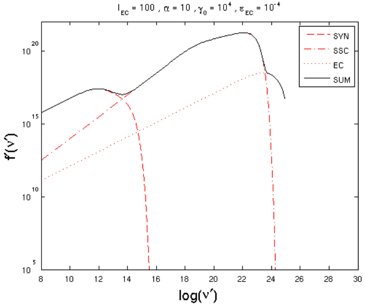

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- Comparable with EC depending on parameters

- Follow-ups: Lightcurves and optical depth

Summary & Outlook

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Thank you very much!

- Zacharias & Schlickeiser 2012, *in prep.*
- Zacharias & Schlickeiser 2012, *MNRAS* 420, 84
- Schlickeiser, Böttcher & Menzler 2010, *A&A* 519, A19
- Zacharias & Schlickeiser 2010, *A&A* 524, A31
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