

# Observing Black Holes at High Energies

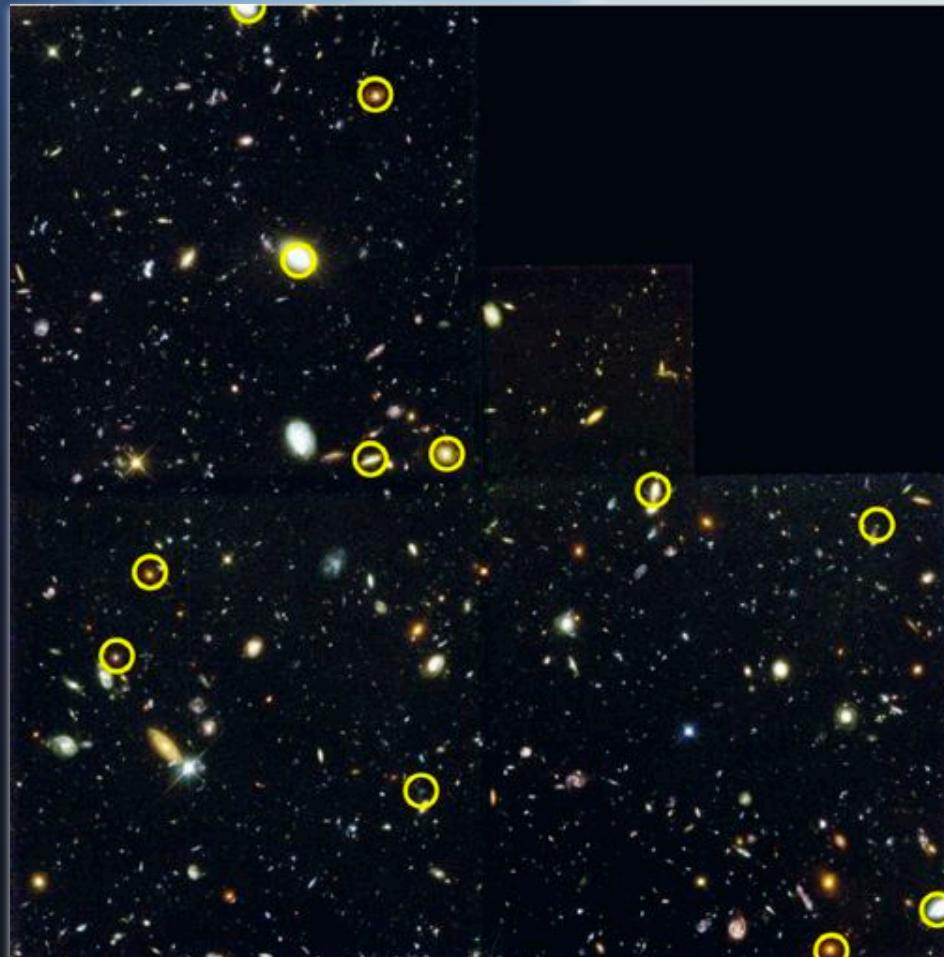
Matthias Kadler

Sternwarte Bamberg/ECAP & USRA/CRESST

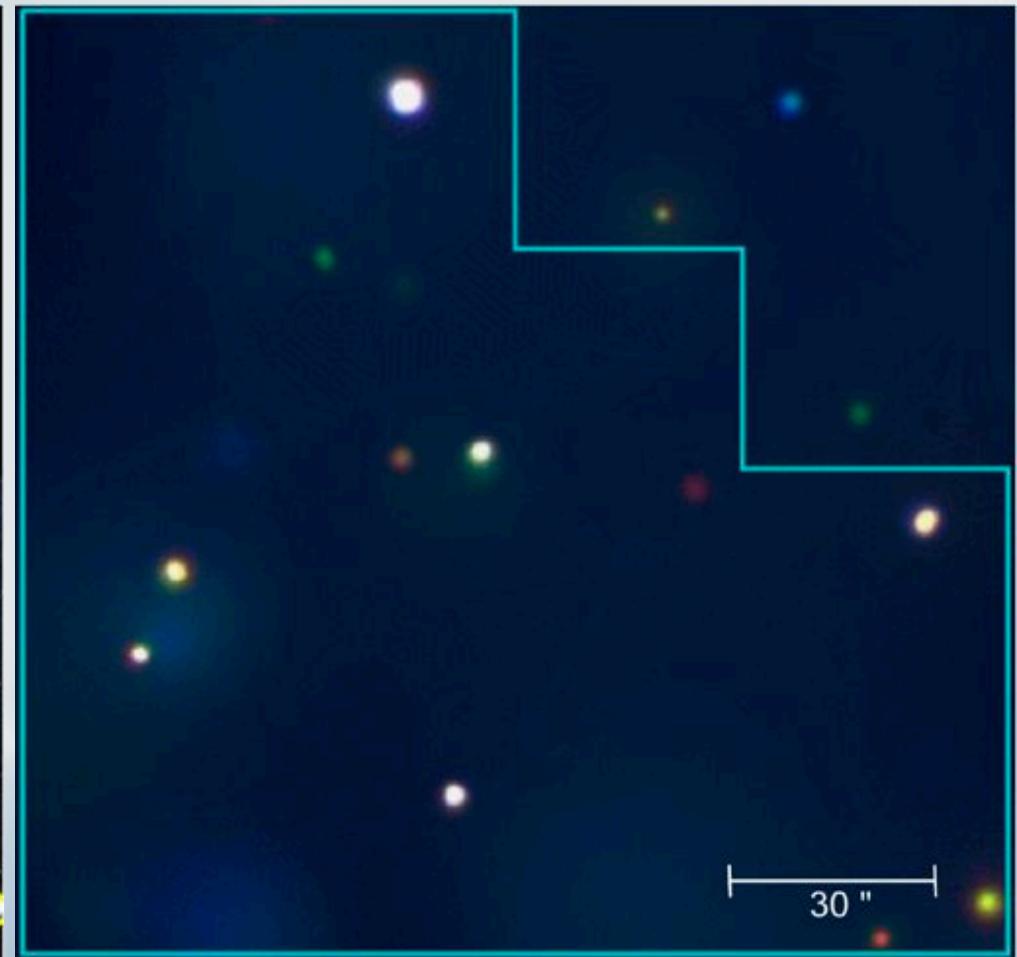
1<sup>st</sup> COST MP0905 Meeting; WG4  
June 25, 2010

# Black Holes in the X-Ray Sky

Optical: Hubble Deep Field

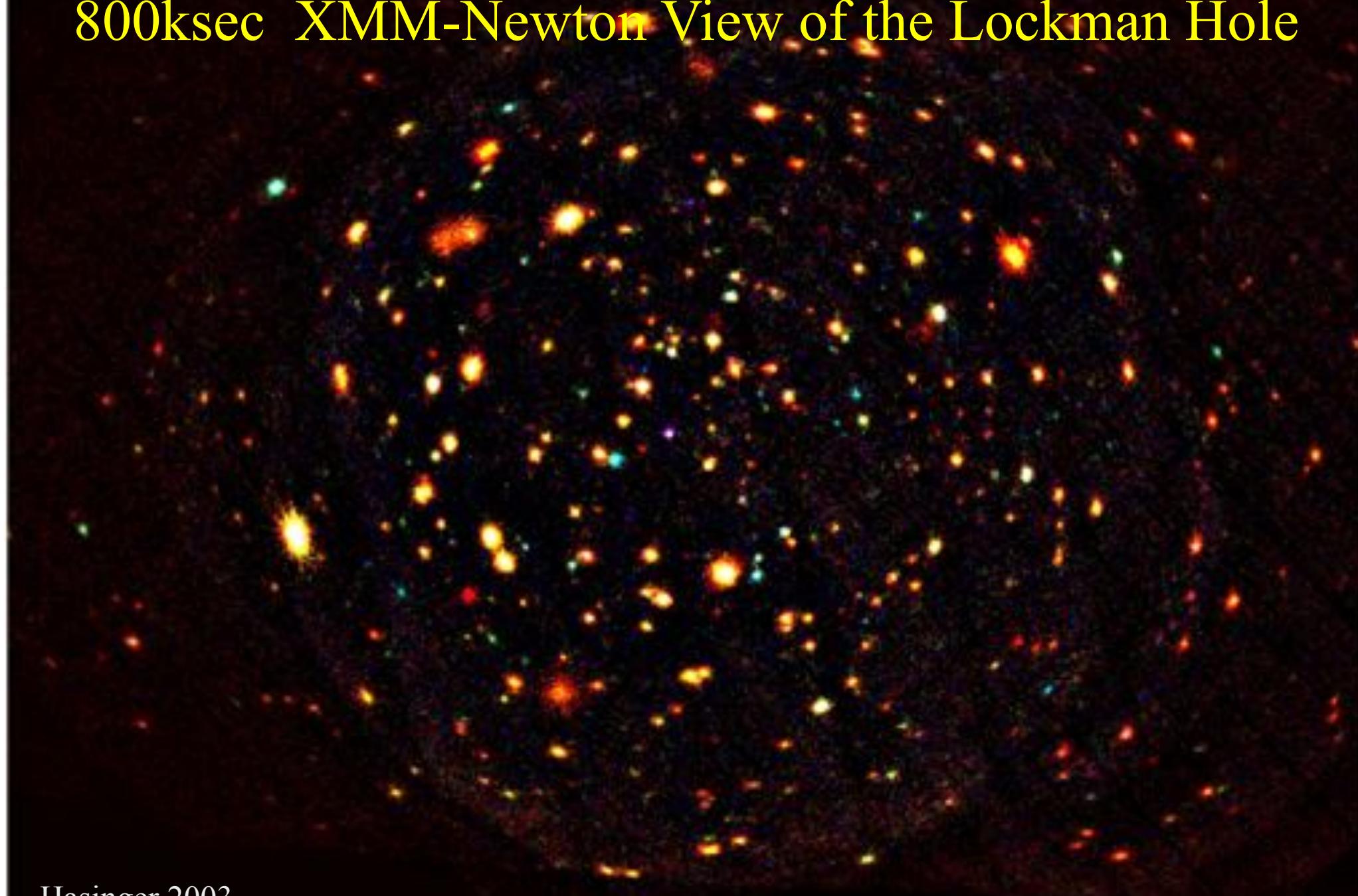


X-ray: Chandra Deep Field



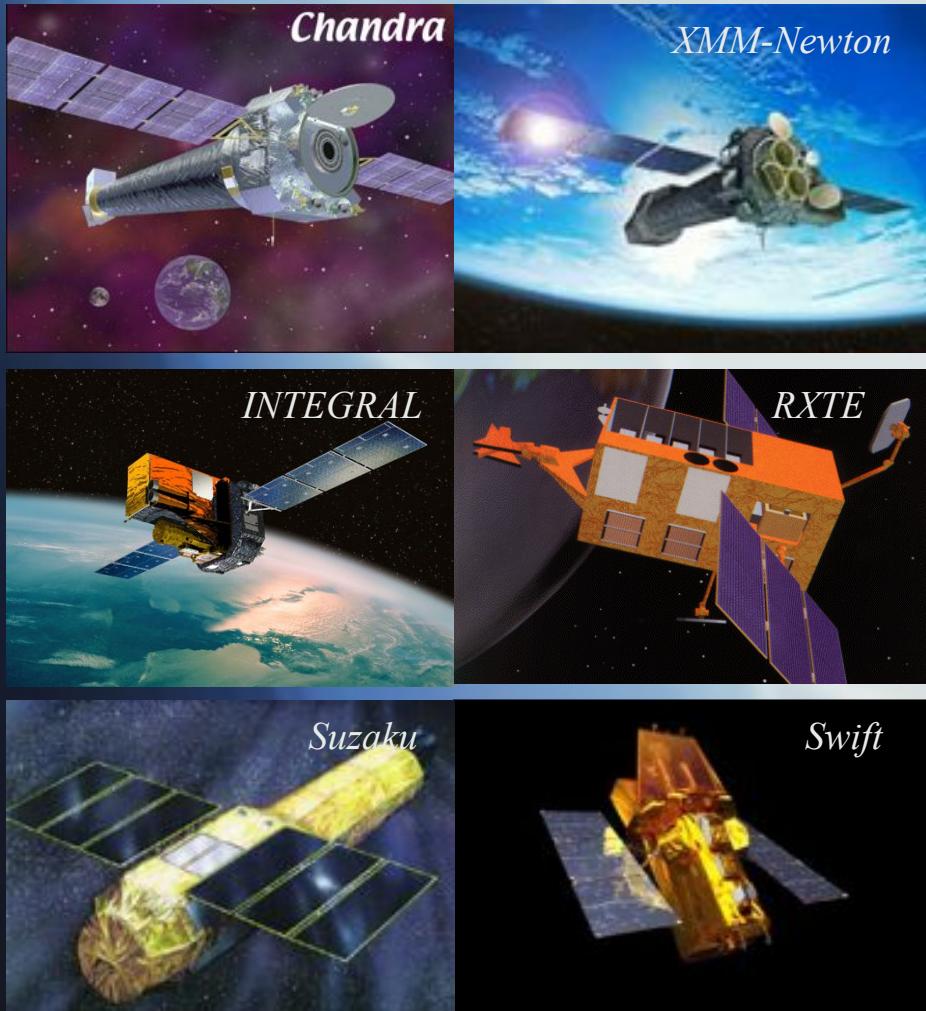
Credit: NASA/Penn State; NASA/PSU/G.Garmire, N.Brandt, et al.

# 800ksec XMM-Newton View of the Lockman Hole



Hasinger 2003

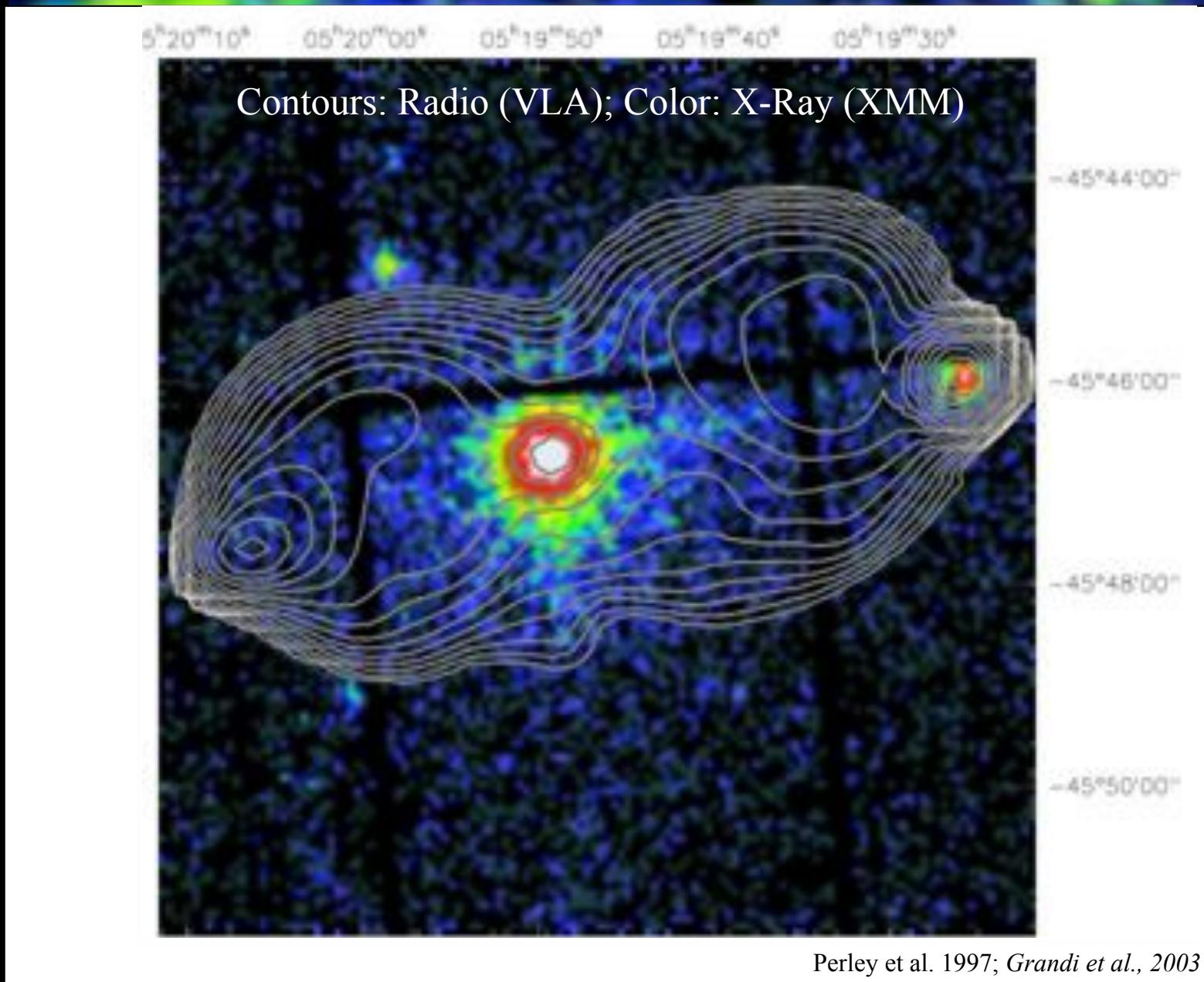
# Current X-Ray Observatories



Images: NASA/ESA/JAXA

- Specialists in orbit:
  - Imaging: *Chandra*
  - Spectroscopy: *XMM*,  
*Suzaku*, *Chandra*
  - Hard X-Rays: *INTEGRAL*,  
*Suzaku*, *RXTE*
  - Monitoring: *RXTE*
  - Rapid Response: *Swift*
  - Broadband Spectra: *Swift*,  
*Suzaku*

# Pictor A



# Pictor A

XMM Newton

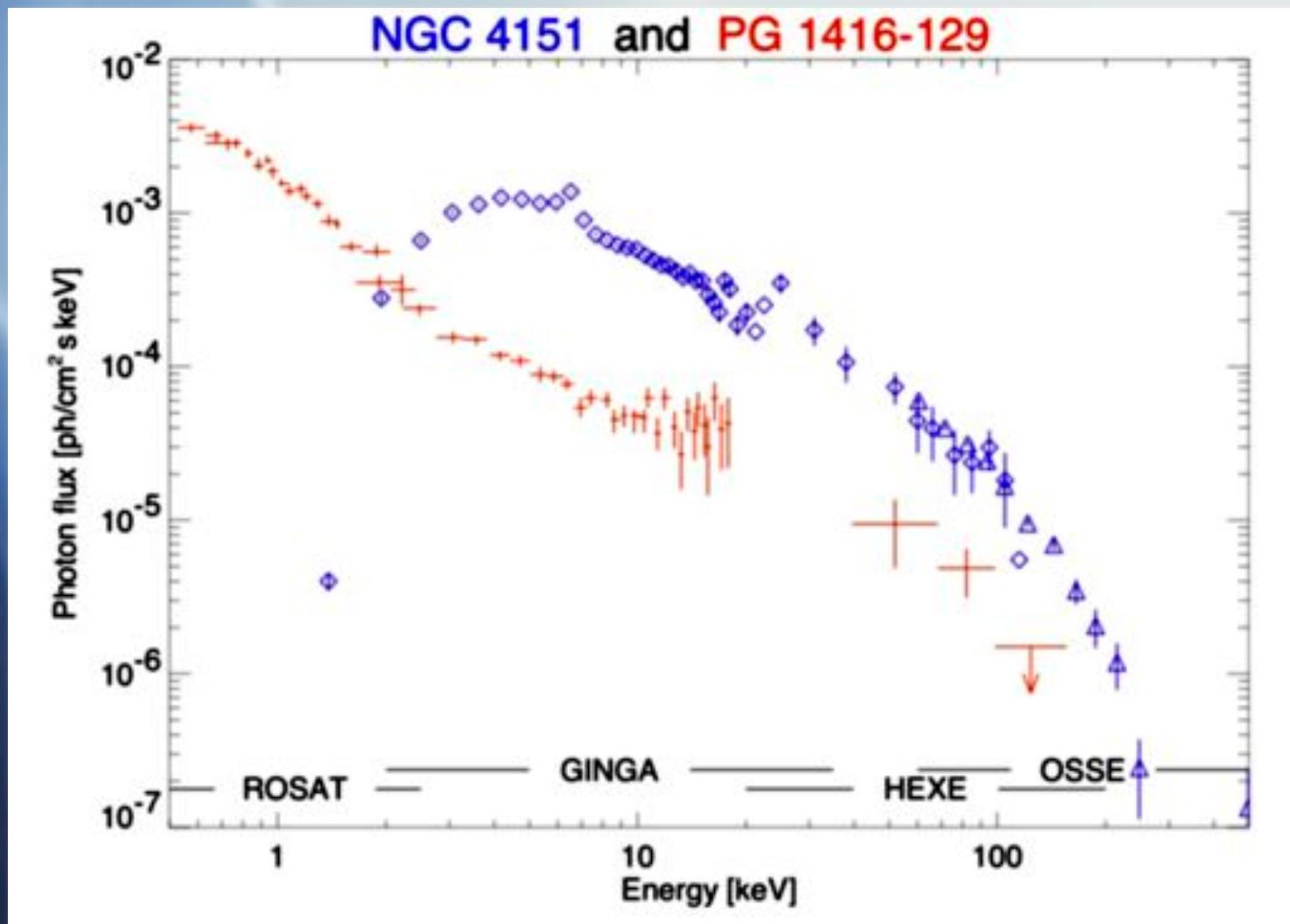
Grandi et al. 2003

← →  
10 arcsec

Chandra

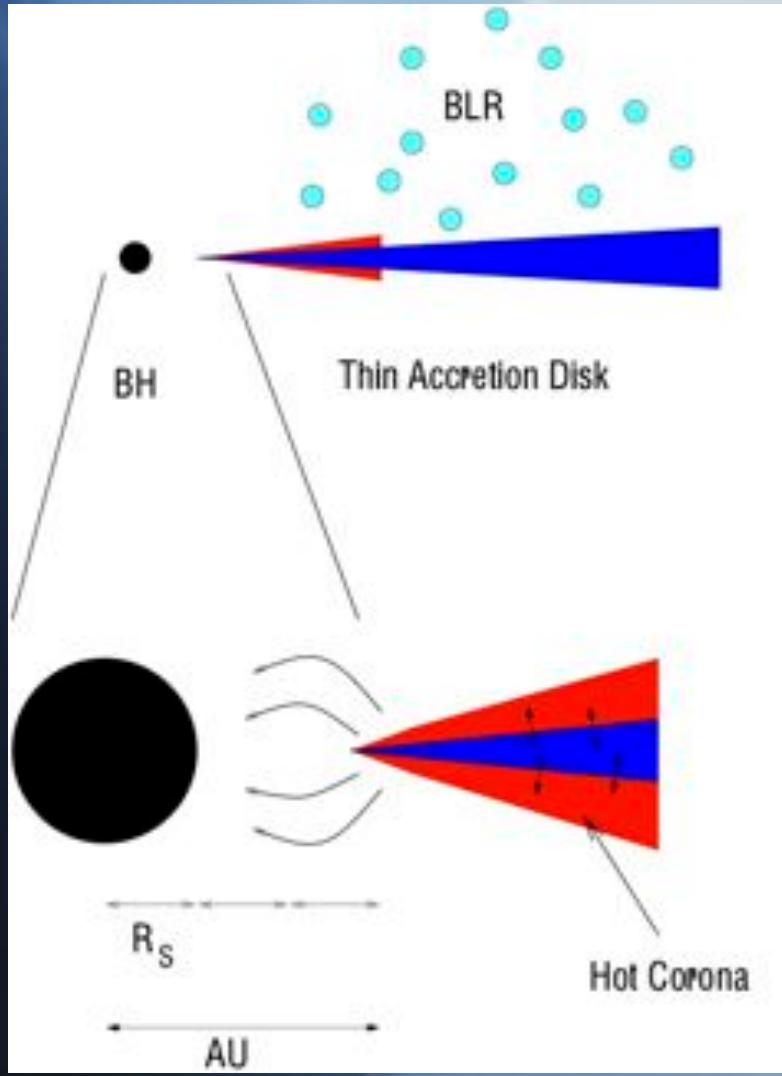
NASA/UMD/A.Wilson et al.

# Black Hole X-Ray Spectra

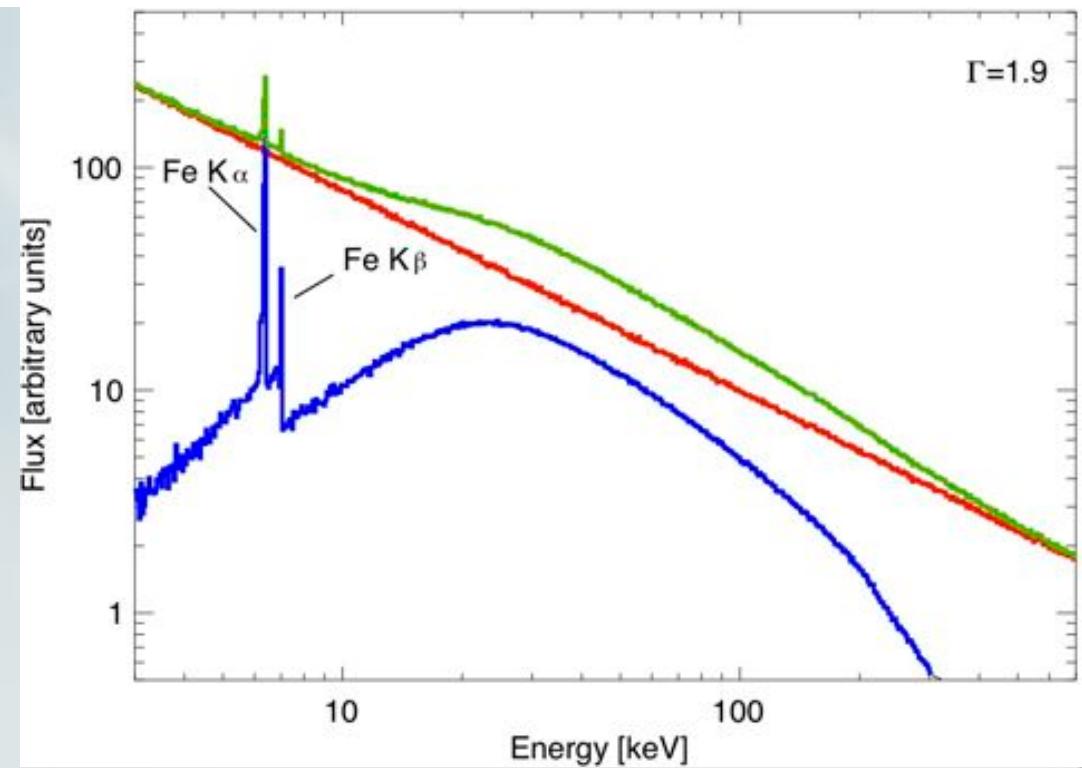


de Kool et al., 1994; Maisack 1993

# AGN X-Ray Spectra

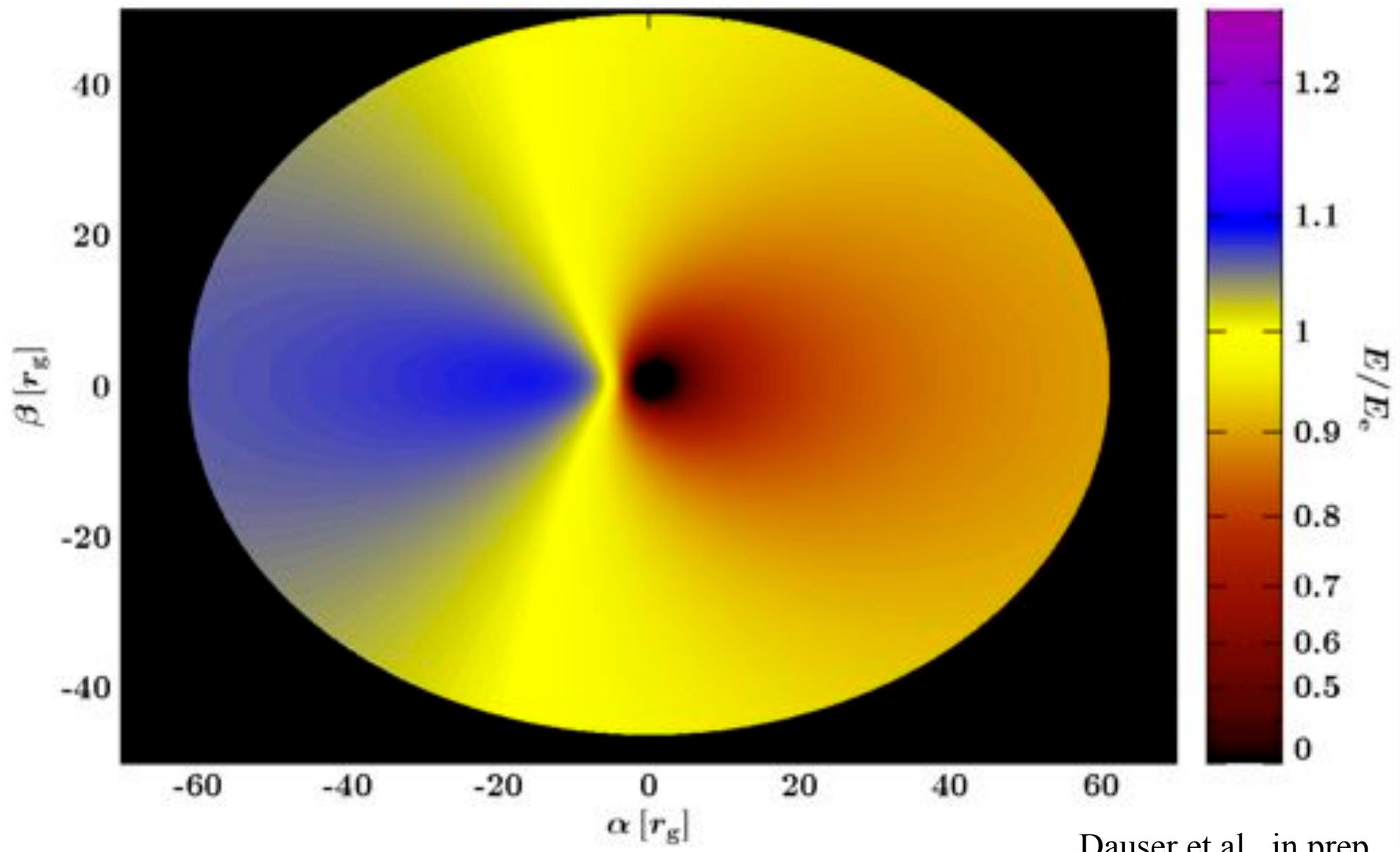


J. Wilms



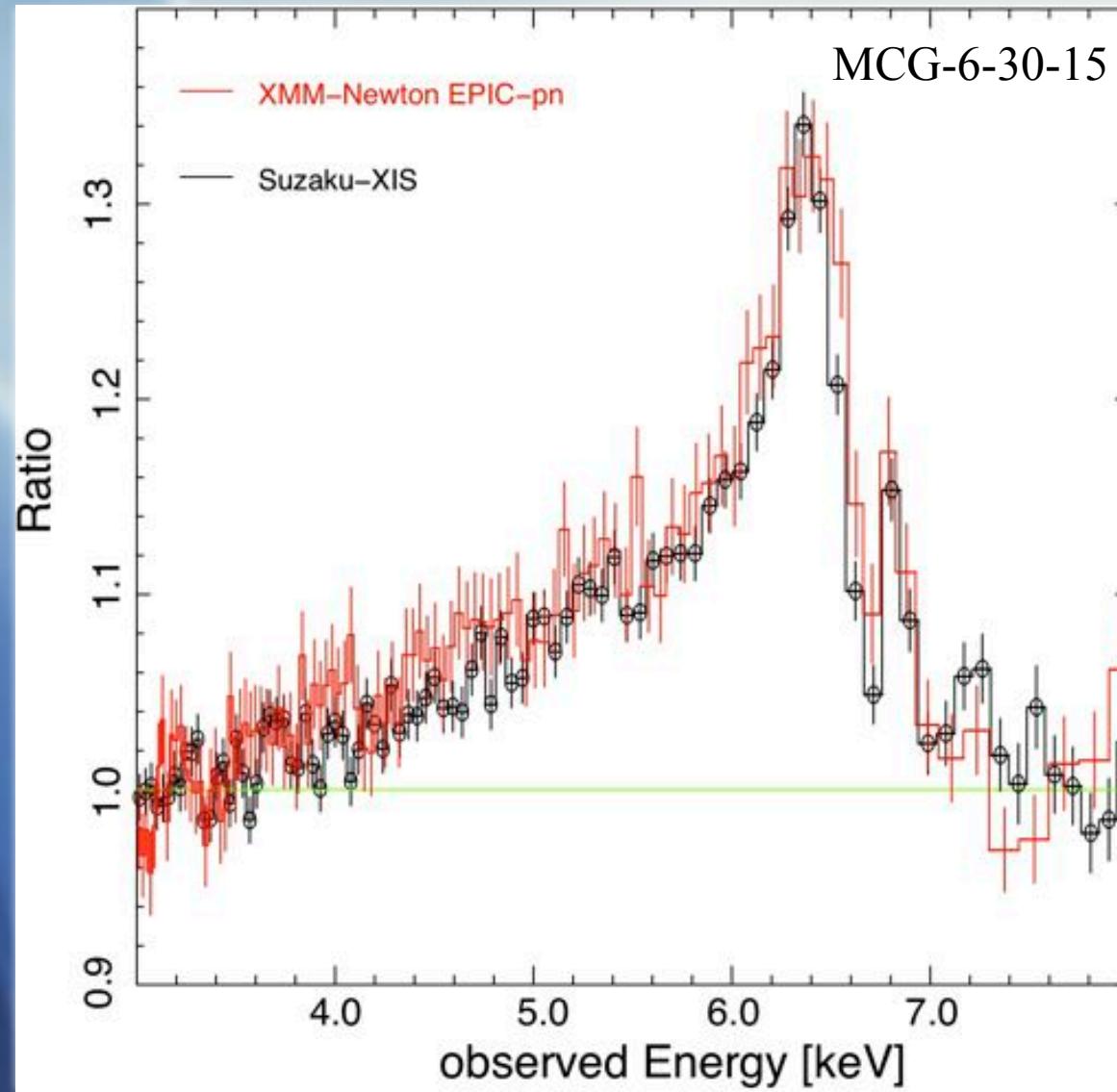
- Comptonization of soft X-rays from accretion disk in hot corona ( $T \sim 10^8 K$ ): power law continuum

# AGN Broad Iron Line Emission



Dauser et al., in prep.

# Broad Iron Lines Probe BH Accretion Disks



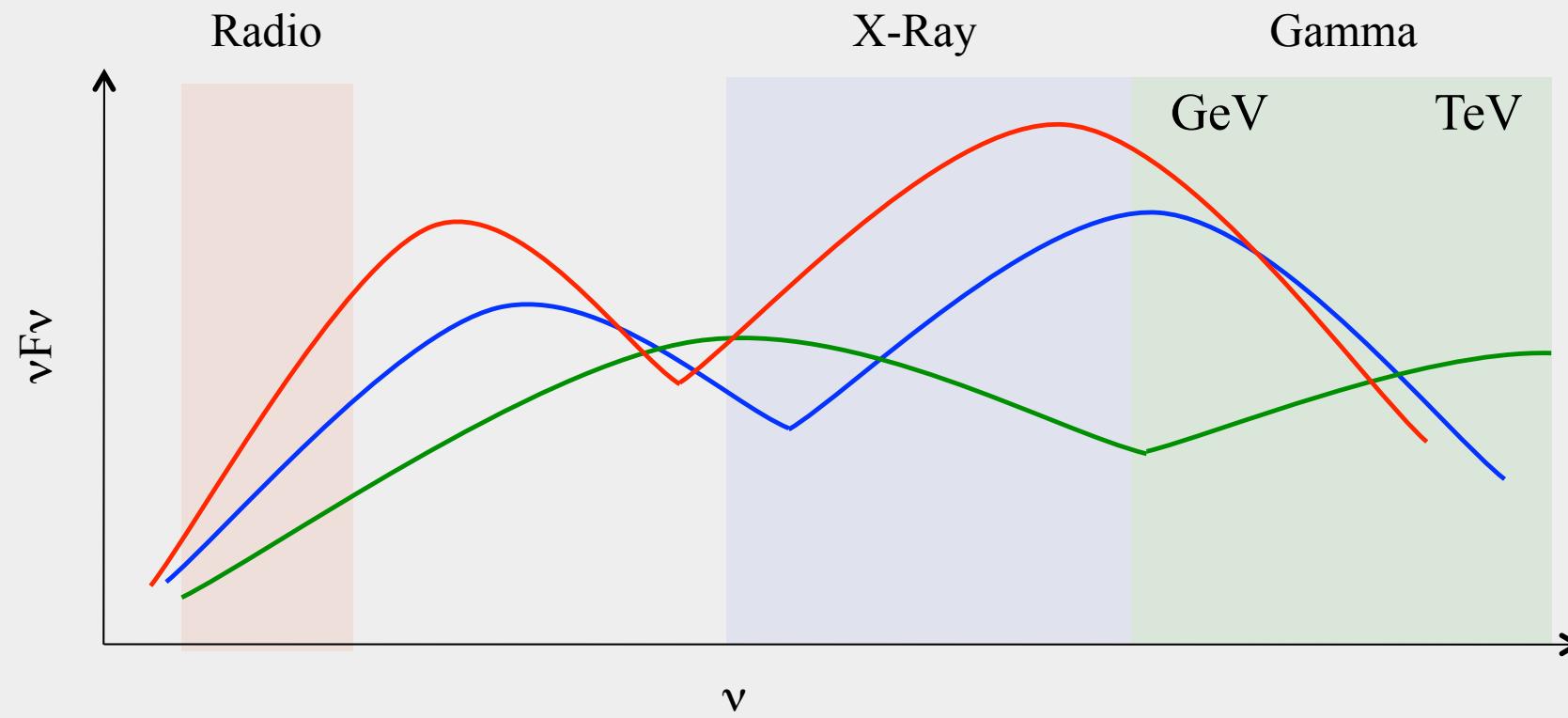
Miniutti et al. 2007

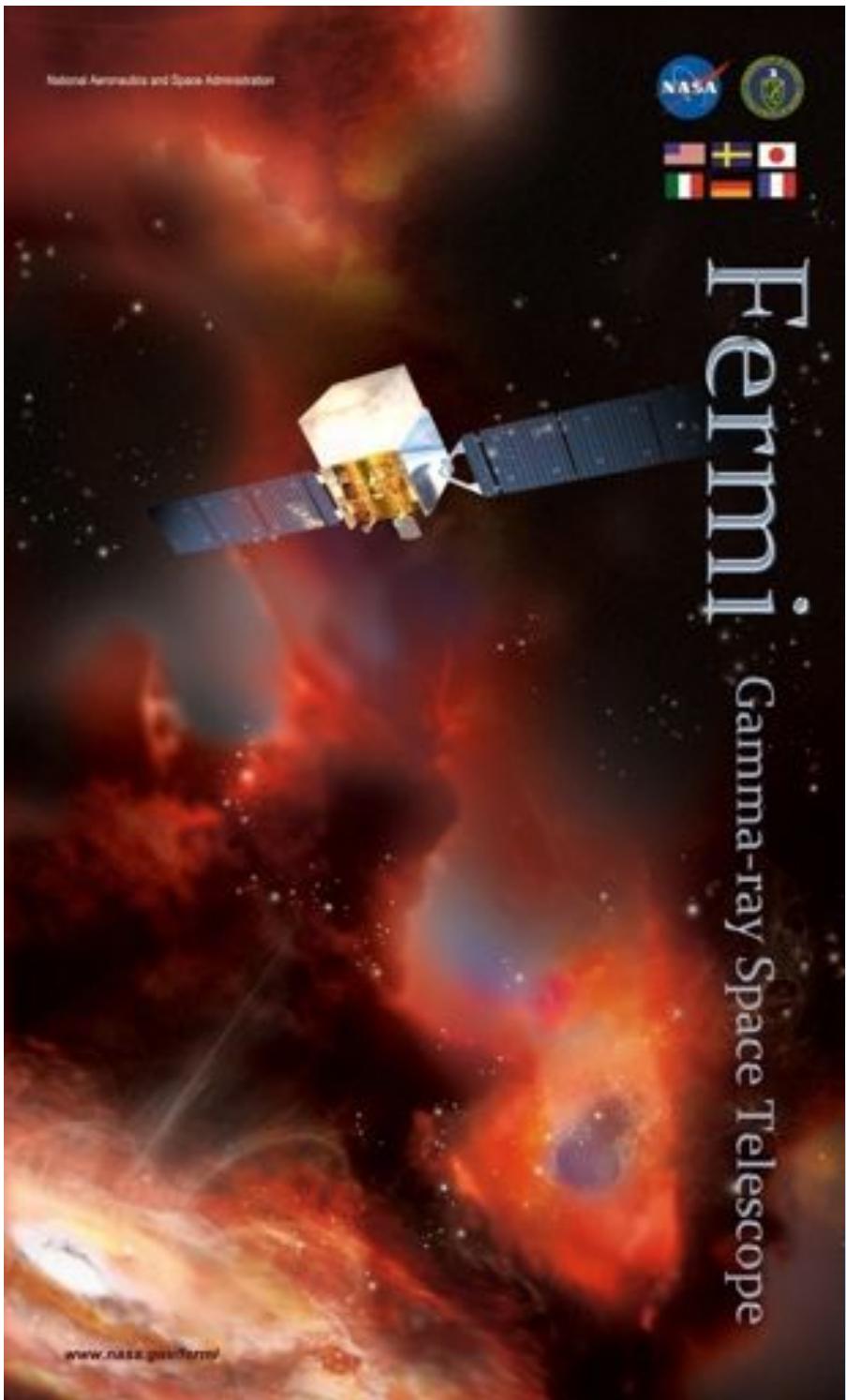
# *Spectral Energy Distribution (SED) in Blazars*

Blazars: Extragalactic jets pointing from supermassive BHs towards earth

Broadband SEDs: Radio to Gamma (Double-Hump Structure)

1. Synchrotron!
2. leptonic (inv. Compton) or hadronic?



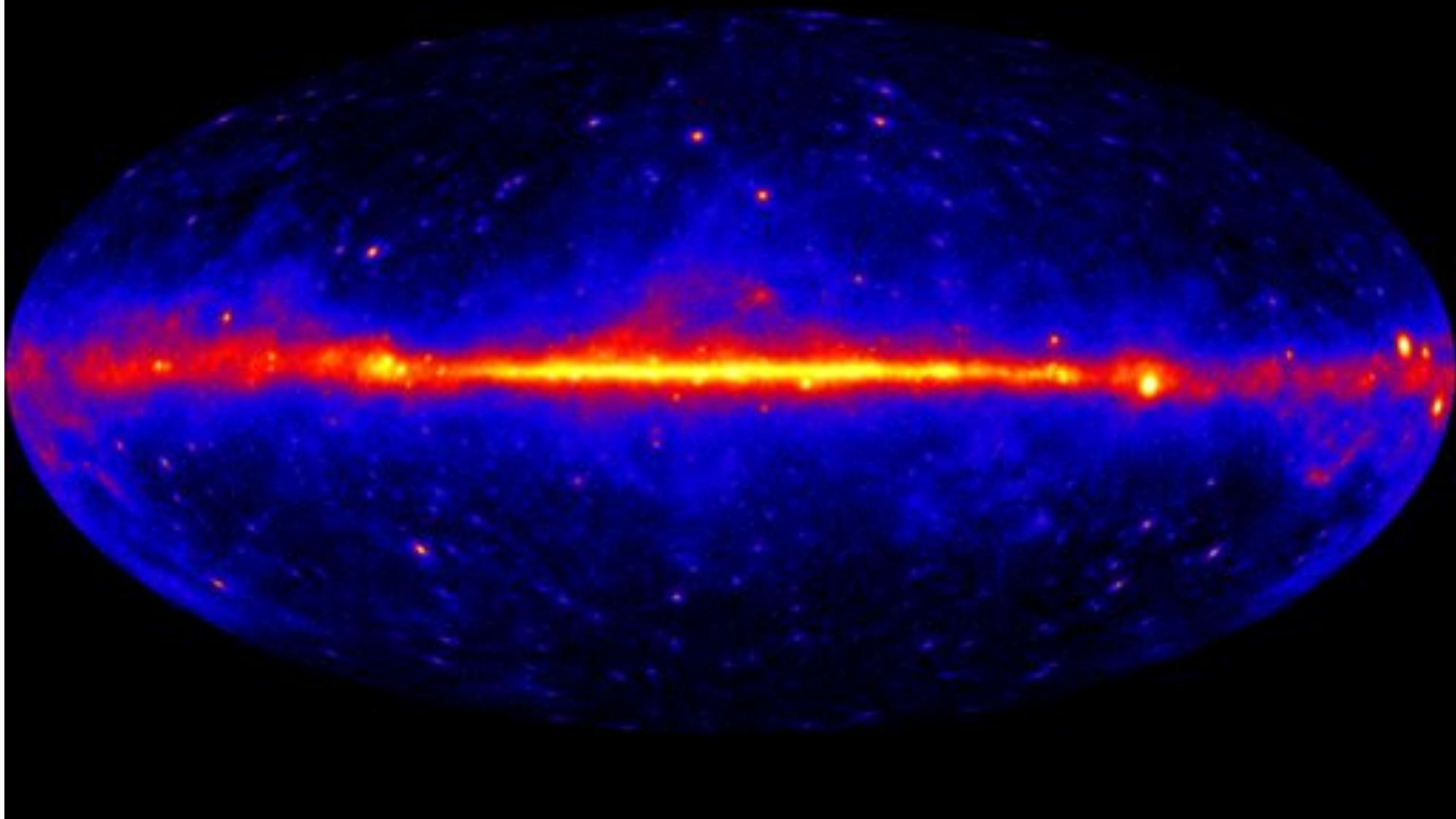


# The Fermi $\gamma$ -Ray Observatory

- Launch from Cape Canaveral Air Station 11 June 2008 at 12:05PM EDT
- Two instruments:
  - Gamma-ray Burst Monitor (GBM)
  - Large Area Telescope (LAT): 20MeV to  $>300\text{GeV}$
- Continuous all-sky monitoring

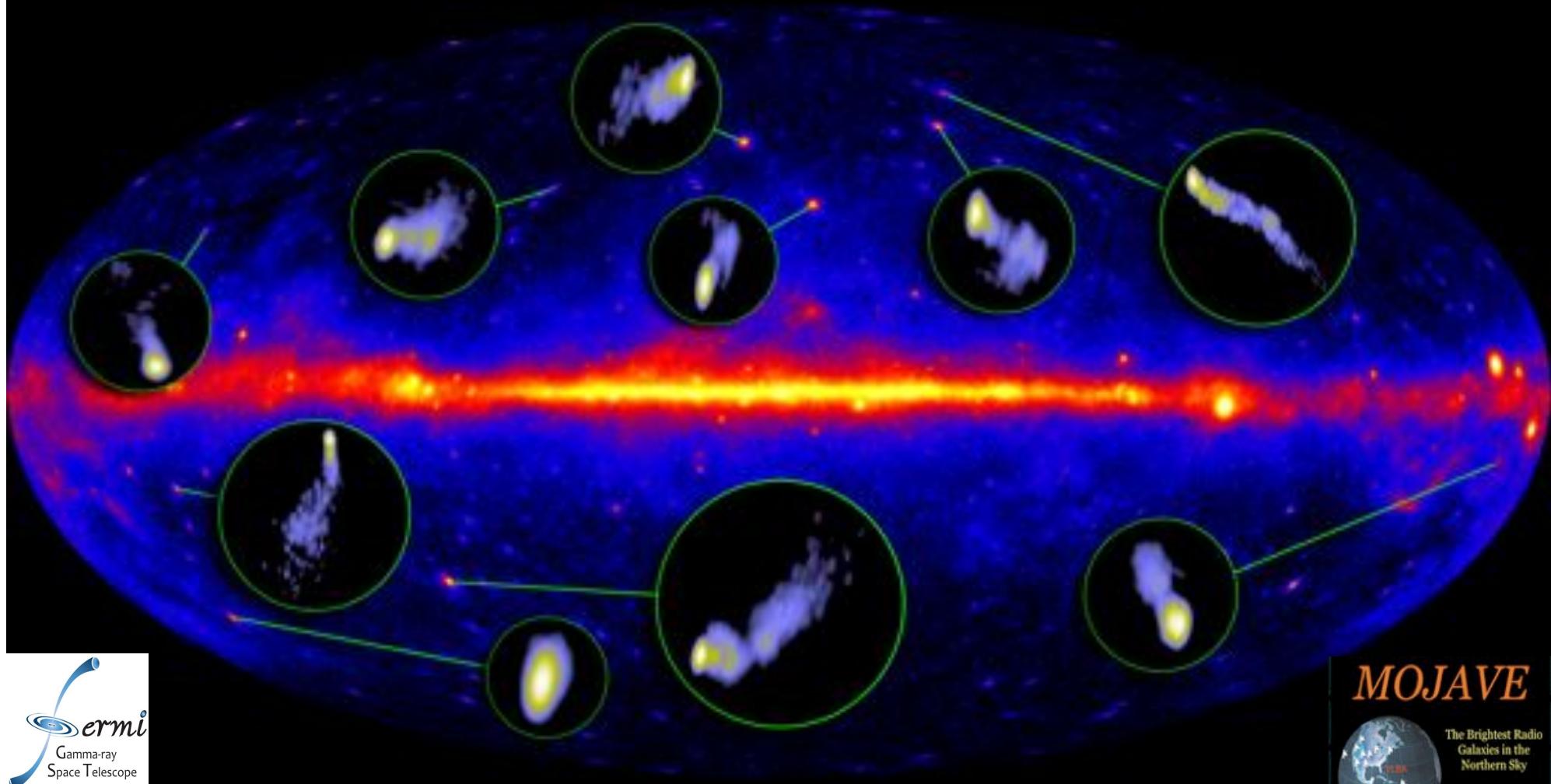
# *Fermi/LAT* Year 1

NASA-DOE-Fermi LAT Collaboration



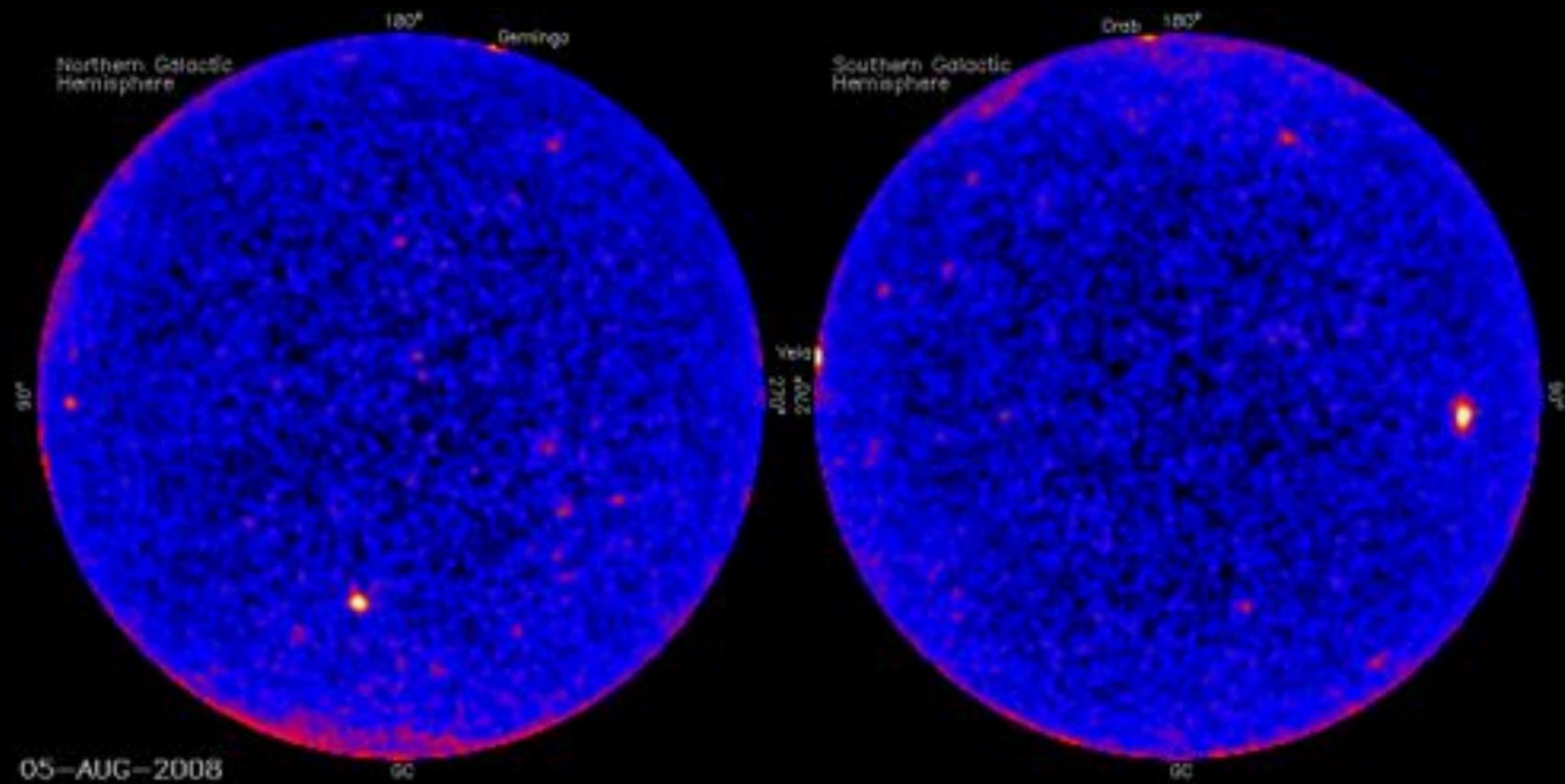
# Radio-Gamma Jets

LAT & MOJAVE Collaborations; M. Kadler

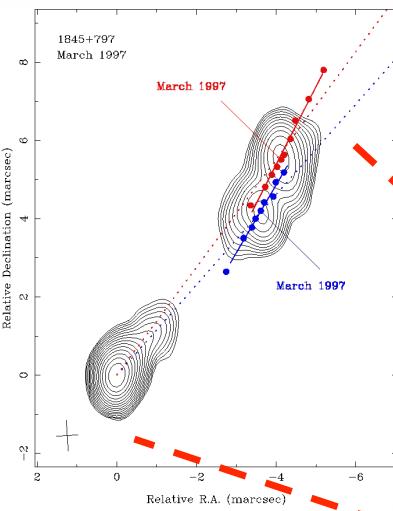


# The variable Gamma-Sky

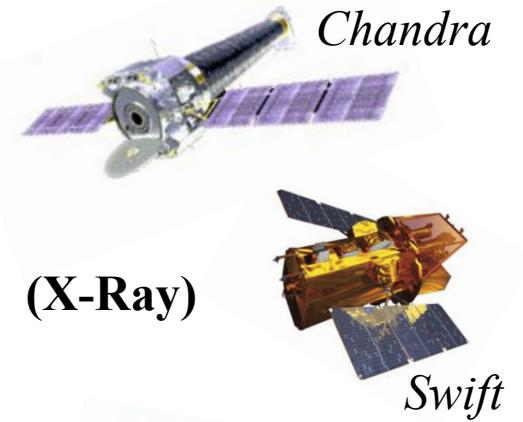
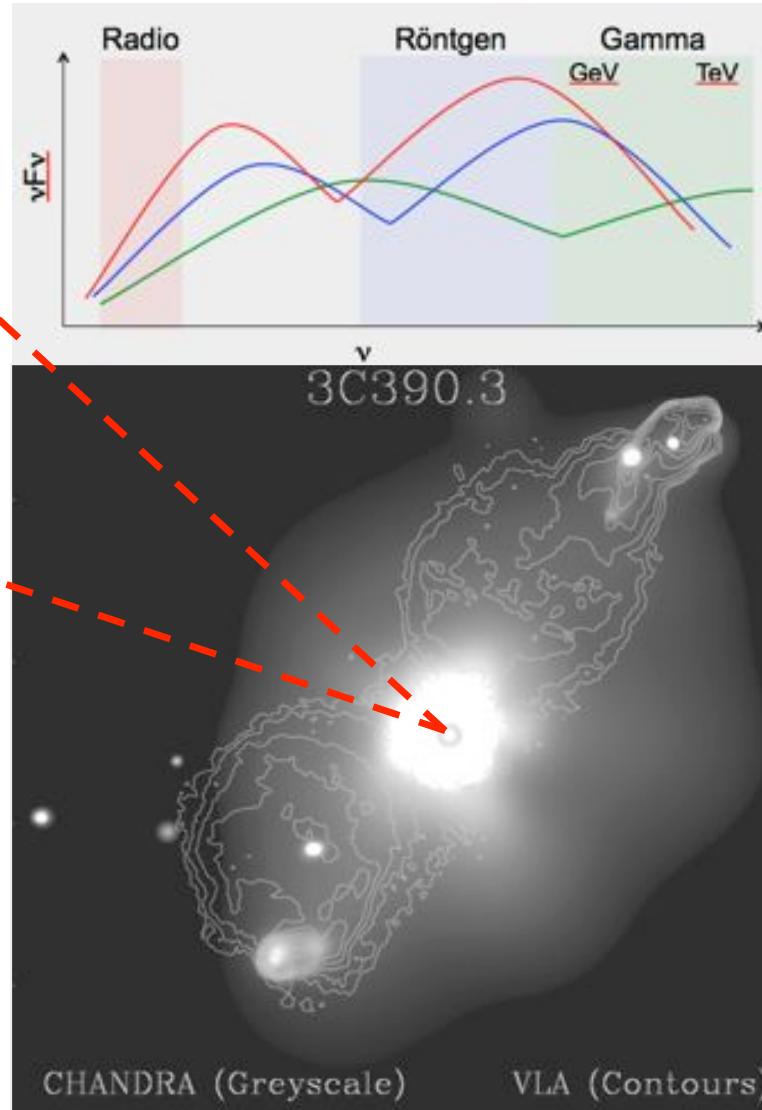
NASA-DOE-Fermi LAT Collaboration



# Multiwavelength BH Observations



VLBI  
(Radio)

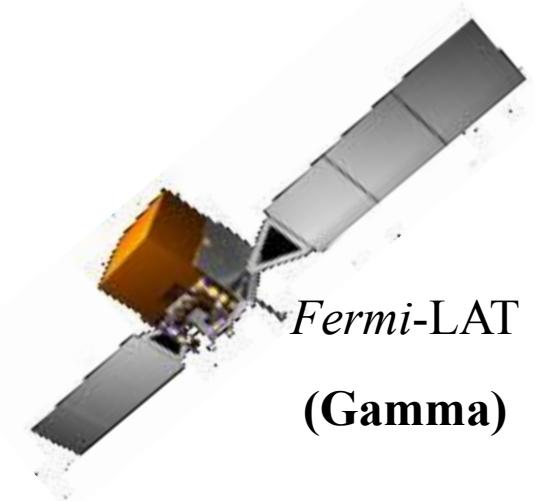


(X-Ray)



Swift

XMM-Newton



Fermi-LAT  
(Gamma)

# Summary

- Many different high-energy observatories available
- Each mission with unique strengths and characteristics
- X-ray spectroscopy probes BH accretion disks, disk coronae, and jets
- $\gamma$ -ray all-sky monitoring with *Fermi*/LAT