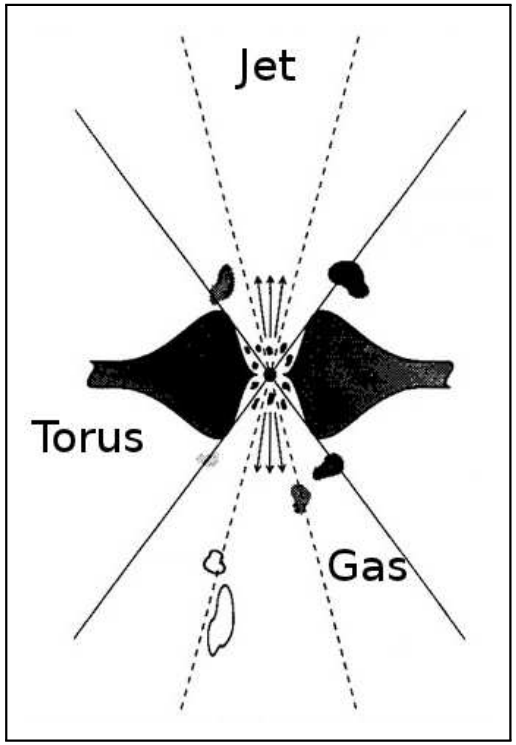
The hybrid AGN core of 3C 111

Sandra de Jong

François Arago Centre, APC, Université Paris Diderot

31 May 2012

Active Galactic Nuclei

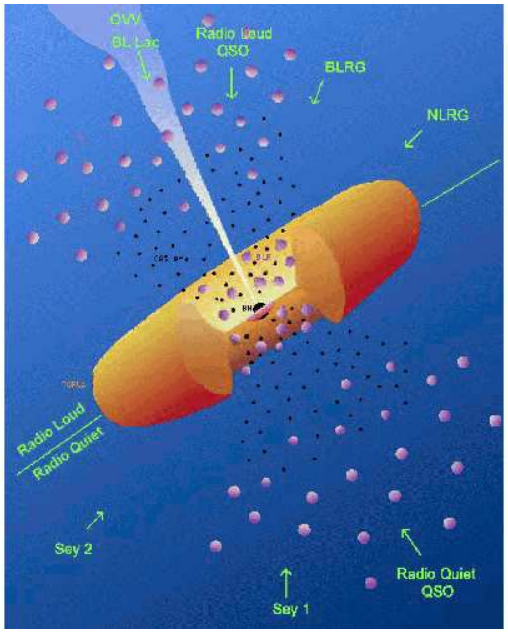


Pogge, 1989

* Core of active galaxy (<1 pc)
* High luminosity emission at almost every wavelength
* Powered by accreting super massive black hole
* Variety of objects: BL Lac, radio galaxy, Seyfert galaxy etc

AGN in γ-rays

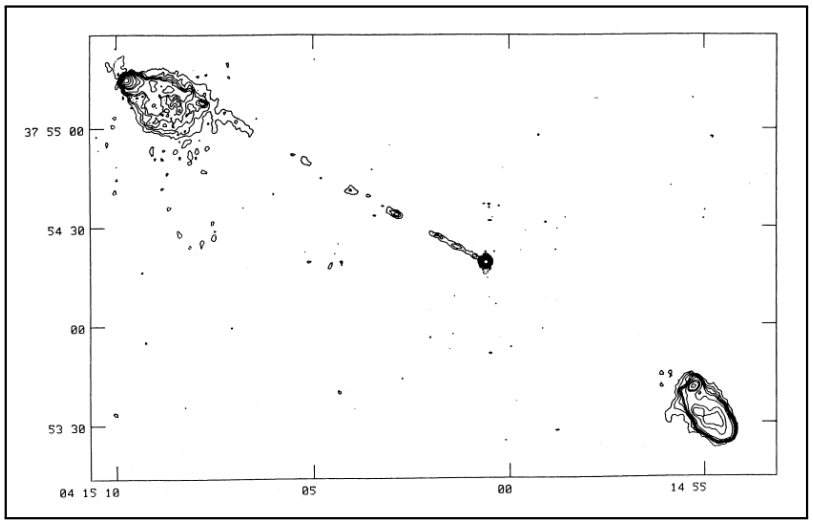
Unification of AGN: same central engine
Differences in:
* viewing angle
* jet presence
* accretion efficiency
* black hole mass



Urry & Padovani, 1995 (adapted)

Introduction 3C 111

* Radio galaxy FRII z=0.049
* Broad emission lines (optical), iron line (X-rays)
* Radio: one visible jet with projected size of 78 kpc
* Recent detection in γ-rays by Fermi/LAT!

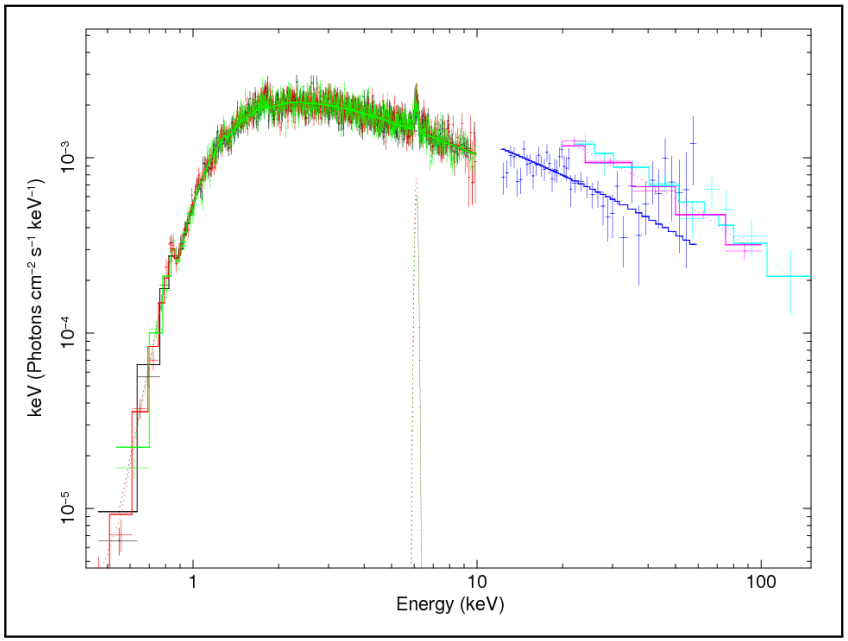


Linfield & Perley, 1984

3C 111 in γ-rays

* CGRO/EGRET: 3C 111 tentatively associated with a γ-ray source, however outside 99% probability region (Hartman et al., 1999)
* Re-analysis of EGRET data: earlier probability region larger (Sguerra et al. 2005) and likely to be blending of several sources (Hartman et al. 2008)
* Fermi/LAT 1st LAT catalog: 3C 111 is included with a significance of 4.3σ(Abdo et al., 2010)
* Fermi/LAT 2nd LAT catalog: 3C 111 is no longer included (Abdo et al., 2011), but 3C 111 is likely to be variable (Ackermann et al., 2011)
* 24 months of Fermi/LAT data, 3C 111 is detected with $>5\sigma$ (Kataoka et al., 2011)

3C 111: X-ray spectrum



de Jong et al., 2012 (A&A submitted)

Model: absorbed cut-off power law with Compton reflection and a Gaussian component:

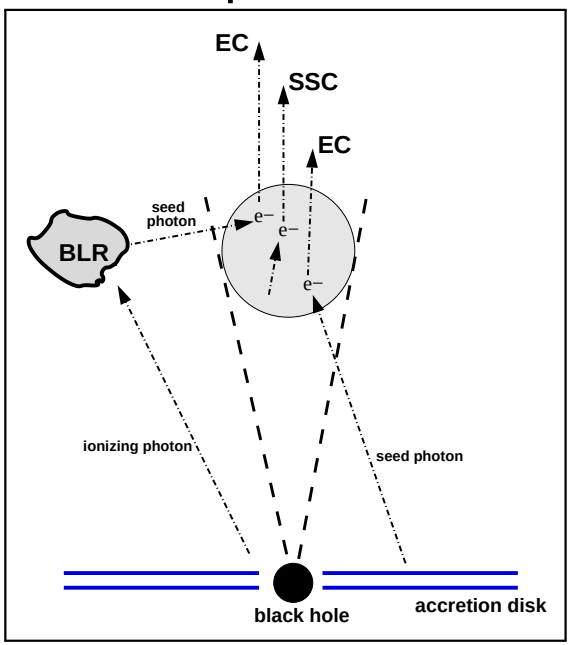
$E_{cut} = 227^{+143}_{-67}\,\mathrm{keV}$

$R = 0.7 \pm 0.3$

$EW = 85 \pm 11\,\mathrm{eV}$

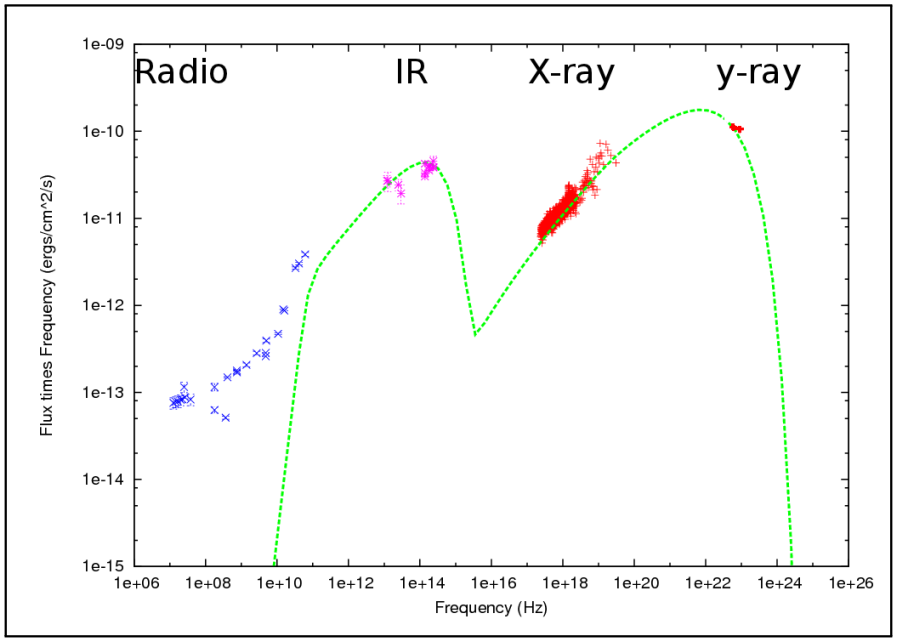
3C 111: Spectral energy distribution

Model: single zone synchrotron self-Compton



Beckmann & Shrader 2012

Broad band SED of 3C 111 with best-fit model



de Jong et al., 2012 (A&A submitted)

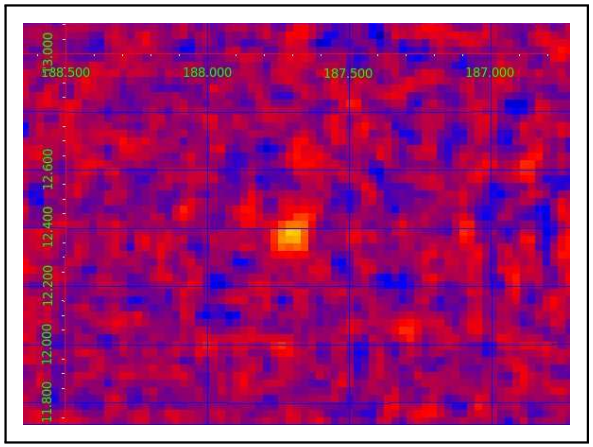
Doppler factor $\delta = 14$

Magnetic field $B = 0.04\mathrm{G}$

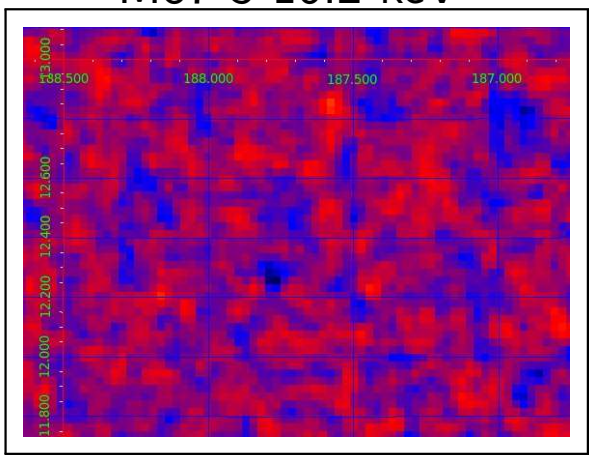
M 87: another γ-ray detected radio galaxy

INTEGRAL/JEM-X significance maps

Next up: radio galaxy FRI M 87 (z=0.004)
* Detection in γ-rays and TeV
* No detection in hard X-rays!
* Now: analyse the Fermi/LAT data of M87
* Next: set an upper limit in hard X-rays with INTEGRAL/ISGRI
* Goal: model the broadband SED



M87 3-10.2 keV



M87 10.2-25.2 keV

Conclusion

* The question: how is γ-ray radiation produced in non-blazar AGN?
* 3C 111: a FRII radio galaxy detected by Fermi/LAT
* X-ray spectrum: Seyfert-like, dominated by thermal component; iron line and reflection
* SED: dominated by non-thermal processes; SSC without EC component
* Solution: hybrid model
* Next : M 87: a FRI radio galaxy detected by Fermi/LAT and in TeV