Extragalactic sources – IC models

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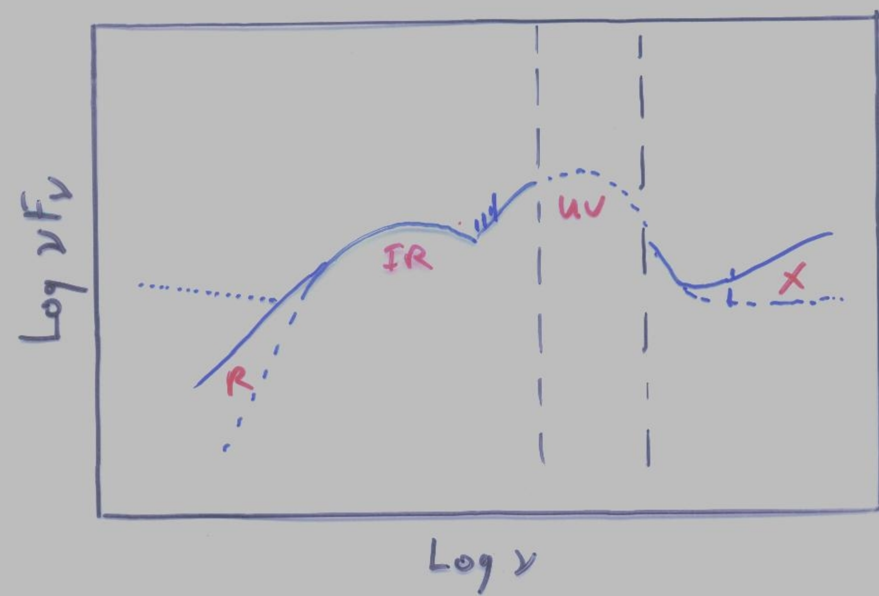
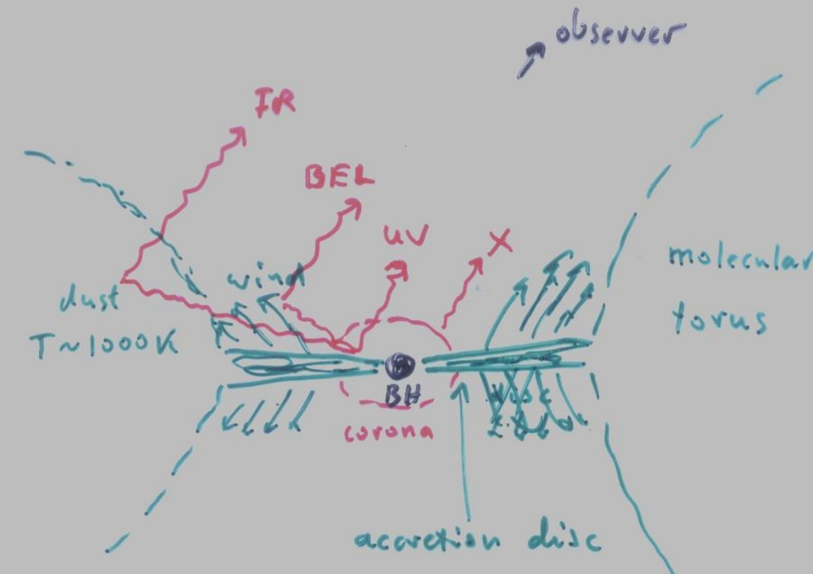
QUASARS



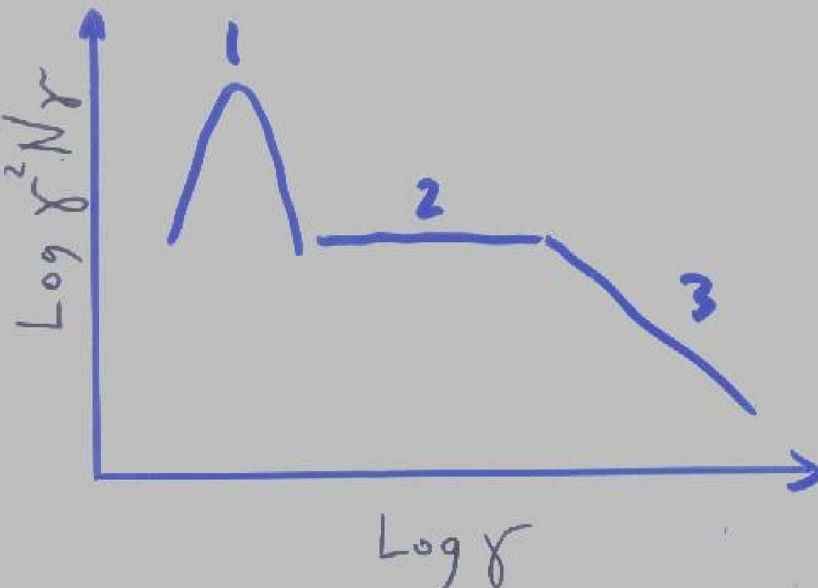
Log νFν
Log ν
R
IR
UV
X

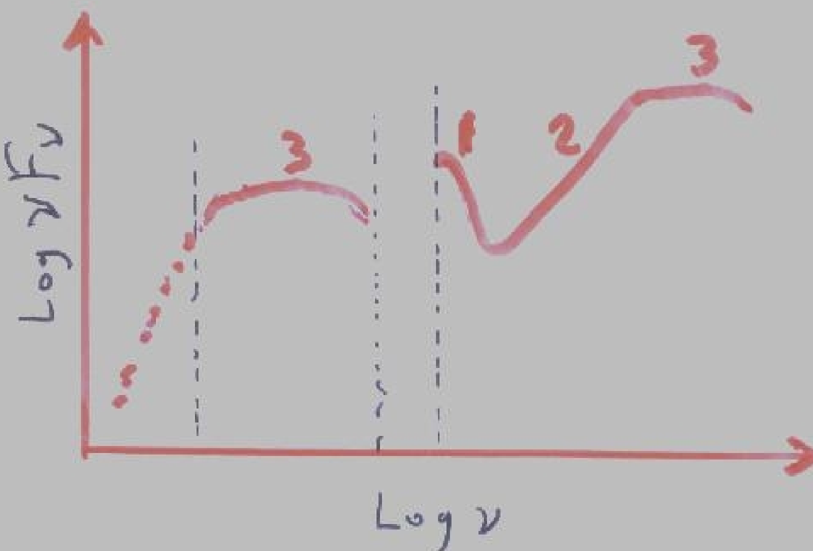


observer
IR
BEL
UV
X
wind
dust
T~1000K
molecular
torus
BH
corona
accretion disc

SYN (optically thin)	ERC (EC, IC) (Thomson regime)
$\nu_B \sim \frac{B}{B_{cr}} \frac{m_e c^2}{h}$ $(B_{cr} \sim 4.4 \cdot 10^{13}$ Gauss$)$	ν_{ext}
$\nu_{syn} \sim \gamma^2 \nu_B \delta$	$\nu_{EC} \sim \gamma^2 \nu_{ext} \delta^2$
$\lvert\dot\gamma\rvert_{syn} \propto \gamma^2 u_B$	$\lvert\dot\gamma\rvert_{EC} \propto \gamma^2 u'_{diff}$ $u'_{diff} \sim \frac{1}{c}\int I'_{ext}\, d\Omega' \sim \Gamma^2 u_{diff}$
$[\nu L_\nu]_{syn} \propto$ $[\gamma N_\gamma]\,\lvert\dot\gamma\rvert_{syn}\,\delta^4$	$[\nu L_\nu]_{EC} \propto$ $[\gamma N_\gamma]\,\lvert\dot\gamma\rvert_{EC}\,\delta^4 \left(\frac{\delta}{\Gamma}\right)^2$
For $N_\gamma \propto \gamma^{-s}$	$L_\nu \propto \nu^{-\alpha}$

where $\alpha = \frac{s-1}{2}$


1
2
3
Log γ²Nγ
Log γ


3
1
2
3
Log νFν
Log ν

L_{EC} vs. L_{syn}:

$$\frac{L_{EC}}{L_{syn}} = \frac{u'_{dif}}{u_B}$$

$$u'_{dif} \approx \Gamma^2 \frac{\xi L_{uv}}{4\pi r^2 c}$$

$$u_B \simeq \frac{L_B}{\pi R^2 c \Gamma^2}$$

$$R = \theta_j r$$

$$\frac{L_{EC}}{L_{syn}} = q \Rightarrow \boxed{\Gamma \simeq \sqrt{\frac{4 L_B q}{\xi L_{uv}}}}$$

For $q \simeq 10$, $\xi = 0.1$, $L_B \simeq L_{uv}$

$$\Gamma \simeq 20$$

L_{EC} vs. L_{SSC}:

$$\frac{L_{EC}}{L_{SSC}} \sim \frac{u'_{dif}}{u'_{syn}}$$

$$u'_{syn} \sim \frac{L'_{syn}}{2\pi R^2 c} \simeq \frac{L_{syn}}{2\pi R^2 c}\frac{1}{\Gamma^4}$$

$$u'_{dif} \sim \Gamma^2 \frac{\xi L_{uv}}{4\pi r^2 c}$$

$$R = \theta_j r$$

$$L_{EC} > L_{SSC} \Rightarrow \boxed{\Gamma > \left(\frac{L_{syn}}{2\xi L_{uv}}\right)^{1/4}}$$

For $\xi = 0.1$, $L_{syn} \simeq 10 L_{uv}$

$$\Gamma \gtrsim 3$$

MODELING BLAZARS

$$t_{var} \Rightarrow R < c\,t_{var}\,\delta \Rightarrow r \le \frac{c\,t_{var}\,\delta\,\Gamma}{(\theta_j \Gamma)}$$

no bulk-Compton features $\Rightarrow r \ge r_{BLR}$

$\Rightarrow r \Rightarrow u_{dif}$ (u_{BLR} and/or u_{IR})

VLBI $\rightarrow \Gamma \sim 10 \div 20$

$$[\nu L_\nu]_\gamma \Rightarrow [\gamma N_\gamma] \Rightarrow N_e$$

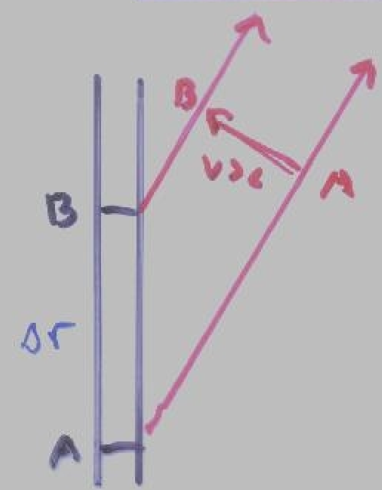
$$\frac{[\nu L_\nu]_{EC}}{[\nu L_\nu]_{syn}} \simeq \frac{\Gamma^2 u_{dif}}{u_B} \Rightarrow B$$

blob model

$$\frac{N_p m_p c^2}{\frac{4}{3}\pi R^3} > u_B$$

$$\Rightarrow \frac{N_e}{N_p} \le \ldots$$

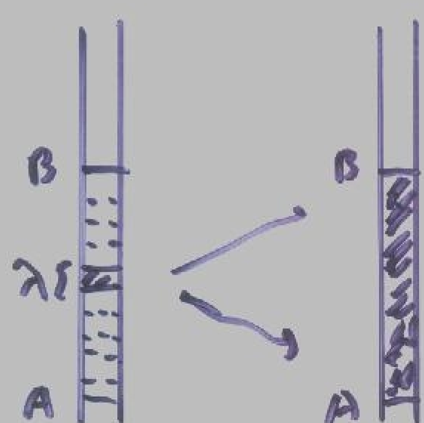
CONTINUOUS JET



$$\Delta t_{obs} = \frac{\Delta r}{c}(1-\beta\cos\theta_{obs}) =$$

$$= \frac{\Delta r}{c}\,\frac{1}{\delta\Gamma}$$

$$\left.\begin{aligned} \dot{N}_{obs} &= \dot{N} \\ t_{obs} &= \frac{t_{\Delta r}}{\delta\Gamma} \end{aligned}\right\} \Rightarrow \quad N_{obs} = \frac{N}{\delta\Gamma}$$



$$\boxed{\lambda = \frac{\Delta r}{\delta\Gamma}}$$

$$\lambda' = \frac{\Delta r}{\delta} \simeq R$$

for $\Delta r \sim r$
and $\delta = \Gamma = \frac{1}{\theta_j}$

DISSIPATION RATE AND THE POWER OF A JET

$$L_1' \equiv \frac{L_{obs}}{\delta^4} = \frac{\Delta E_{rad}'}{\Delta t'} \simeq \frac{\Delta E}{\Delta t} = L_1$$

$$L_{rad}(\Delta r) = \left(\frac{N_e}{N_{obs}}\right)\bar{L}_1 = \delta\Gamma \cdot \frac{\bar{L}_{obs}}{\delta^4}$$

$$= \frac{\bar{L}_{obs}}{(\delta^3/\Gamma)}$$

$$\boxed{L_{diss}(\Delta r) = \frac{1}{\eta_{rad}} \frac{\bar{L}_{obs}}{\delta^3/\Gamma}}$$

where $\bar{L}_{obs} = \dfrac{\int^{\Delta r/c} L_{obs}\, dt}{\Delta r/c}$

$$L_B = \pi R^2 u_B c \Gamma^2 = \pi r^2 u_B c (\theta_j \Gamma)^2$$

$$\boxed{L_j > L_{diss} + L_B}$$

KN effects

(Moderski et al. '05)

$$\frac{\partial N_\gamma}{\partial t'} = -\frac{\partial}{\partial \gamma}\left[N_\gamma \cdot \dot{\gamma}\right] + Q = 0$$

$$N_\gamma \sim \frac{1}{|\dot{\gamma}|}\int Q\, d\gamma \qquad \text{where } |\dot{\gamma}| = |\dot{\gamma}|_{EC} + |\dot{\gamma}|_{syn}$$

$$|\dot{\gamma}|_{EC} \propto \gamma^2 F_{KN}(\gamma)$$

$$|\dot{\gamma}|_{syn} \propto \gamma^2$$

$$|\dot{\gamma}|_{EC} \gg |\dot{\gamma}|_{syn}$$

$$\downarrow$$

$$|\dot{\gamma}|_{EC} \lesssim |\dot{\gamma}|_{syn}$$

$$\downarrow$$