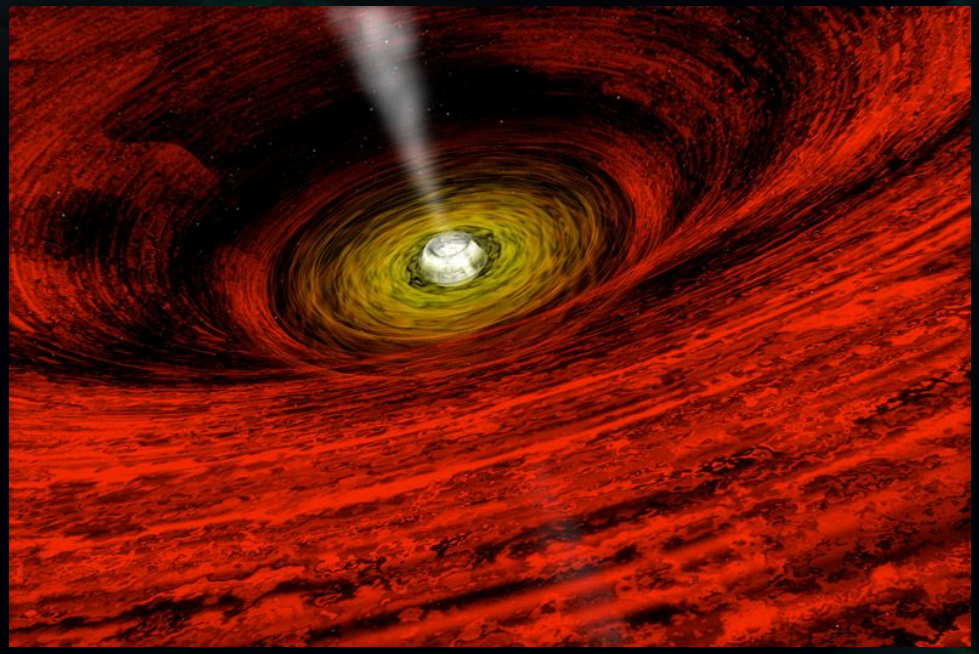
Introduccion a Los Nucleos Galacticos Activos



Material de:

STScI (HST), Chandra, muchos homepage de otros individual's
(Brad Petersen, Bill Keel, y otros)

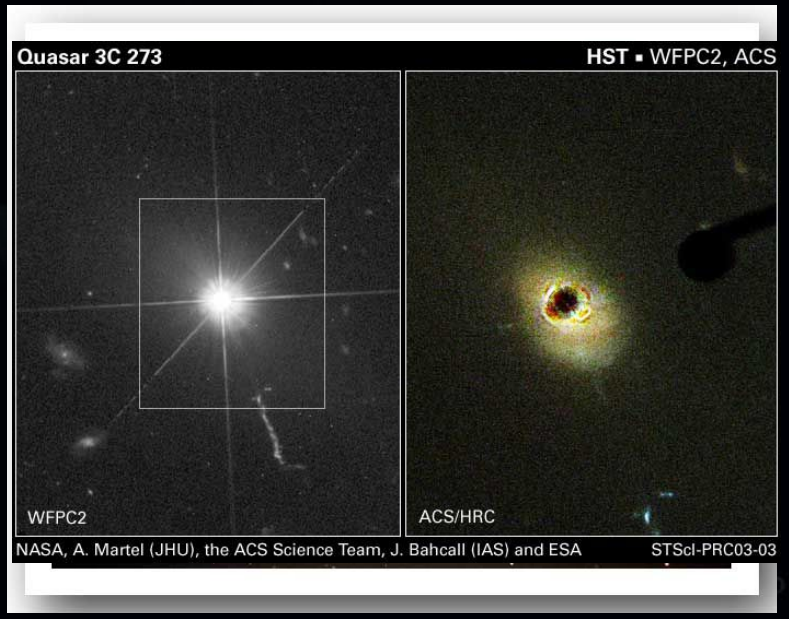
Resumen

- Nucleos Activos verso Nucleos quietos
- Acreciente in agujero negro (physicos basicos)
- `Esquema unificado de AGN' - the AGN zoo
- Agujero Negros: ubicuidad y escalamiento
  - Estimar la masa del agujero negro
- `Super-unificados'
- In el principio : agujero negros de alto redshift
- Resumen finale

Semana Siguente: Secret `Active' Lives of Nearby `Normal' Galaxies

~~Nucleos activos vs quietos~~

- *"Quietos" : motor relacionado de la formacion de la estrella*
  - *Estrellas jovenes y viejas; gas y polvo*
  - *Supernovae (SN) y remanante de la SN*
  - *Otros productos remanante, e.g. Binario X-ray*
- *"Activos" : a mucha actividad a ser el antedicho*
  - *Fuentes luminosas compactas de la emision*
  - *Jets y Outflows (comedores sucios)*
  - *Creido para ser accionado por un `supermasssive' agujeros negros*



Active vs. Normal Galaxies (continuum)

Galaxies

All men are created equal,

active

But some are more equal than others

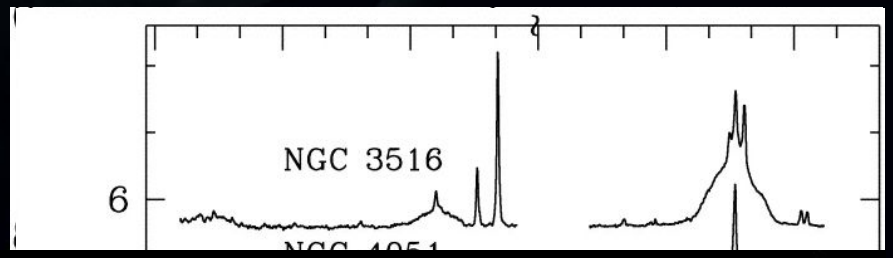
active

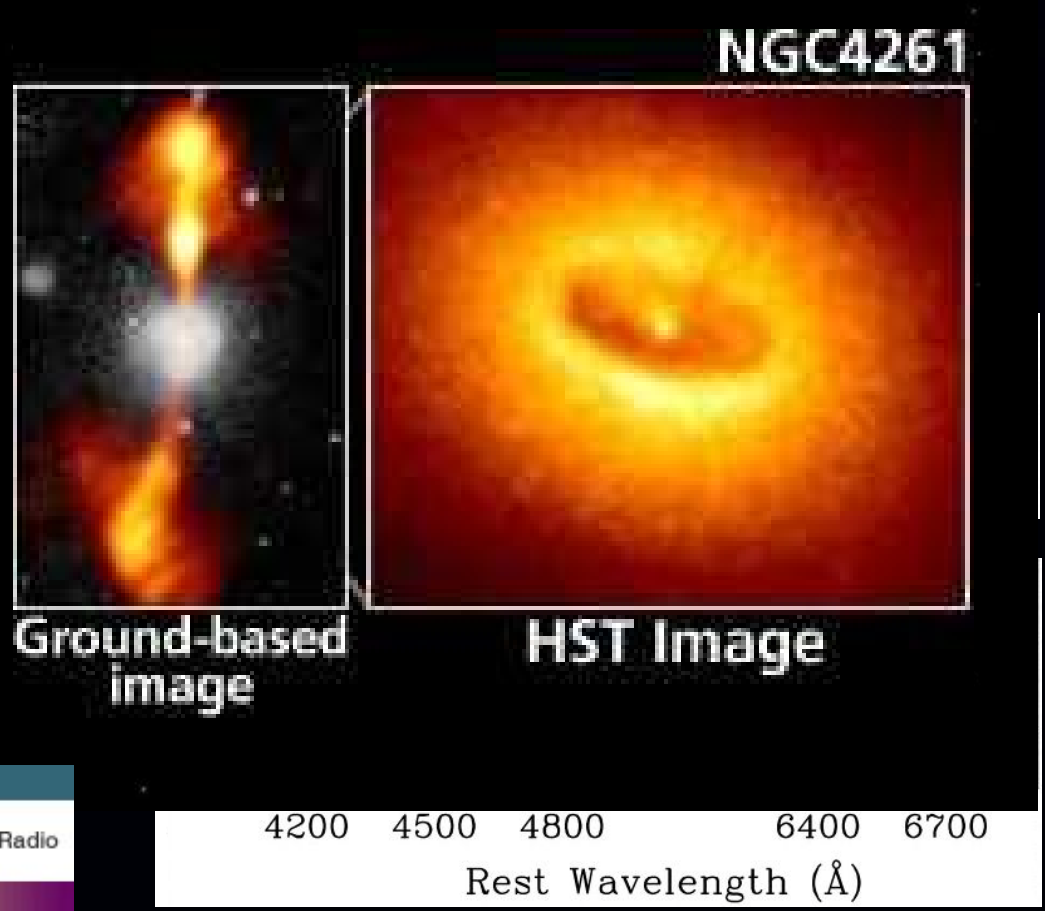
George Orwell, "Animal Farm"

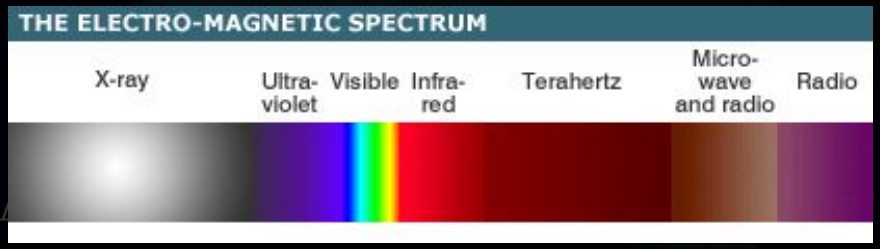
AGN identificacion

- Espectroscopia Optica y infra-rojo
  - (amplio) lineas de emision fuertes
- Fuentes compactas (hard X-ray, optica, radio, infra-rojo)
- Jets y lobulos de radio grandes (relativista)
- Variabilidad grande

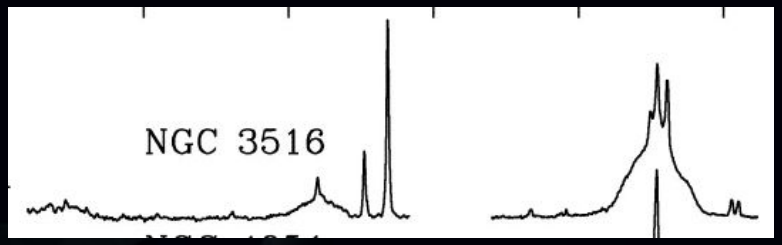
10,000 km/s `broad' Halpha)





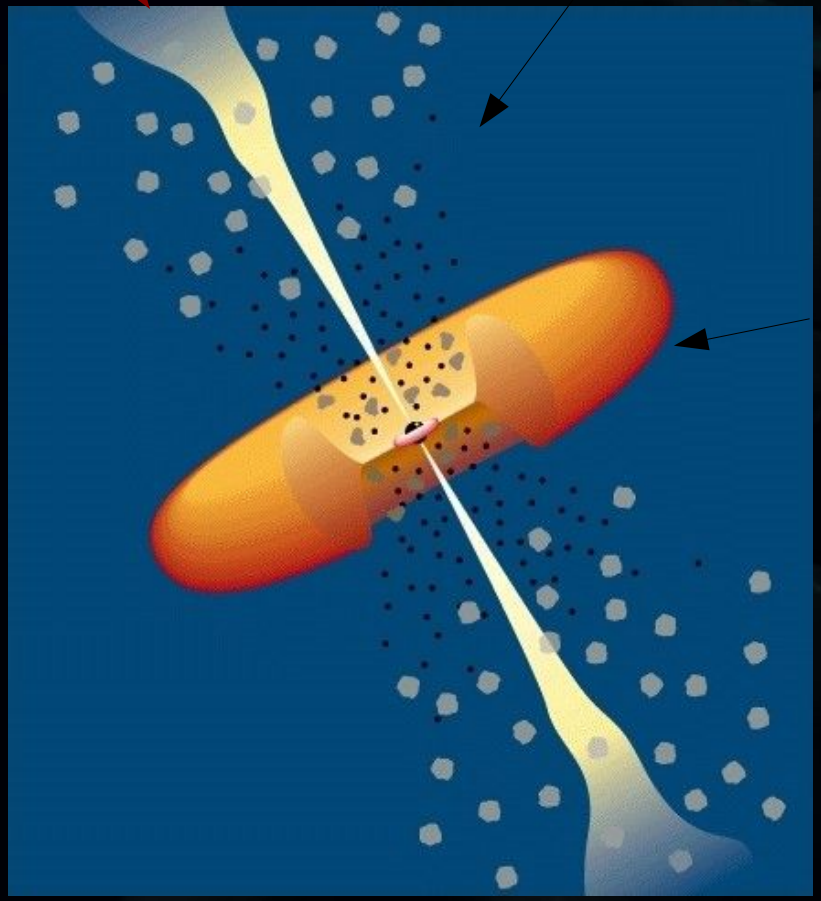


Esquema Unificado de AGN

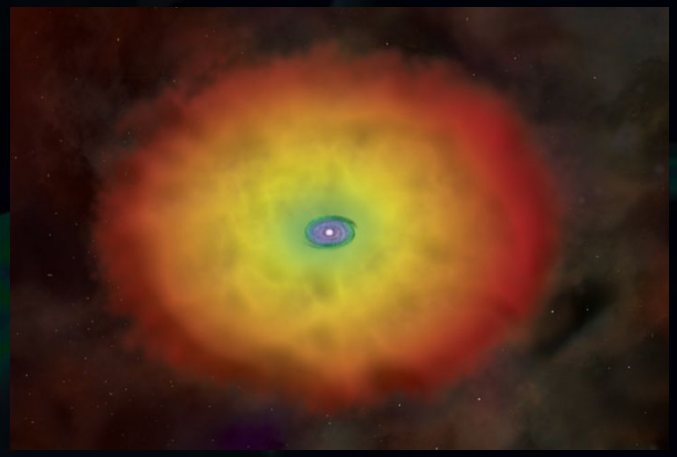


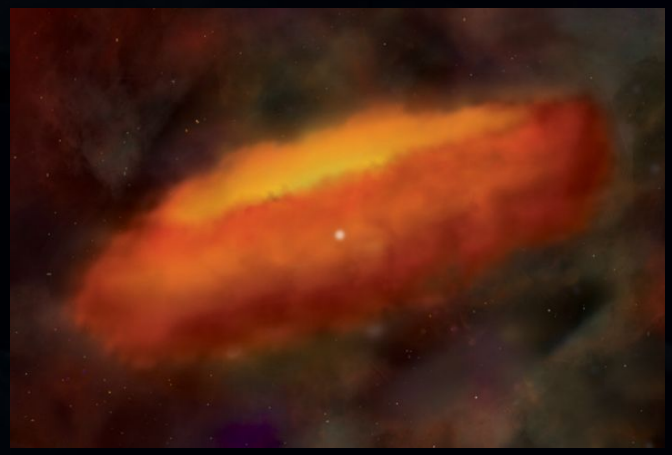
Tipo 0

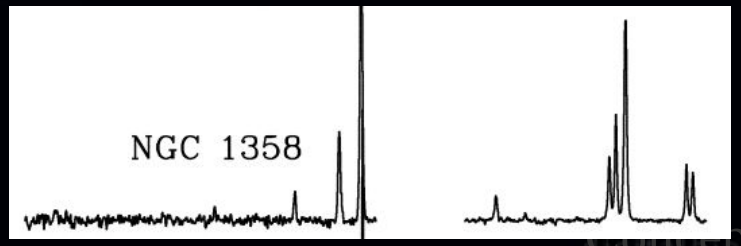
Tipo 1



Tipo 2







DONT PANIC

AGN Taxonomy (Urry & Padovani, Antonucci & Miller)

Luminosita
Orientacion
spin(?)

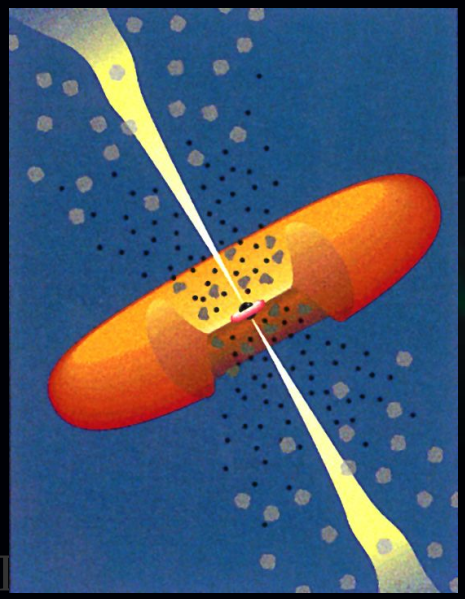
806 URRY AND PADOVANI

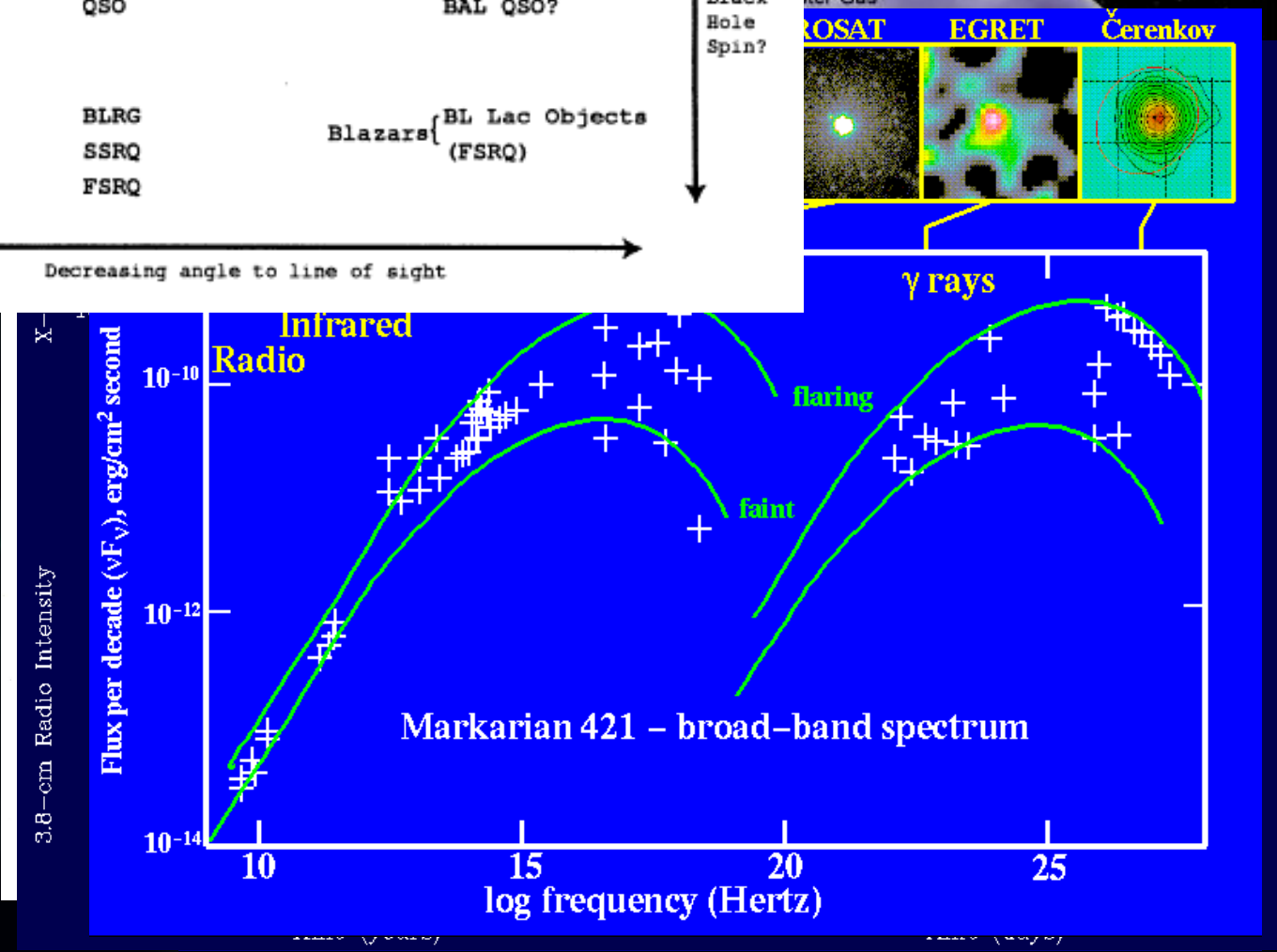
TABLE 1
AGN Taxonomy
Optical Emission Line Properties

Radio Loudness	Type 2 (Narrow Line)	Type 1 (Broad Line)	Type 0 (Unusual)
Radio-quiet:	Sy 2	Sy 1	
	NELG		
	IR Quasar?	QSO	BAL QSO?
Radio-loud:	NLRG {FR I, FR II}	BLRG	Blazars {BL Lac Objects (FSRQ)}
		SSRQ	
		FSRQ	

Black Hole Spin? ↓

Decreasing angle to line of sight →





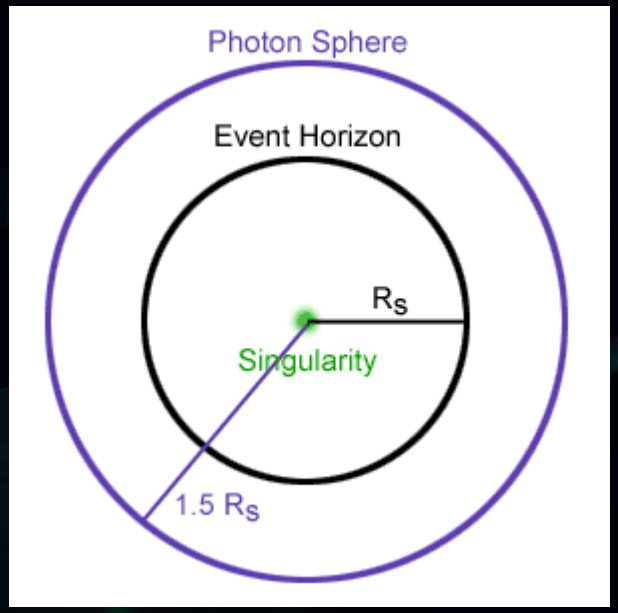
Fisicas basicas de acretar :

$R_{cSchwarzschild} = 2\ G\ M / c^2$

Tierra : 0.9 cm

Sol : 3 km

$10^9\ M_{Sol}$: *60 A.U.*



Energia de accrecion (potencial)

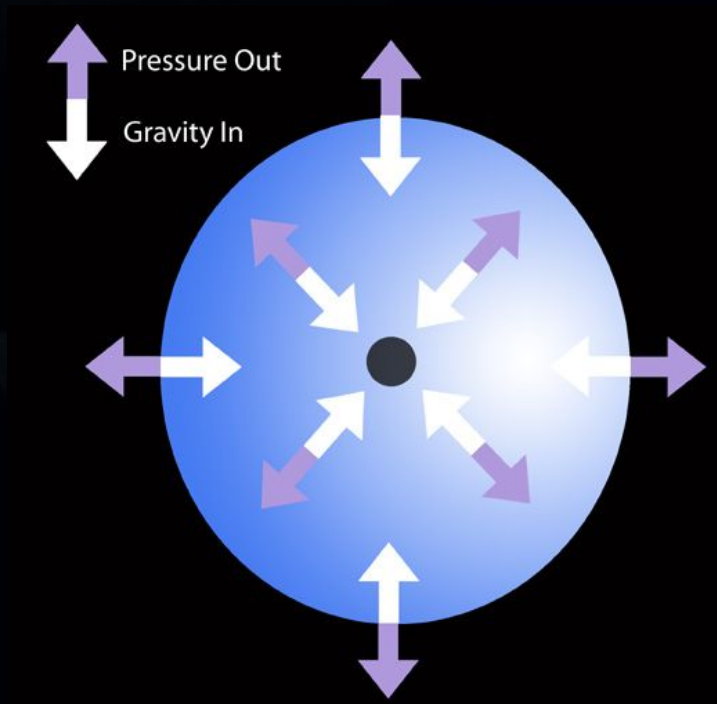
Limite de Eddington:

$$\frac{L\ s_T}{4\ p\ c\ r^2} = \frac{G\ M\ m_p}{r^2}$$

$L_{Edd} = 1.2 \times 10^{38}\ (M/M_{sun})$ *erg/sec*

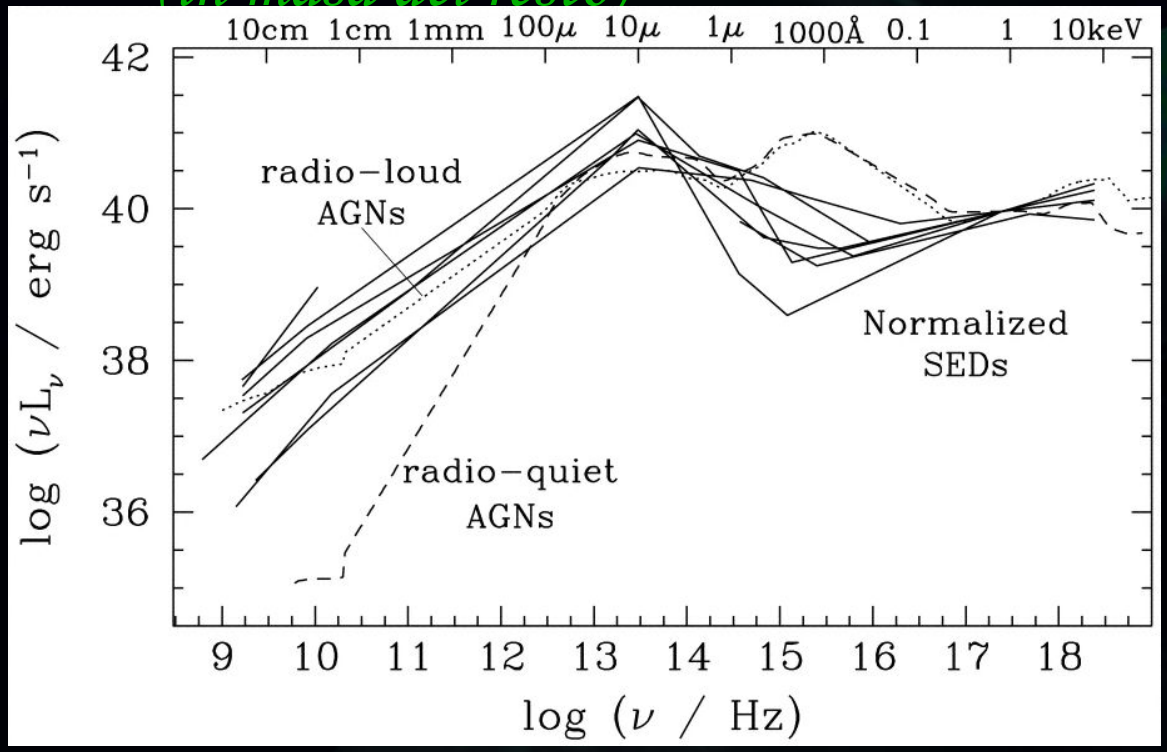
Rotar agujero negro : $a = J / (GM/c)$

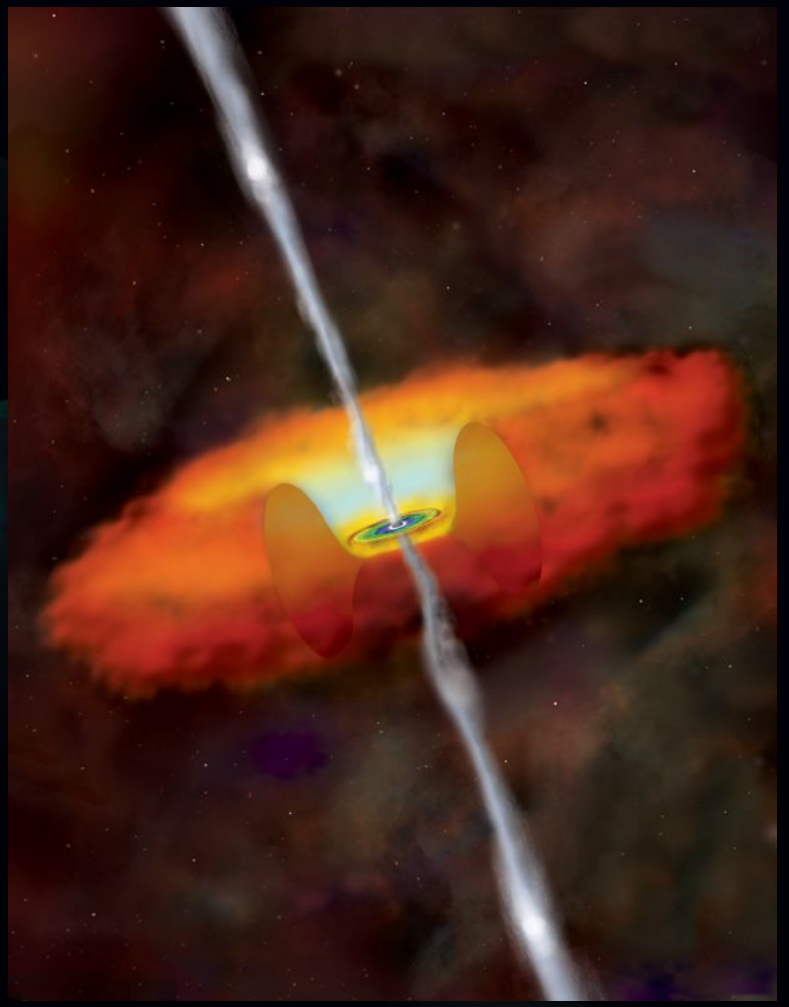
la orbita estable mas cercana (materia) = $5\ R_{Sch}$



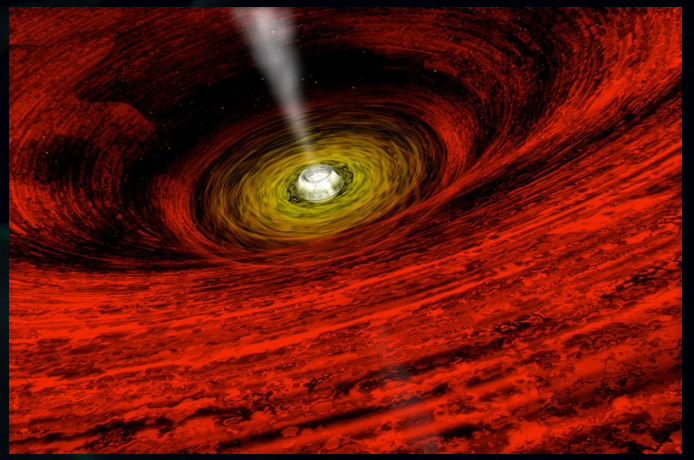
Regulas emperical de acretar :

~ 10% eficacia del accrecion
(in masa del resto)



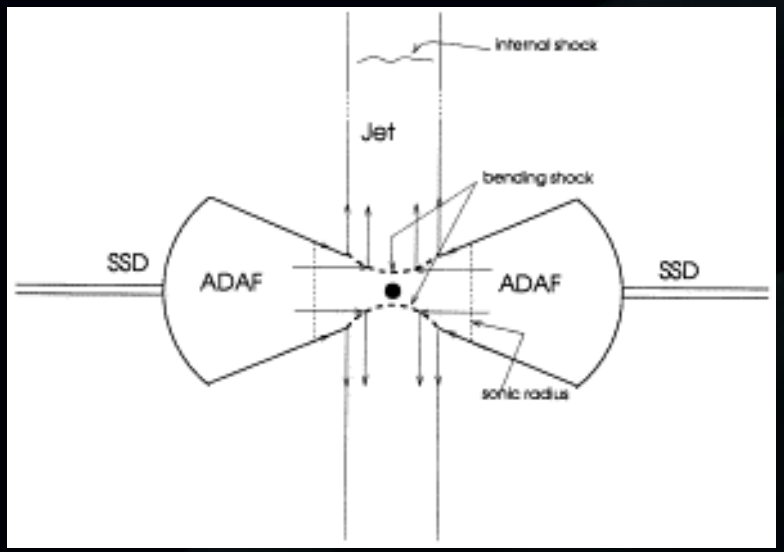


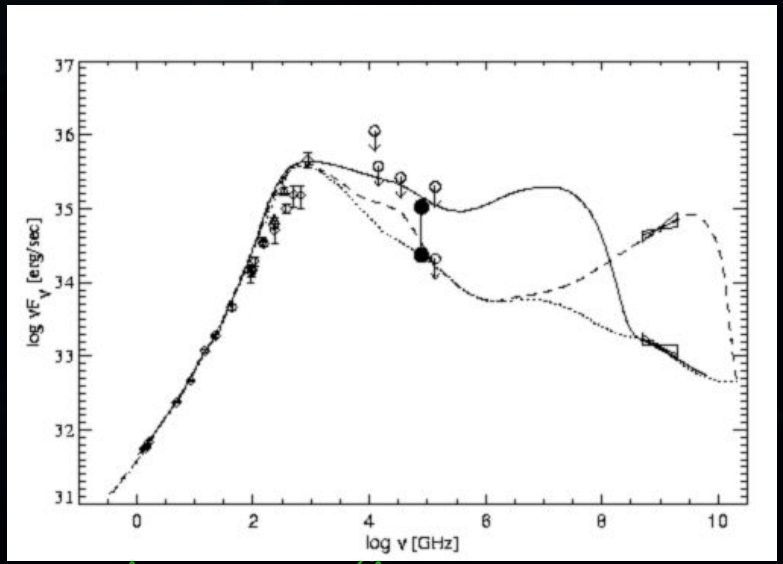
Radiatively Inefficient Accretion Flows (RIAFs)
(flujos radiatively ineficaces del accrecion)



'Bending shock' produces power-law electron distribution. Synchrotron and SSC from these electrons give IR and X-ray emission.

neil nagar

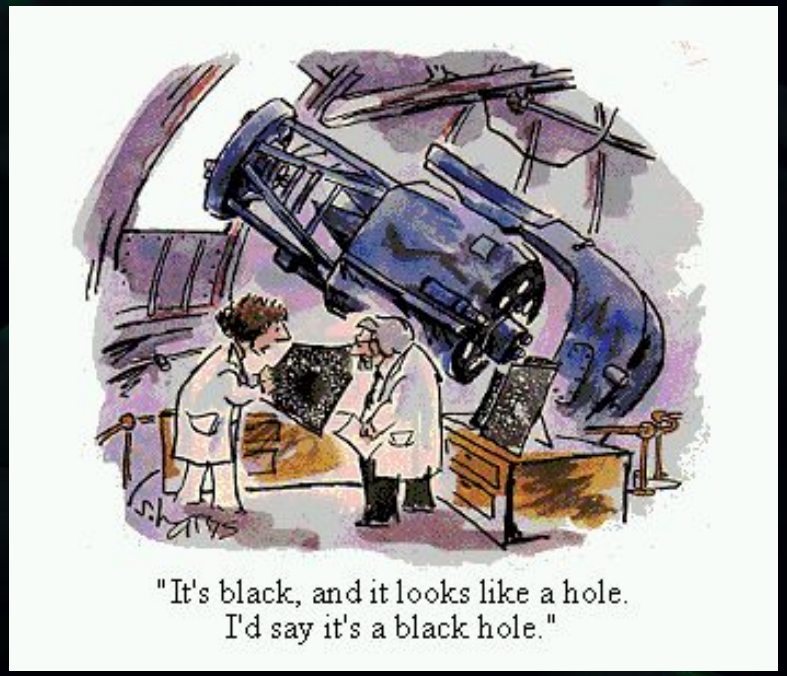




opticamente fino.

DONT PANIC

Concep. 2004



Su negro, y el parece un agujero, opinion de i'd su un agujero negro.

Importante:
Ahora nos estamos desviando a las galaxies "normales"

Medir la masa del agujero negro (masa oscura)
(cualquier coleccion de objectos mas pequenos se derrumbara dentro de un `tiempo Hubble')

Razones de favorecer presencia del agujero nero:

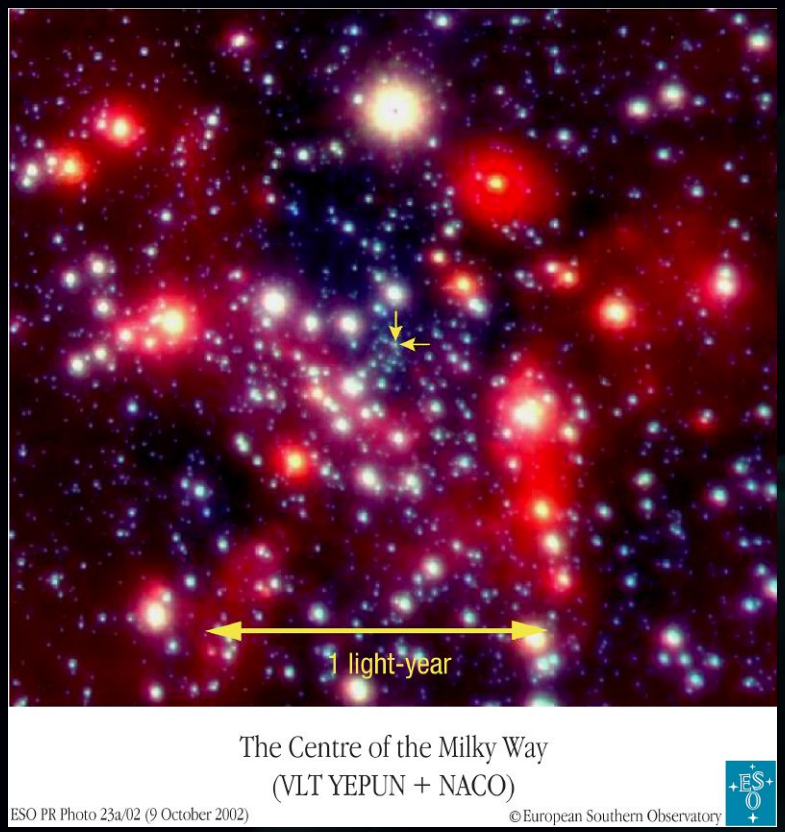
- *Energia mas de 10^{40}–10^{44} erg/s de un area menos de 1pc*
- *chorro relativistica el extender mas alla de 10kpc*
- *afluencia del gas que desaparece (?)*
- *grande (relativista) velocidades de rotatcion*

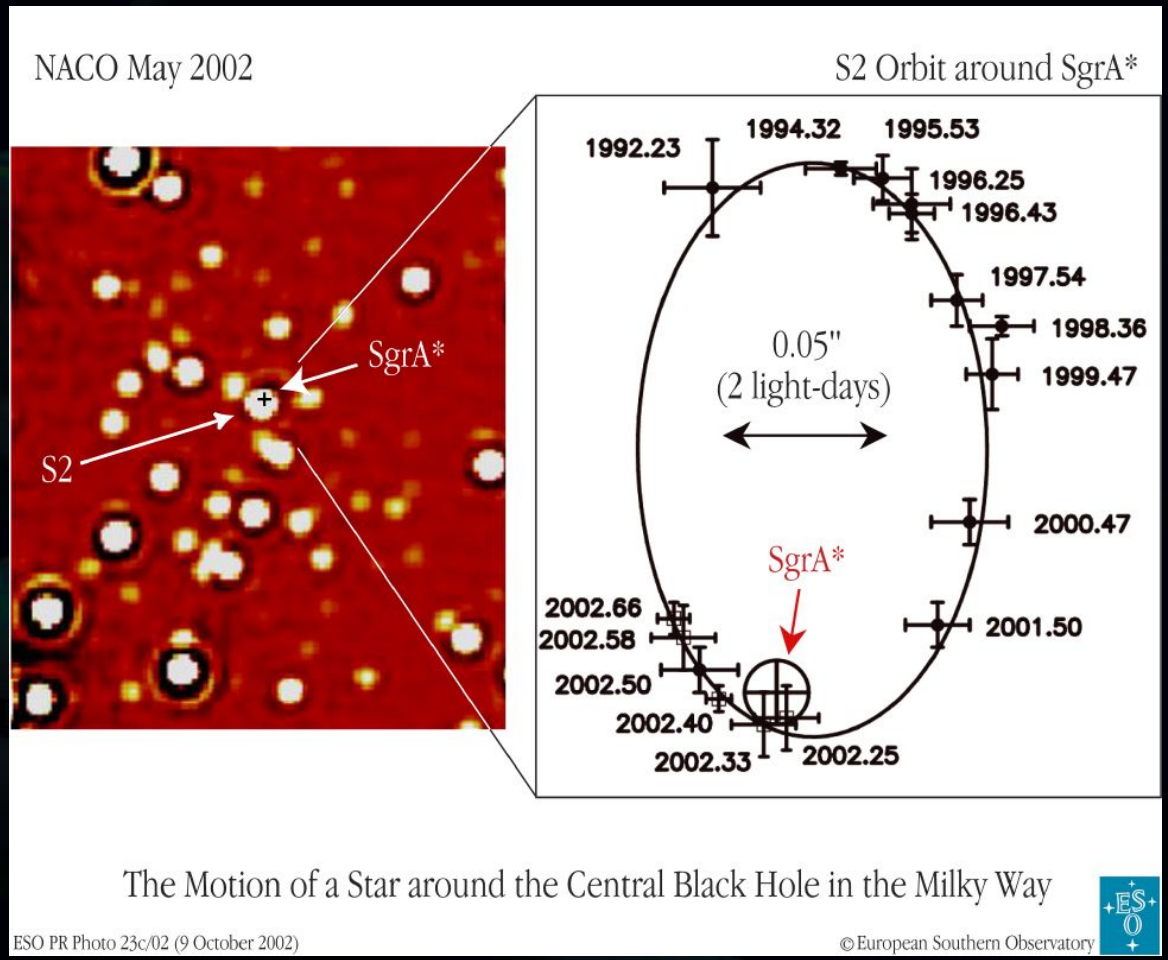
No sabemos ningun otro proceso fisico que pueda crear estos efectos

*Sgr A**

Direct dynamic measurement:

3.6 x 10^6 solar masses





Genzel et al.
Ghez et al.

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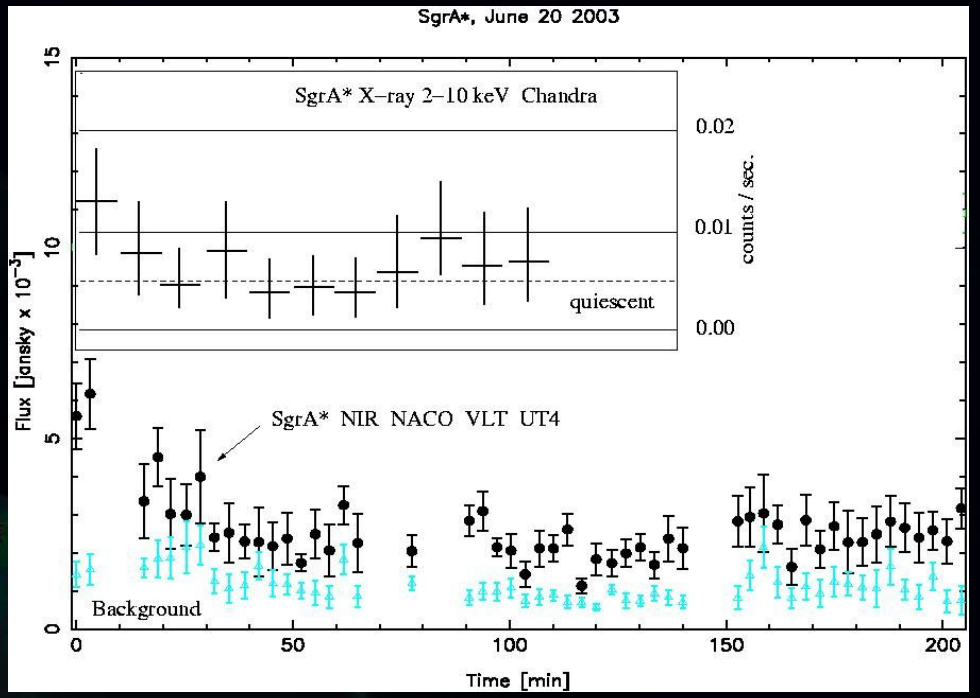
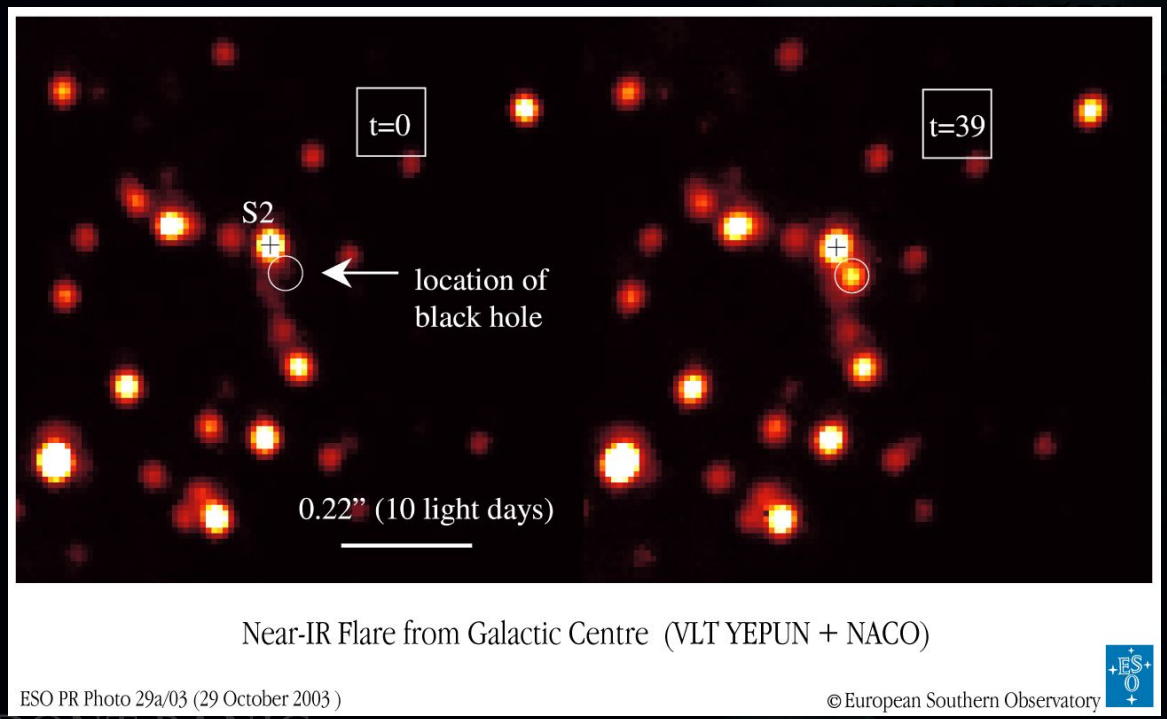
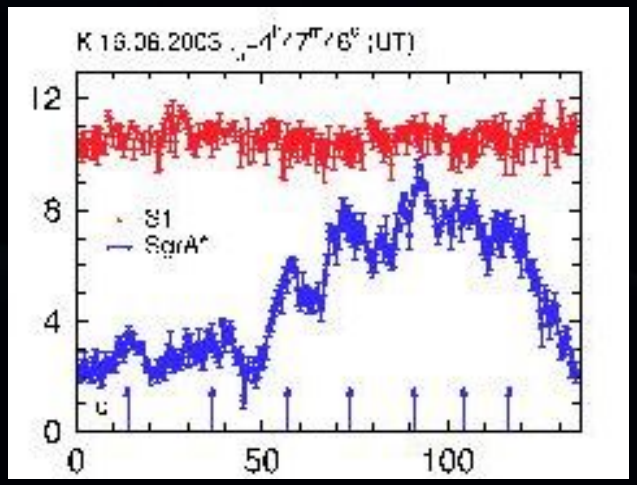
Sgr A : rotating (a > 0.5) black hole? radio, IR, X-ray quasi-periodic (17min) flares. Higher than orbital frequency of innermost orbit of a non-rotating BH.*







Genzel et al. 2003

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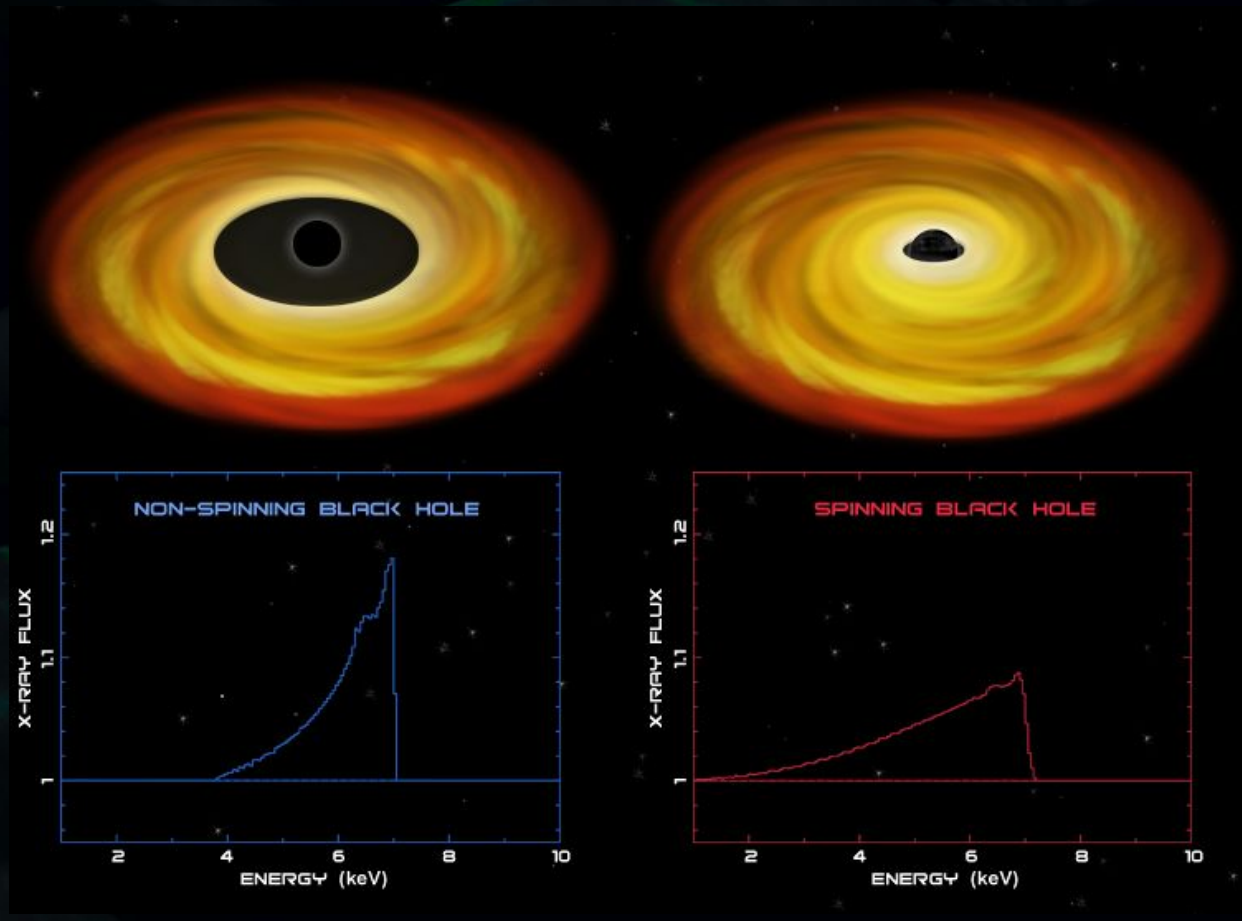

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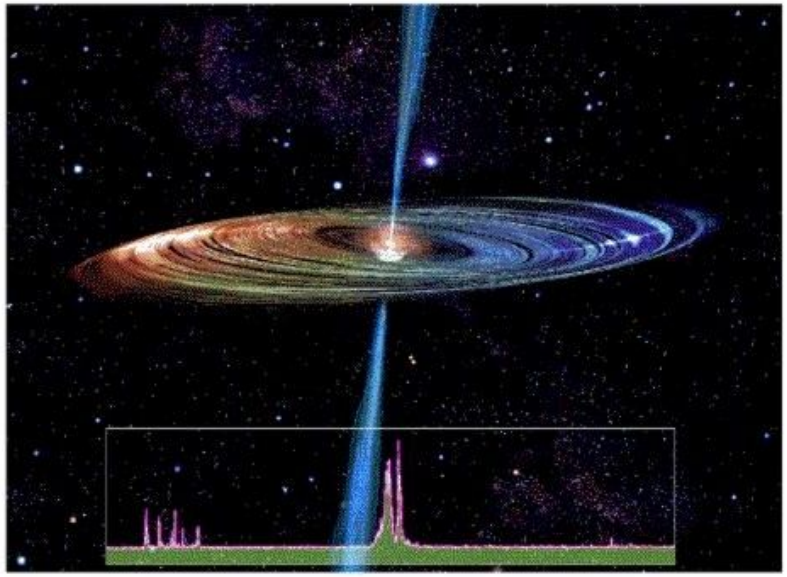
Concep. 2004

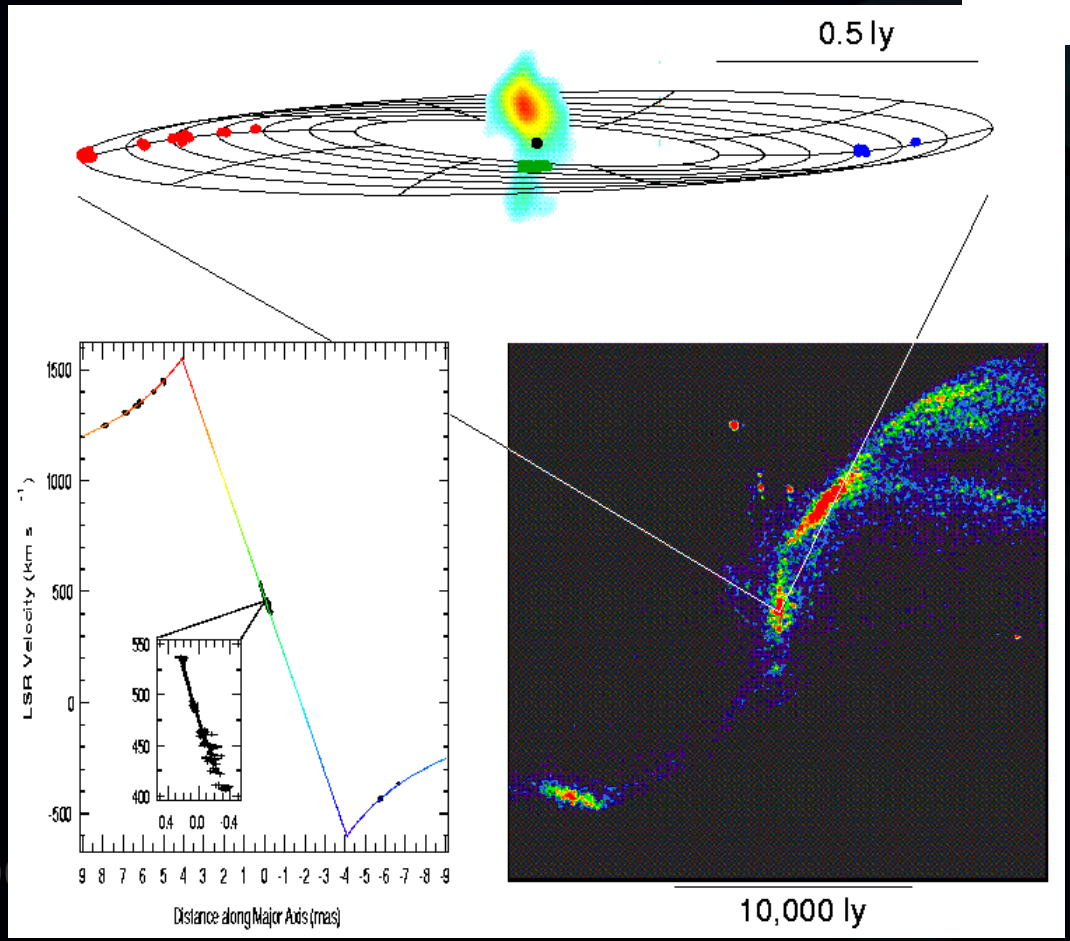
NGC4258: accretion disk & jet

3.5 x 10^7 M_{Sol} in < 0.13pc

Chorro comienza a 4000 R_s

desde agujero negro

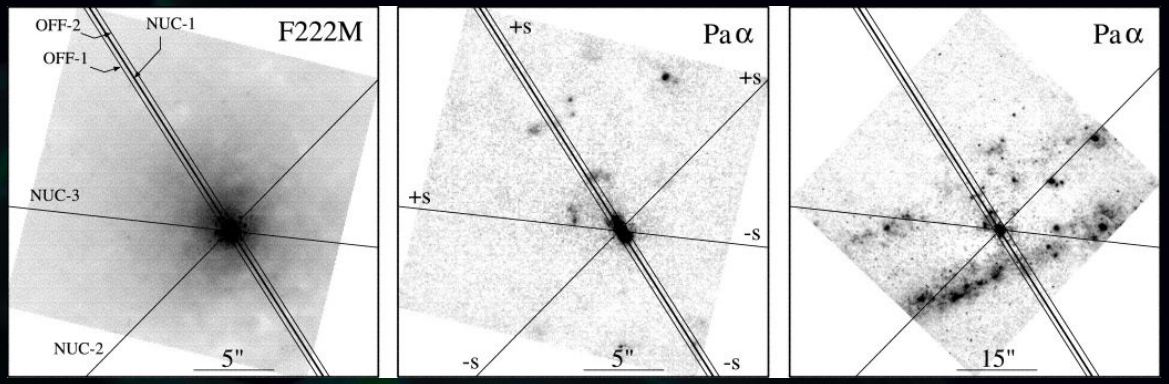


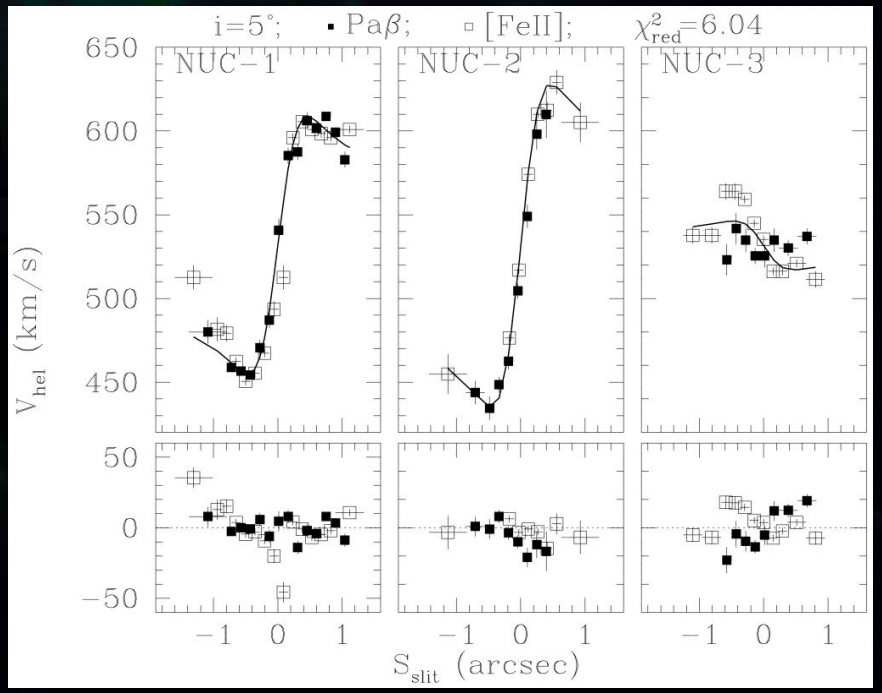


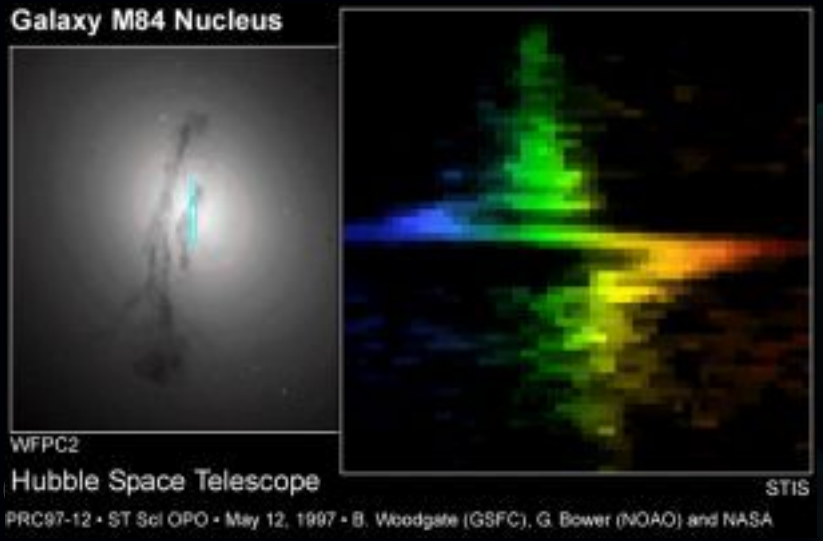
Miyoshi et al. 1995
Herrnstein et al. 1997,1999
Greenhill et al. 1995

Cen A: gas dynamics of rotating gas disk

2×10^8 Msun

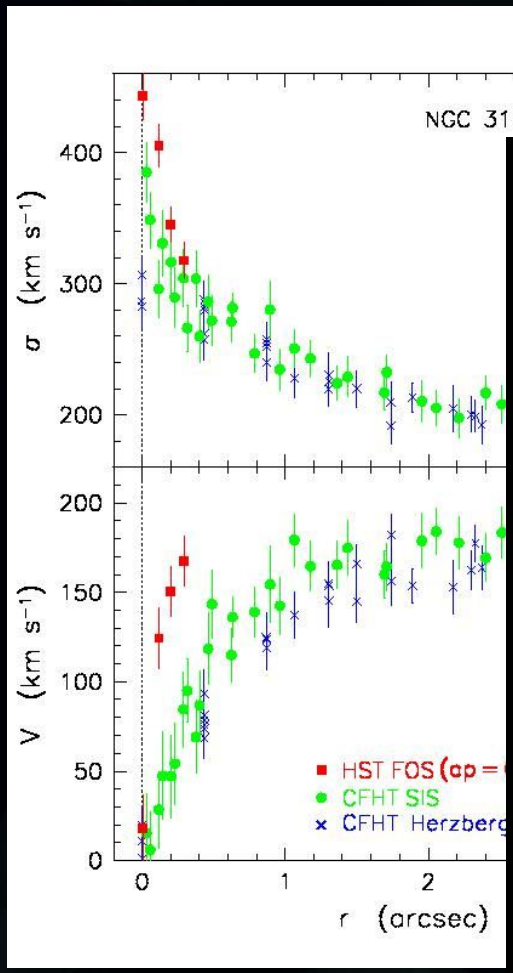


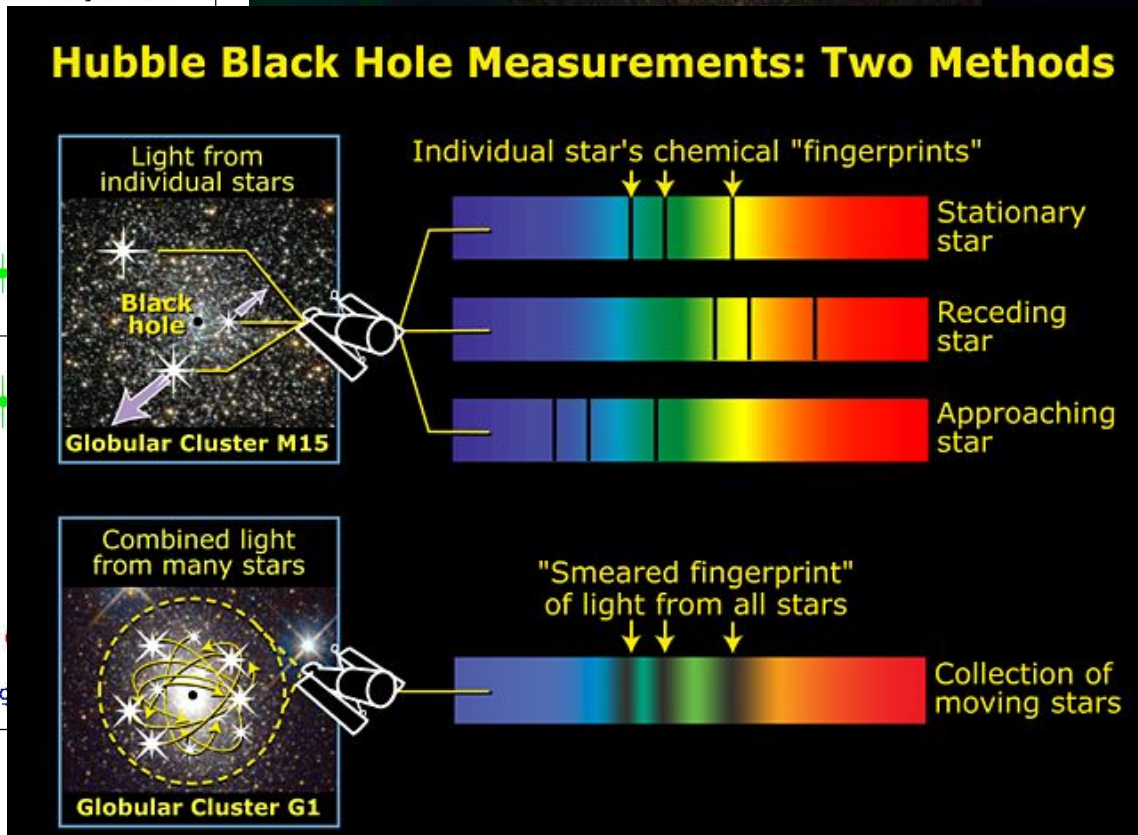




NGC 3115: Stellar Dynamics :

Black Hole of ~10^9 Msun



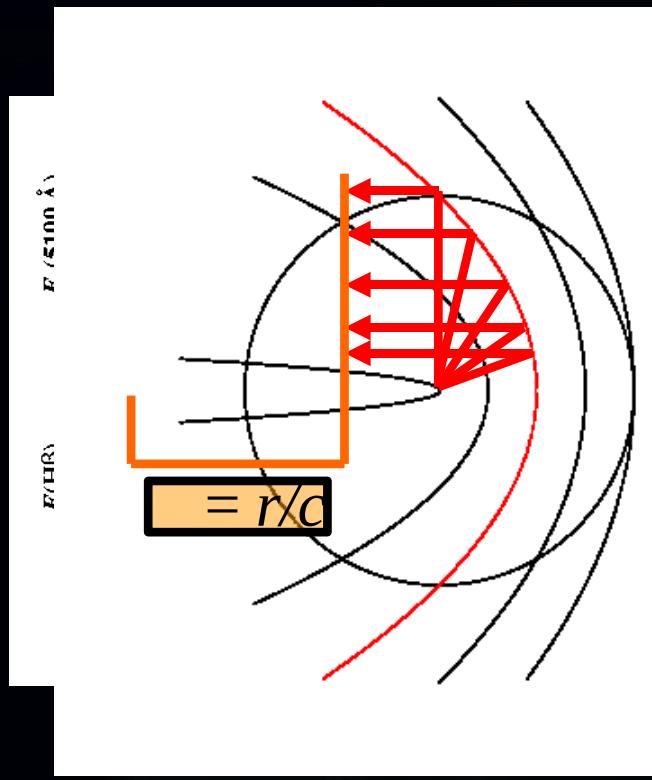


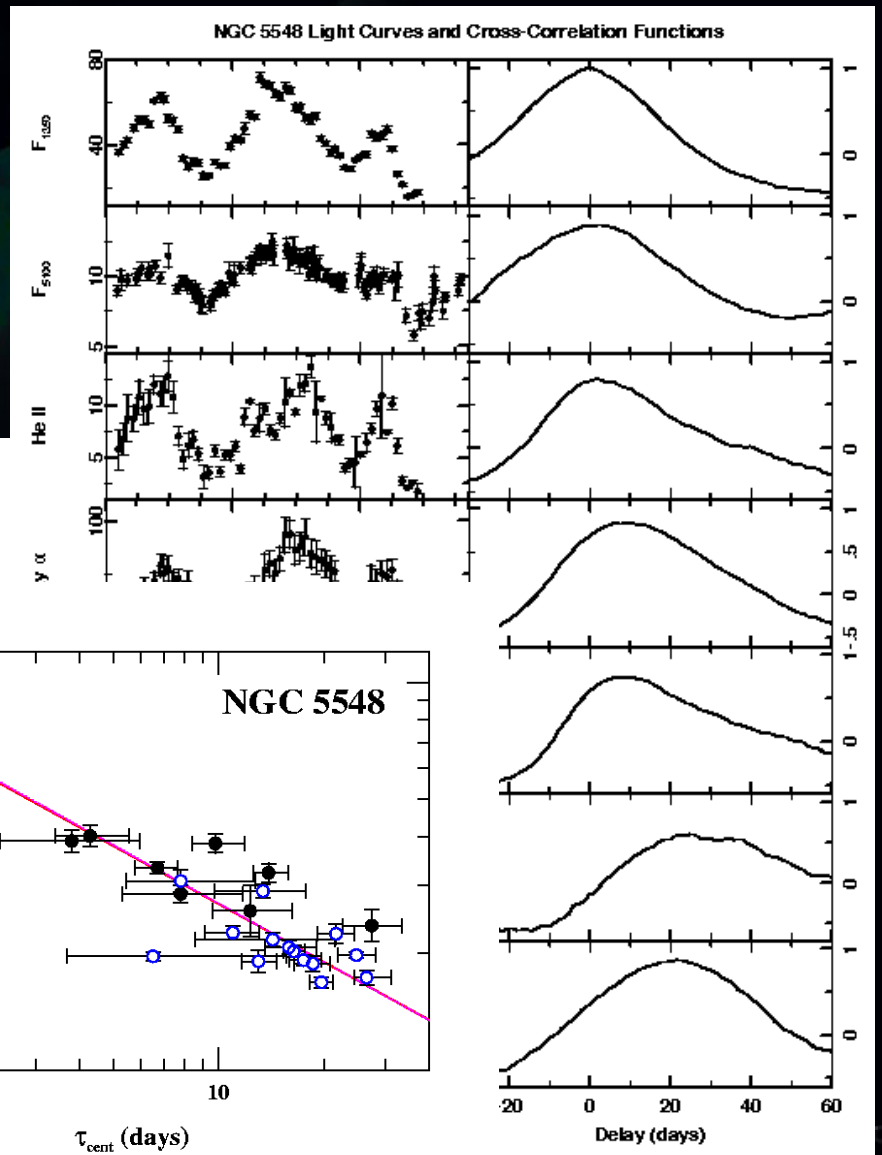
Seyfert 1s : reverberation mapping (AGN)

agujero negro, masa ~10^6 - 10^8 Msol

Virialized disco de accrecion:

r propto s $^{-2}$





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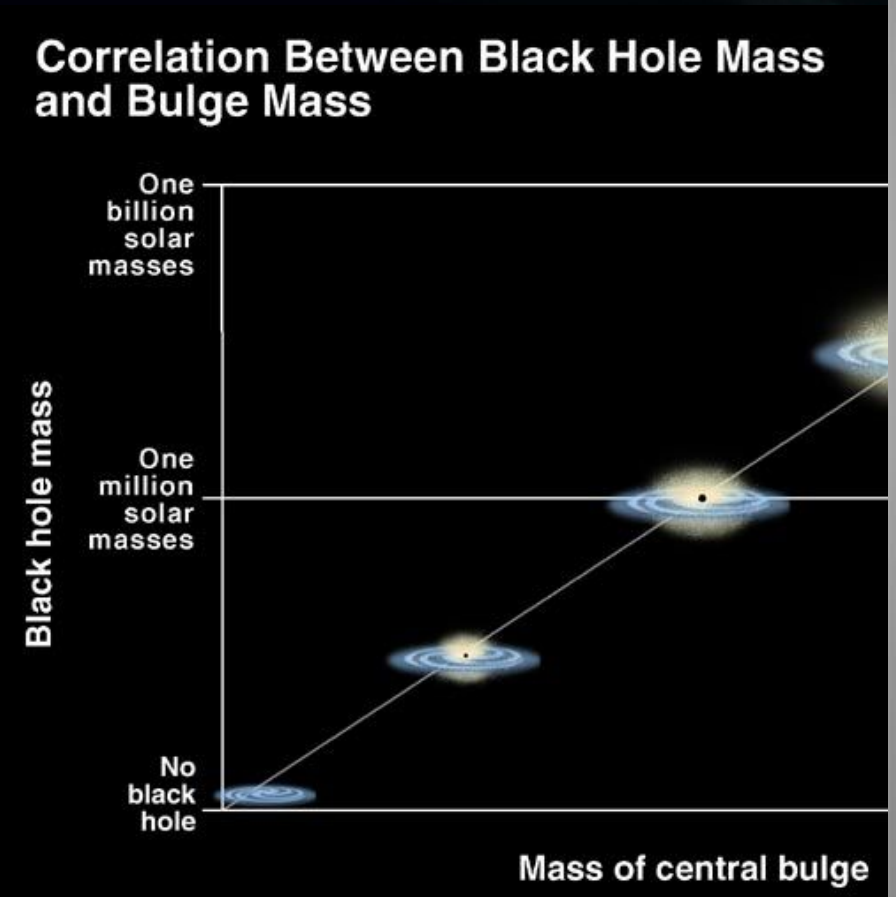
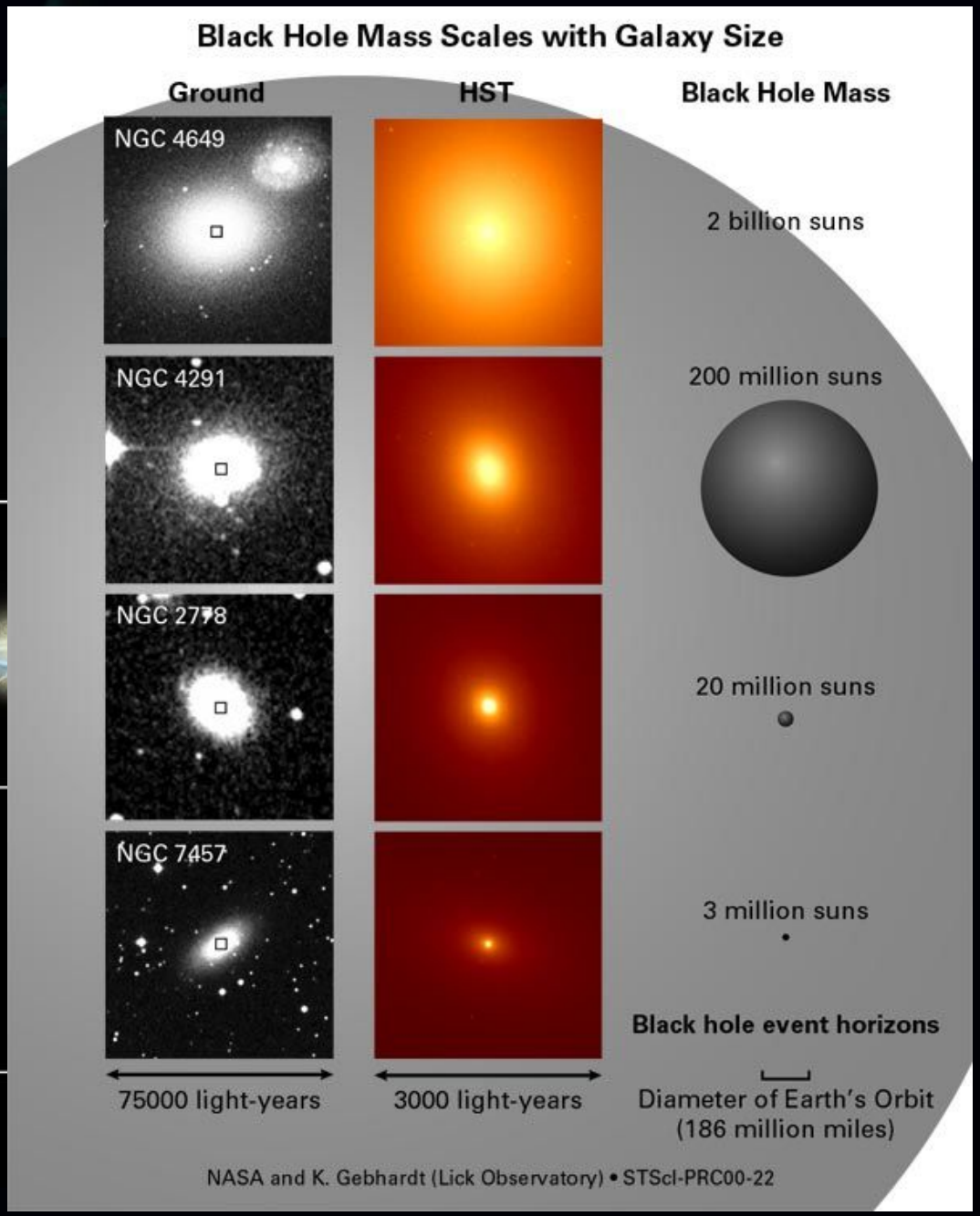
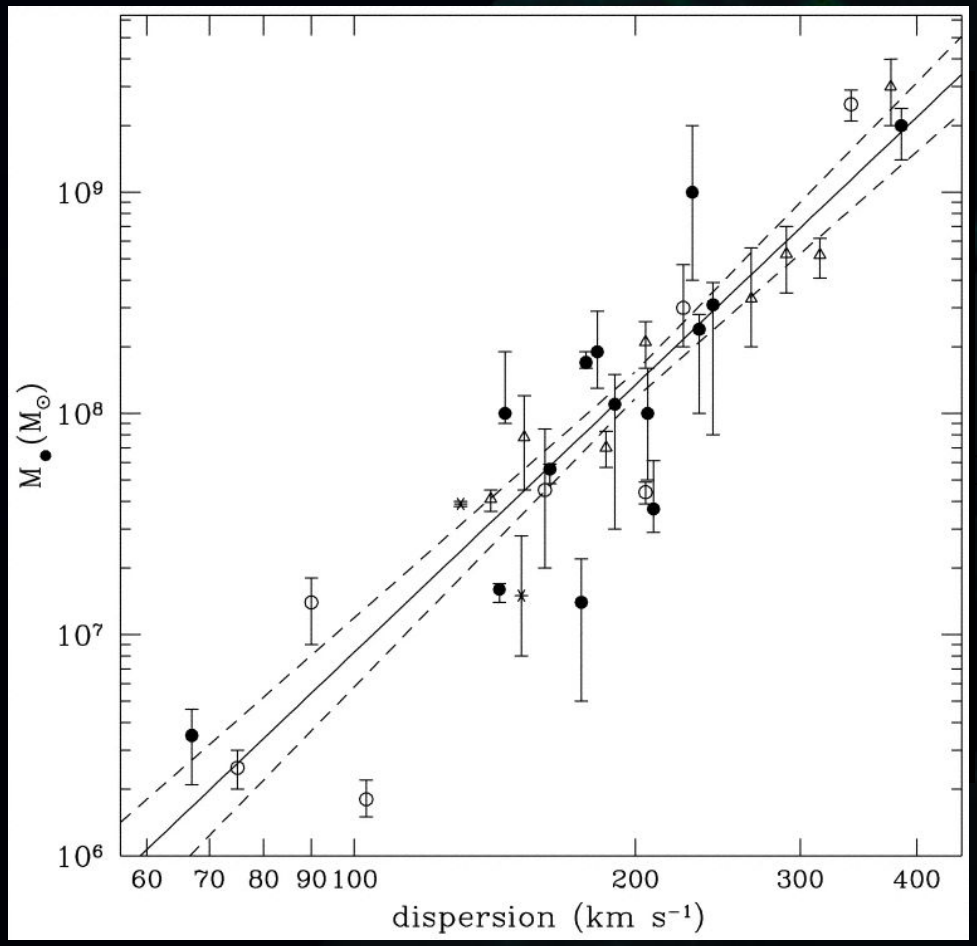
neil nagar

Cielo de la noche (rompecabezas)

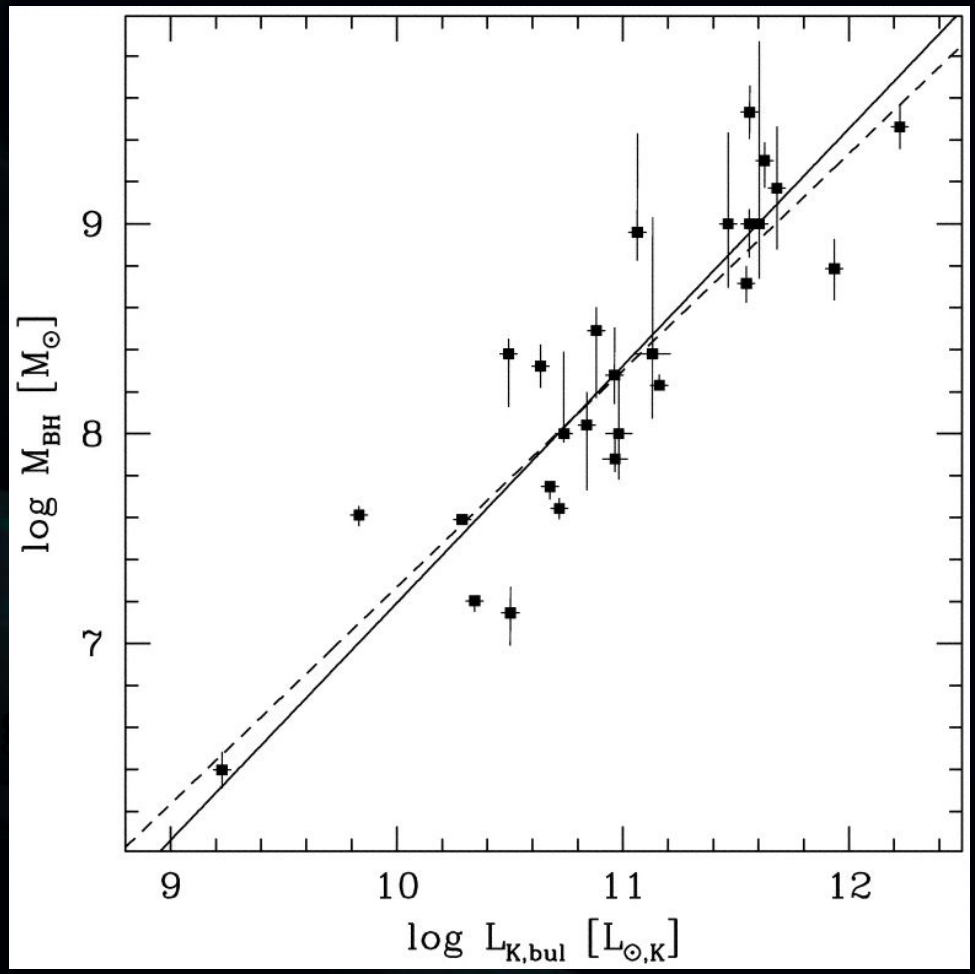

Correlation Between Black Hole Mass and Bulge Mass
One billion solar masses
One million solar masses
No black hole
Black hole mass
Mass of central bulge


Black Hole Mass Scales with Galaxy Size
Ground
HST
Black Hole Mass
NGC 4649
2 billion suns
NGC 4291
200 million suns
NGC 2778
20 million suns
NGC 7457
3 million suns
Black hole event horizons
75000 light-years
3000 light-years
Diameter of Earth's Orbit (186 million miles)
NASA and K. Gebhardt (Lick Observatory) • STScI-PRC00-22

Indicadores secundarios de Massa de agujero negro



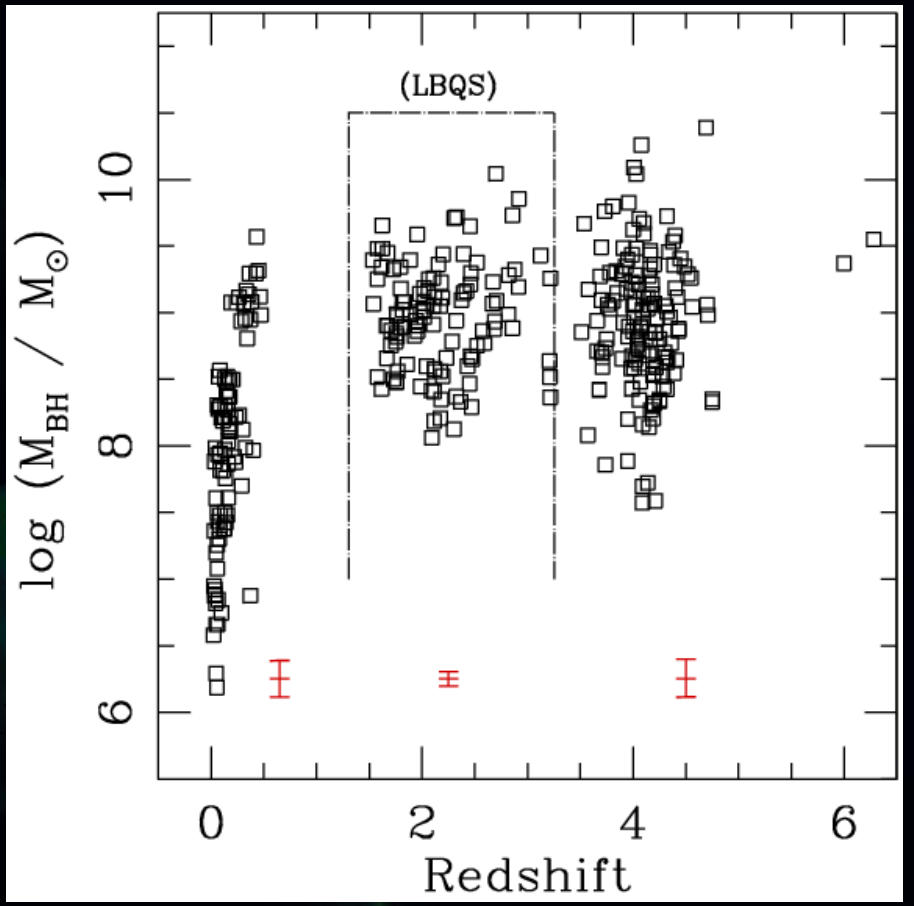
Tremaine et al. 2002: masa de agujero nero verso **S***c (dispersione centrale de stelle)*

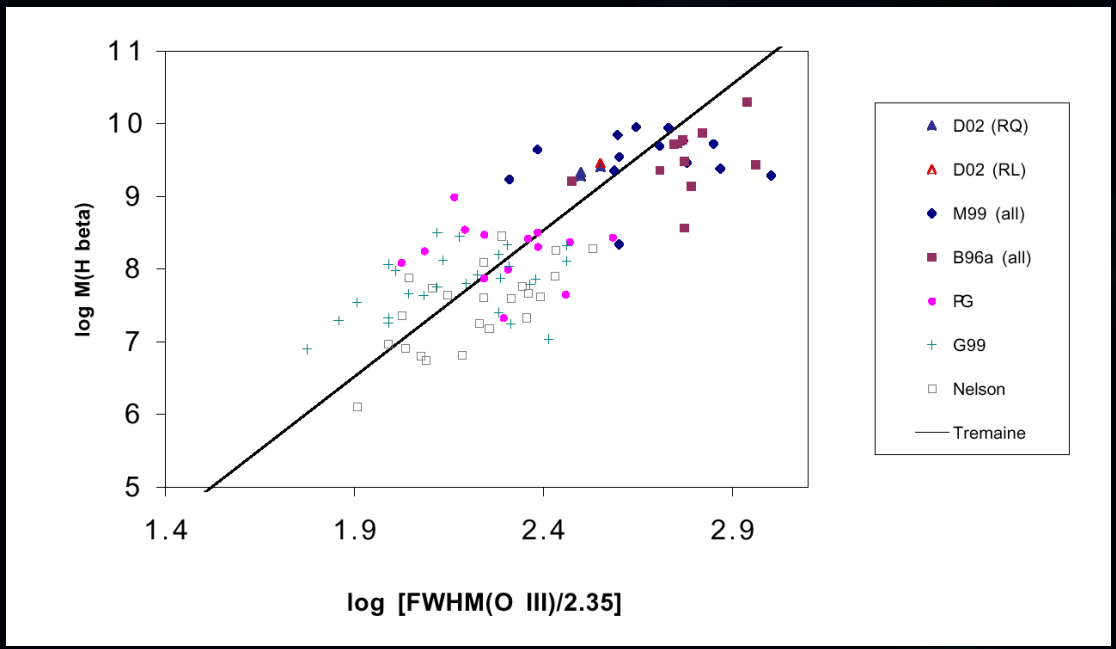


Marconi & Hunt 2003, masa de agujero nero verso la masa de galaxia (in realidad, la luminosita de galaxia)

Indicadores terciarios

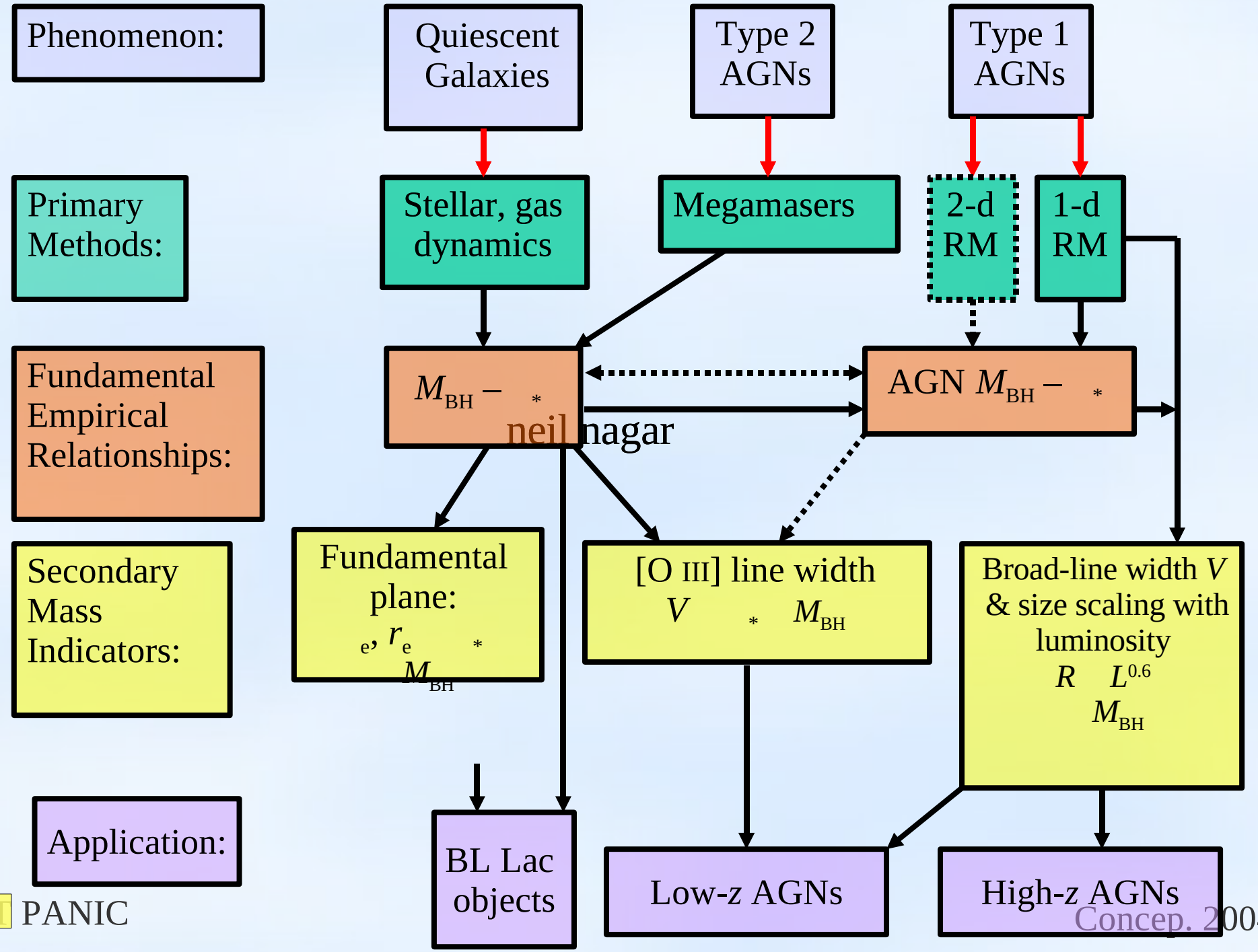
Shields et al. 2003: anchura de la linea estrecha escalas con **S***c*





Vestergaard (2002)
la relacion de escalamiento r $L^{0.7}$
y anchura de C IV linea

Estimating AGN Black Hole Masses (from B. Peterson)



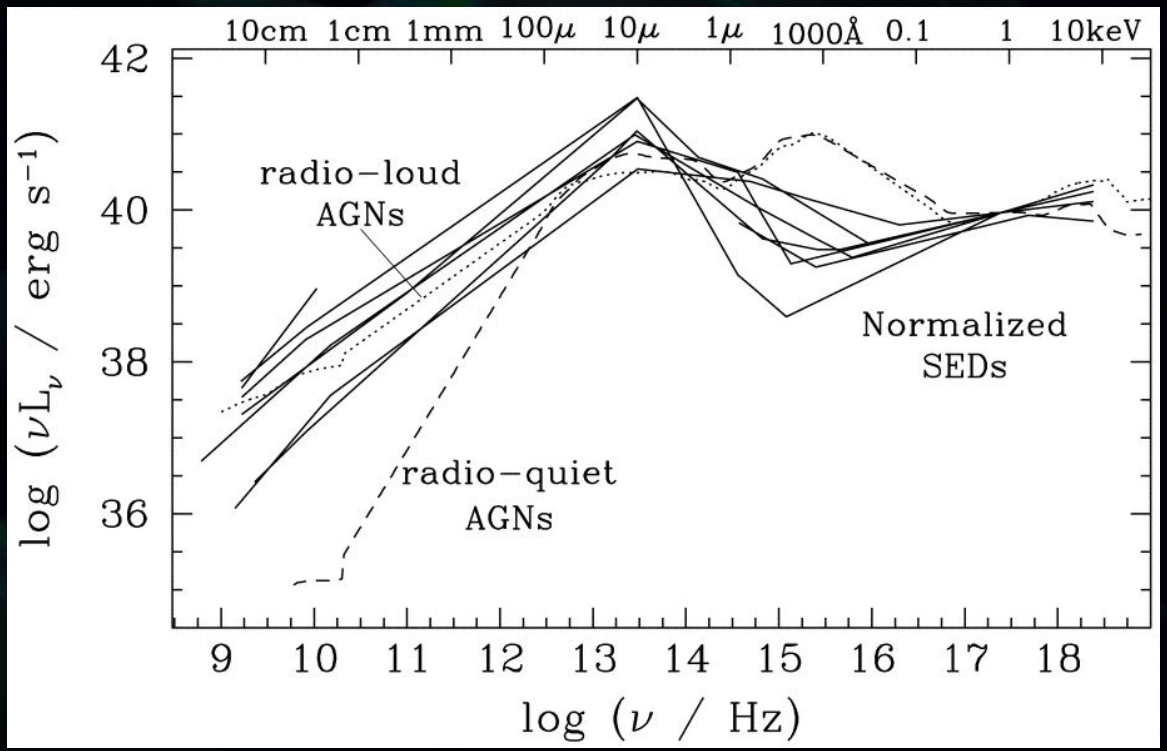
Whew, we're done with black holes! now: accretion rate

Spectral Energy Density (SED) : AGNs and LLAGNs

big blue bump (accretion disk)

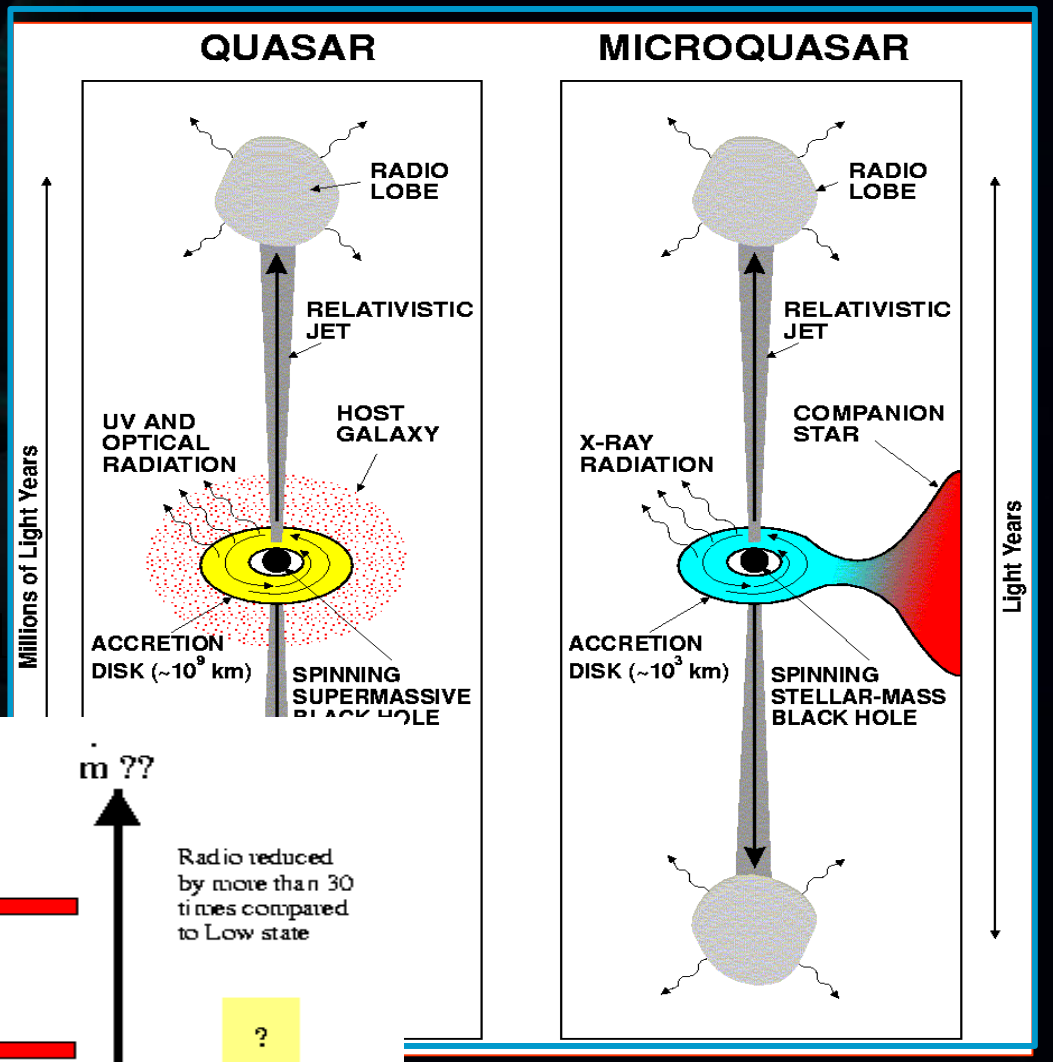
radio loud/quiet

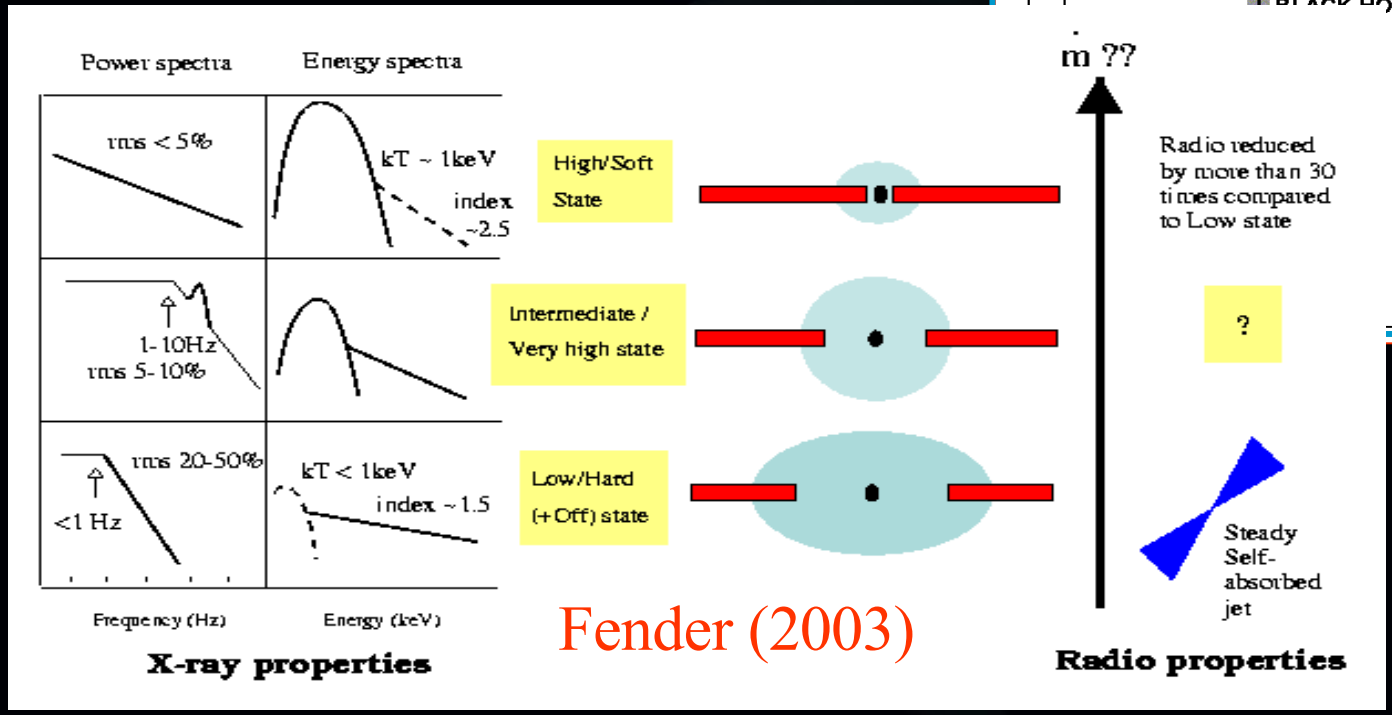
$$f_E = L_{bol} / L_{Edd}$$



Micro-Quasars

- *Cerca.*
- *Scalo de tiempo proportionale de masa de agujero negro*

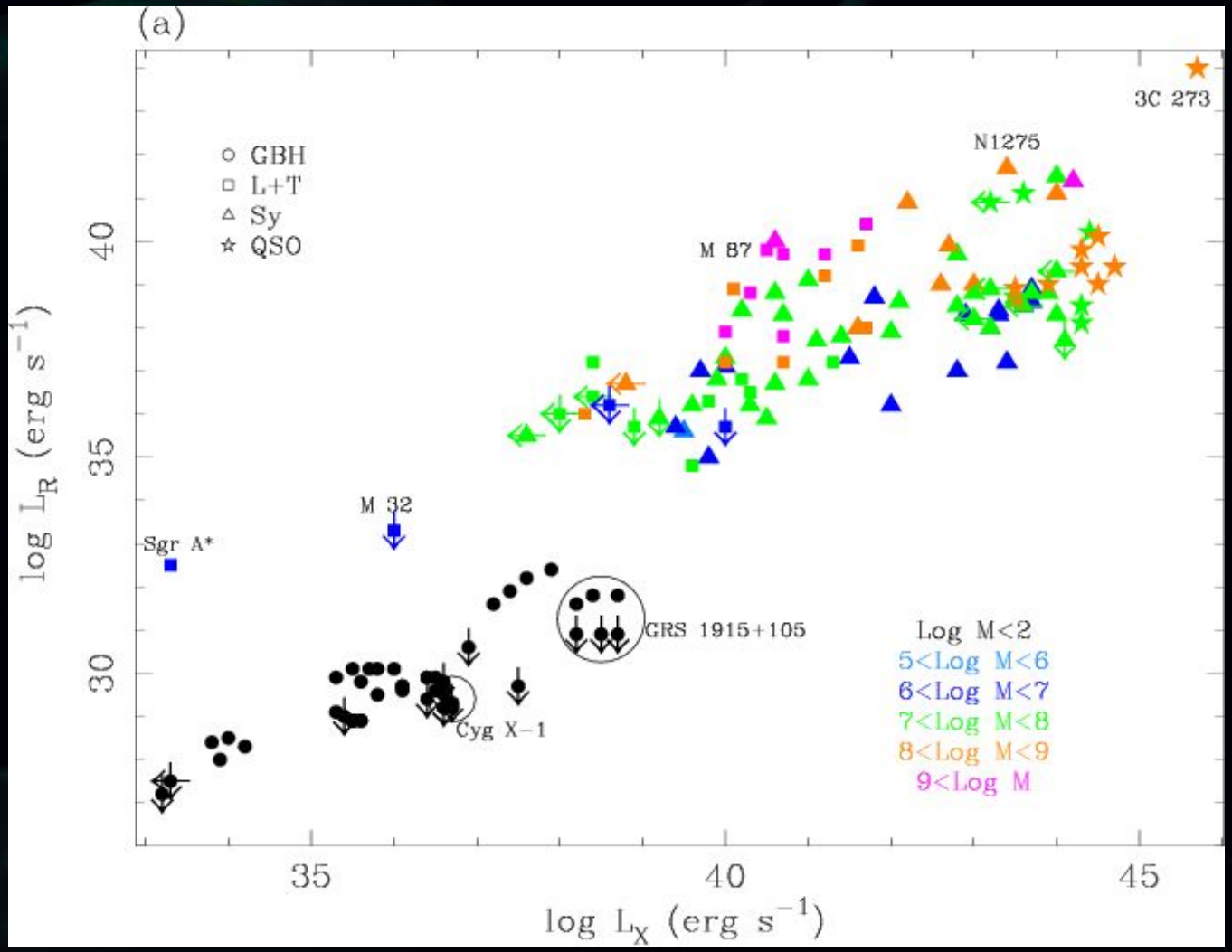




Fender (2003)

Plano fundamental in L_r, L_x and M_{mdo}

Galactic BH s
and
Extragalactic
SMBHs



Merloni, Heinz & DiMatteo 2003
(similar results in Falcke et al. 2003)

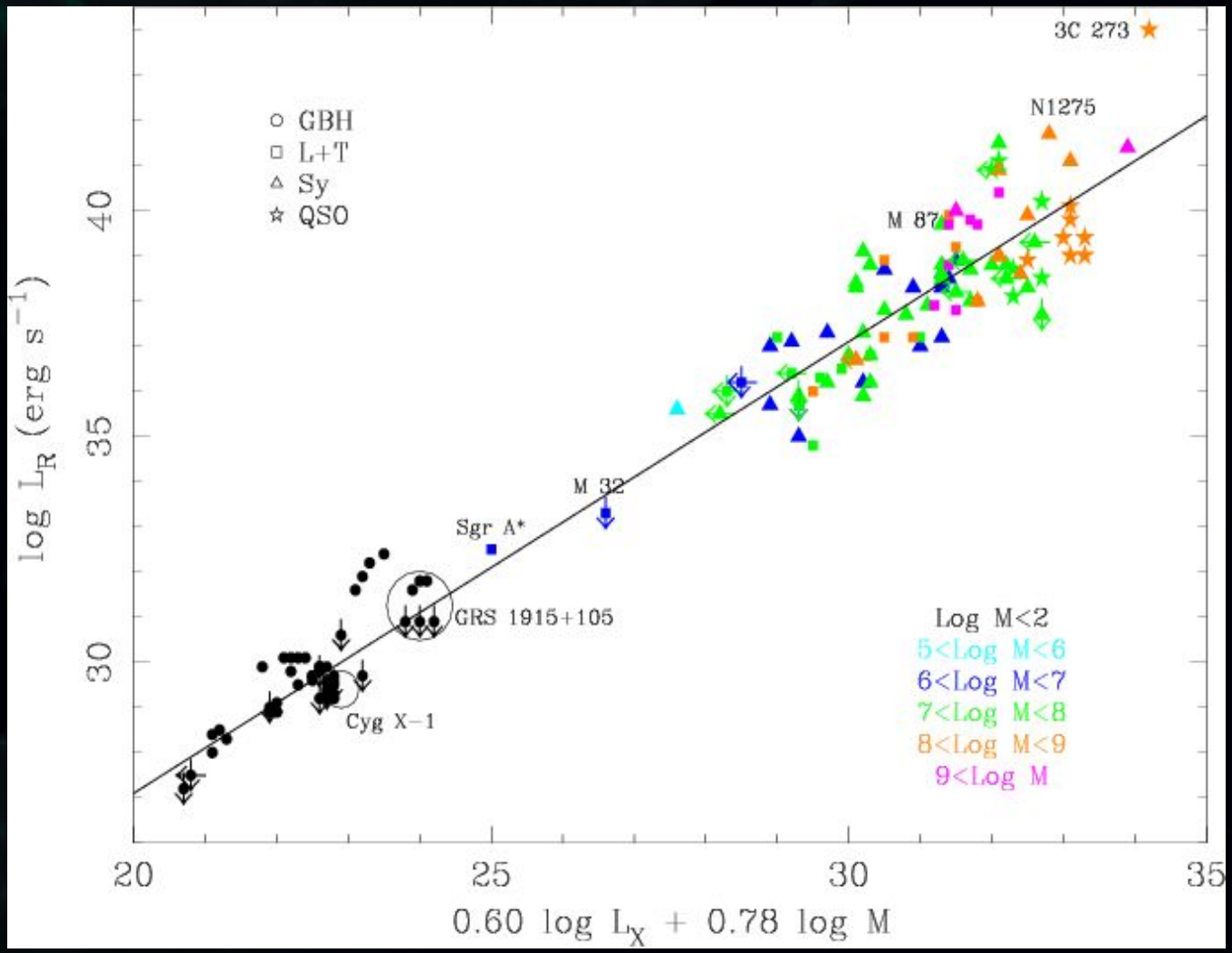
Fundamental Plane in L_r, L_X and M_{mdo}

RIAF: consistent

Jet models: marginally consistent (X-ray from jet synchrotron model)

standard accretion disk: no.

But: radio emission also (mostly?) from shocks in the jets i.e. Flux and electron energy distribution could be different.



Merloni, Heinz & DiMatteo 2003

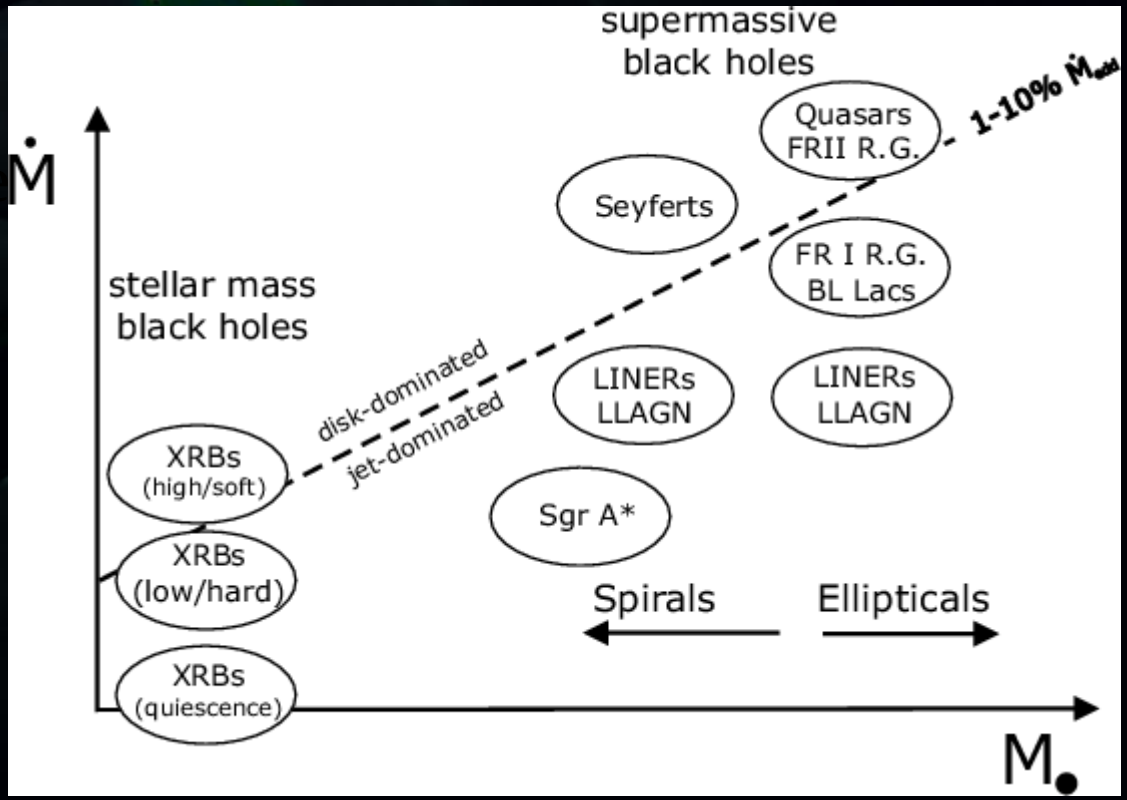
Esquema Super-unificacion

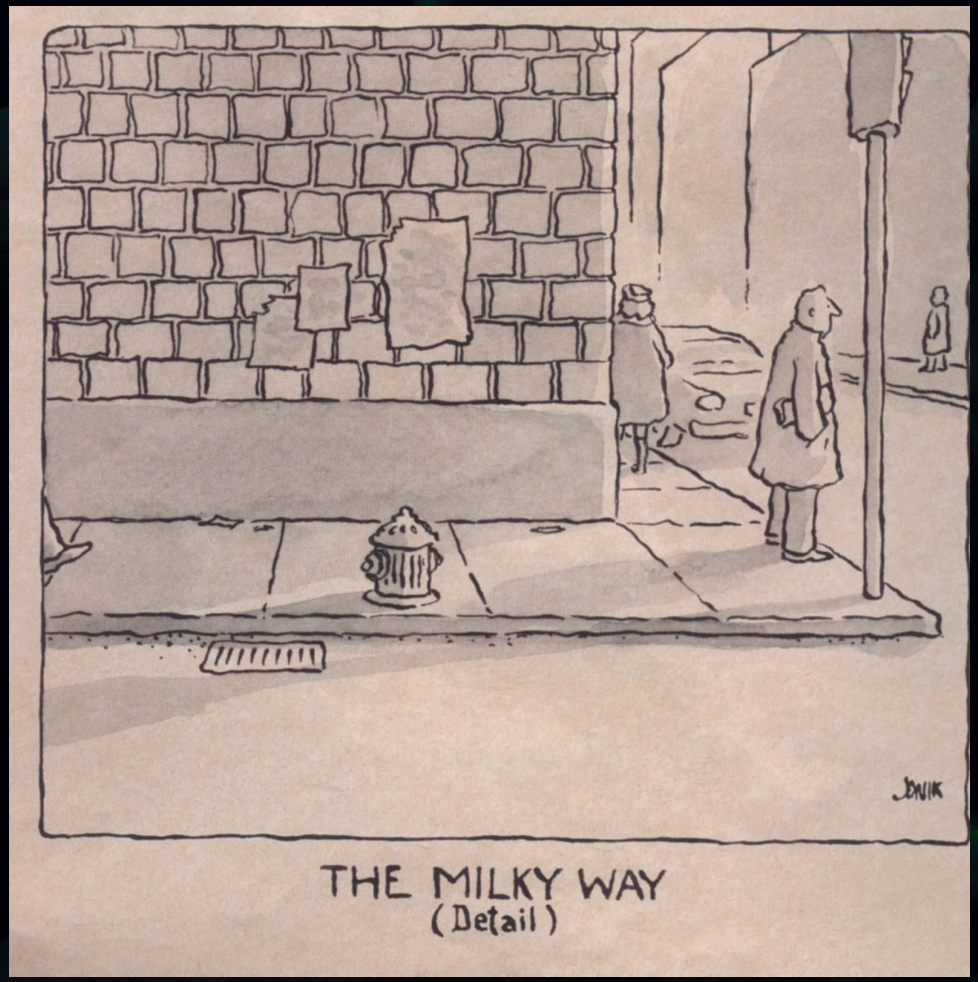
$M_{black\text{-}hole}$: medido or estimado

M_dot o l_E : $L_{Bol} + M_{black\text{-}hole}$

esquema unificado: orientacion

rotacion de agujero nero:
`radio loud / quiet' ?





Via Lactea (Detalle)

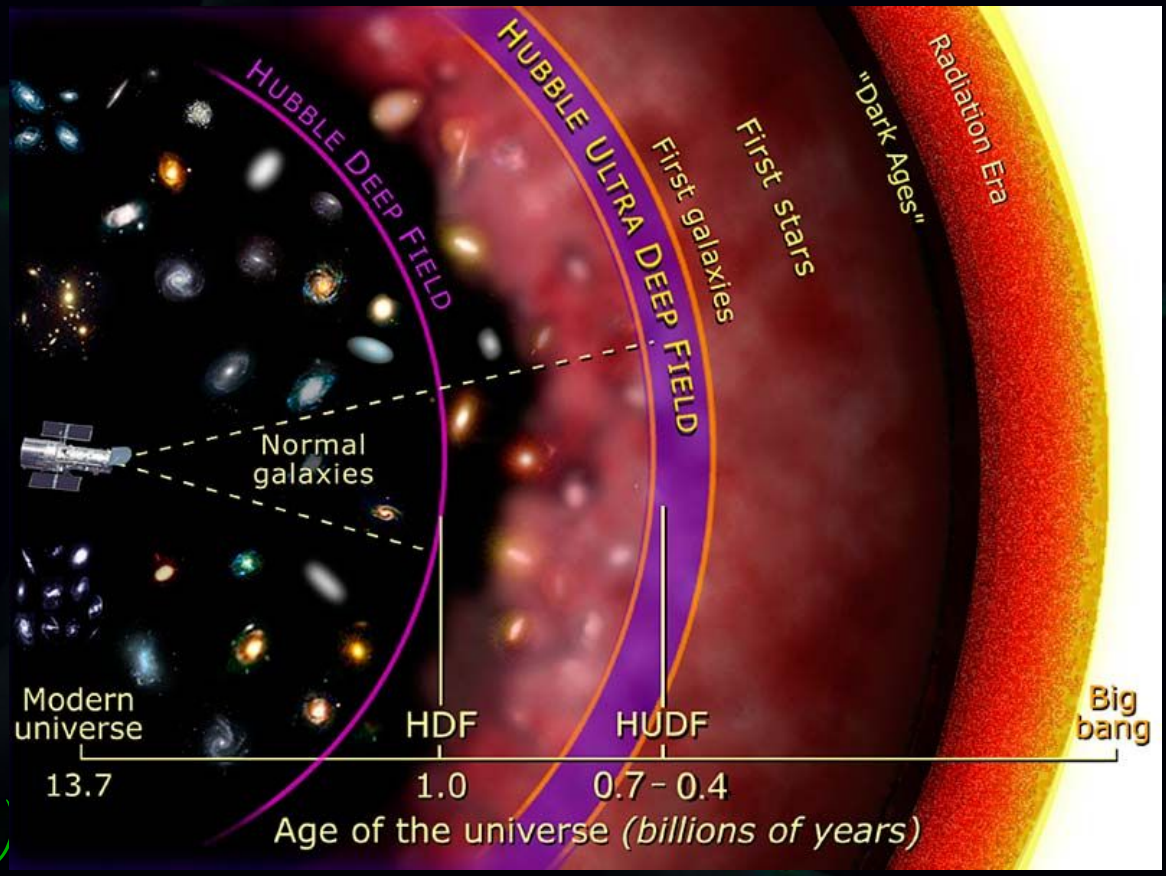
AGN e Galaxia a alto-redshift

Hubble campo ultra profundo (HUDF): galaxia a $z > 3$ (7-8?)

SDSS: AGN a $z > 6.5$

[Fe] => galaxia a $z > 9$ (?)

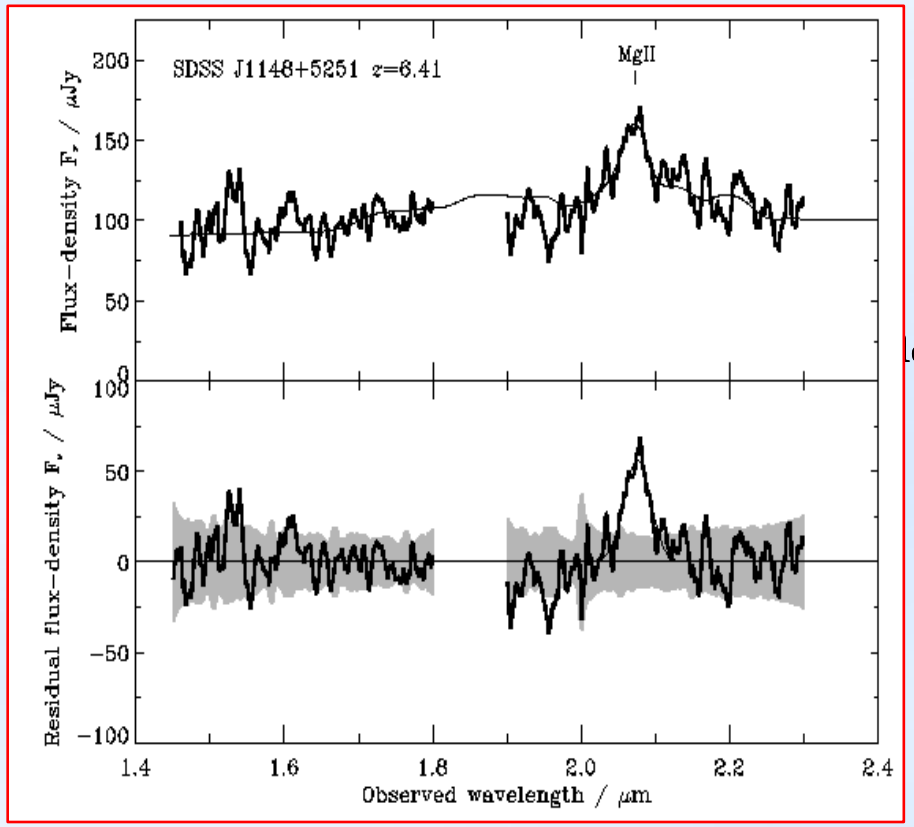
primeras estellas: remanents de 100--200 M_{sun} agujero negros



SMBH in highest redshift quasar (z=6.4)

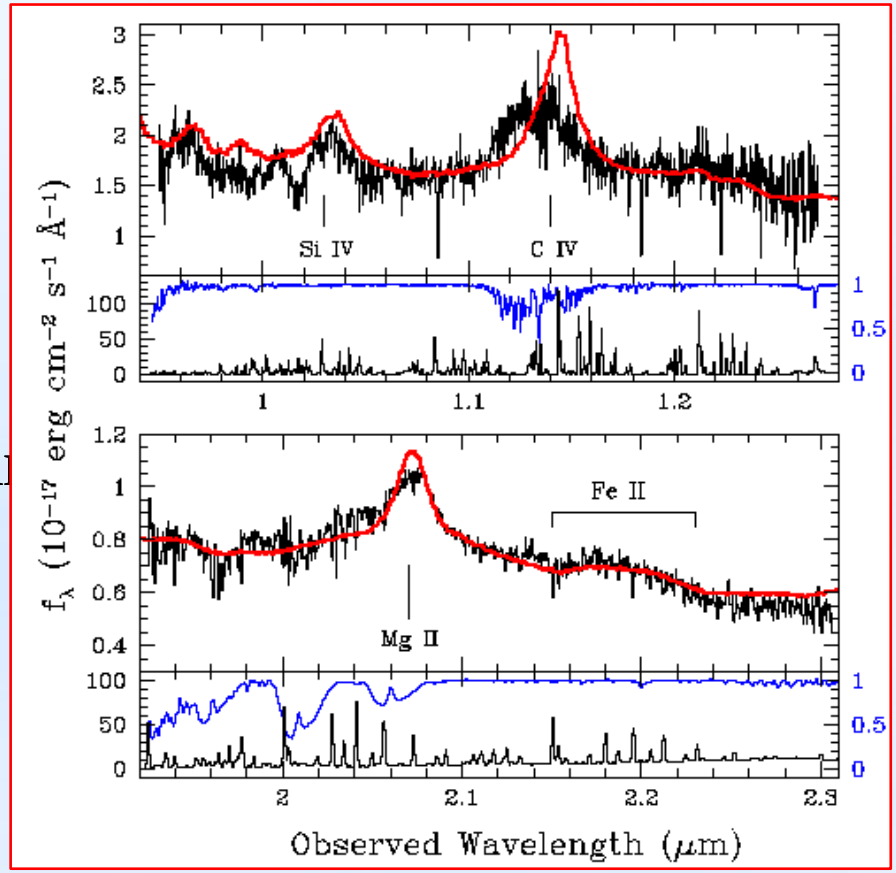
Willott et al. (2003)

$$\frac{M_{bh}}{M_\odot} = 3.37 \left(\frac{\lambda L_{3000}}{10^{37}\mathrm{W}}\right)^{0.47} \left(\frac{\mathrm{FWHM(Mg\,II)}}{\mathrm{kms}^{-1}}\right)^{2}$$



FWHM(MgII)=6000km/s, M_{BH}=3E9M

Barth et al. (2003)



FWHM(MgII)=5500km/s M_{BH}=2E9 M

FWHM(CIV)=9000km/s M_{BH}=6E9 M

DONT PANIC

Concep. 2004

Cual vino primero: el pollo o el huevo?

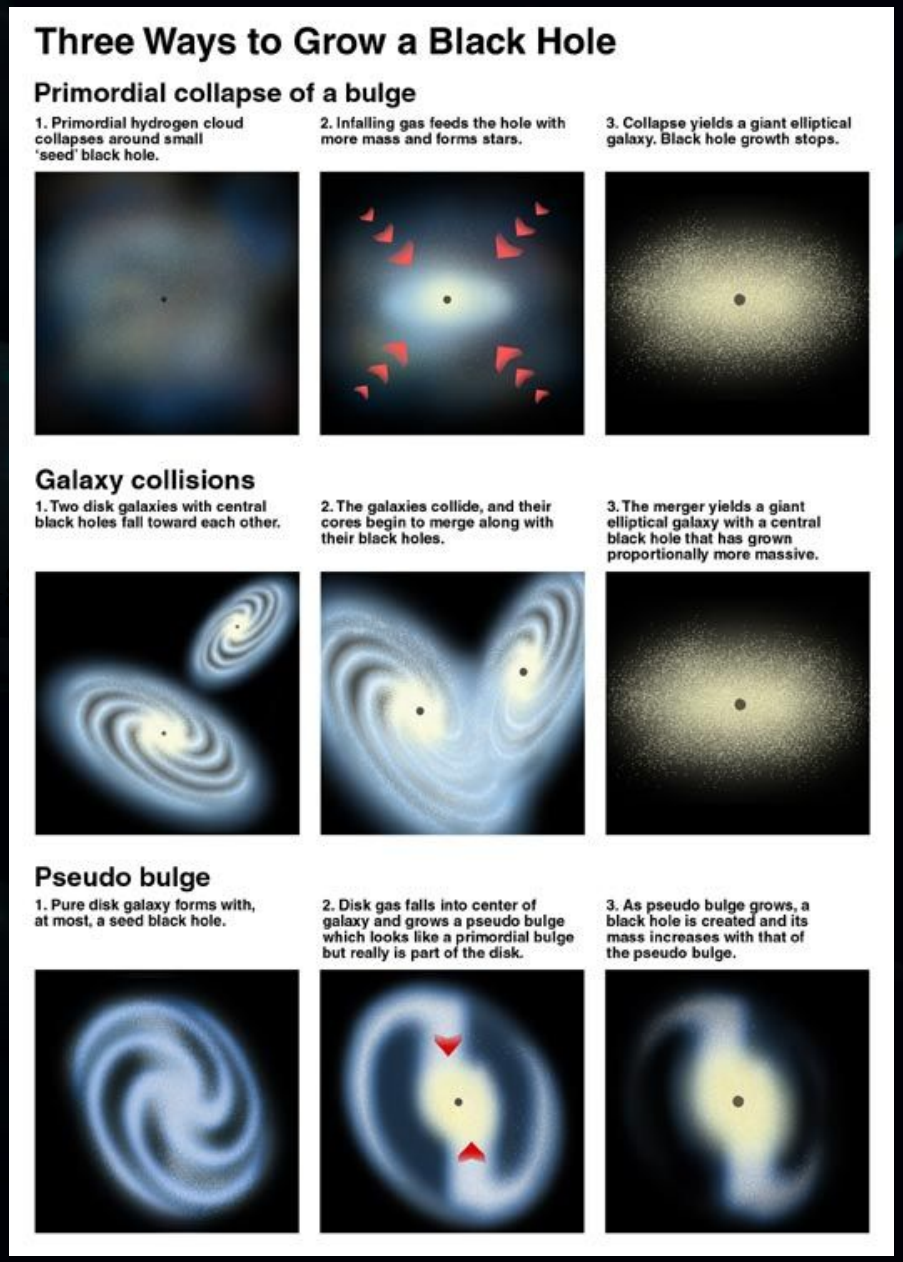
primeras estellas: remanents de 100--200 M_{Sol} agujero negros

combinacion de agujero negro:

$M_{final} = M_1 + M_2$

$M_{final} = (M_1^2 + M_2^2)^{1/2}$ + ondas grav

$M_{final} = M_1$ + expulsado M_2



M87: sub-pc to kpc

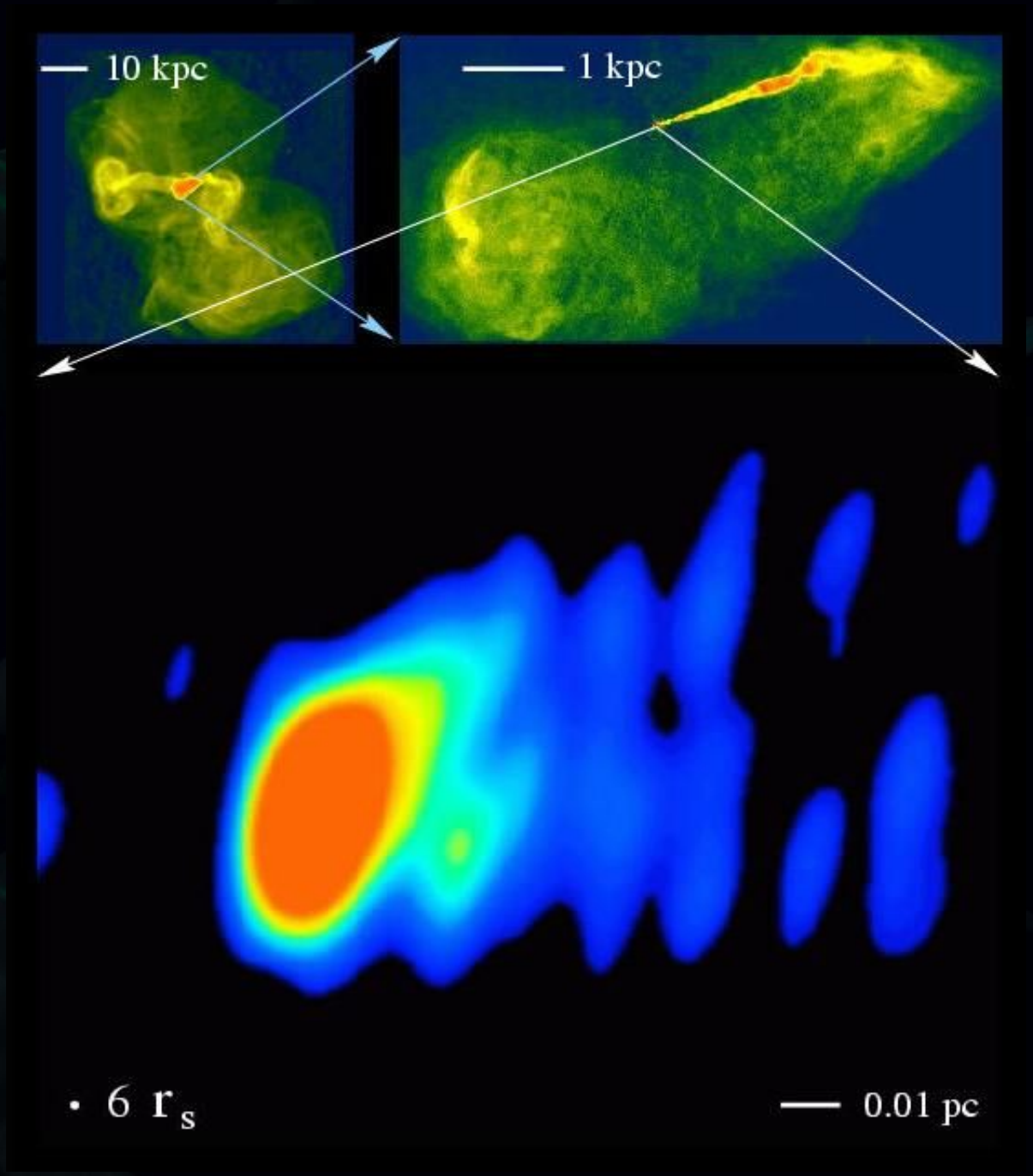
LINER / FR I

Nucleo + chorro

Radio "blobs"
<0.03c

optical "blobs":
superluminal

Collimacion de chorro:
< 100 R_s

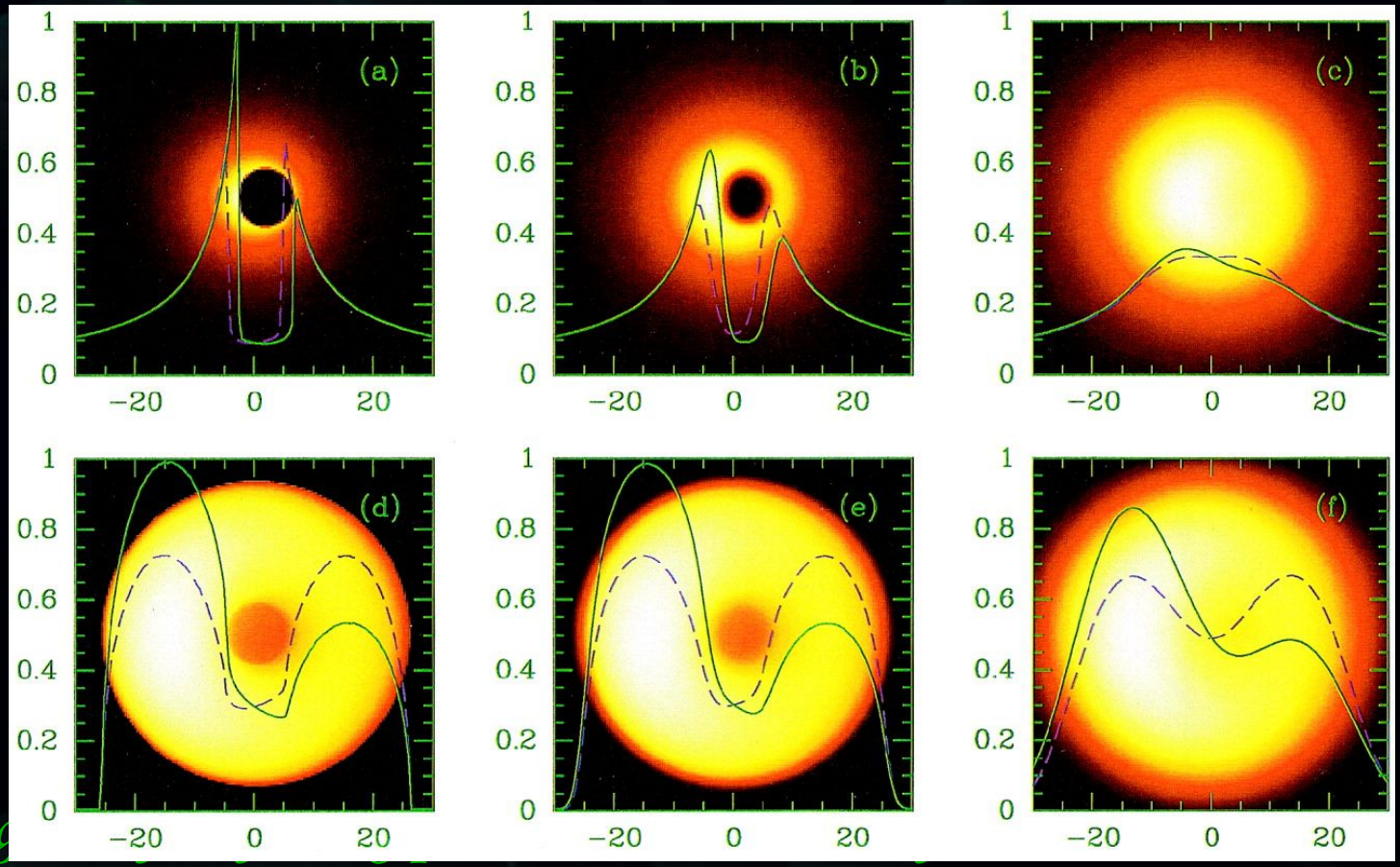


Junor et al. 1999

Imagen la sombra de un agejero negro

sombra: 10 R_s
(flexion luz)

per Sgr A:*
requerido 0.6mm

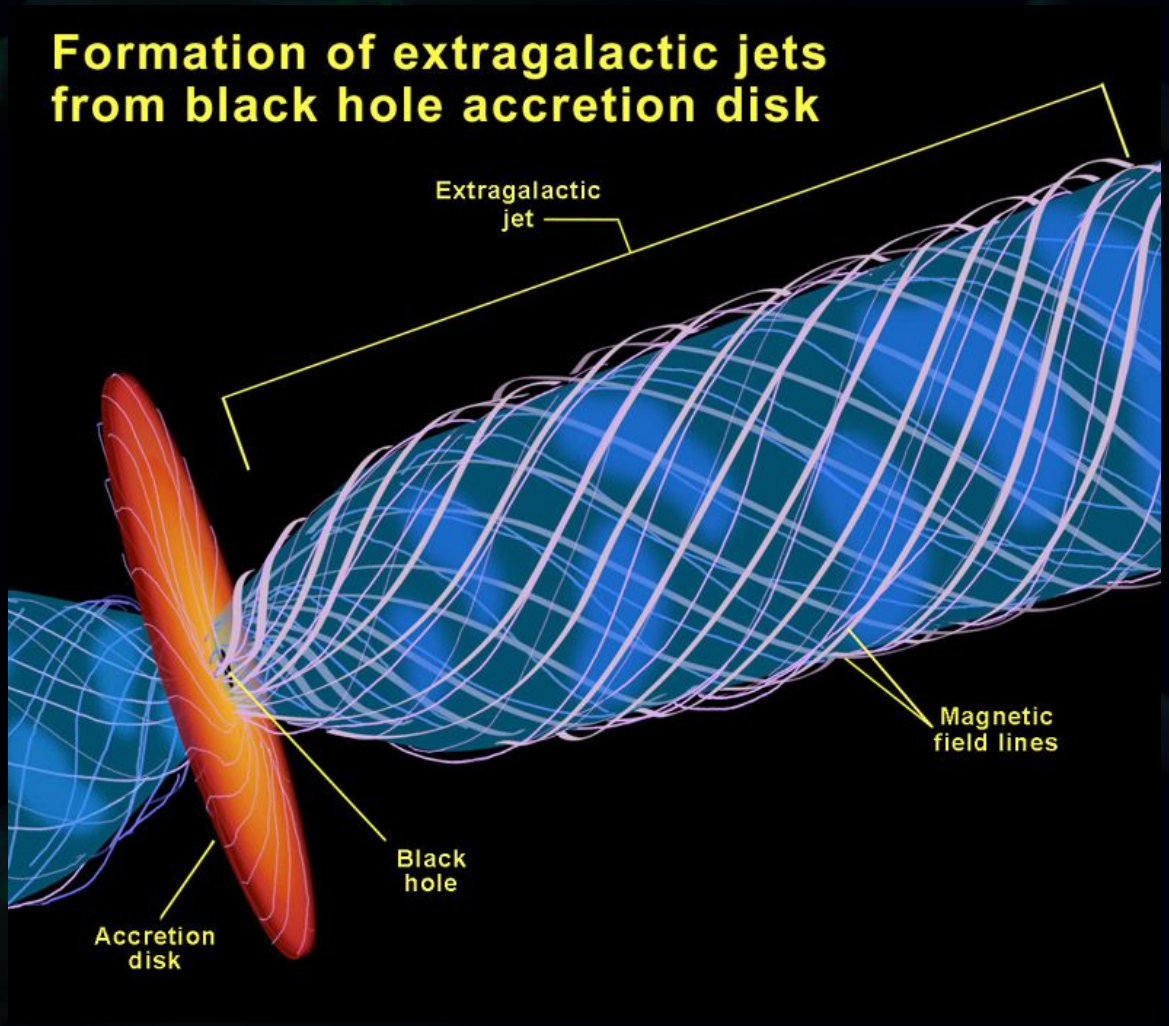


Agol, Falcke et al.

superior: max rotating
bajo : nonrotating BH; Keplerian rotation; uniform emissivity
izquierdo: ray tracing; medio: .6mm VLBI ideale; direcha: 1.3mm VLBI

Resumen

- Los agujeros negros de acrecentamiento son ubicuos.
  - Fuerte AGN: la alta energia
  - Galaxia normale : la oscura masa nucleare.
- Muchos nombres y tipos. Estamos mas cercanos ahora a un modelo fisico de la unificacion: $M_{black\ hole}$, orientacion, accretion rate, spin.
- Necesitamos todos los regimenes de la longitud de onda.
- La evolucion de una galaxia y su agujero negro es `coeval' y comenzado en el alto redshift.
- Con los telescopios sensibles nuevos, y los leyes confiables del escalamiento, podemos ahora alcanzar redshifts muy altos


Formation of extragalactic jets
from black hole accretion disk
Extragalactic
jet
Magnetic
field lines
Black
hole
Accretion
disk