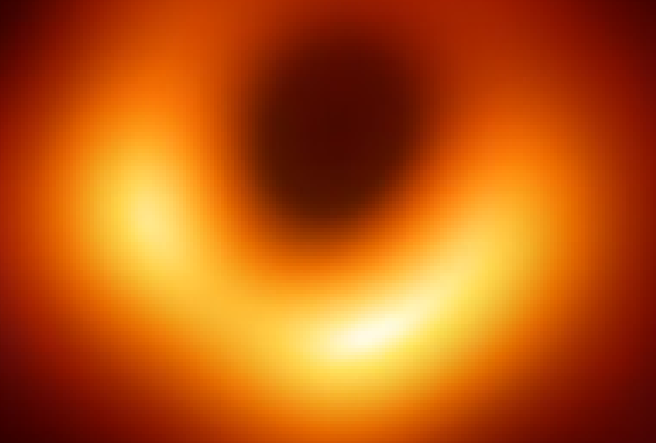
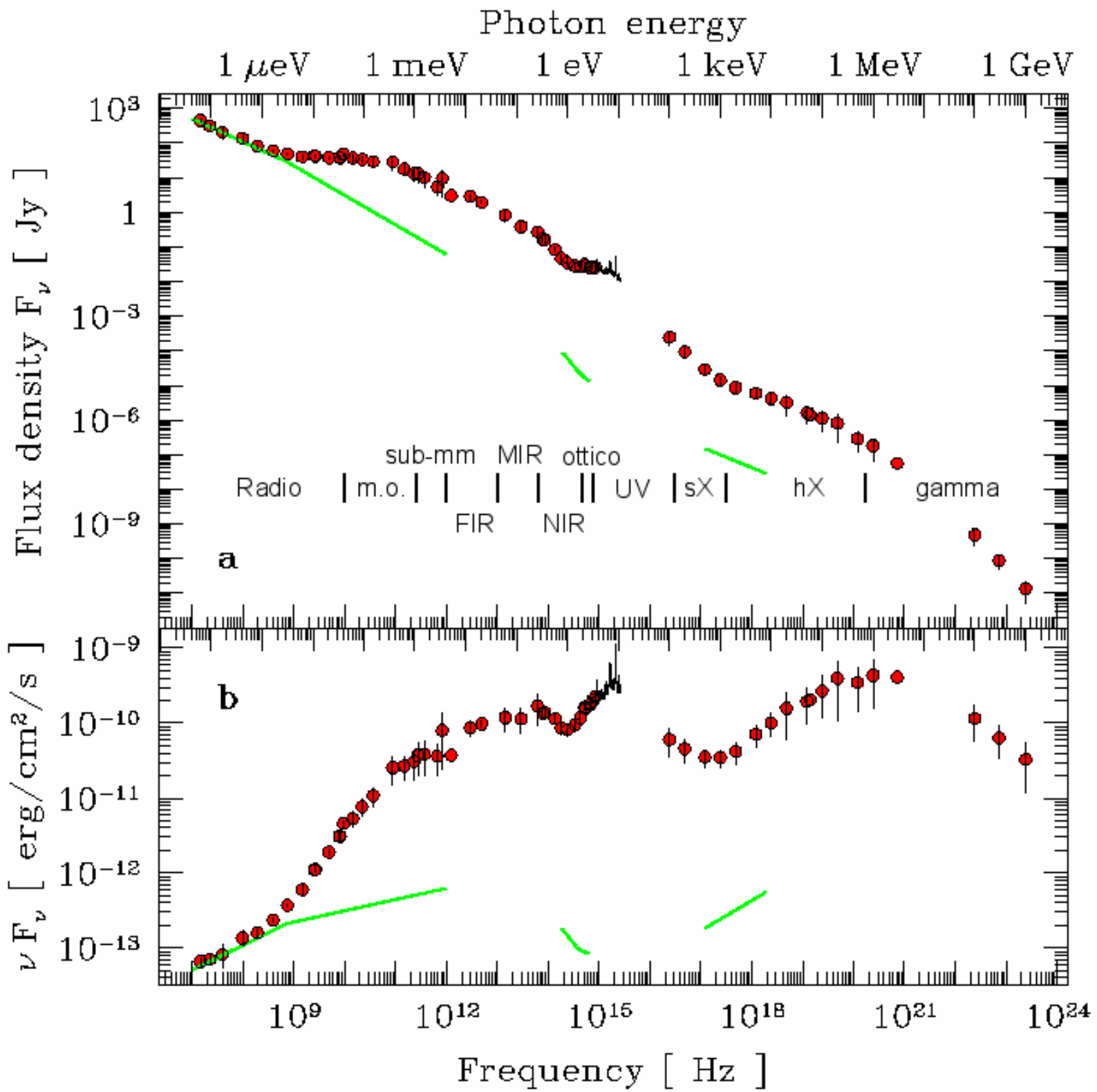


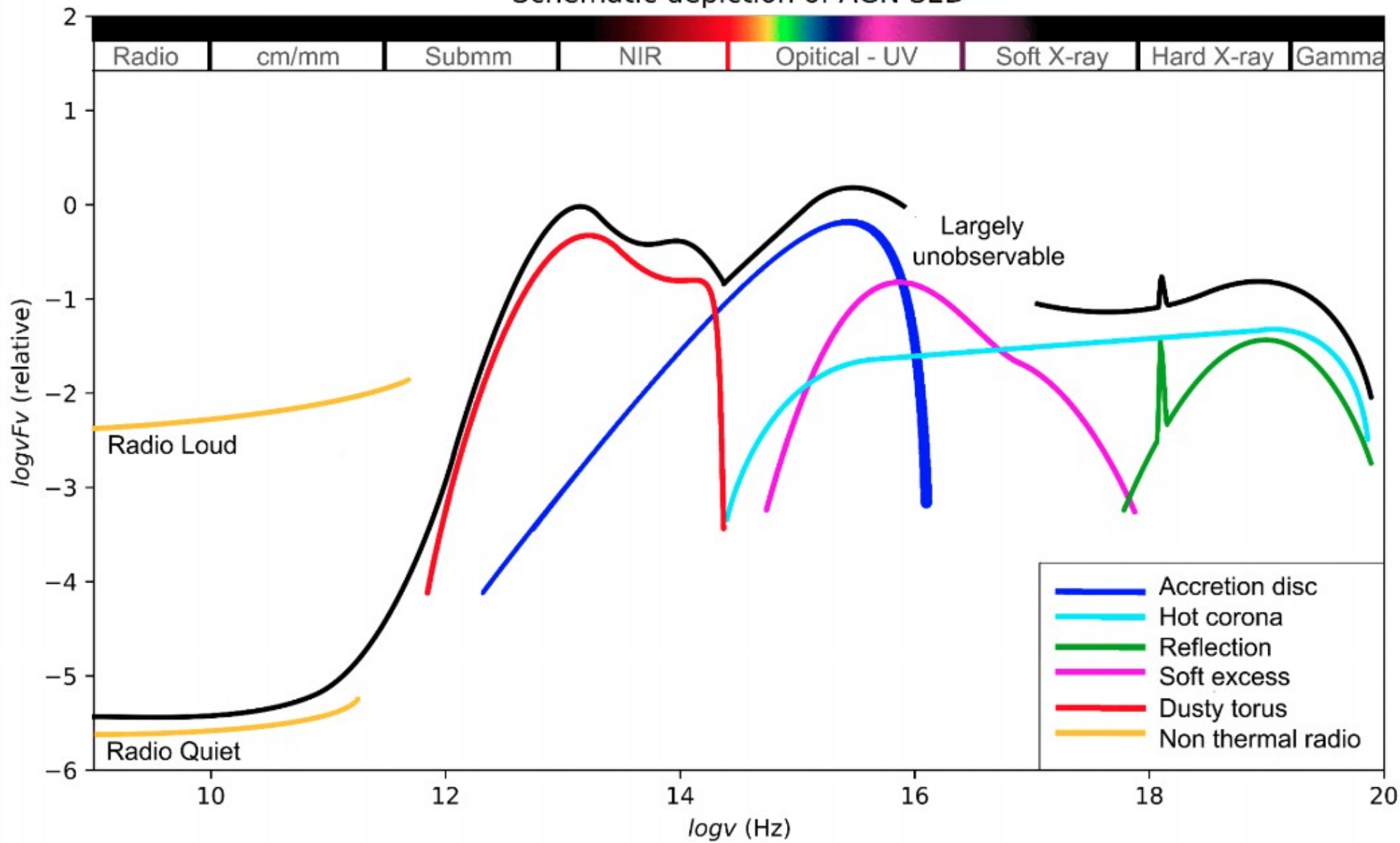
# **Active Galactic nuclei**

**Pierluigi Monaco, Radioastronomy**  
**2025/2026**



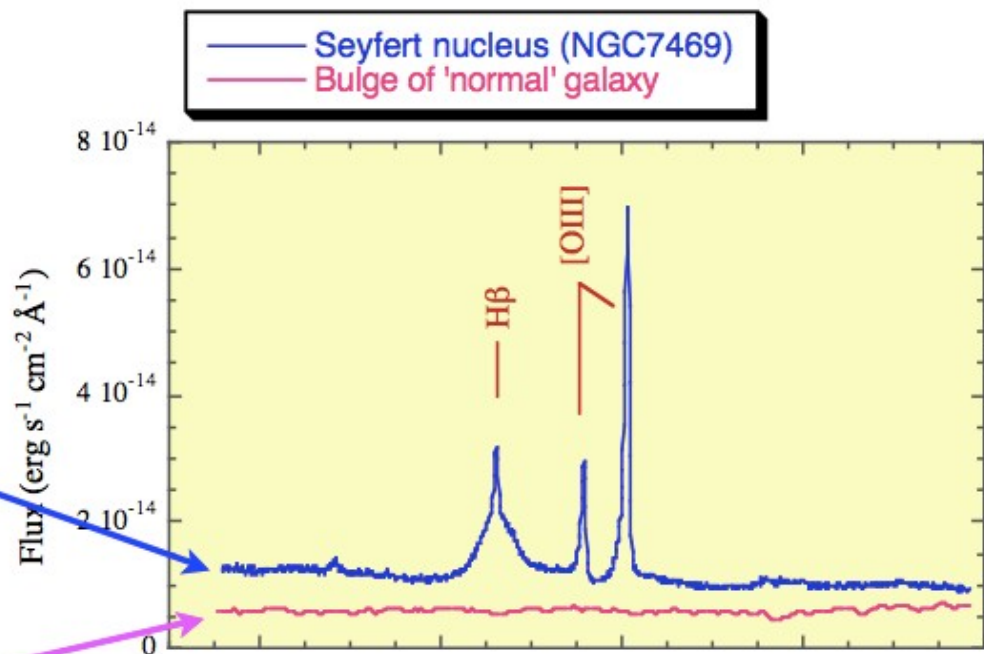
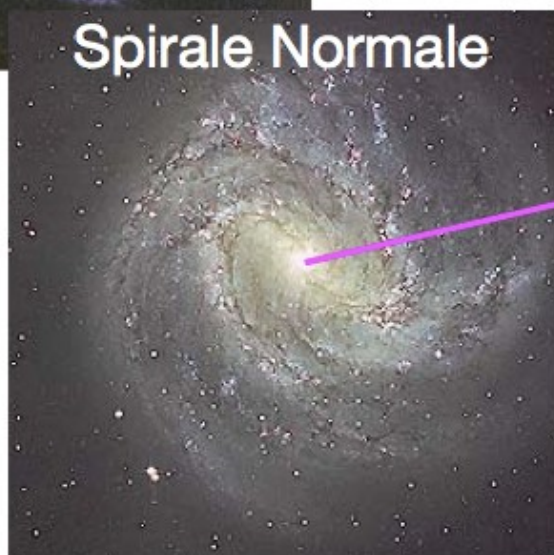


Schematic depiction of AGN SED

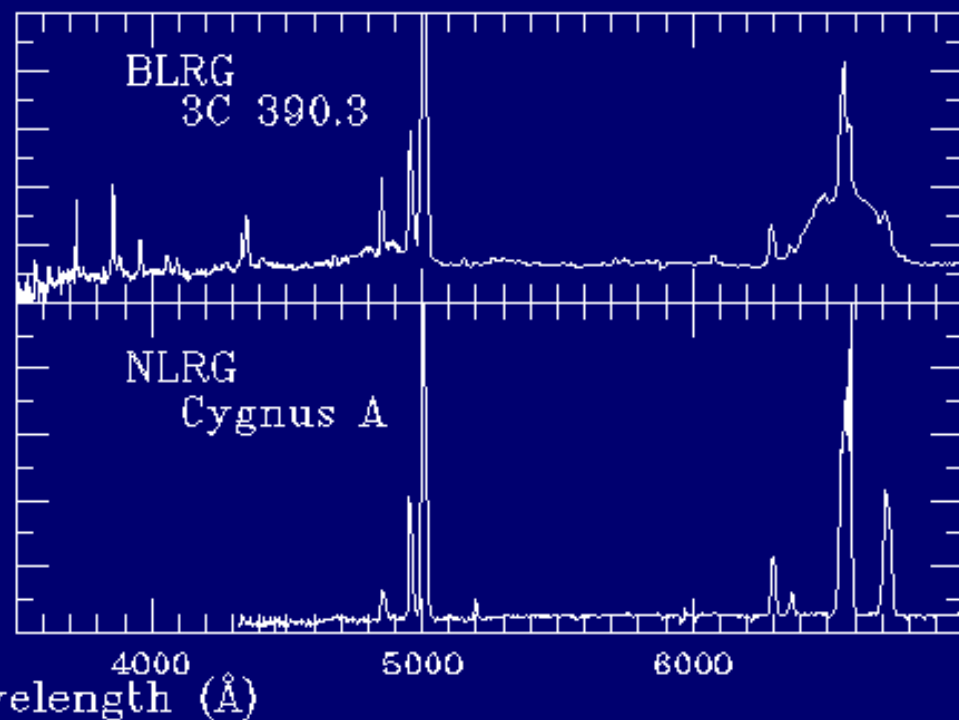
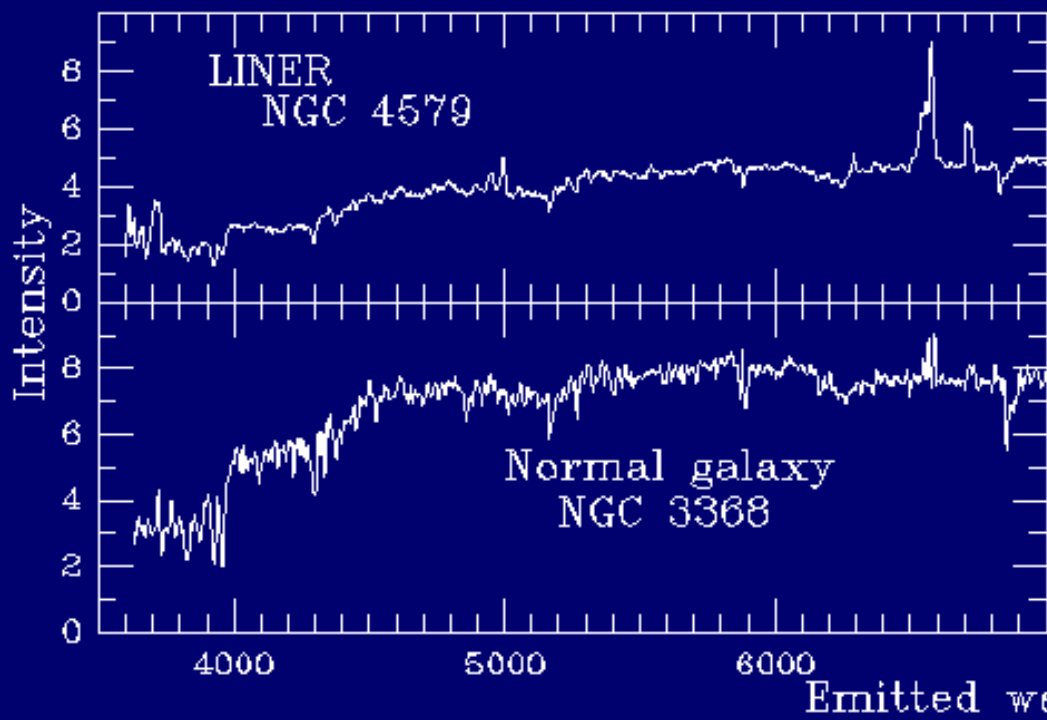
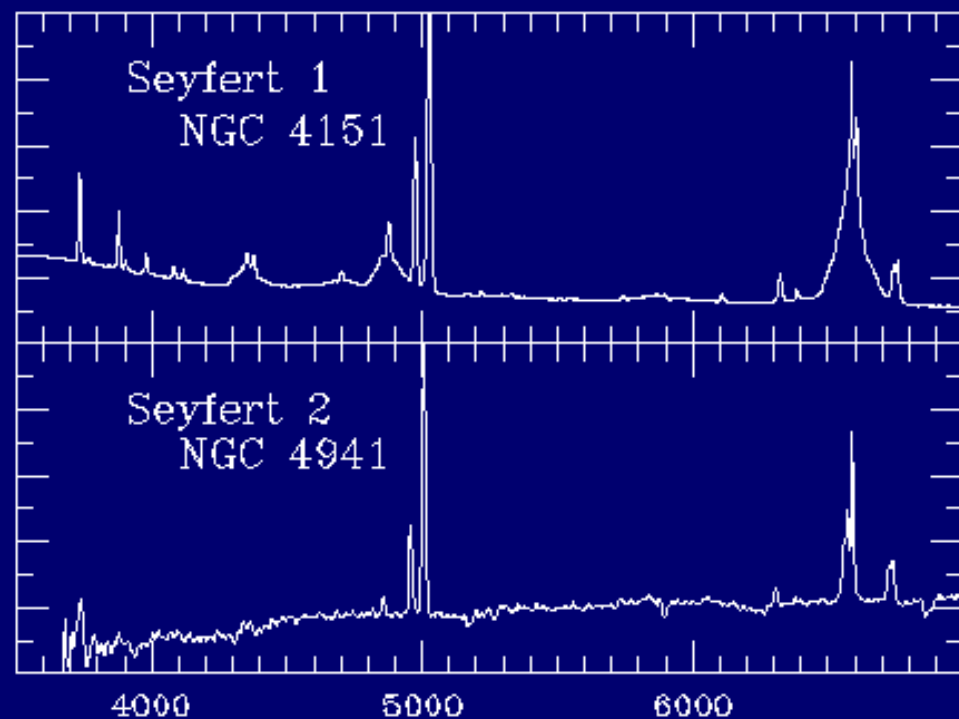
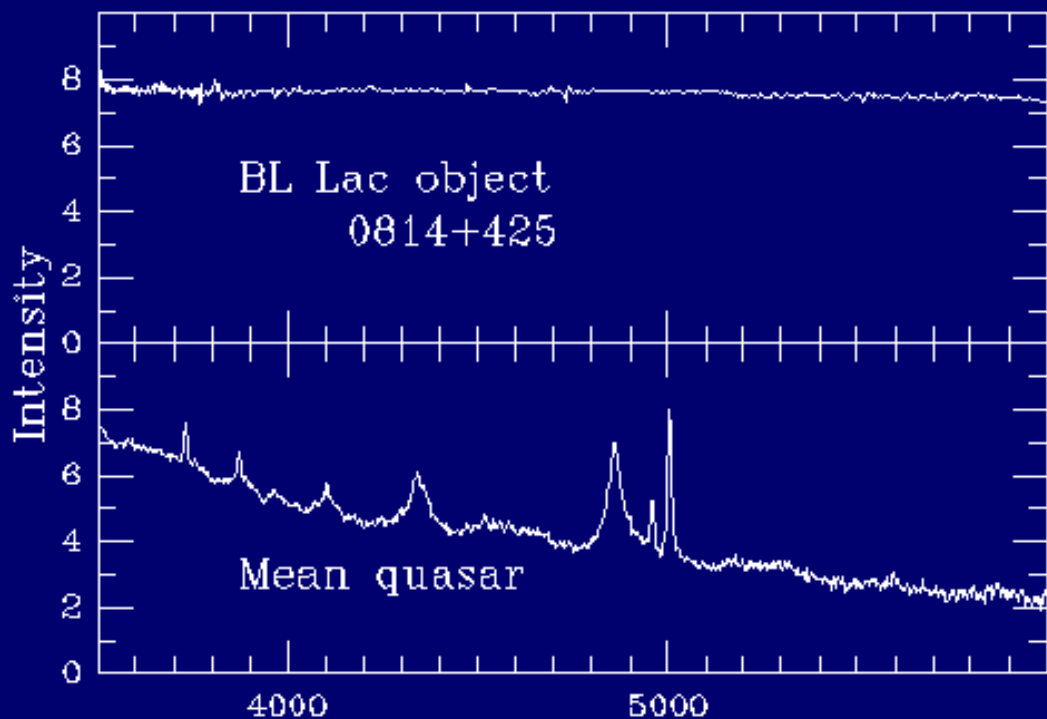


# Le Galassie di Seyfert

Scoperte da Karl Seyfert nel 1943 come galassie a spirali peculiari caratterizzate da forti righe di emissione nel nucleo.



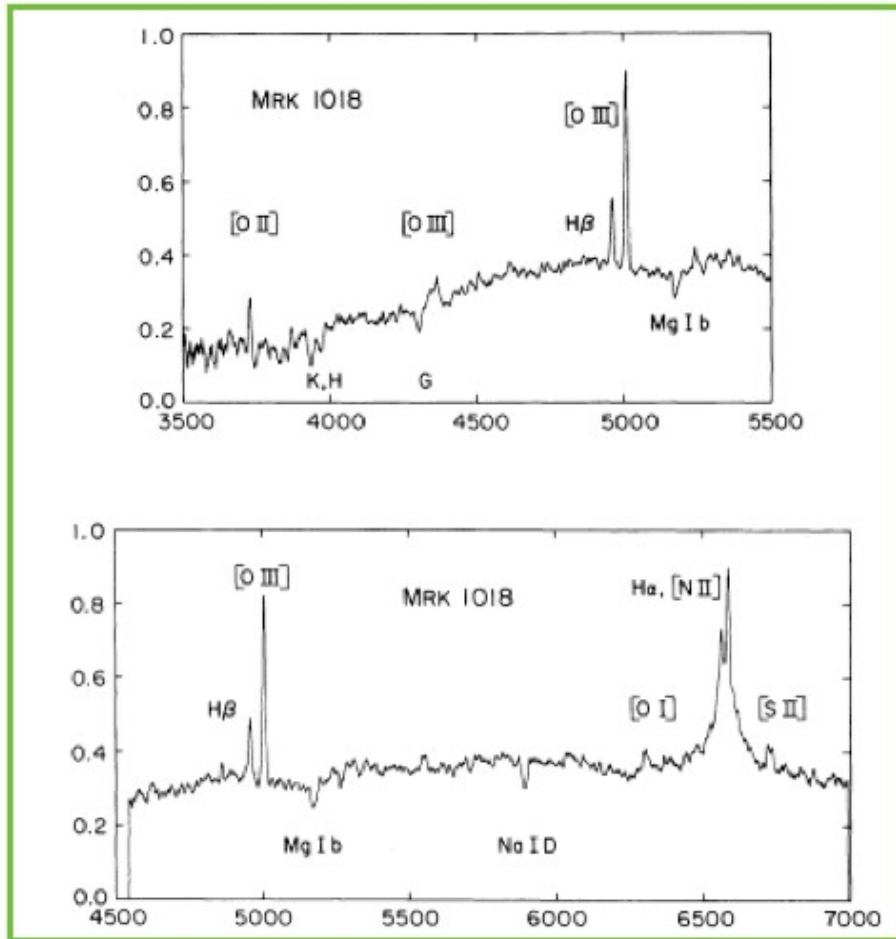
Lo spettro di una galassia di Seyfert ha righe di emissione che indicano un livello di ionizzazione del gas più elevato di quello riscontrato nelle galassie starburst (o nelle regioni HII). In alcuni casi le righe hanno larghezze elevate  $\text{FWHM} > 1000 \text{ km/s}$  (galassie normali  $\text{FWHM} < 300 \text{ km/s}$ )



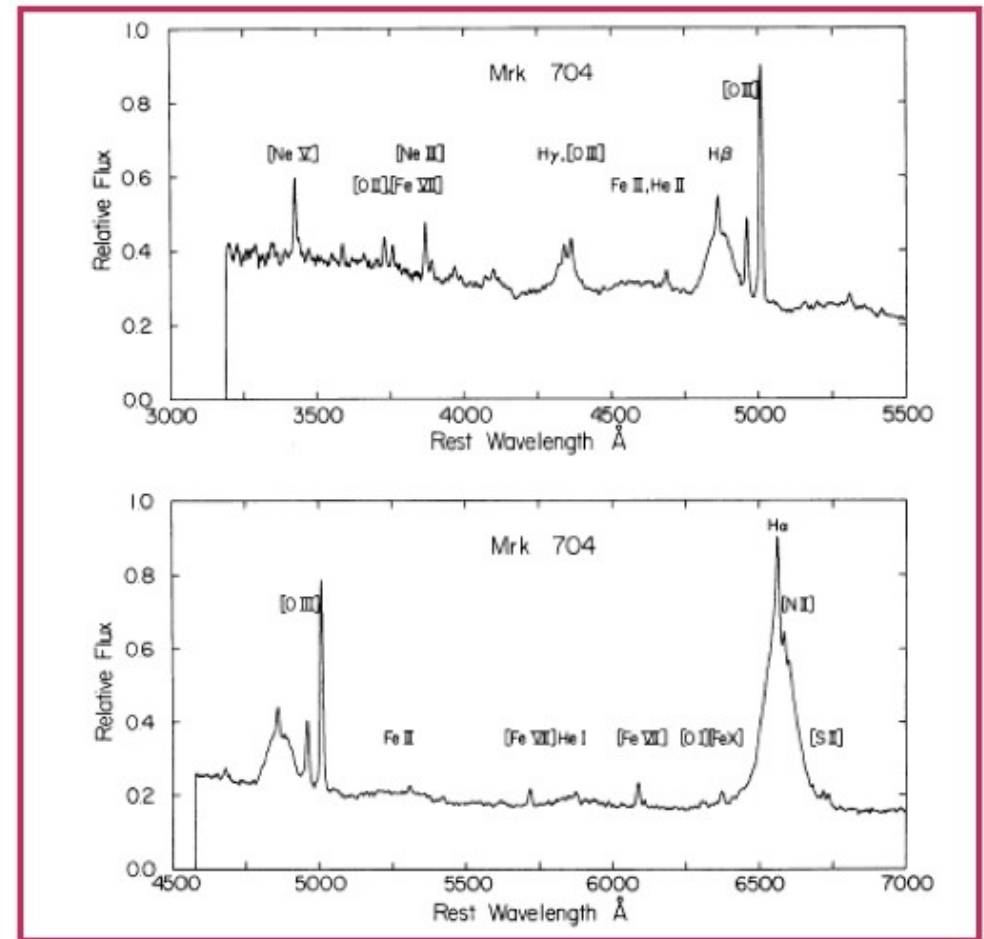
# Galassie di Seyfert

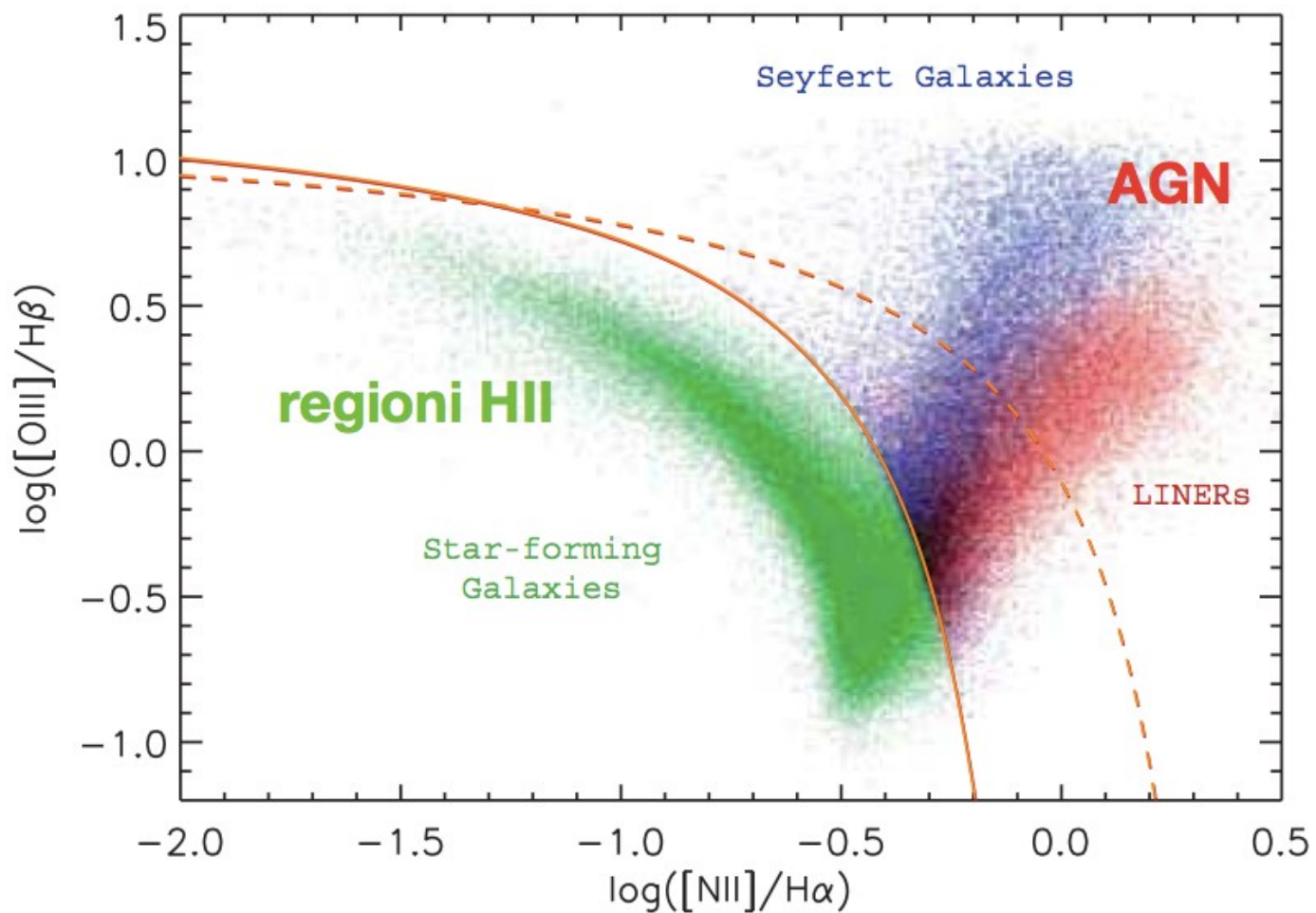
## TIPI "INTERMEDI"

Type 1.9



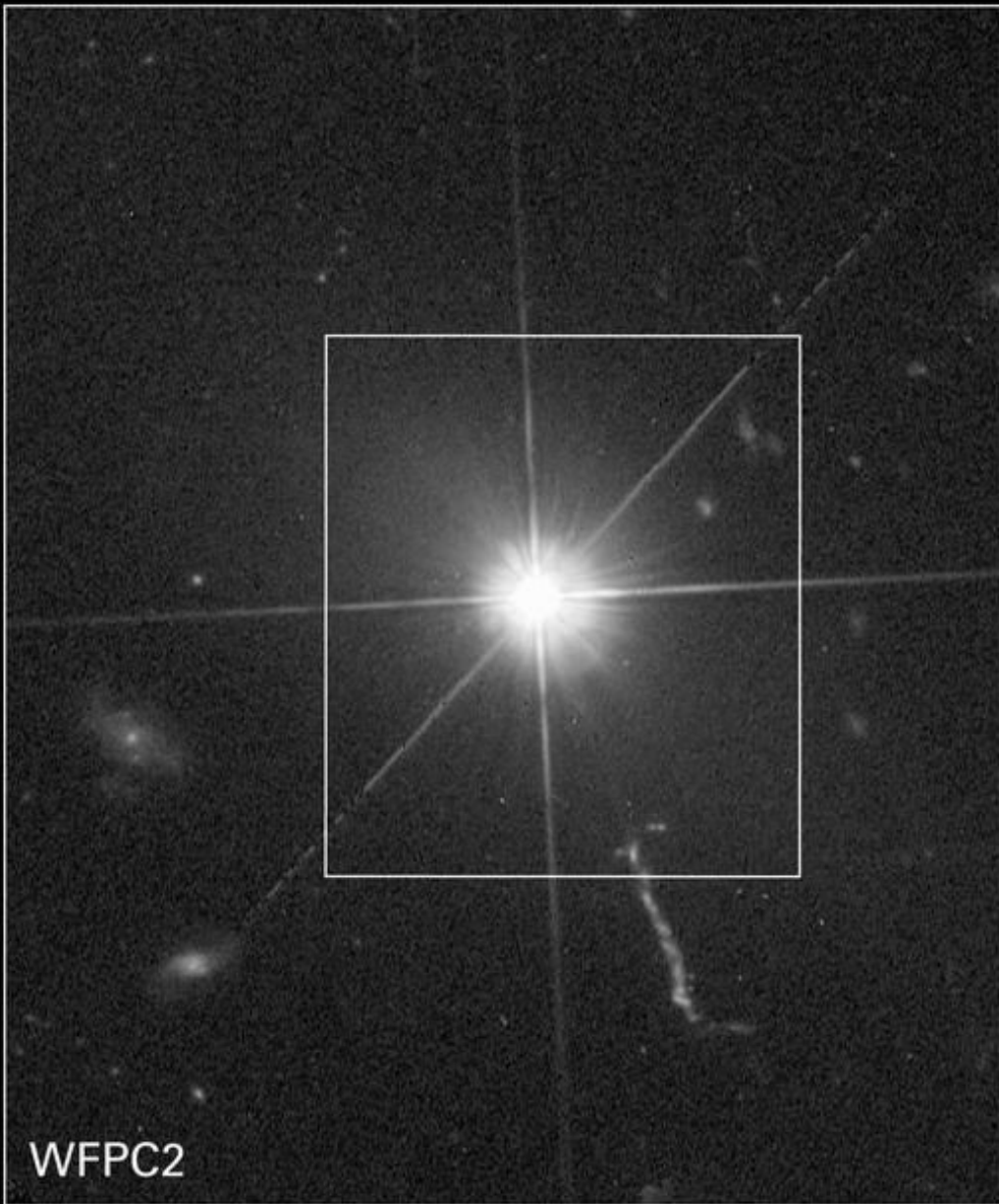
Type 1.5



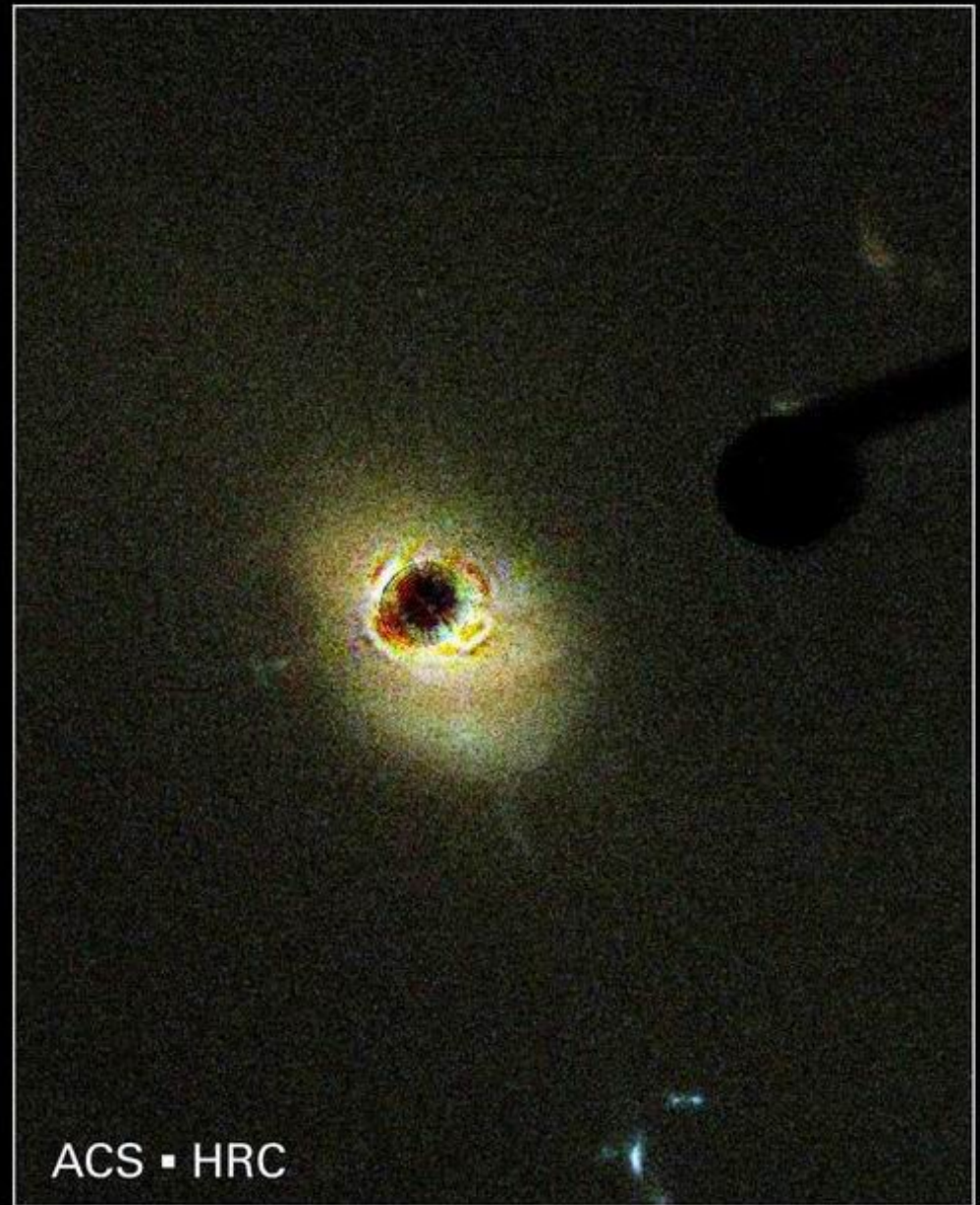


parametro di ionizzazione U

continuo ionizzante più "hard"

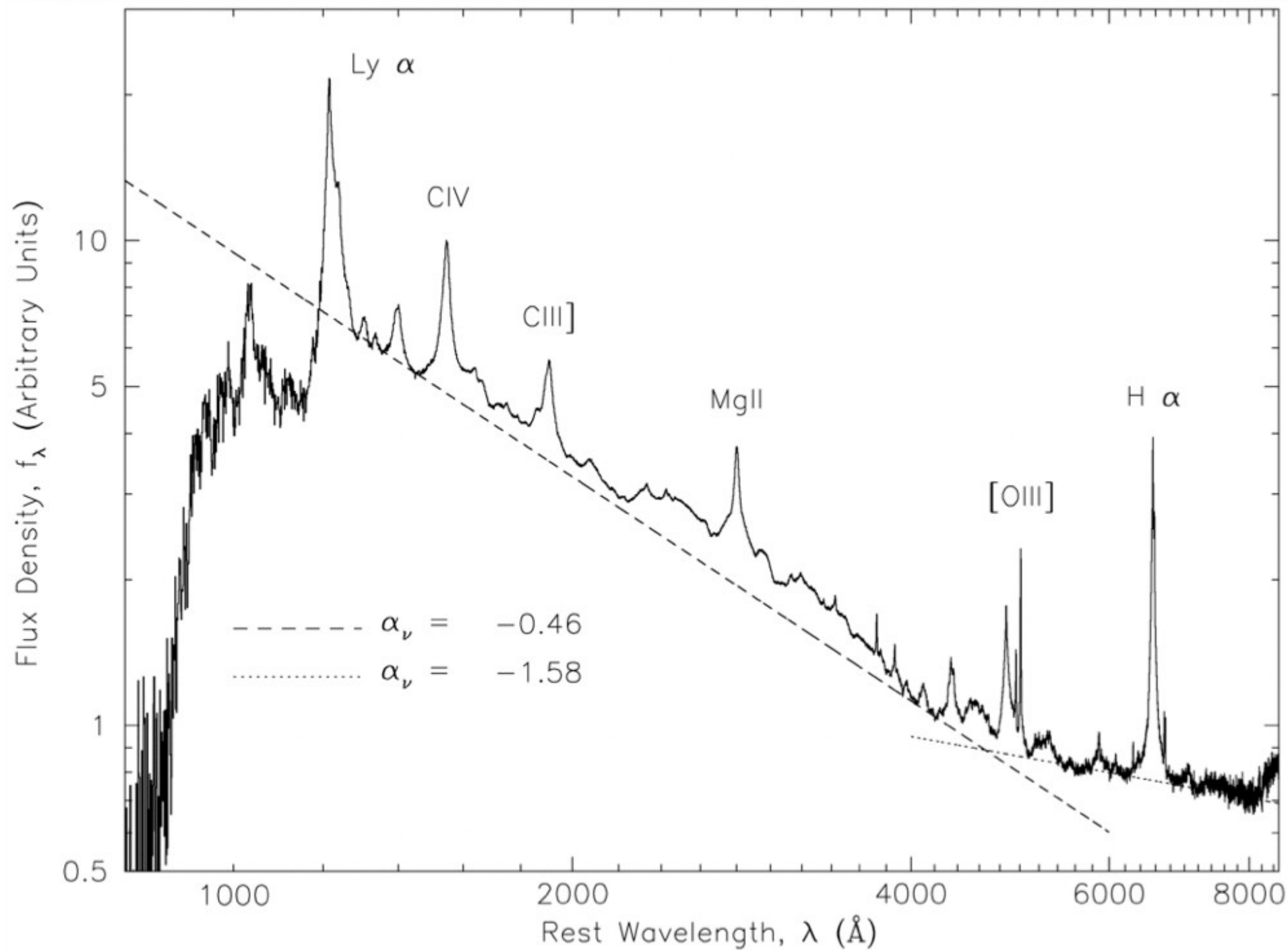


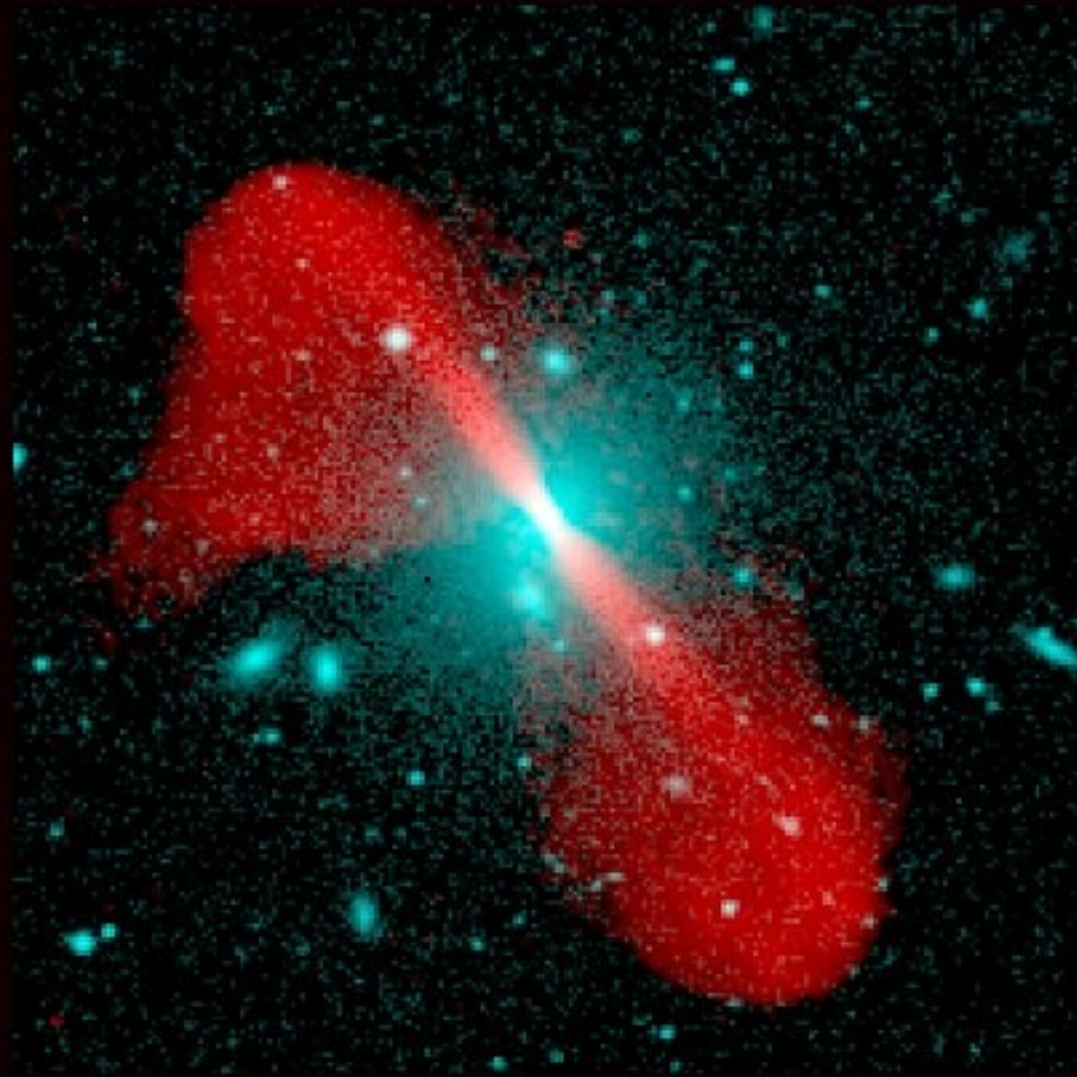
WFPC2



ACS ▪ HRC

**Quasar 3C 273**  
**Hubble Space Telescope ▪ ACS HRC Coronagraph**





Radio Galaxy 3C296  
Radio/optical superposition

Copyright (c) NRAO/AUI 1999

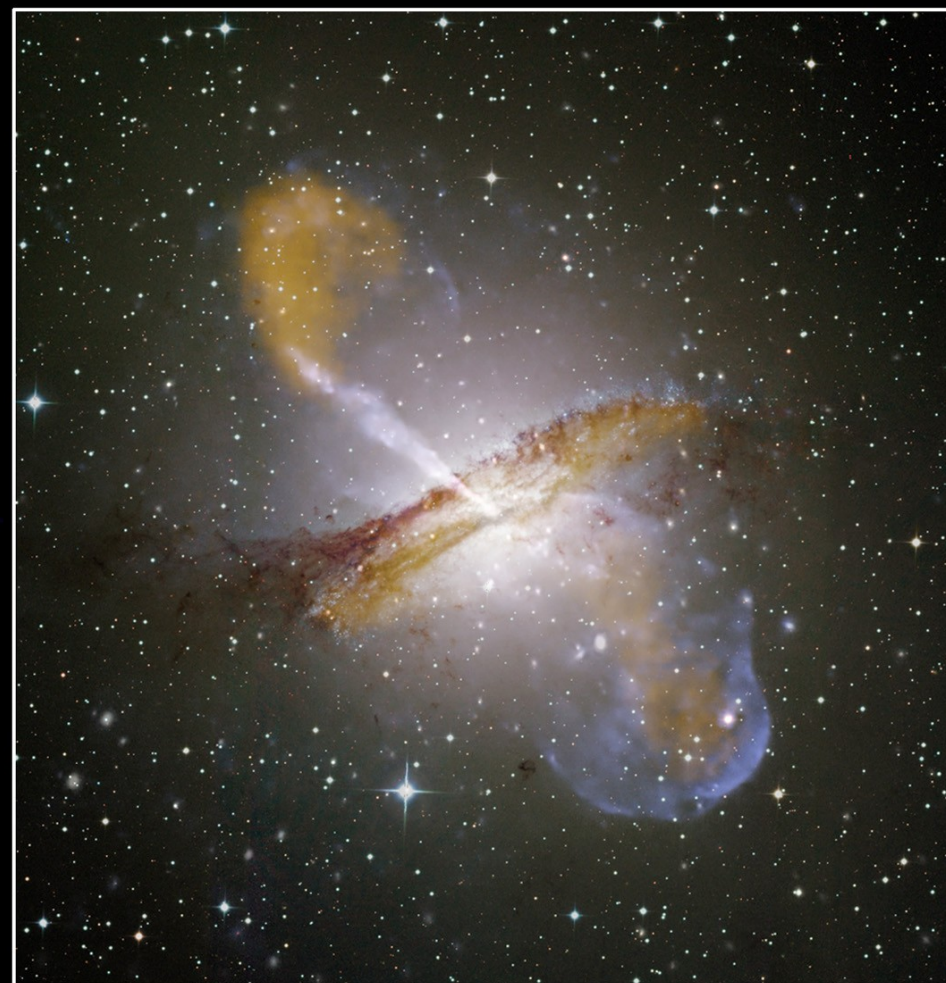
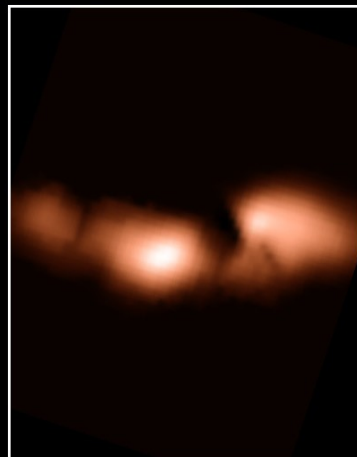
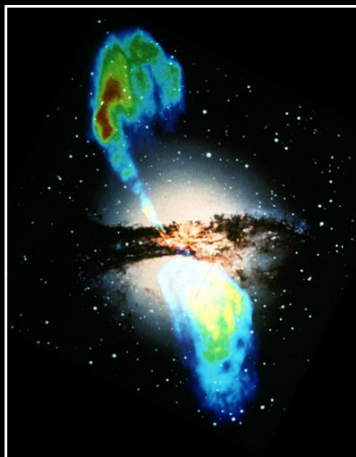
X ray



UV



Optical



MIR

Radiocontinuum

HI

X ray + Optical + Submillimetre + Radio Composition

Esistono due tipi di sorgenti radio (galassie o quasar) classificate in base alla loro apparenza radio:

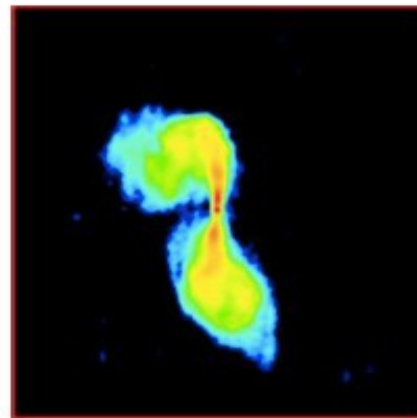
Sorgenti Fanaroff-Riley I (FR I)

Sorgenti Fanaroff-Riley II (FR II)

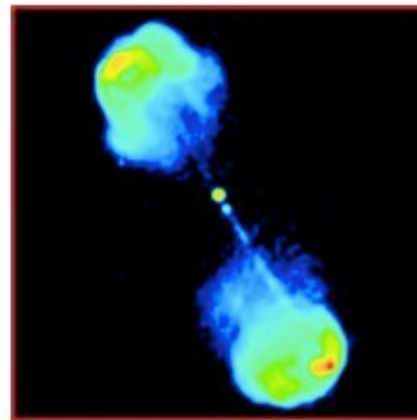
$< 2 \times 10^{25} \text{ W}$     **FR I**

Radio  
Loudness  
 $L(178\text{MHz})$

$> 2 \times 10^{25} \text{ W}$     **FR II**



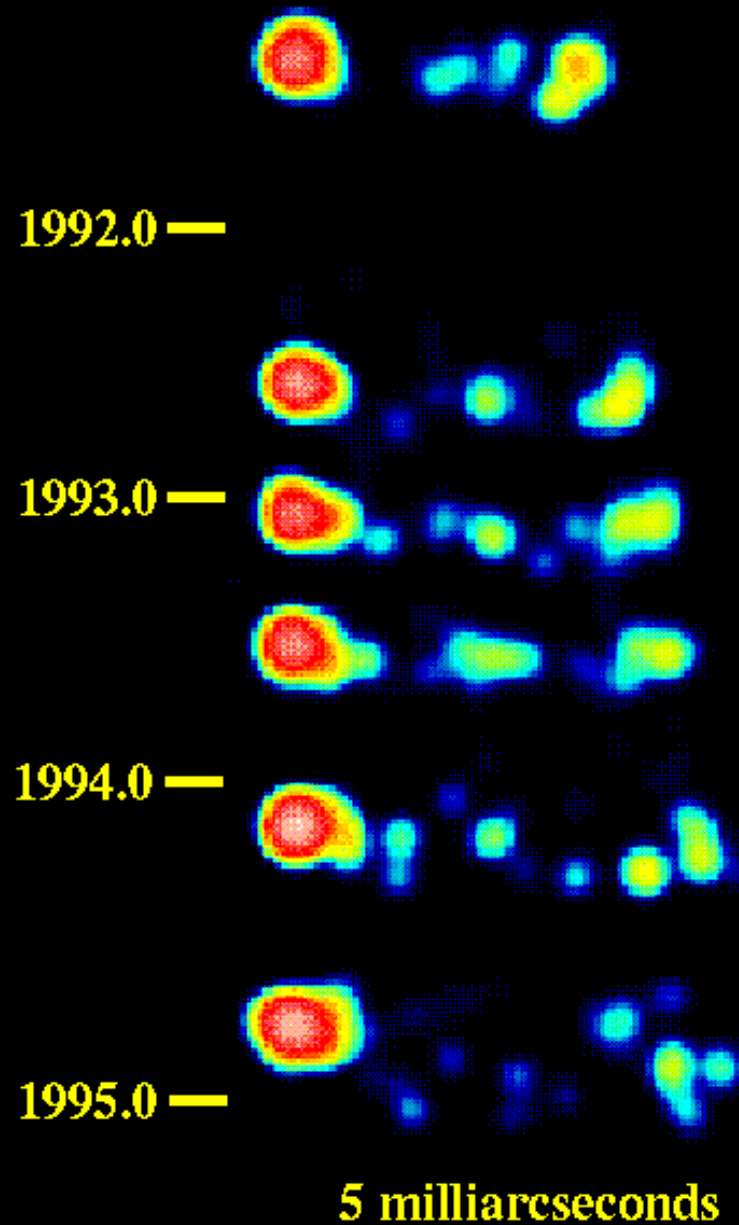
Getti radio gemelli, molti "blob" di emissione, estesi, oscurate ai bordi (edge darkened)

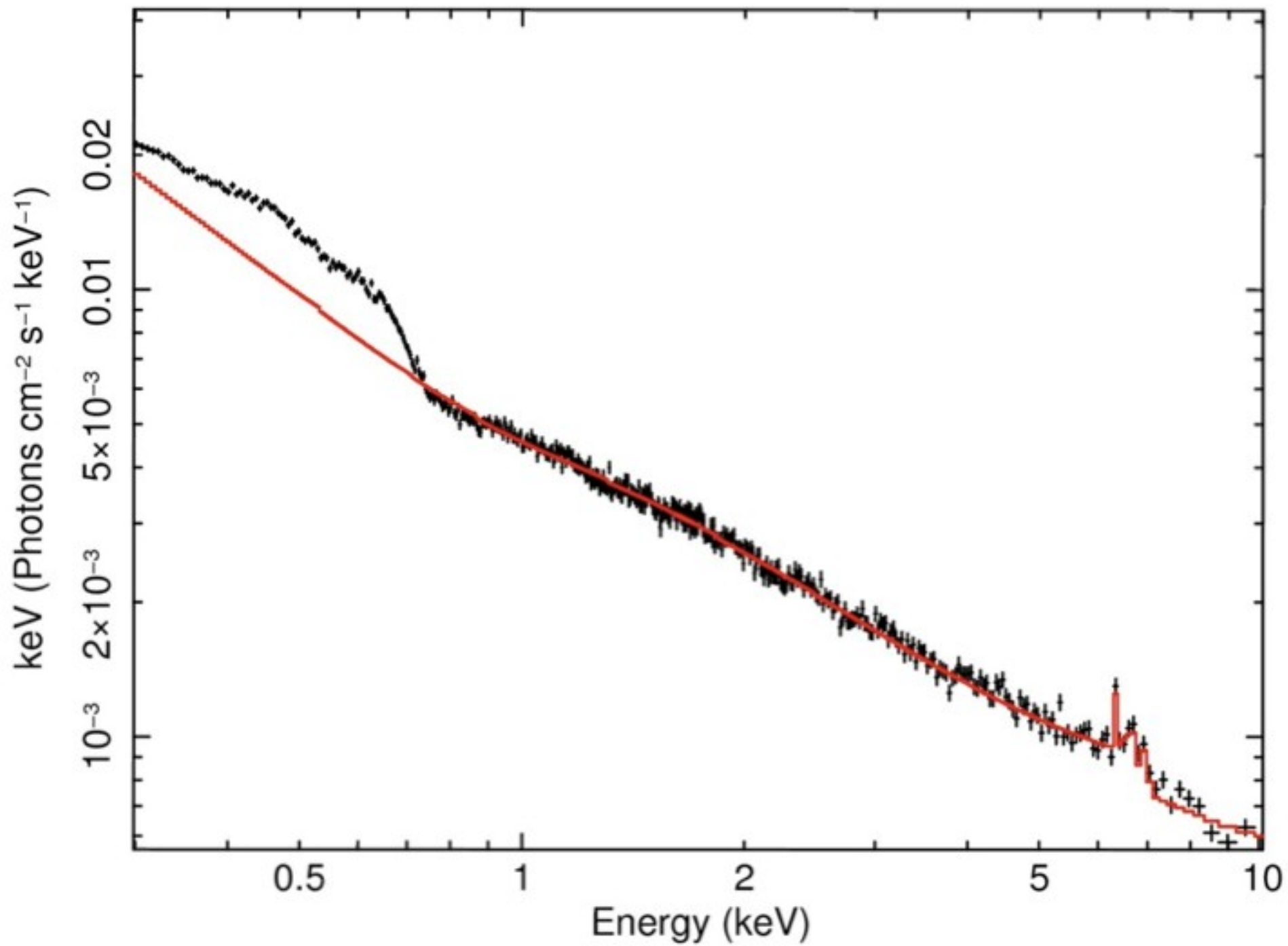


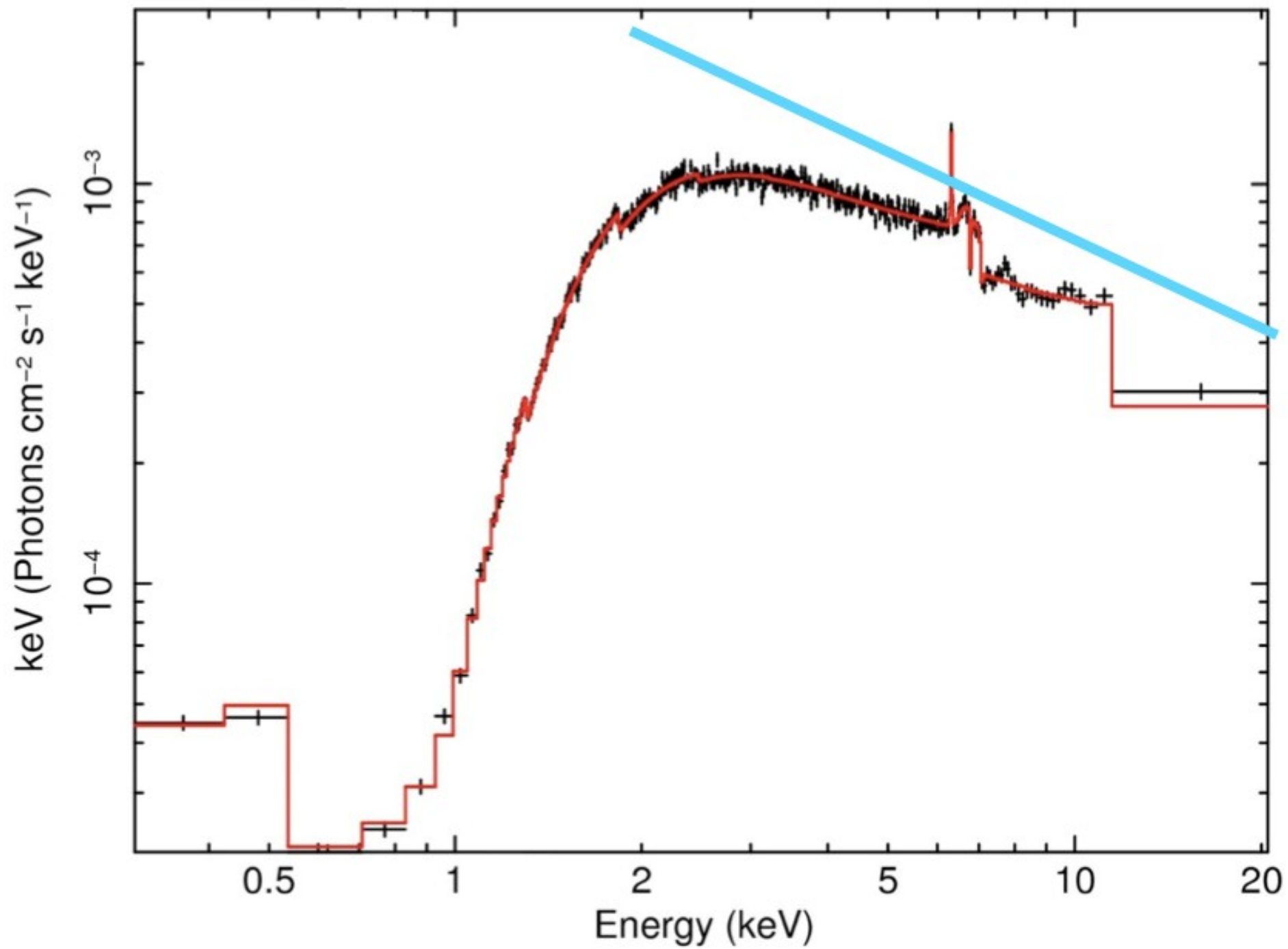
Getti radio singoli e altamente collimati, brillanti ai bordi (edge brightened)

# 3C 279

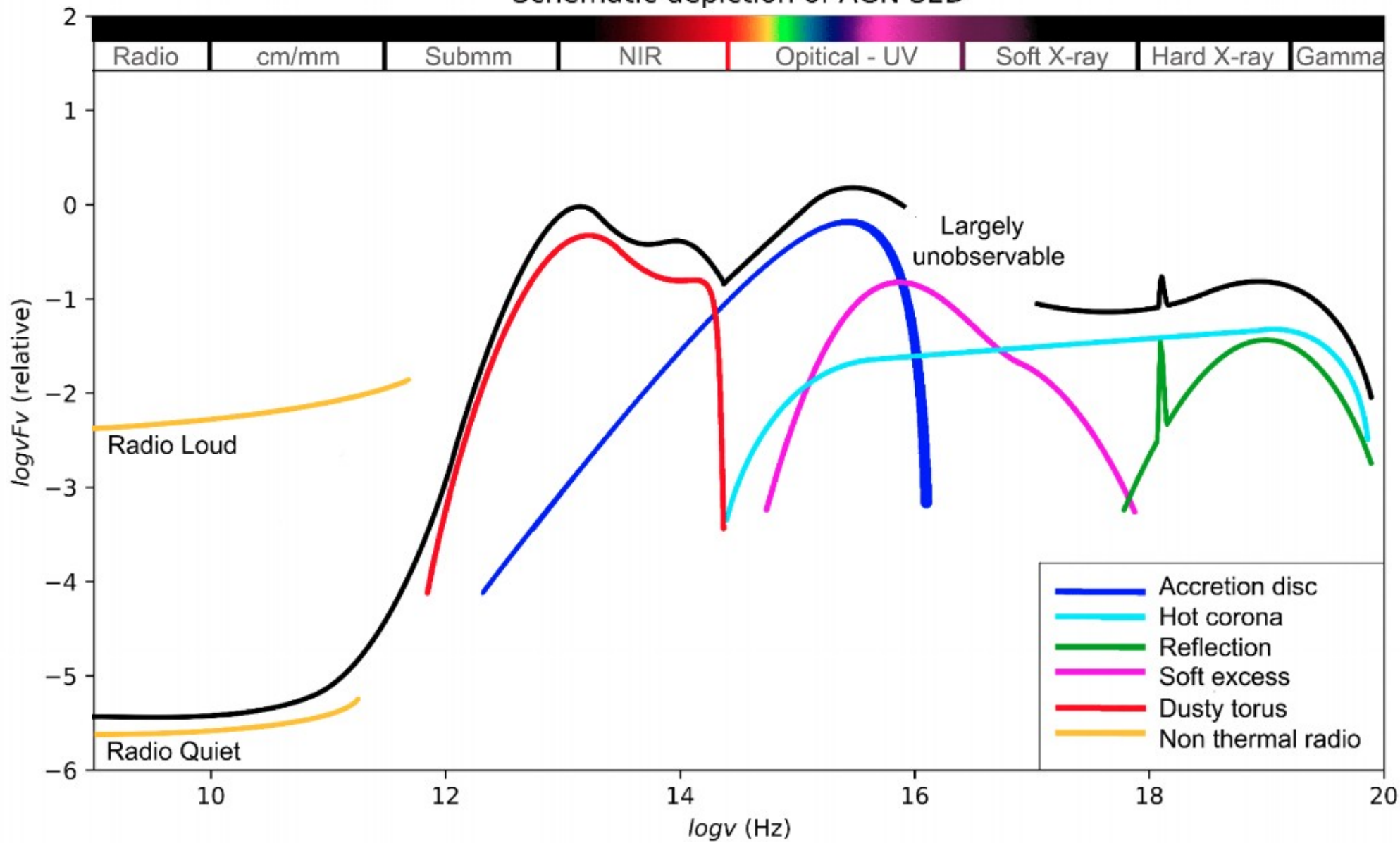
## Superluminal Motion





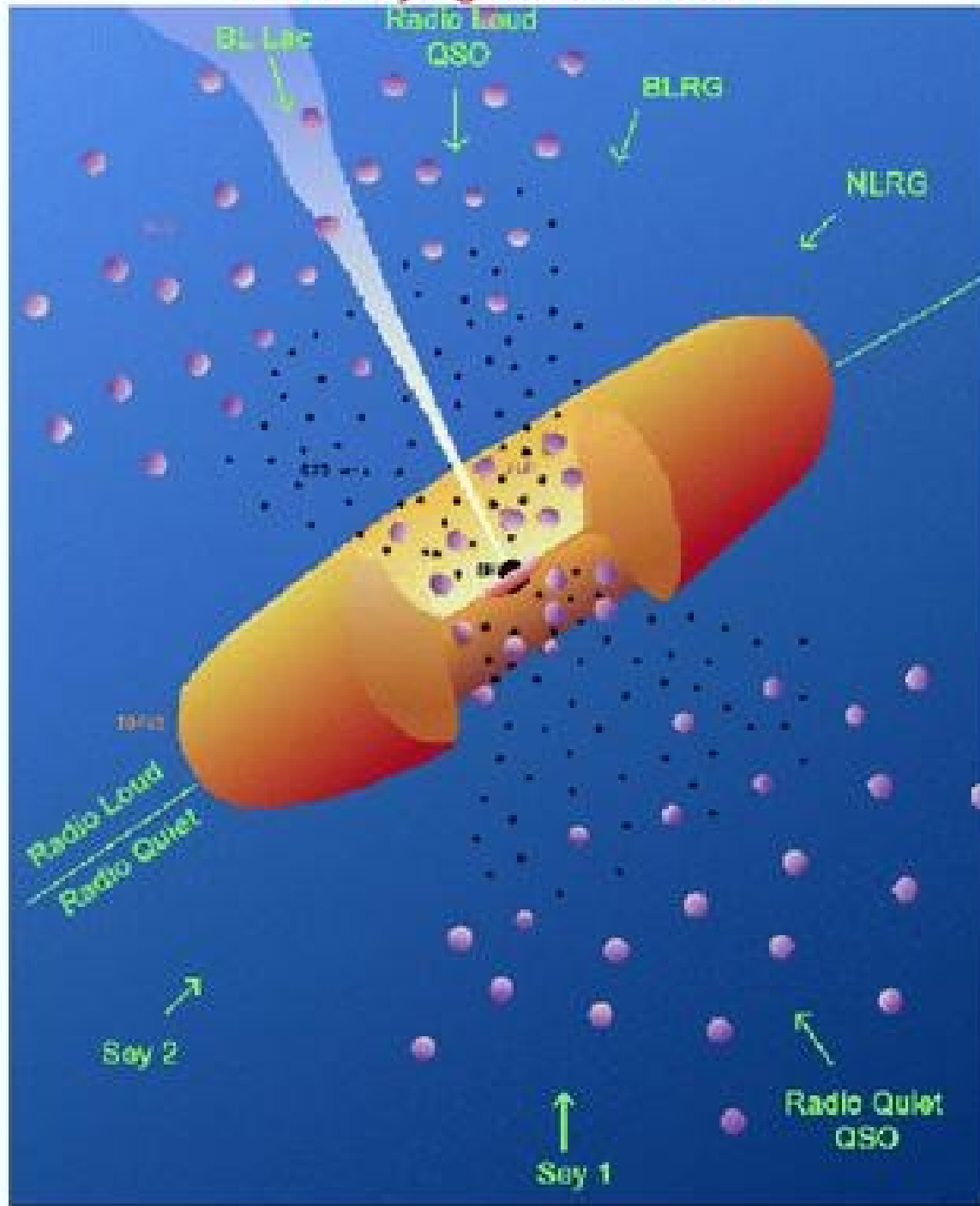


Schematic depiction of AGN SED

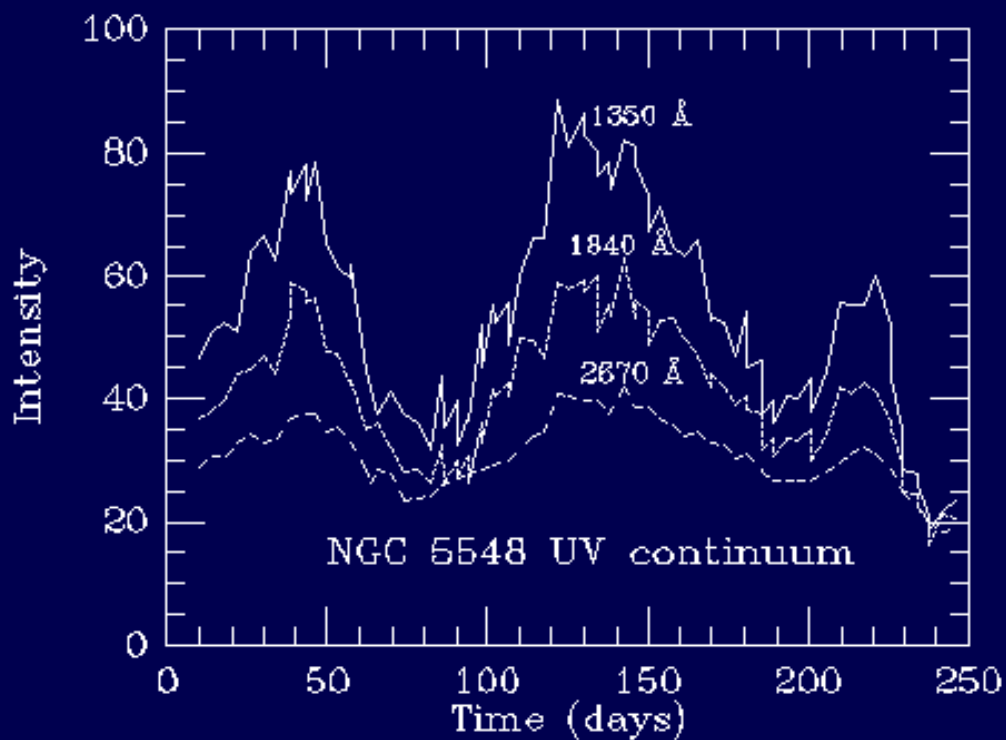
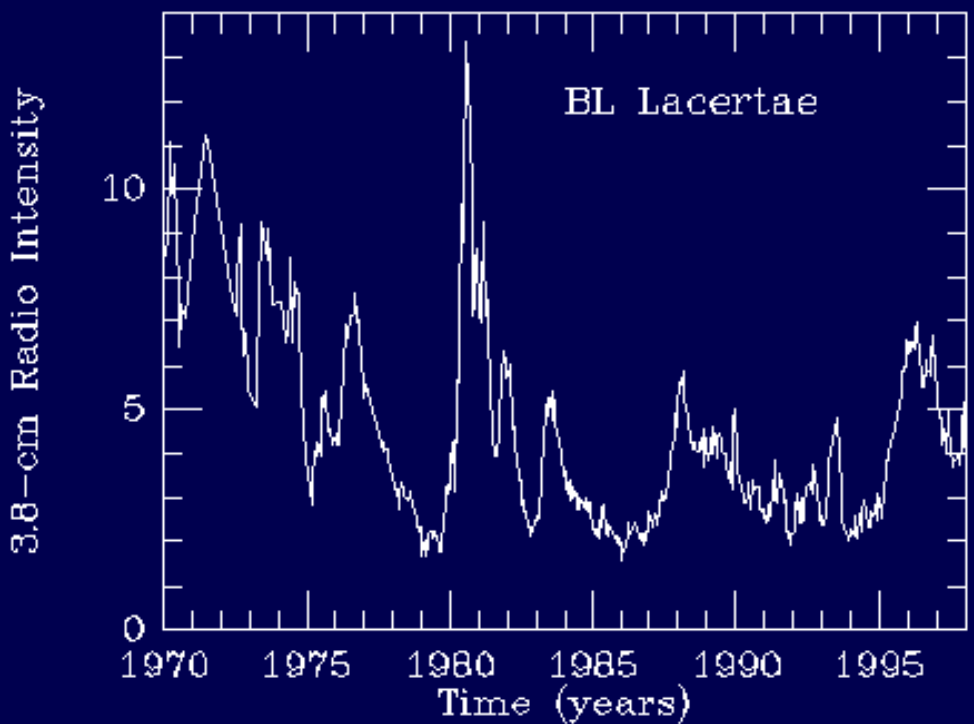
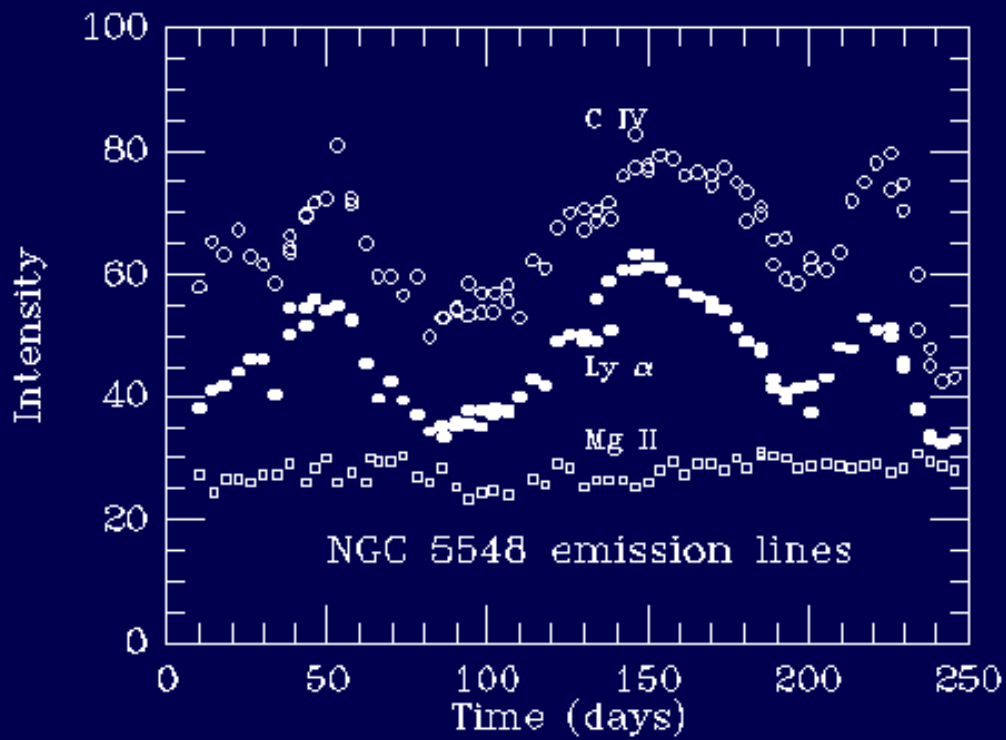
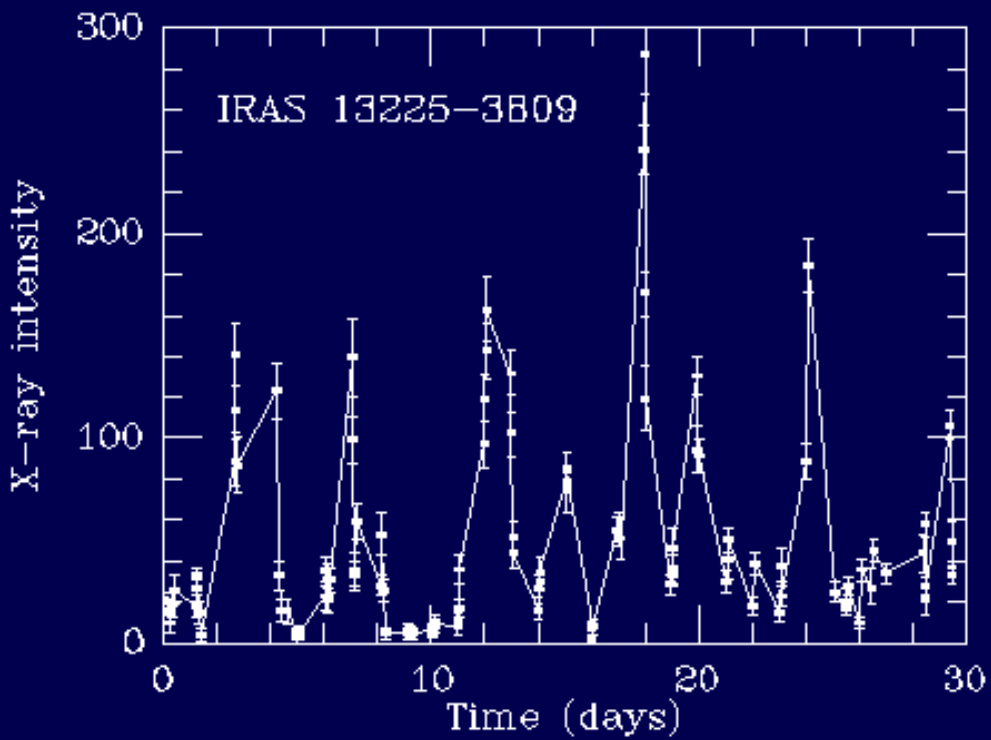




# The Unifying Model of AGN

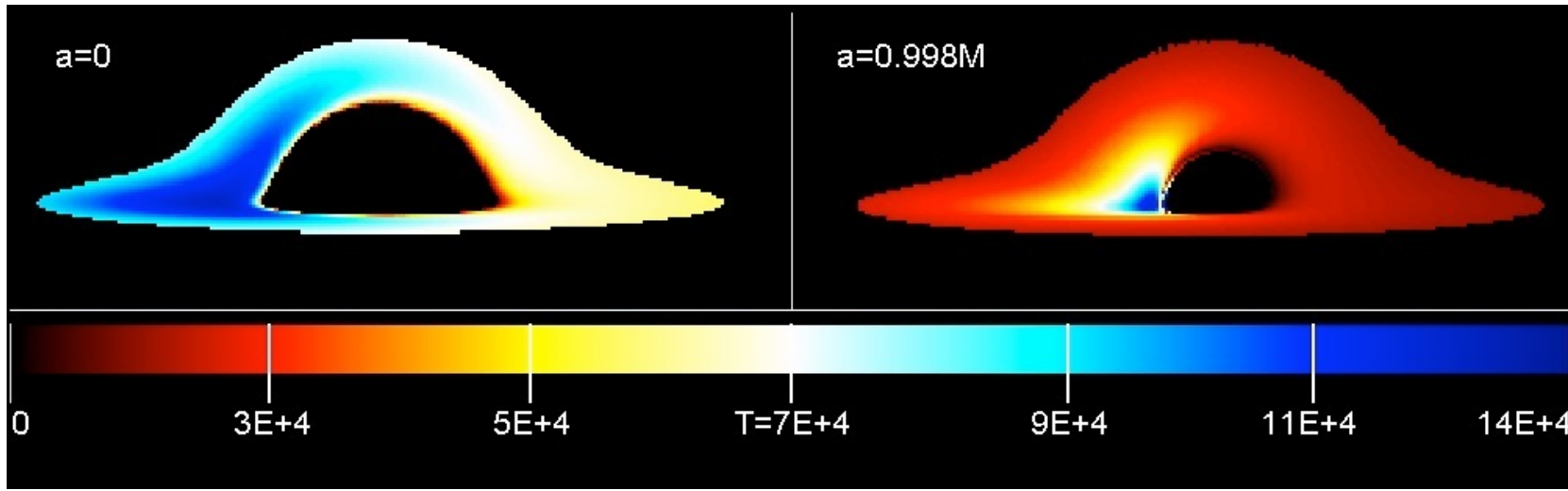




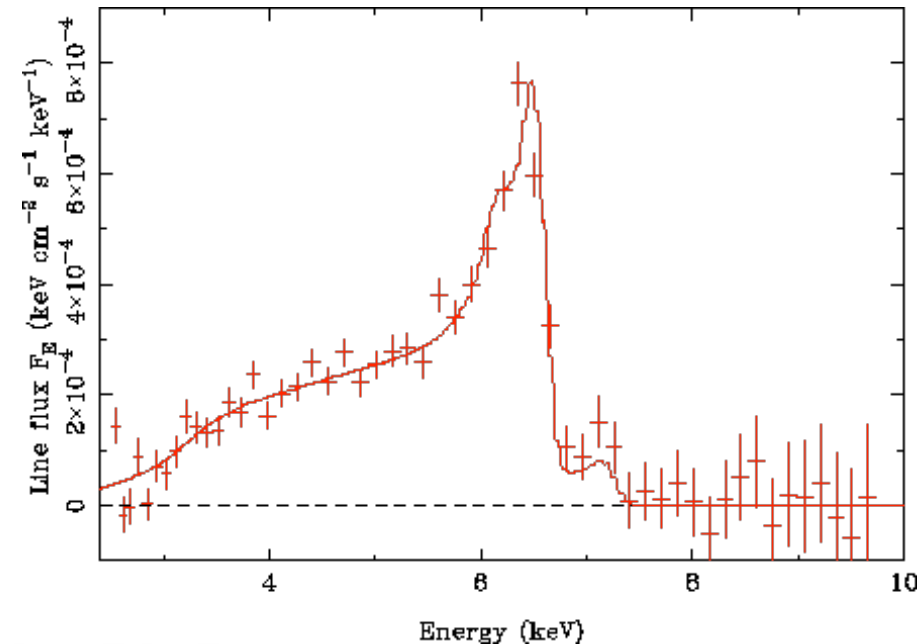
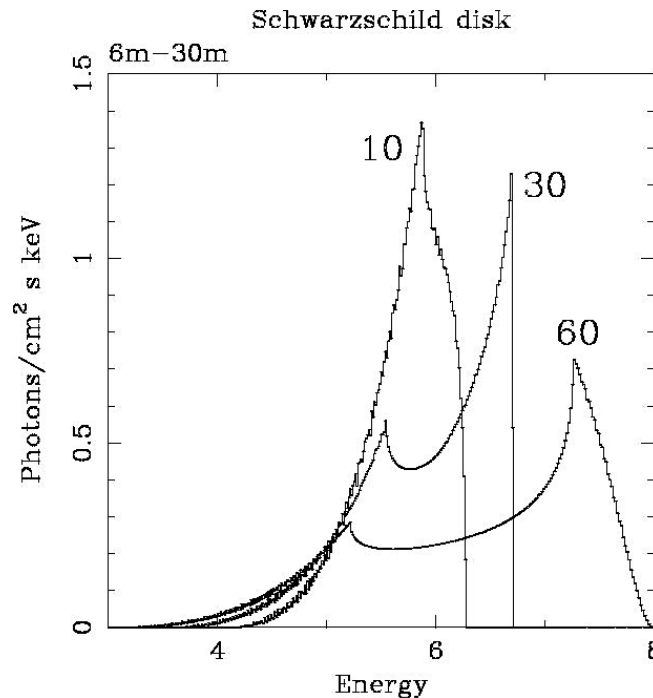


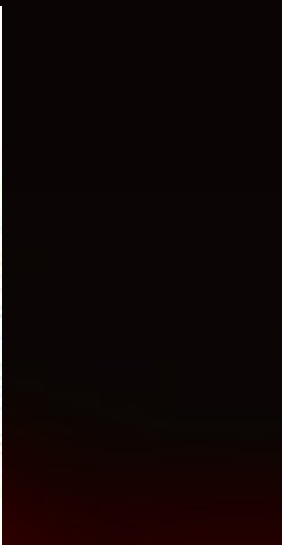
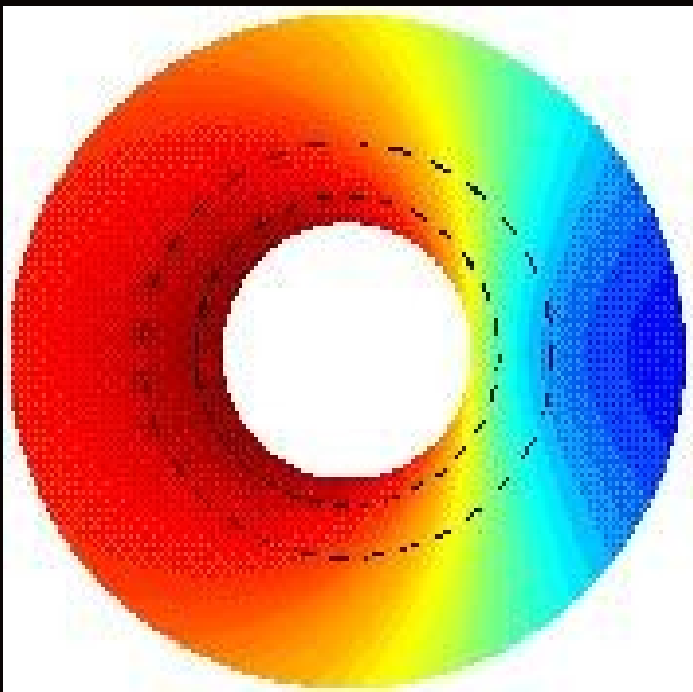
# Effetti Osservabili

## 2) Emissione dalle regioni interne di un disco di accrescimento



Effetti “facilmente” osservabili: riga di emissione. La riga di emissione piu’ intensa attesa dalle regioni interne del disco e’ la Ka del ferro a  $\sim 6.4$  keV

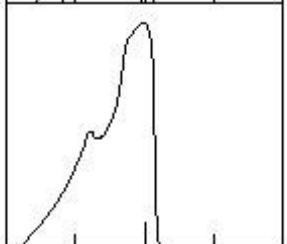
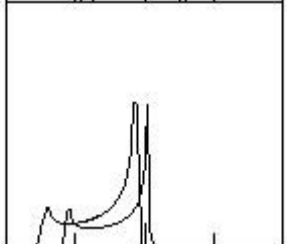
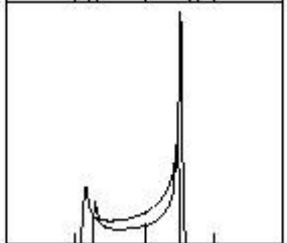
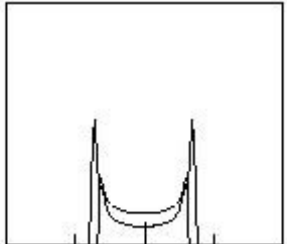




Newtonian

Special relativity

General relativity

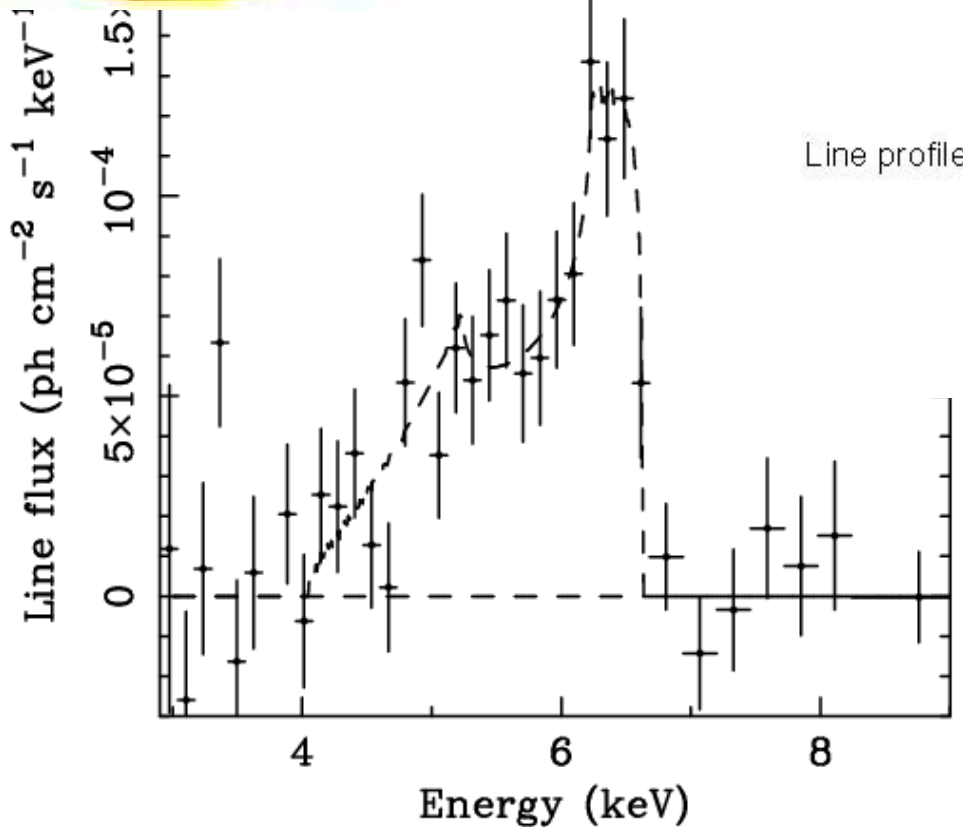


$v_{obs}/v_{em}$

Transverse Doppler shift

Beaming

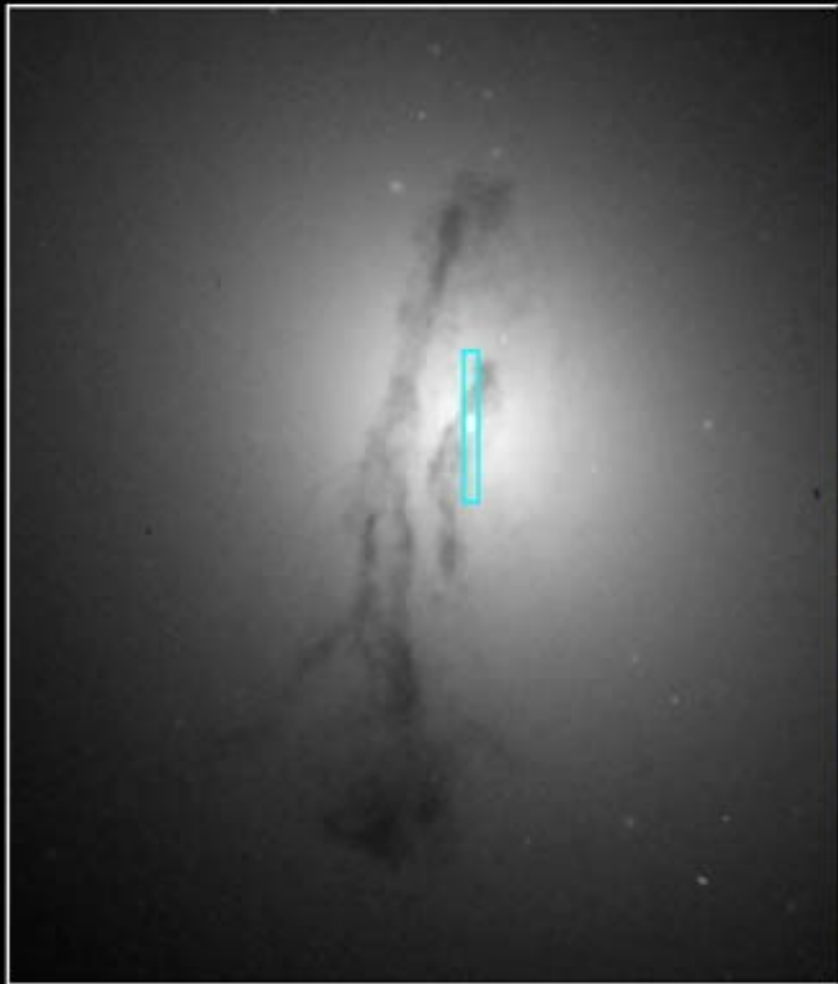
Gravitational redshift



Line profile

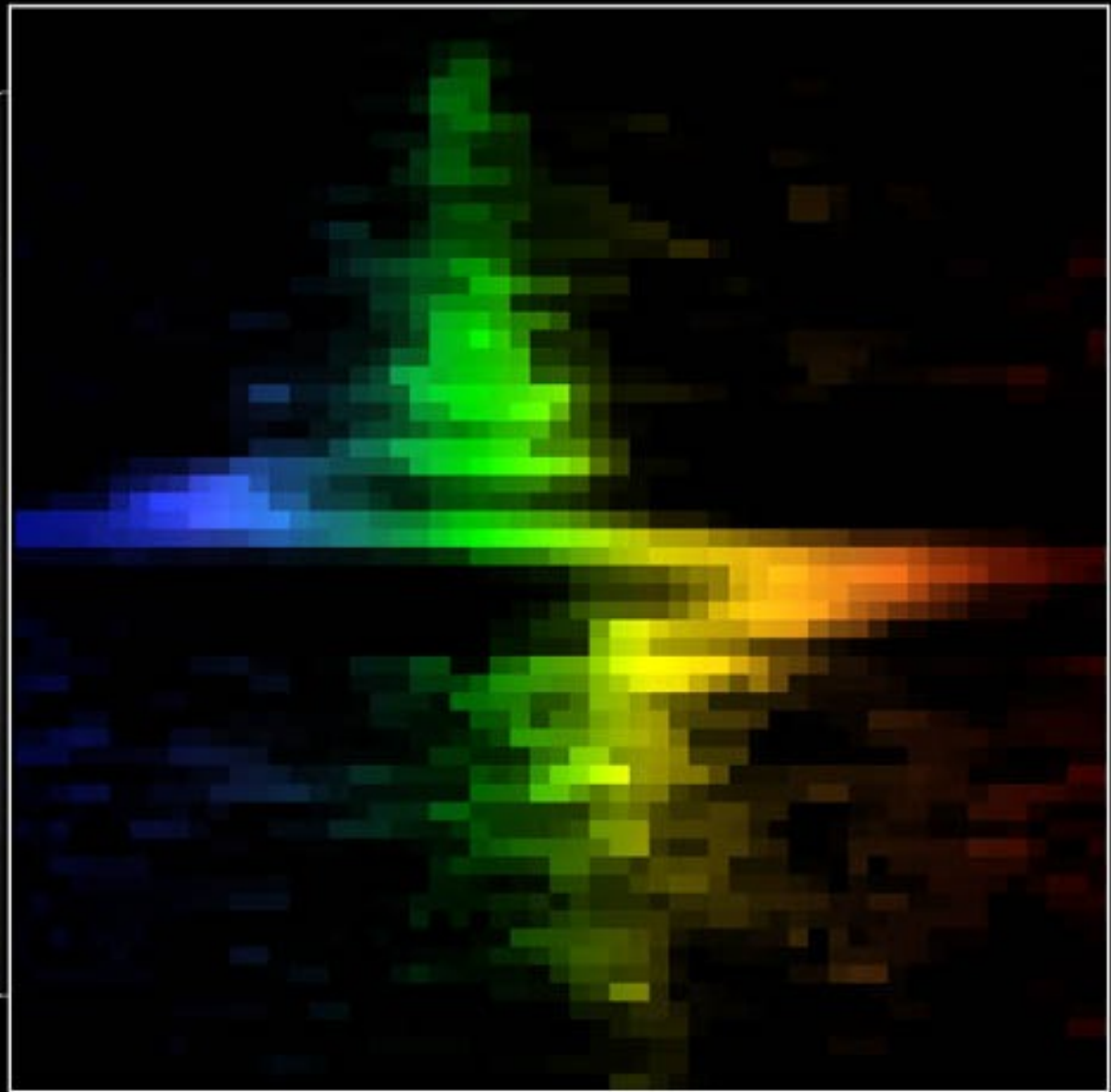


# Galaxy M84 Nucleus



WFPC2

Hubble Space Telescope



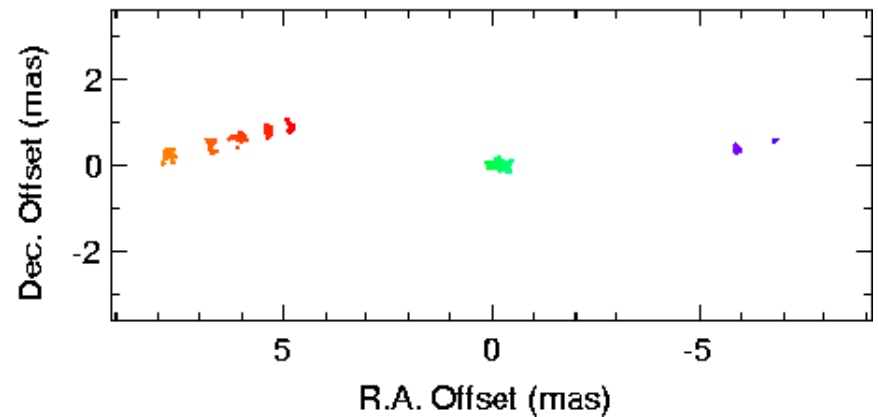
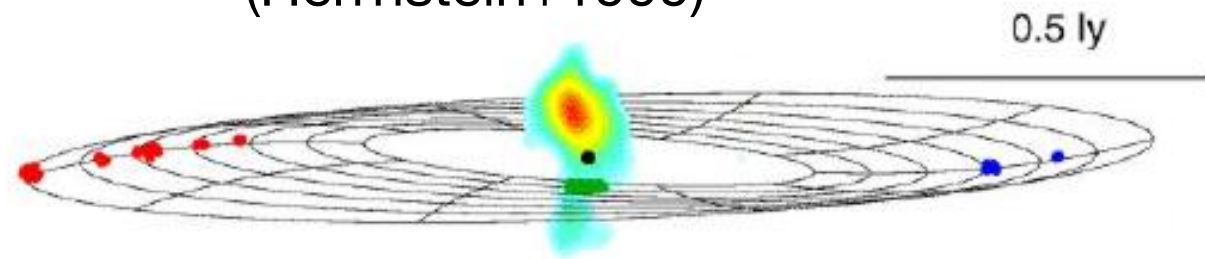
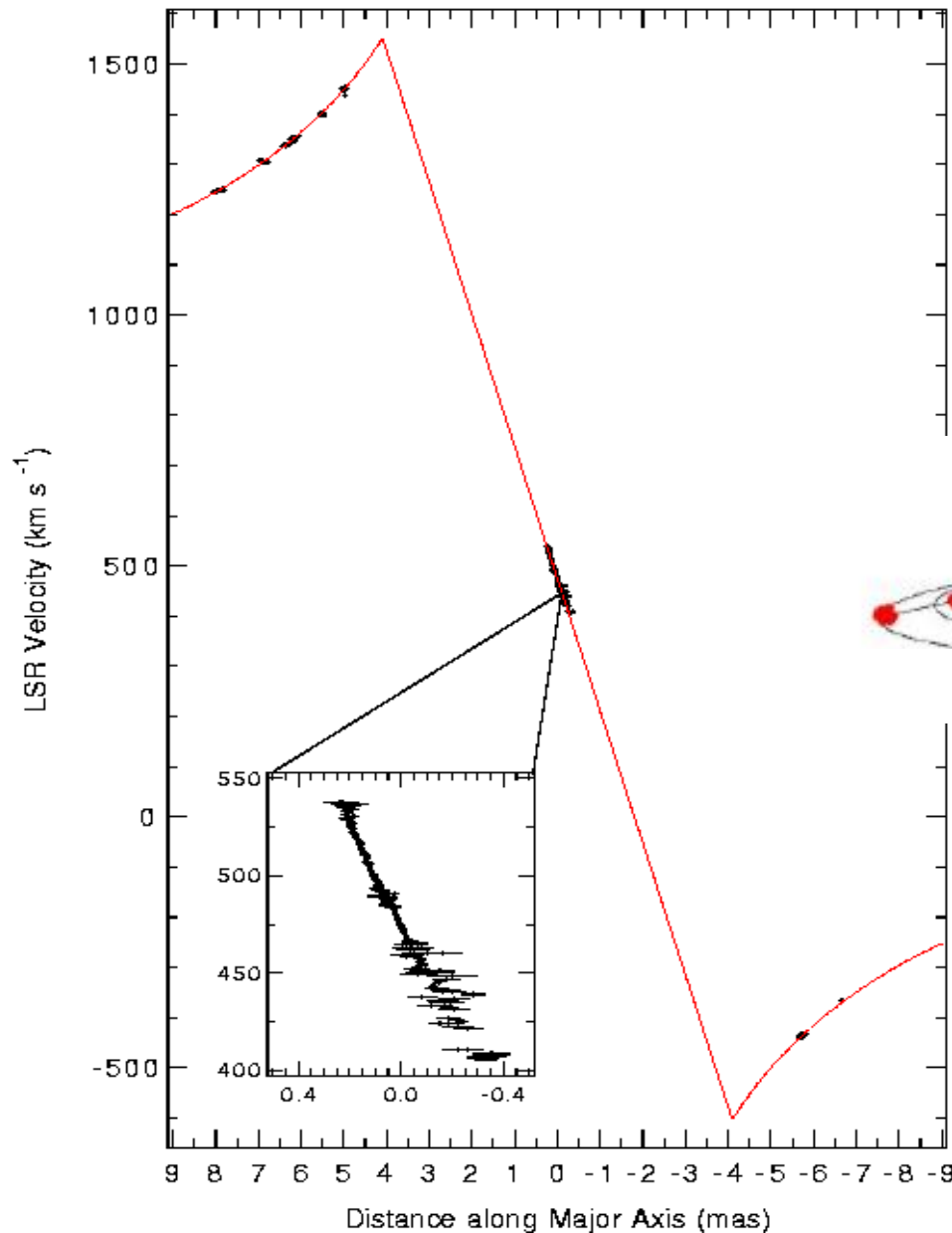
STIS

PRC97-12 • ST Sci OPO • May 12, 1997 • B. Woodgate (GSFC), G. Bower (NOAO) and NASA

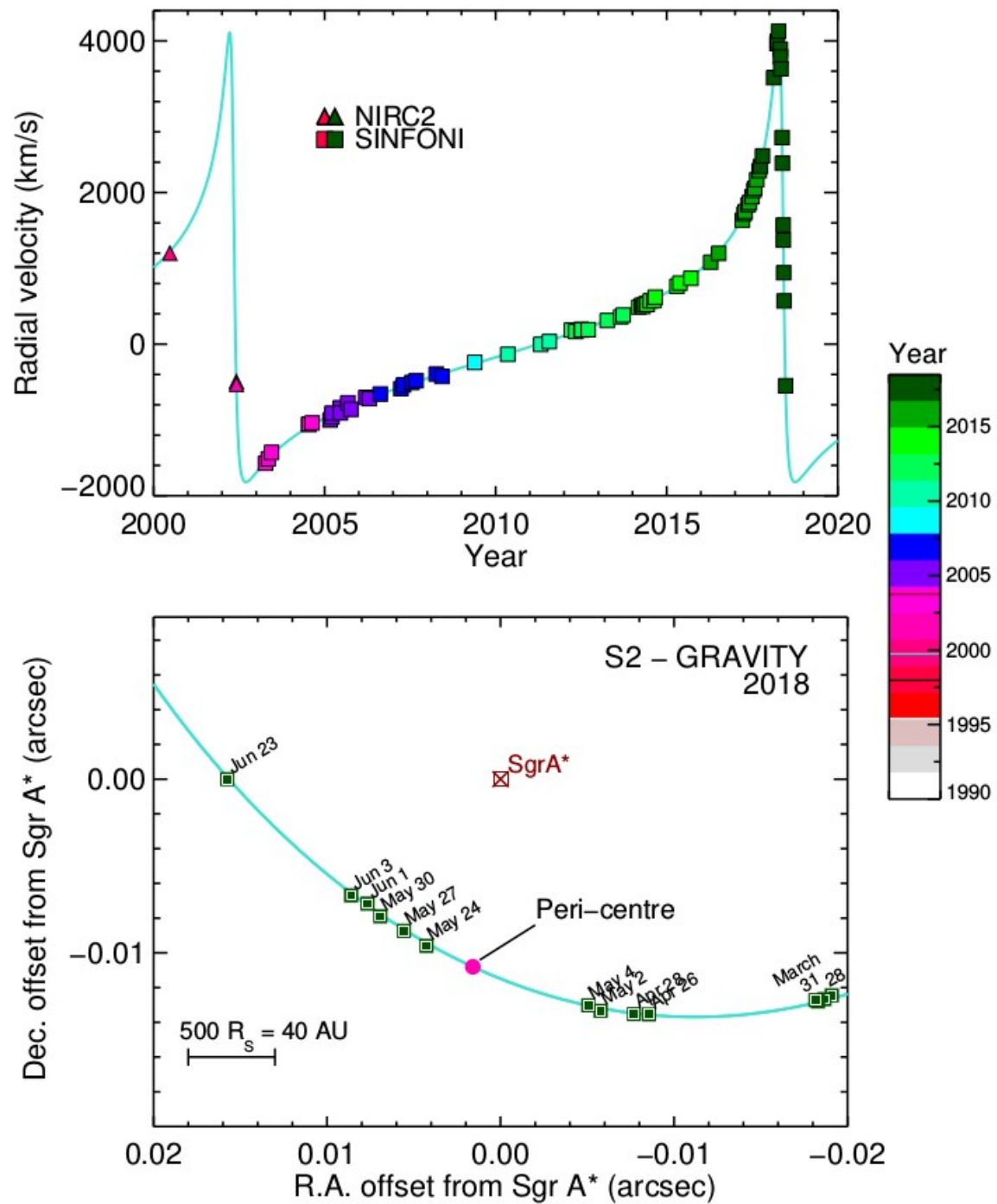
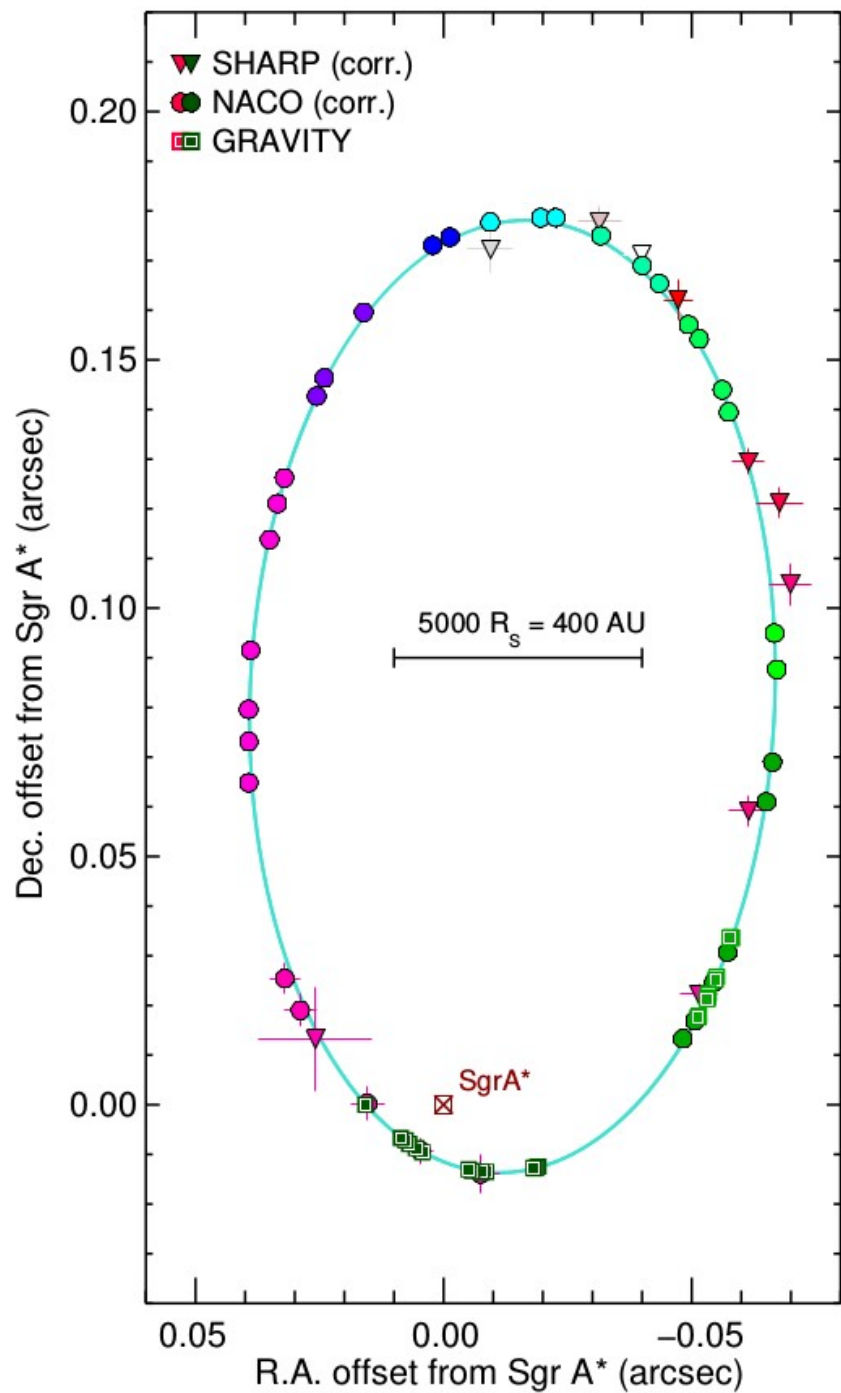
# $M_{\text{BH}}$ from $\text{H}_2\text{O}$ megamasers: NGC 4258

★  $M_{\text{BH}} = (3.9 \pm 0.1) \times 10^7 M_{\odot}$   
(Miyoshi+1995, Herrnstein+1999)

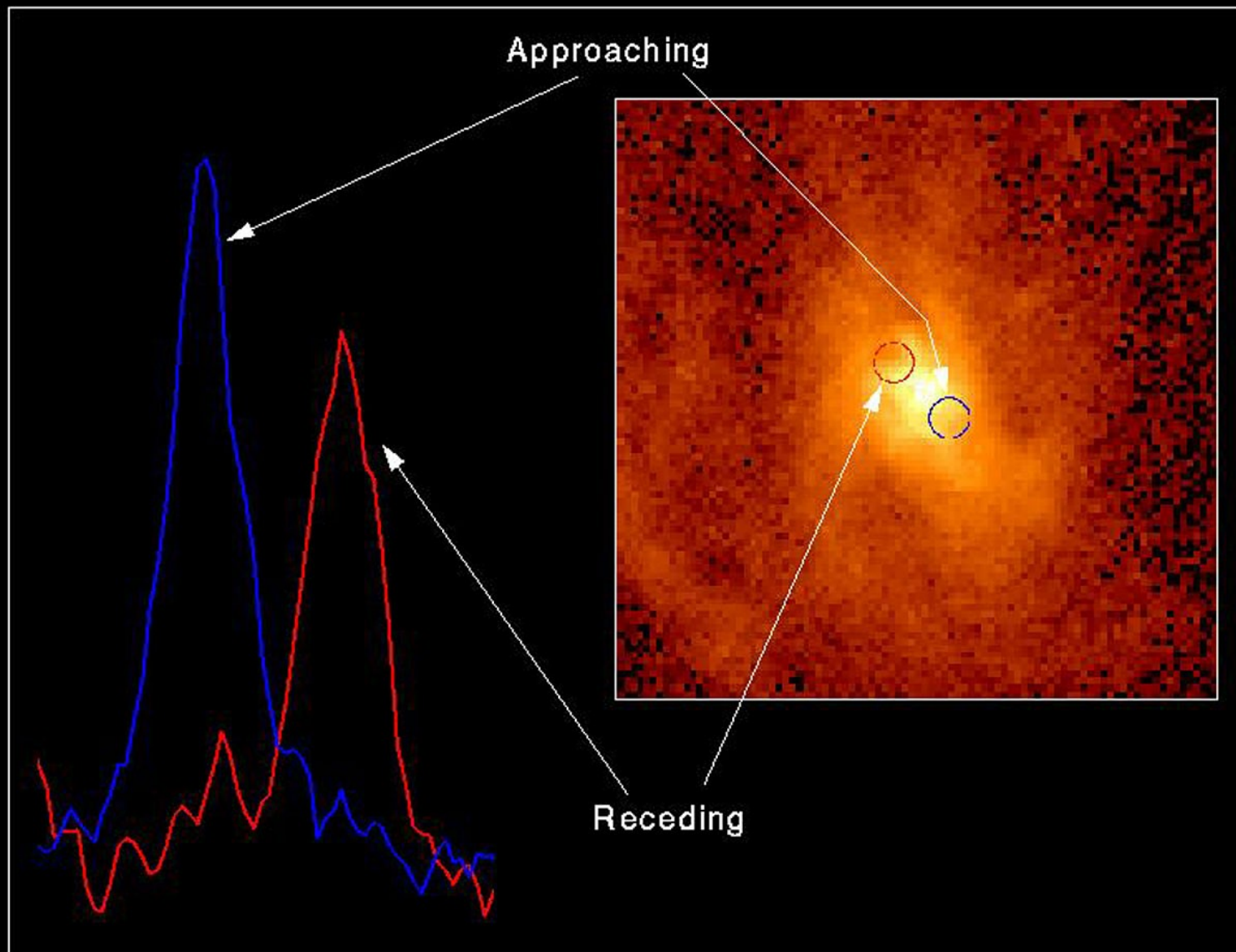
★ Using rotation curves, it is also possible to measure centripetal acceleration of maser spots and derive galaxy distance (Herrnstein+1999)



★ Disk is also slightly warped



# Spectrum of Gas Disk in Active Galaxy M87



Hubble Space Telescope • Faint Object Spectrograph

**Simulated Image**

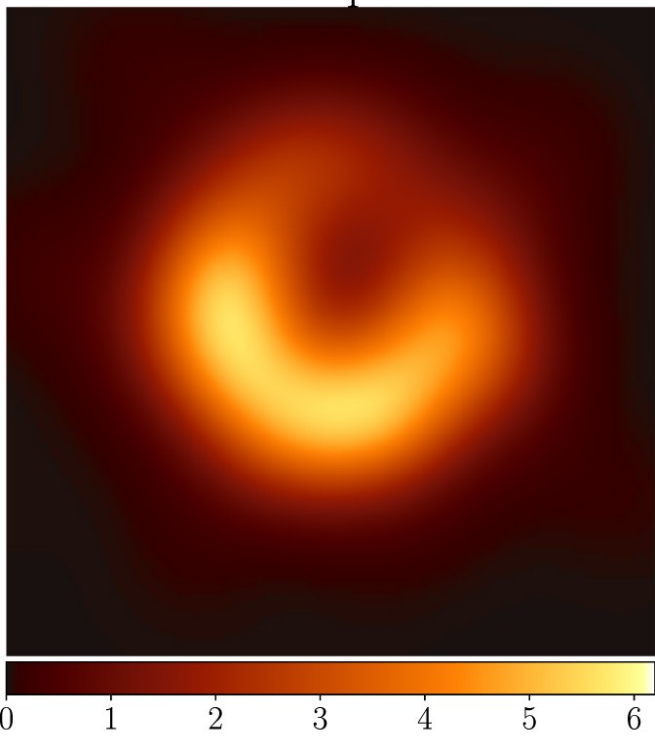


**EHT 2017-2018**

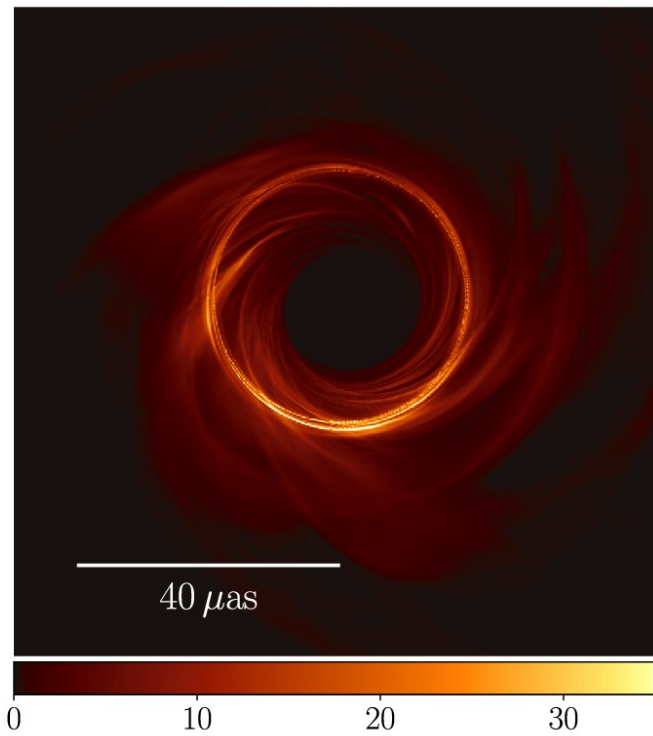




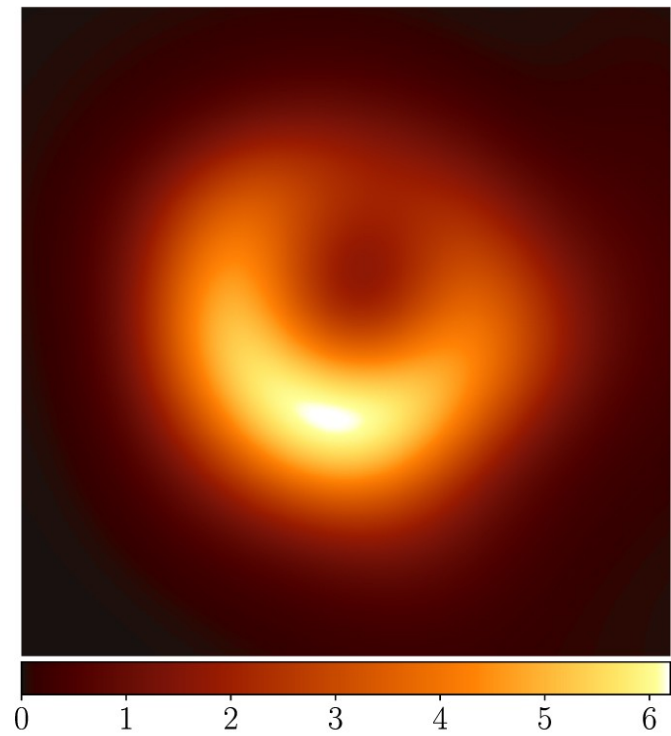
M87 April 6



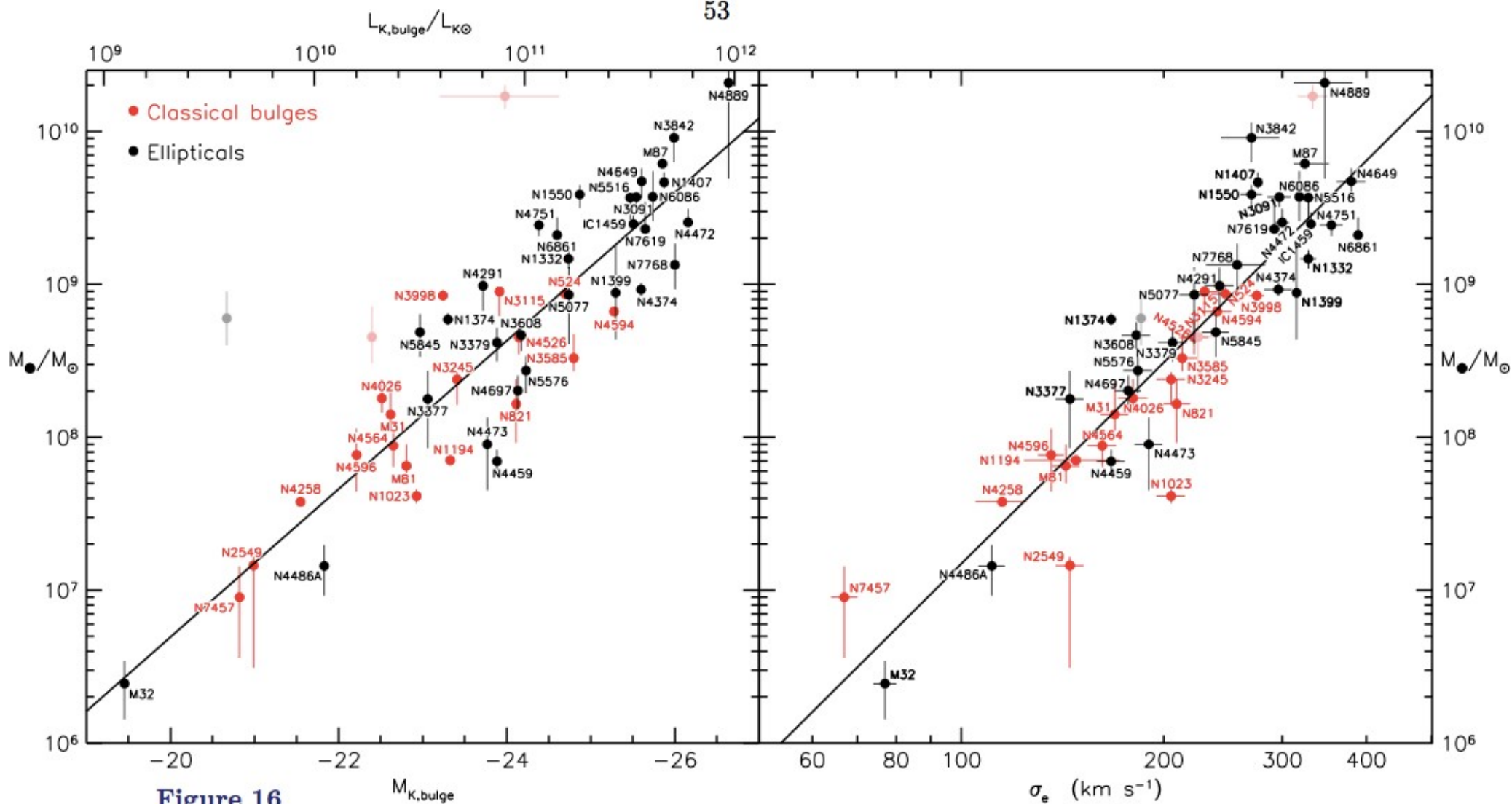
GRMHD

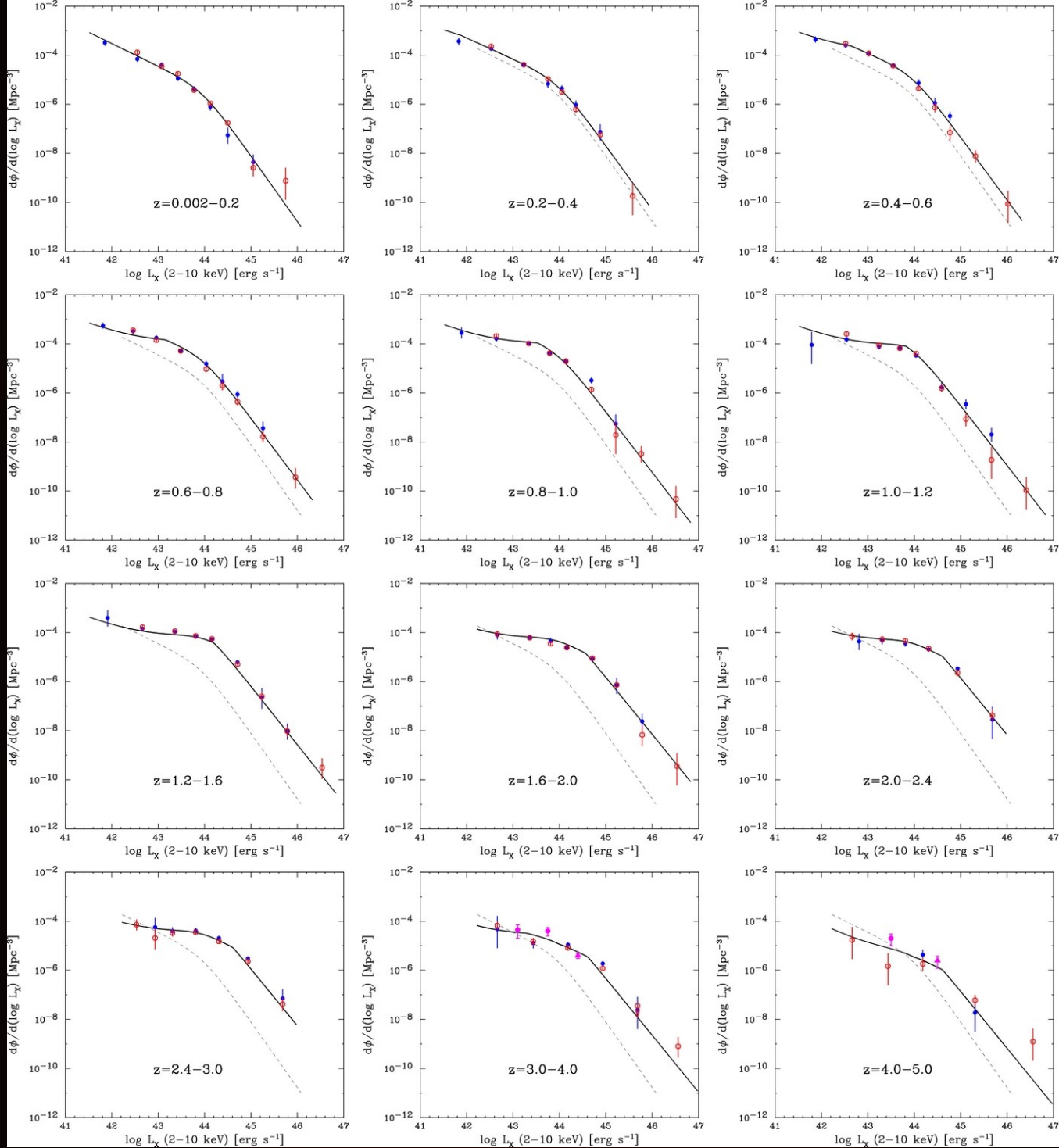


Blurred GRMHD



Brightness Temperature ( $10^9$  K)





# All Galaxies

