Axion Luminosity From AGN

Phenomenology-2010

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Subhayan Mandal*

IFPA, University of Liege-Belgium

May 10, 2010

Features Of AGN

[1]B.M. Peterson, *An Introduction To Active Galactic Nuclei(CUP)*

[2]Accretion power in astrophysics-J. Frank, *A. R. King, Derek J. Raine (CUP)*

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- Luminosity $\sim 10^{45}$ erg-cm [1]

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- Different AGN's
  1. Quasar
  2. QSO
  3. Seyfert
  4. Blazar
  5. BL Lac

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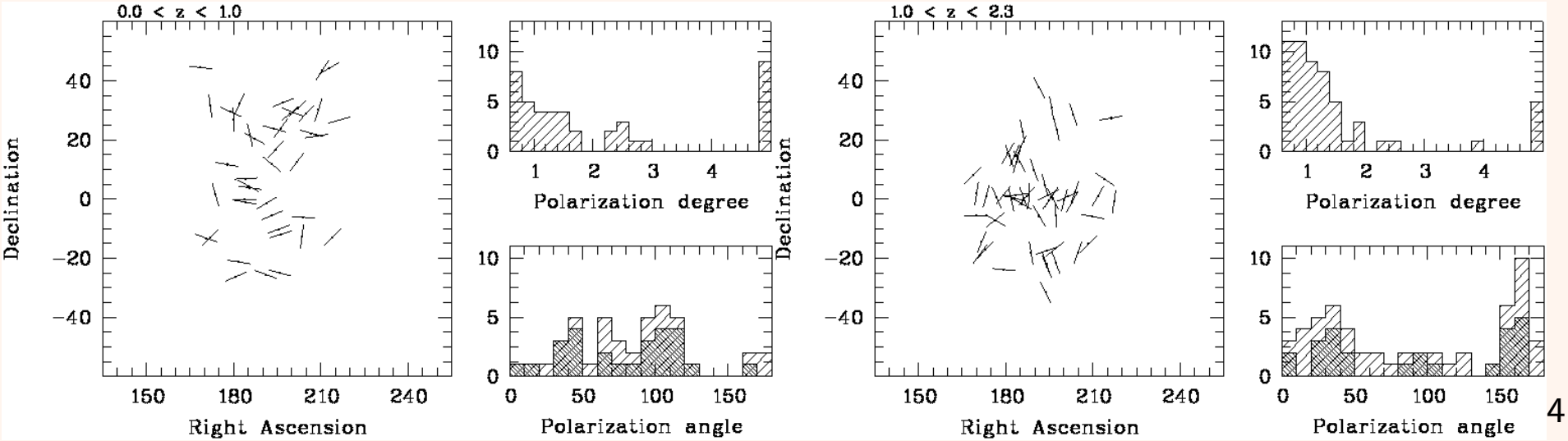
Alignment Effect



[4]

[4] D. Hutsem kers, R. Cabanac, H. Lamy and D. Sluse, Astronomy and Astrophysics, 441, 915, (2005)

Explanation

This curious effect has given way to several theories - such as -

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1. Instrumental Artefact

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7. **Mixing Of γ to ϕ & Dust Extinction** [5]

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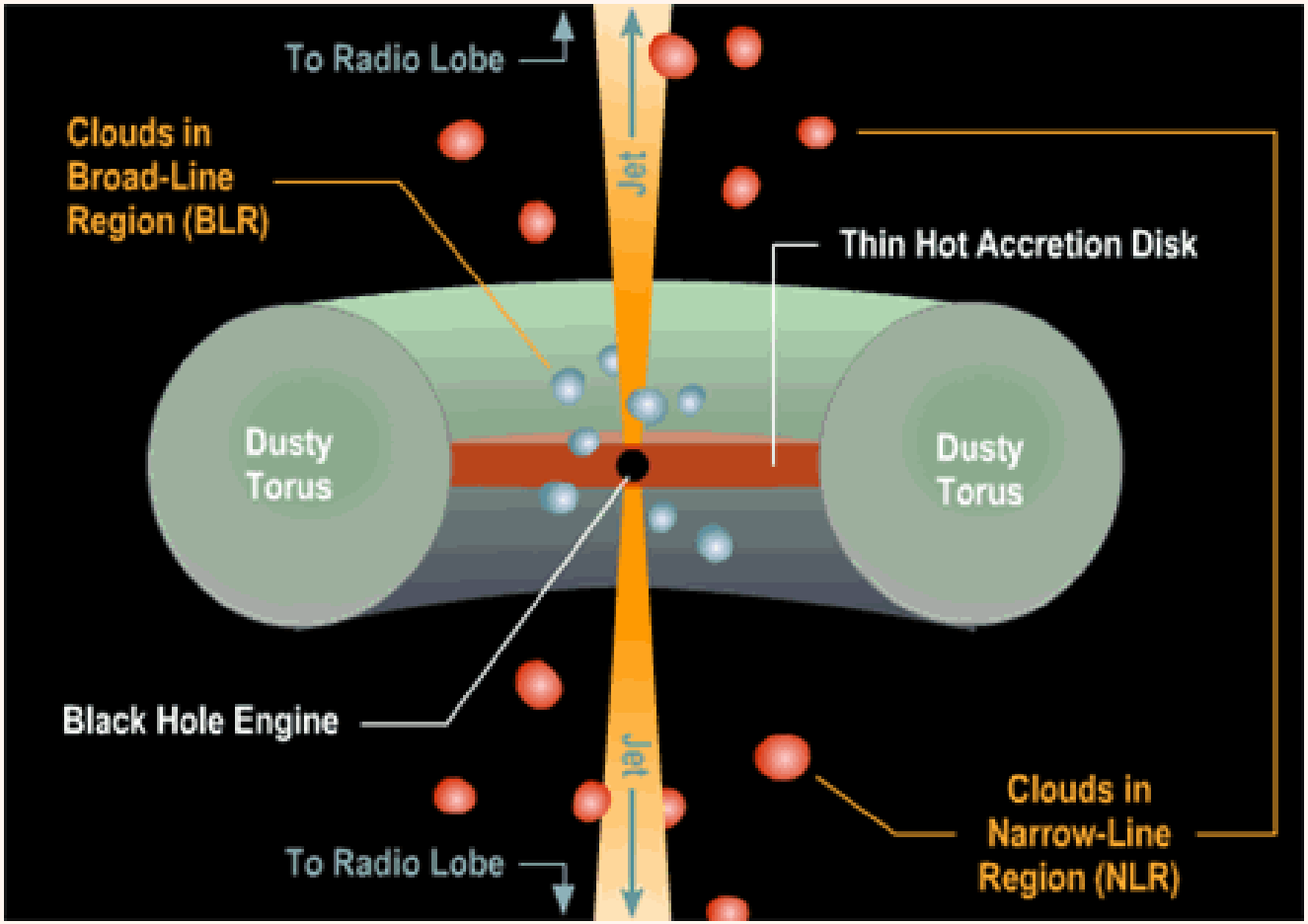
The schematic diagram for an AGN -



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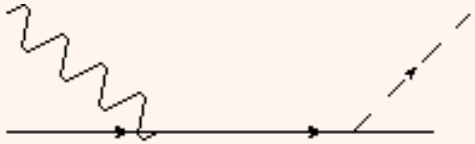

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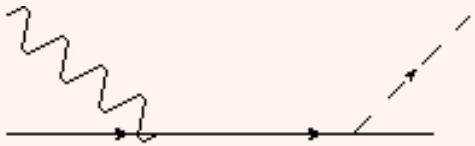
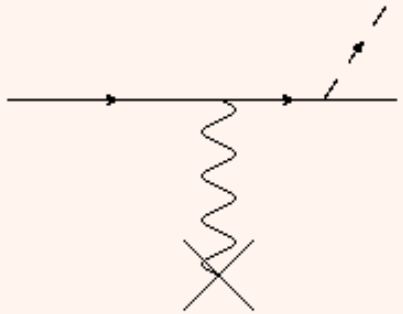


Bremsstrahlung



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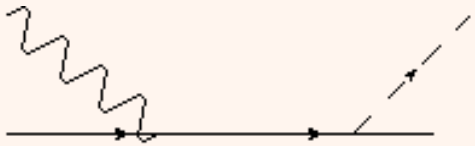

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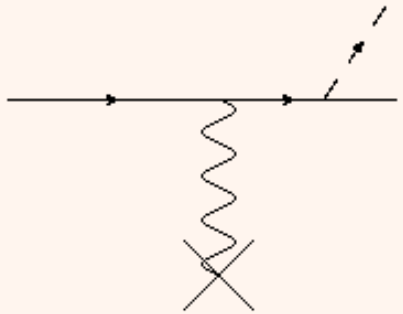
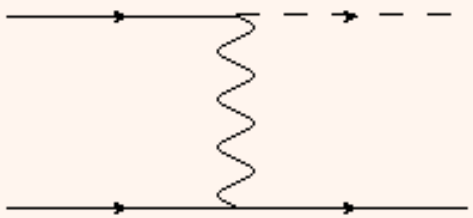


Primakoff



Luminosity From poduction Of ϕ

The integrated luminosity of the accretion disk for the previously mentioned cases are found to be -

$$\mathrm{L_{comp}} = 9.7 \times 10^{29} \ \ \mathrm{erg - s^{-1}} \tag{1}$$

$$\mathrm{L_{brem}} = \int \dot{\epsilon_a}(\mathrm{B})\, \mathrm{dM} = 5.7 \times 10^{36} \ \ \mathrm{erg - s^{-1}} \tag{2}$$

$$\mathrm{L_{Prim}} = 2.84 \times 10^{32} + 7.1 \times 10^{31} \ \ \mathrm{erg - s^{-1}} \tag{3}$$

Which is quite low compared to the γ luminosity[6].

[6] Here the coupling values of g_{aee} & $g_{a\gamma\gamma}$ are used, which, in turn are consensus parameters for axion.

Conversion In AGN Surroundings

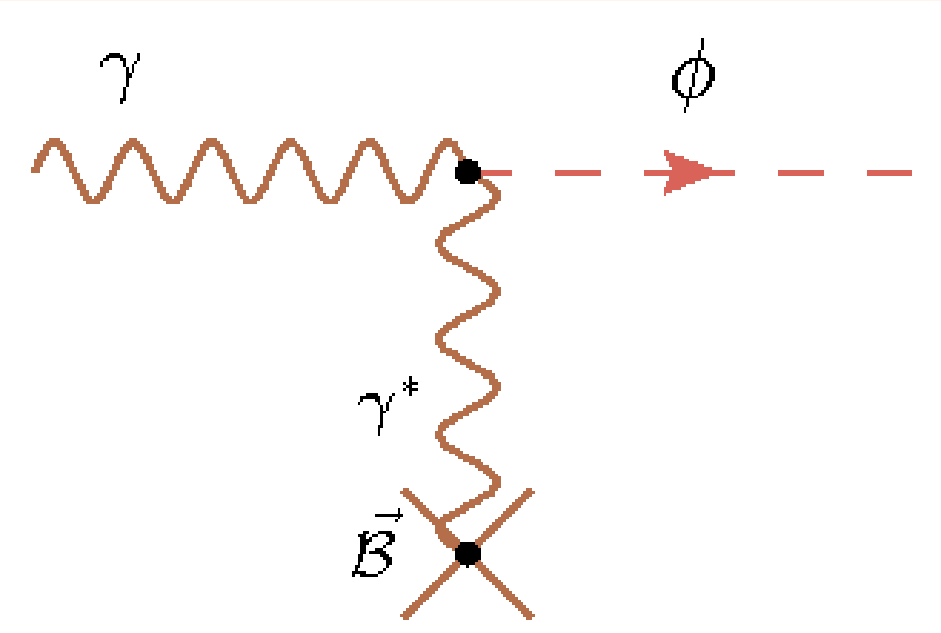
AGN surroundings consists of the disk, jets, BLR, NLR, dust tori & the radio lobes. The exact morphology is not yet known but we can assume a spherical domain (like the camel) of certain magnitude.What is more, it is not known what are the parameters there, or, how they change in different regions. Still, we can go ahead with some representative numbers.

Parameters

Object	Magnetic Field	Plasma density
Cygnus A	4×10^{-4} G	10^{-4} cm^{-3}

Table: The value of of parameters we take for the representative case

Conversion Diagram



Extinction

Here we shall use the standard 2×2 channel ϕ mixing with γ with extinction with intergalactic dust. Again the parameter space is a little flimsy but we can (as a first guess) use the value of the host galaxy gaxtinction found in high redshift (as the aligned quasars) supernovae.

$$(\omega^2 + \partial_z^2) \begin{bmatrix} A_{||}(z) \\ \phi(z) \end{bmatrix} = M \begin{bmatrix} A_{||}(z) \\ \phi(z) \end{bmatrix}. \tag{4}$$

$$M = \begin{bmatrix} \omega_p^2 + i\Gamma(\omega) & -g_\phi \mathcal{B}_\mathcal{T} \omega \\ -g_\phi \mathcal{B}_\mathcal{T} \omega & m_\phi^2 \end{bmatrix} \tag{5}$$

Where,

$$\Gamma = \frac{2\omega^2 K}{z}$$

$$\lambda_{\pm} = \frac{1}{2}\left[\Omega_p^2 + m_\phi^2 \pm \sqrt{(\Omega_p^2 + m_\phi^2)^2 - 4(\Omega_p^2 m_\phi^2 - g_\phi^2 \mathcal{B}_T^2 \omega^2)}\right] \quad (6)$$

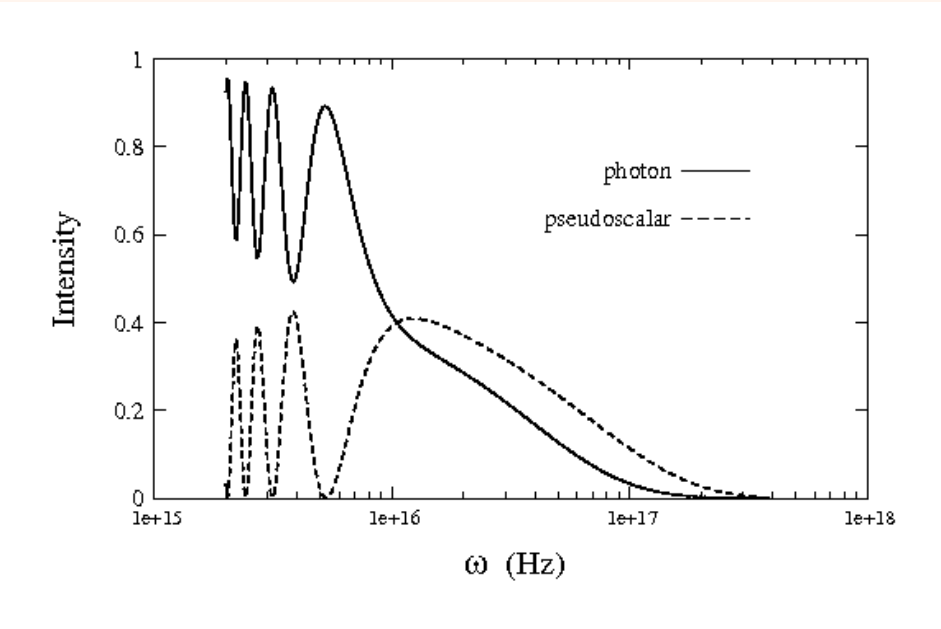
where $\Omega_p^2 = \omega_p^2 + i\Gamma$. We assume the boundary condition, $\phi(0) = 0$, and find the final result

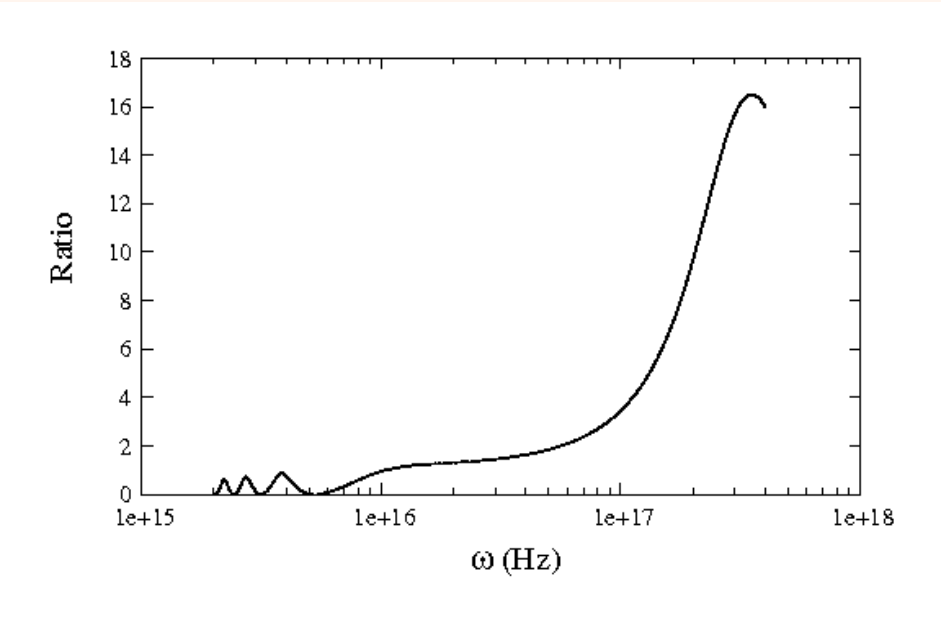
$$\begin{aligned} A_{||}(z) &= \frac{1}{ad - bc}\left[ad\, e^{(iz\sqrt{\omega^2 - \lambda_+})} - bc\, e^{(iz\sqrt{\omega^2 - \lambda_-})}\right] A_{||}(0) \\ \phi(z) &= \frac{bd}{ad - bc}\left[e^{(iz\sqrt{\omega^2 - \lambda_+})} - e^{(iz\sqrt{\omega^2 - \lambda_-})}\right] A_{||}(0) \end{aligned} \quad (7)$$

where $a = (\lambda_+ - m_\phi^2)/\sqrt{N_+}$, $b = -g_\phi B_T \omega/\sqrt{N_+}$, $c = g_\phi B_T \omega/\sqrt{N_-}$, $d = (\Omega_p^2 - \lambda_-)/\sqrt{N_-}$. Here N_+ and N_- are normalization factors which cancel out in the final expressions. The perpendicular component of the electromagnetic wave is given by,

$$A_\perp(z) = A_\perp(0) e^{iz\sqrt{\omega^2 - \Omega_p^2}} \quad (8)$$

Plot


Intensity
photon
pseudoscalar
ω (Hz)
1e+15
1e+16
1e+17
1e+18
0
0.2
0.4
0.6
0.8
1


Ratio
ω (Hz)
1e+15
1e+16
1e+17
1e+18
0
2
4
6
8
10
12
14
16
18

Quasar Polarization Alignment

- In AGN surroundings, the conversion of $\gamma \longrightarrow \phi$ dominates when extinction is assumed.
- The ϕ reconverts to γ upon entering our supercluster.
- The selective attenuation of a particular polarization induces some linear polarization - dichroism.
- The alignment towards local supercluster Virgo emboldens our claim

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- Future Scope $\rightarrow$ To Quantify The Claim.

Conclusion

The standard processes yield a low luminosity of pseudoscalars inside AGN. However, the flux can be sizable at ultraviolet frequencies if we assume a frequency dependent dust extinction in the AGN atmosphere while calculating standard photon to pseudoscalar conversion mediated in a magnetic field. This may in turn be applied to the apparent problem of Quasar alignment.

Thank You

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- Jean-Rene Cudell
- Alexandre Payez
- Davide Mancusi
- Igor Ivanov