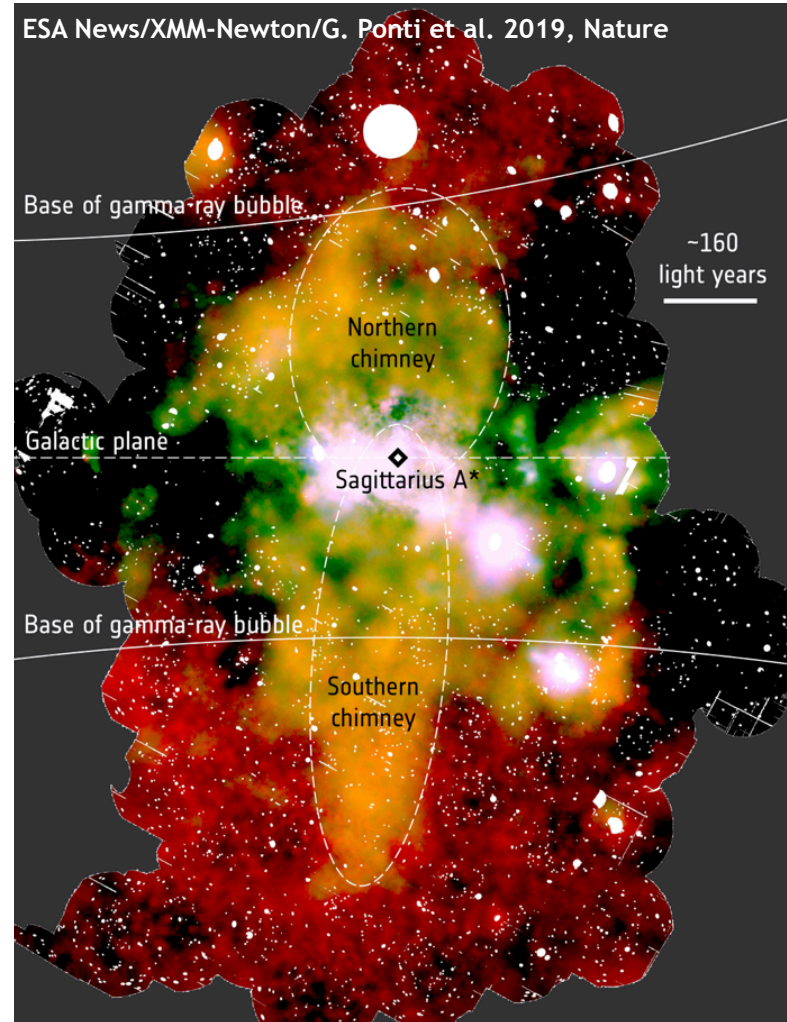


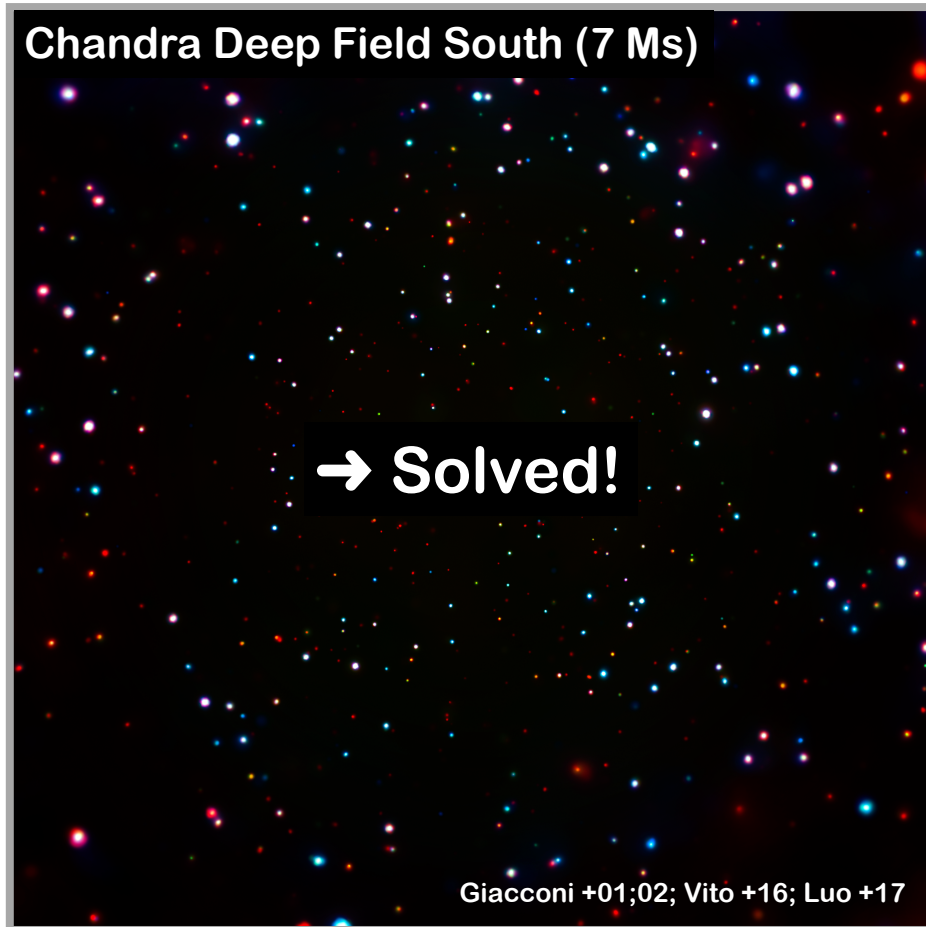
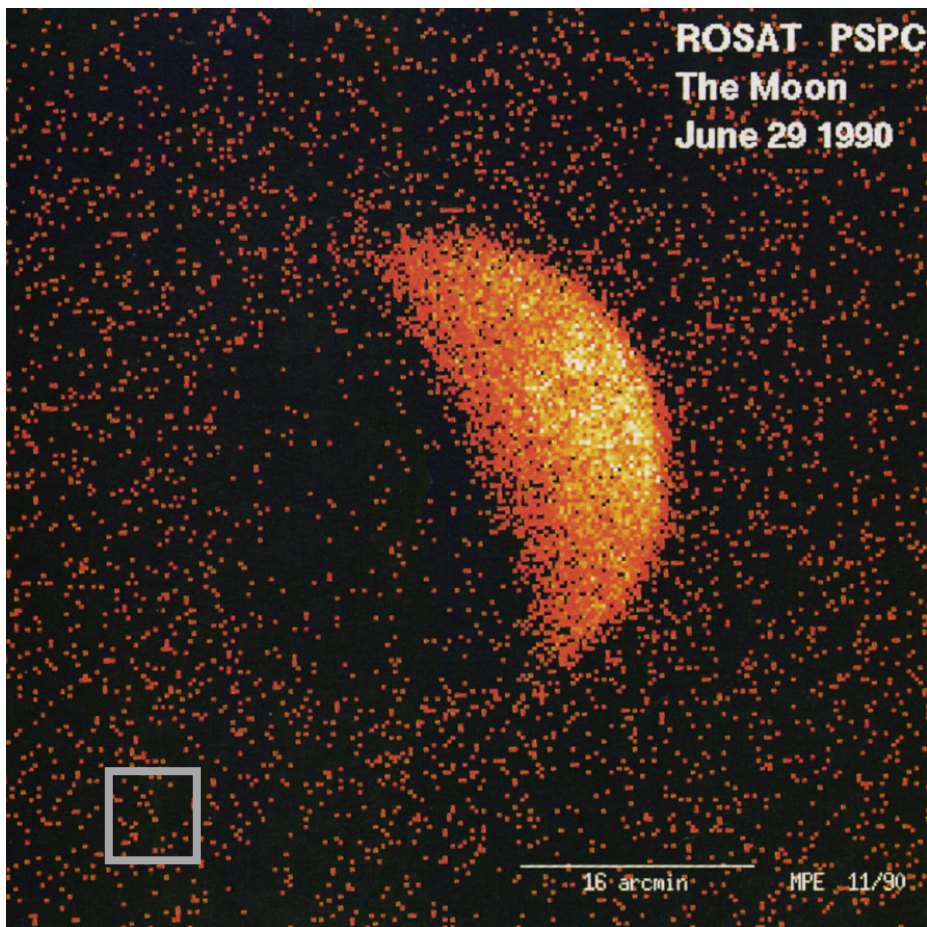
AGN and AGN Feedback



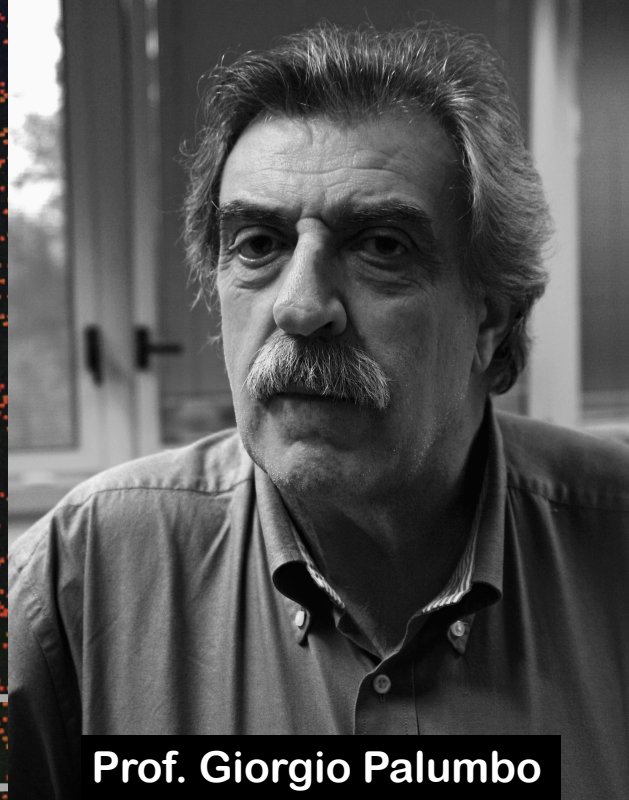
Gabriele Ponti
INAF - Osservatorio di Brera



Chandra: A giant leap forward for astronomy



Chandra: A giant leap forward for astronomy



Prof. Giorgio Palumbo

ROSAT PSPC

oon
9 1990

16 arcmin MPE 11/90

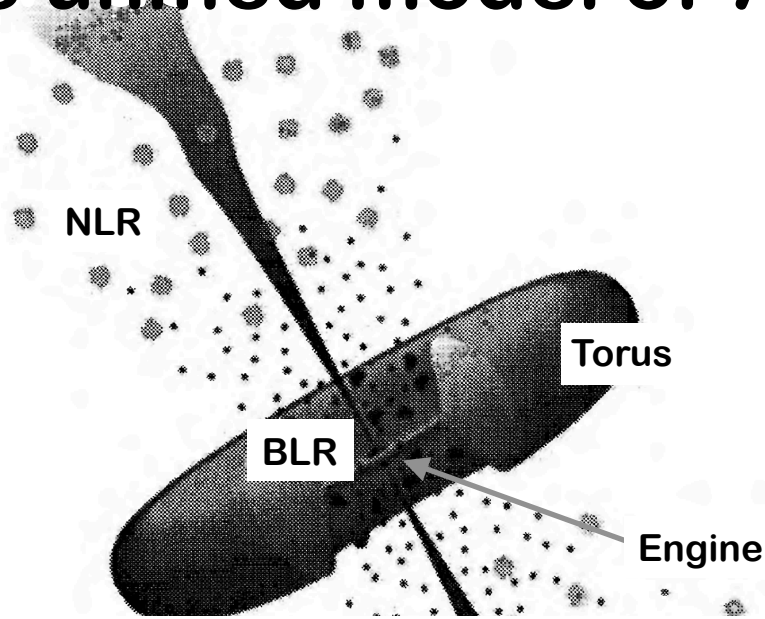
Chandra Deep Field South (7 Ms)



Prof. Riccardo Giacconi

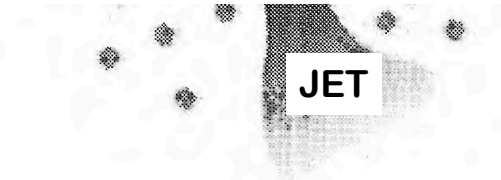
Giacconi +01;02; Vito +16; Luo +17

The unified model of AGN

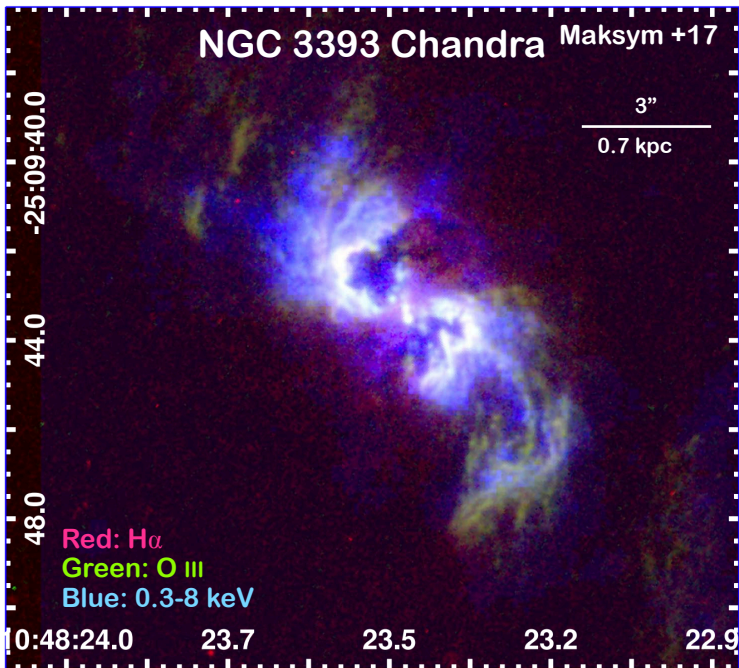


AGN with Chandra → Partially resolving point sources!

→ Understand the fundamental role of winds



Imaging of the Narrow Line Region



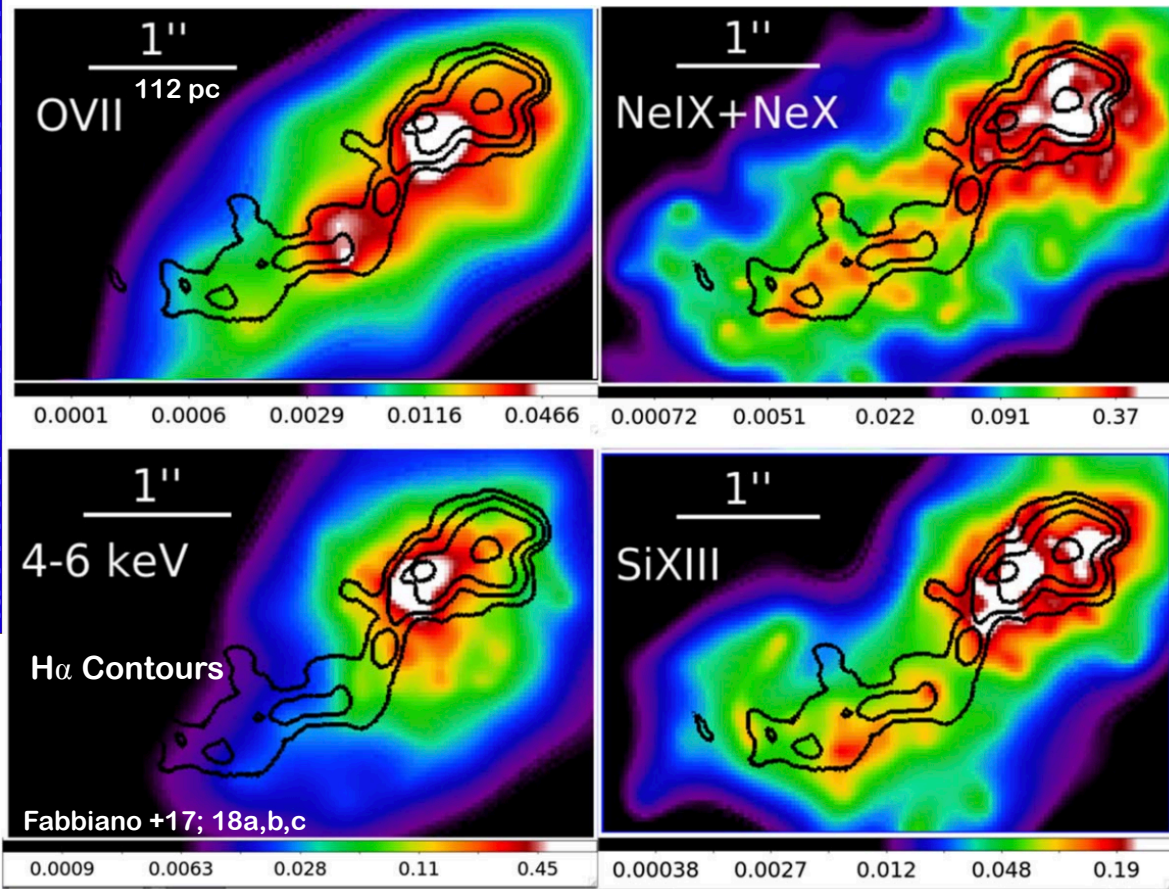
Correlation optical-UV X-ray lines

→ Photo-ionised plasma (primarily)

Likely outflowing & stratified

Multi-phase → shock heated?

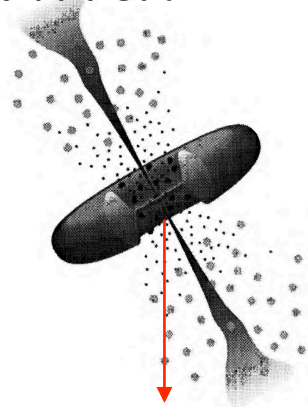
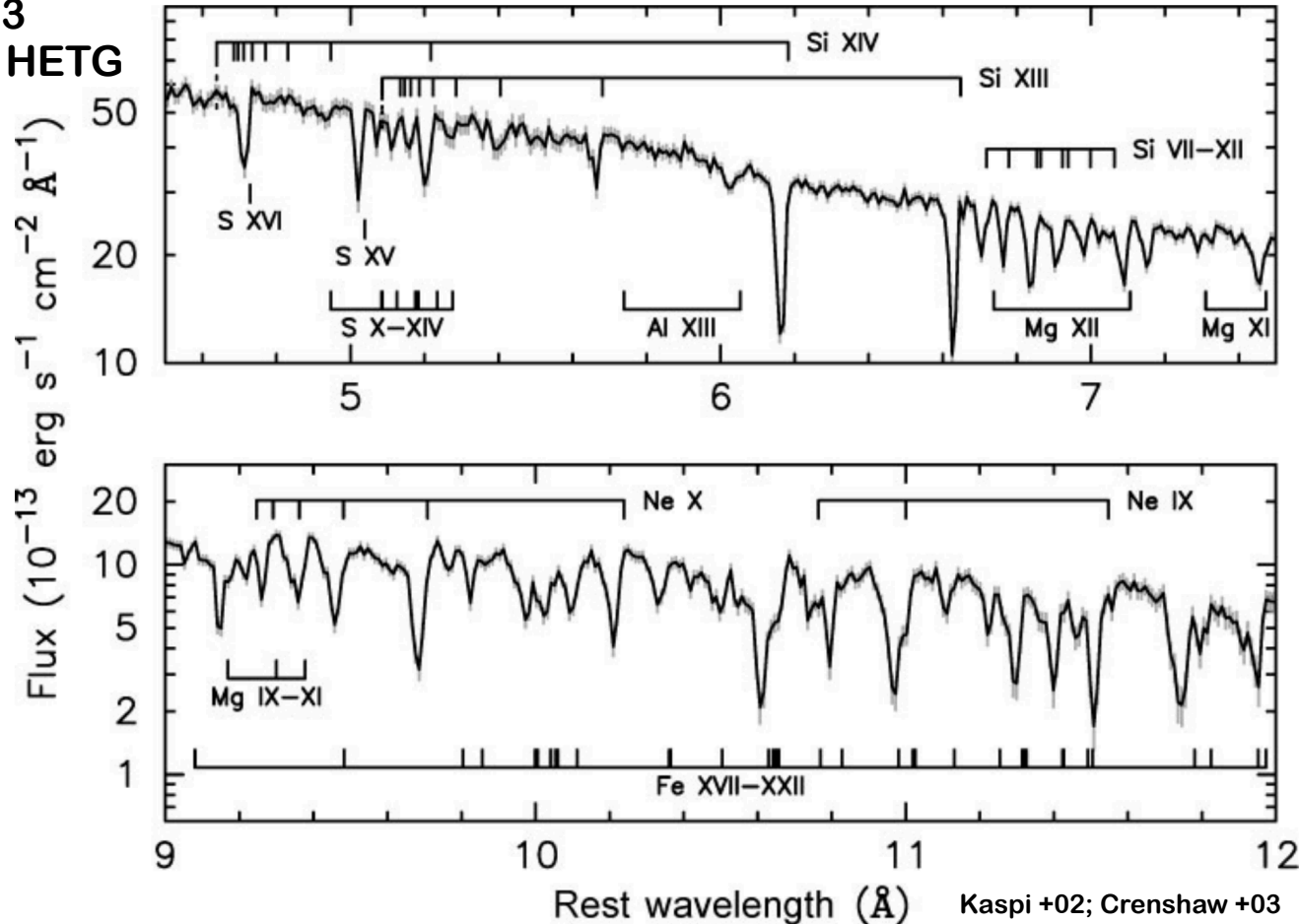
ESO 428-G01 Chandra



See also: Young+01; Kinkhabwala+02; Ogle+03; Schurch+04; Bianchi+06,+07; Levenson+06; Paggi+12; Kallmann+14; Kraemer+15; Maksym+19

Warm absorbers: A multi-phase wind!

NGC 3783
Chandra HETG



Warm absorber
→ wind!

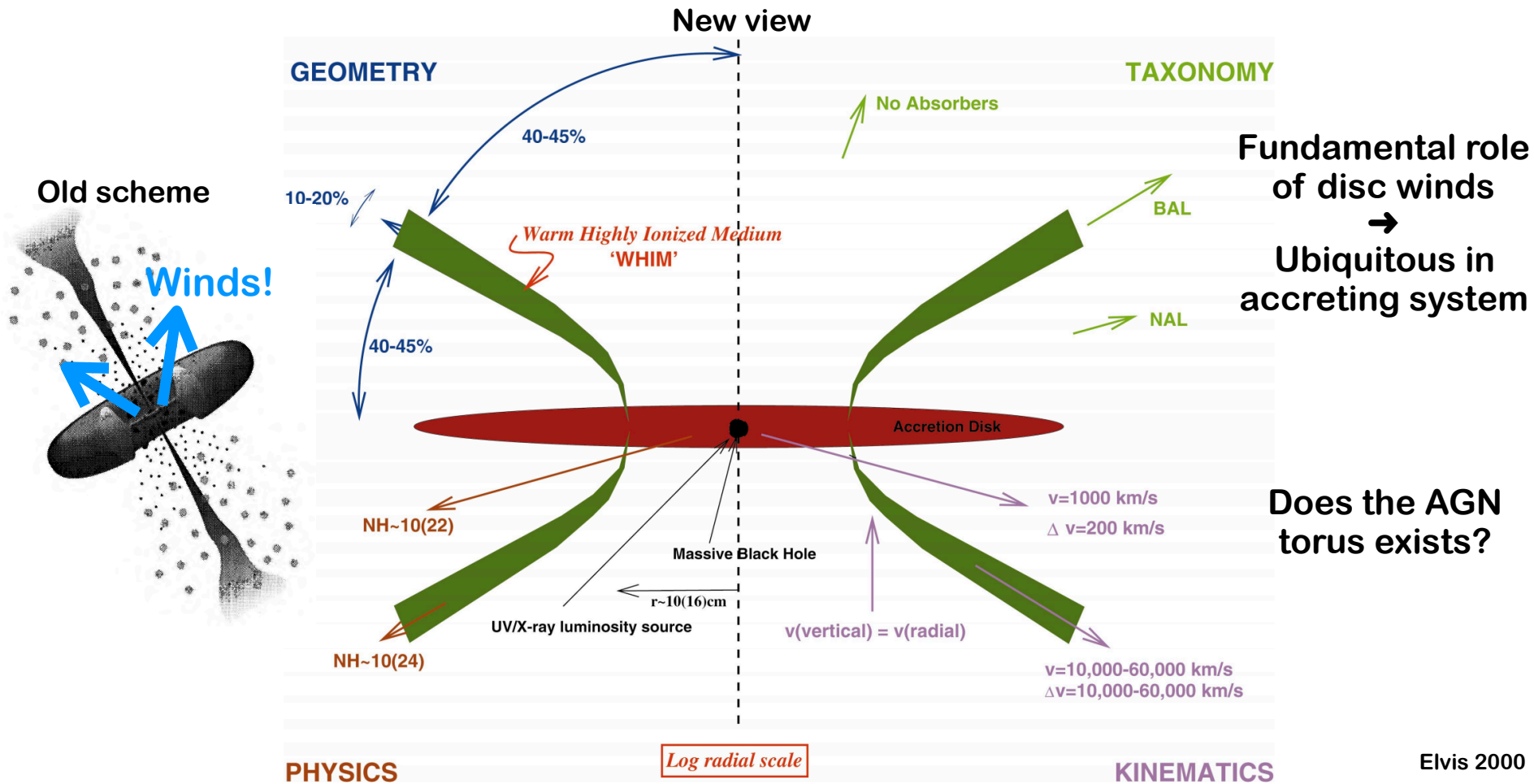
$v_{out} \sim 10^{2-3}$ km s^{-1}

$N_H \sim 20^{21-23}$ cm^{-2}

$f_c \sim 0.5$

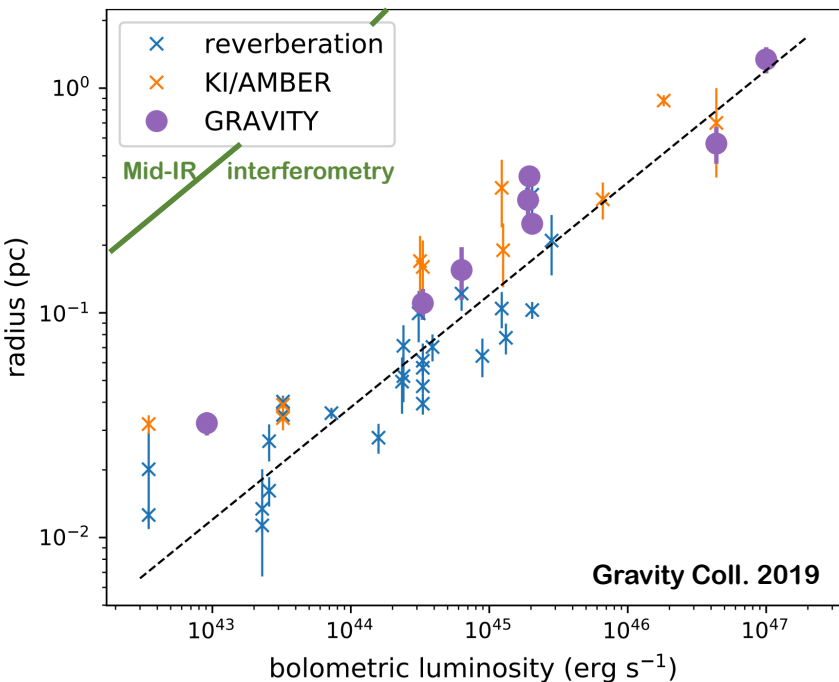
$\log(\xi) \sim 1-3$

The fundamental role of winds in AGN



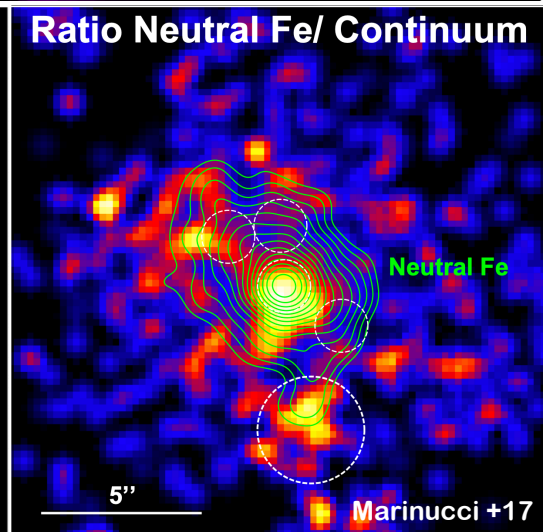
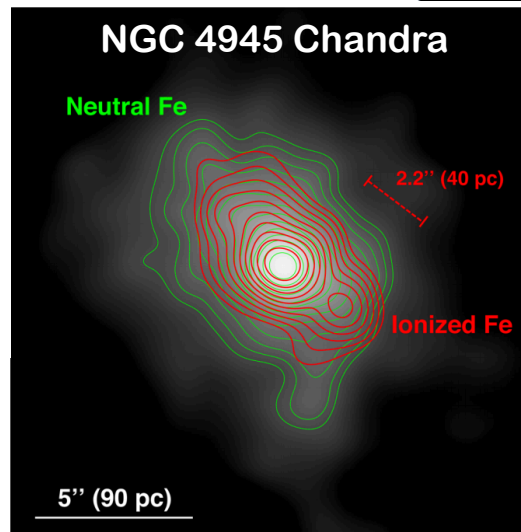
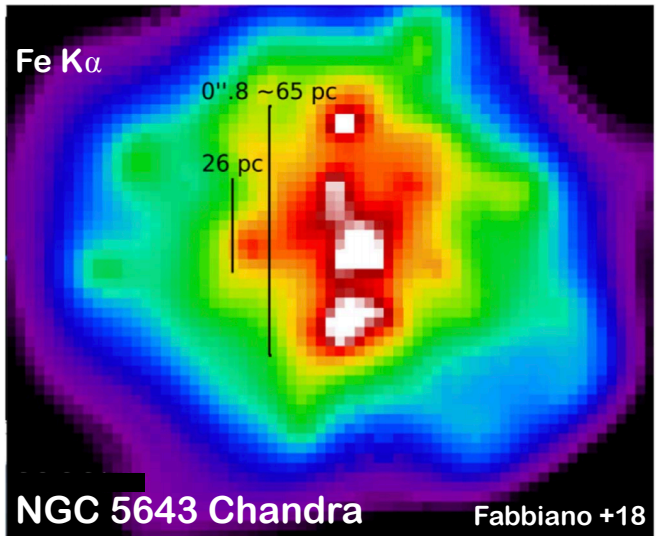
Is a torus present in AGN?

Hot dust (sublimation) radius



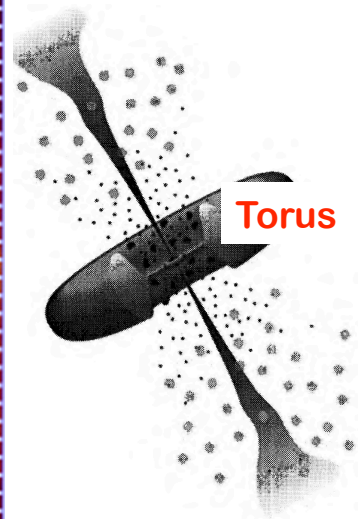
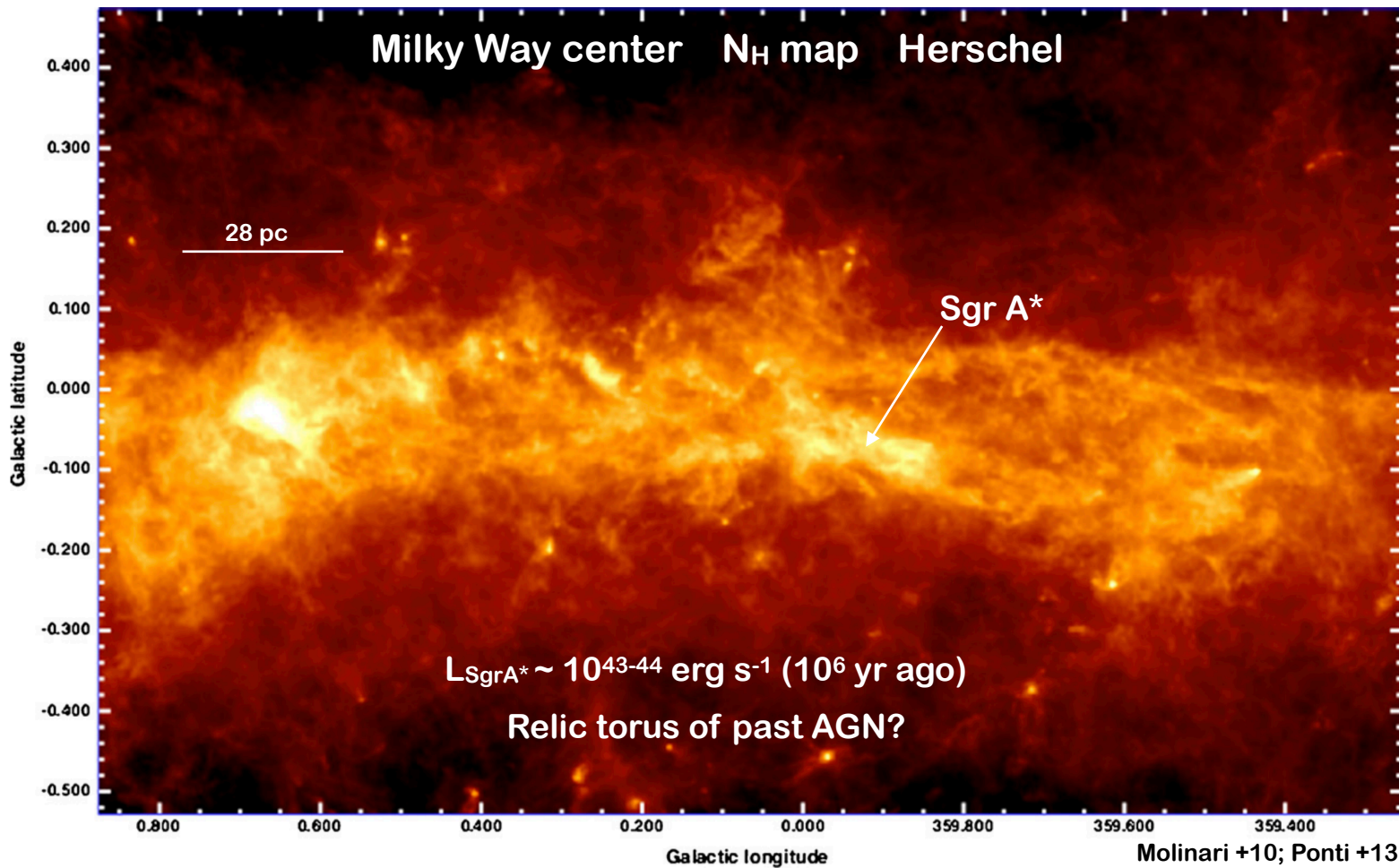
Distributed
(sub-pc to 10^{1-2} pc)

Certainly not a
donut (clumpy & porous),
maybe outflowing?

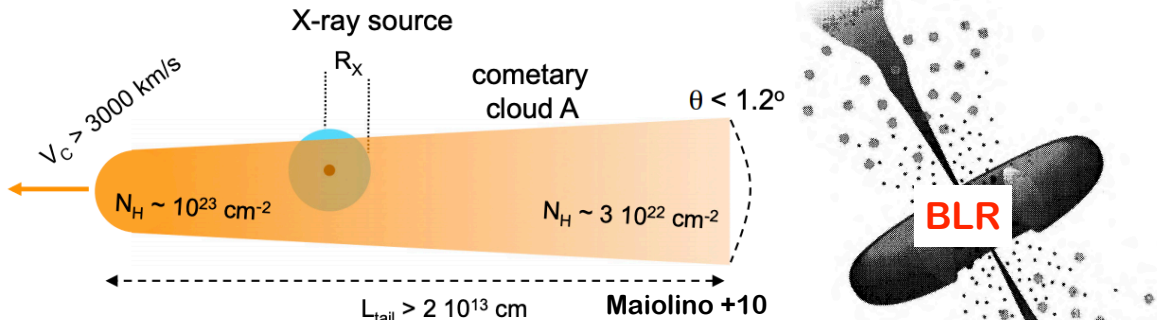
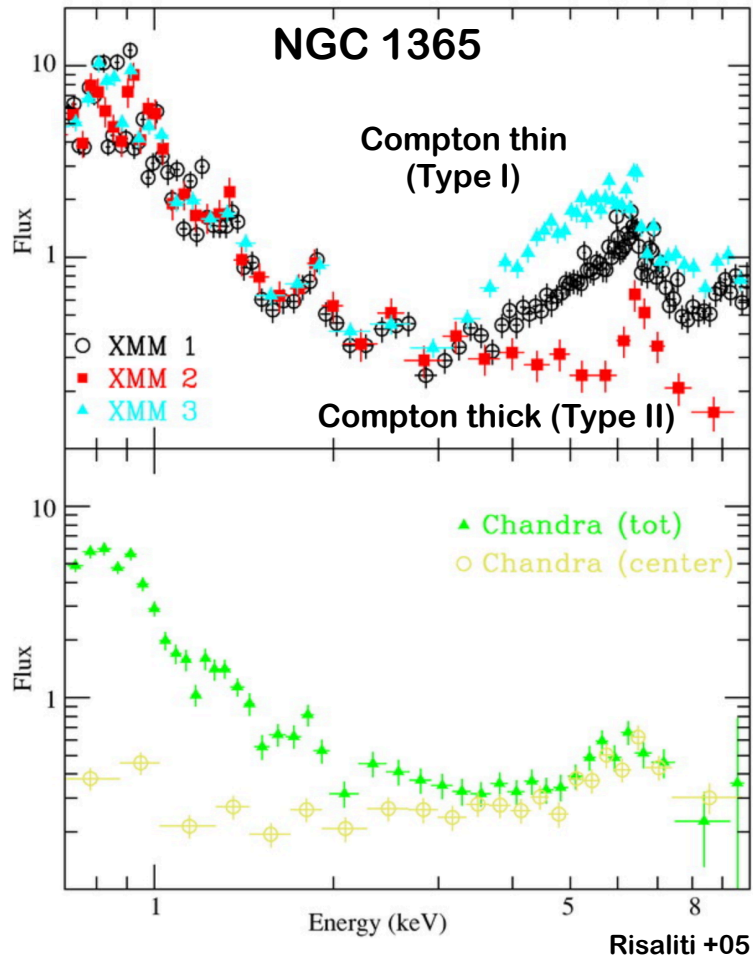


See also Jaffe +04; Suganuma +06; Meisenheimer +07;
Burtscher +09; Kishimoto +07; +11a,b; Koshida +14; Netzer 15

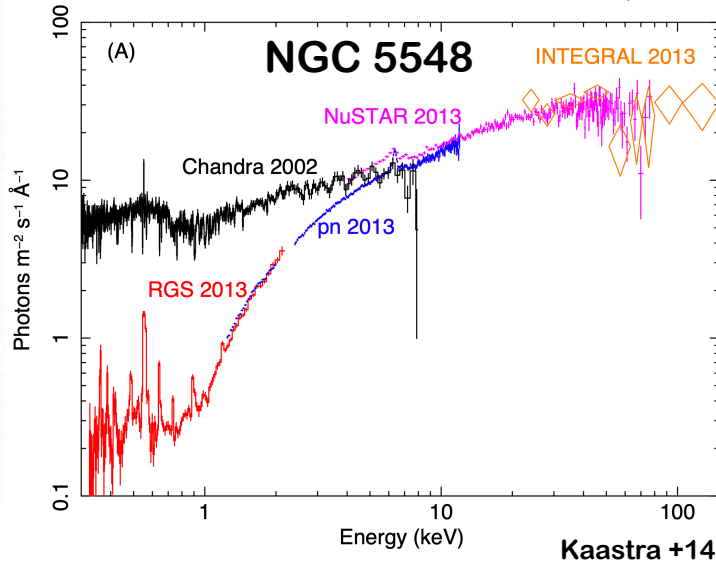
Is a torus present at the Milky Way center?



Variable absorption: Crossing of BLR cloud?



See also Elvis +04; Risaliti +07; +09a,b; +11; Puccetti +07; Turner +09; Markowitz +14; Torricelli-Ciamponi +14;

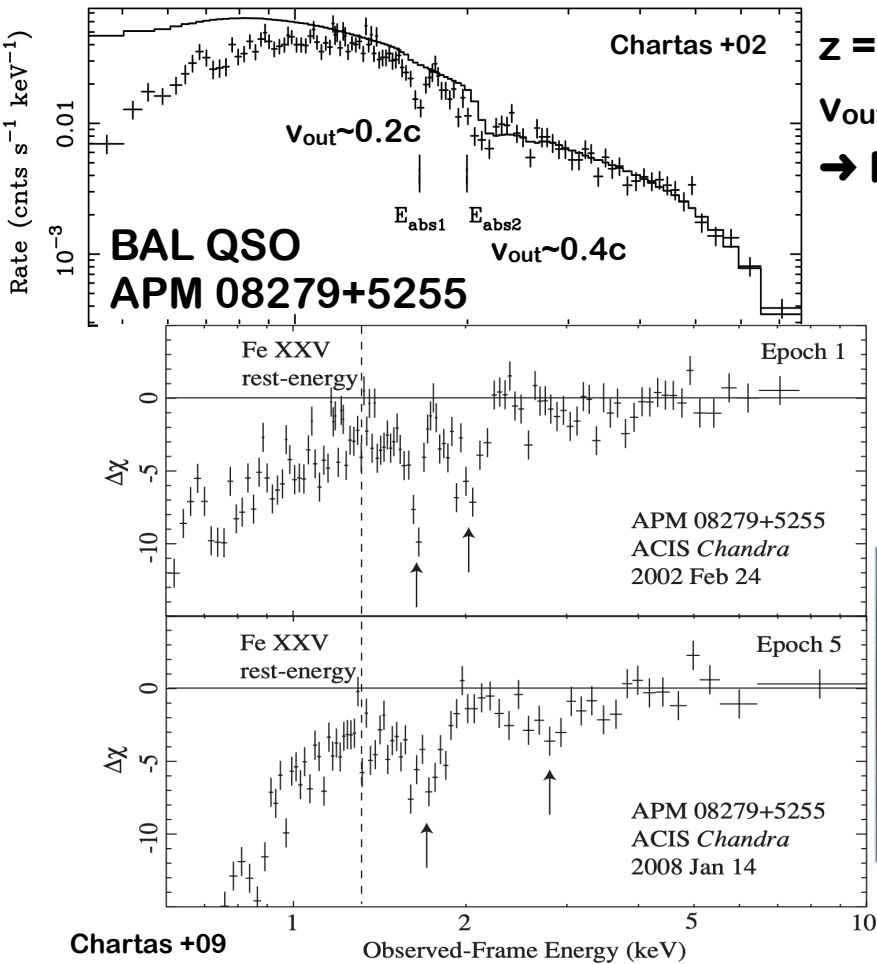


Clouds BLR
→ X-ray absorption

Simultaneous with
broad UV absorption
→ BAL QSO

Arav +15

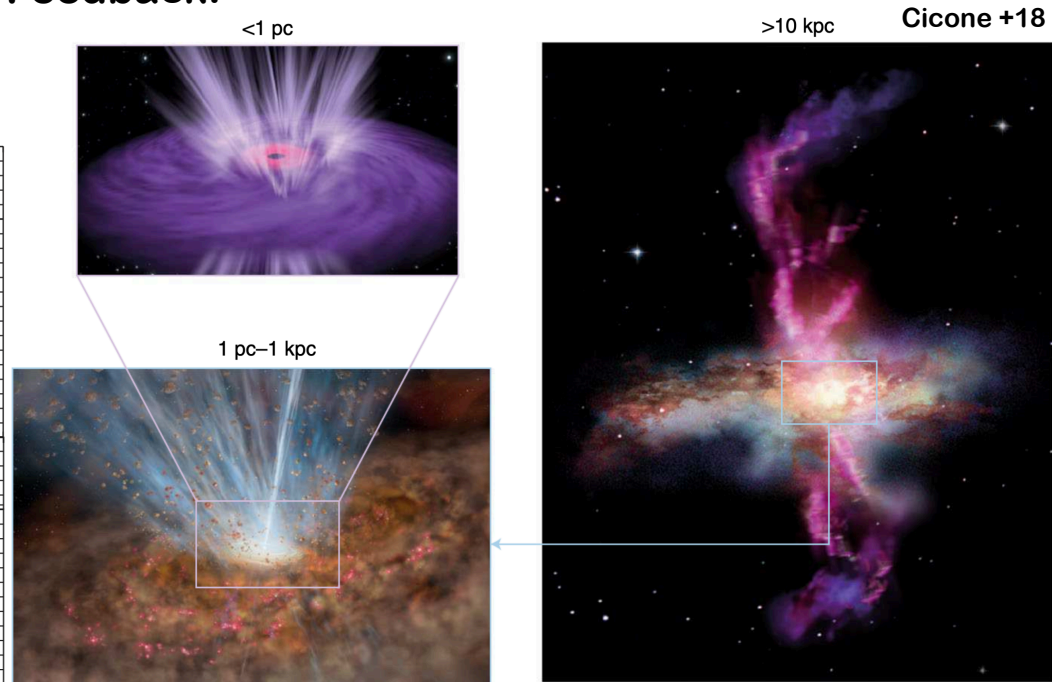
Extreme winds → Feedback



$z = 3.91$ - Lensed → magnification 10x

$v_{out} \sim 0.2-0.4 c \rightarrow \dot{M}_{Wind} \sim 16-60 M_{Sun} yr^{-1} \rightarrow \epsilon \sim 0.2-2$

→ Feedback!



See also Pounds +03; Reeves +03; +09; Tombesi +10a,b; +11; +12; +13; +14; +15;
Cappi 06; +09; Gofford +13; +15; Nardini +15; Fukumura +14; +15;

Feedback: Jets

Cygnus A

Perseus Cluster

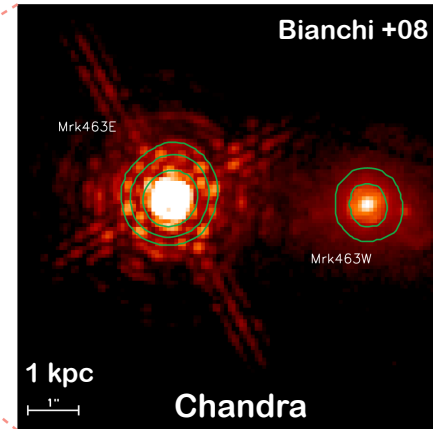
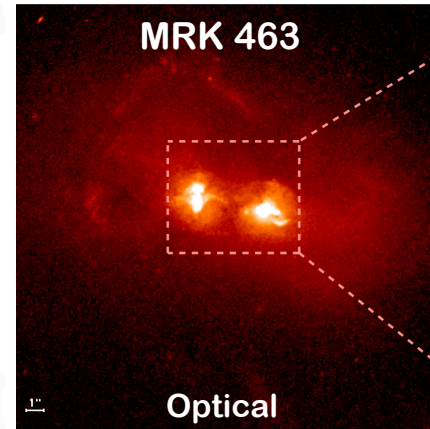
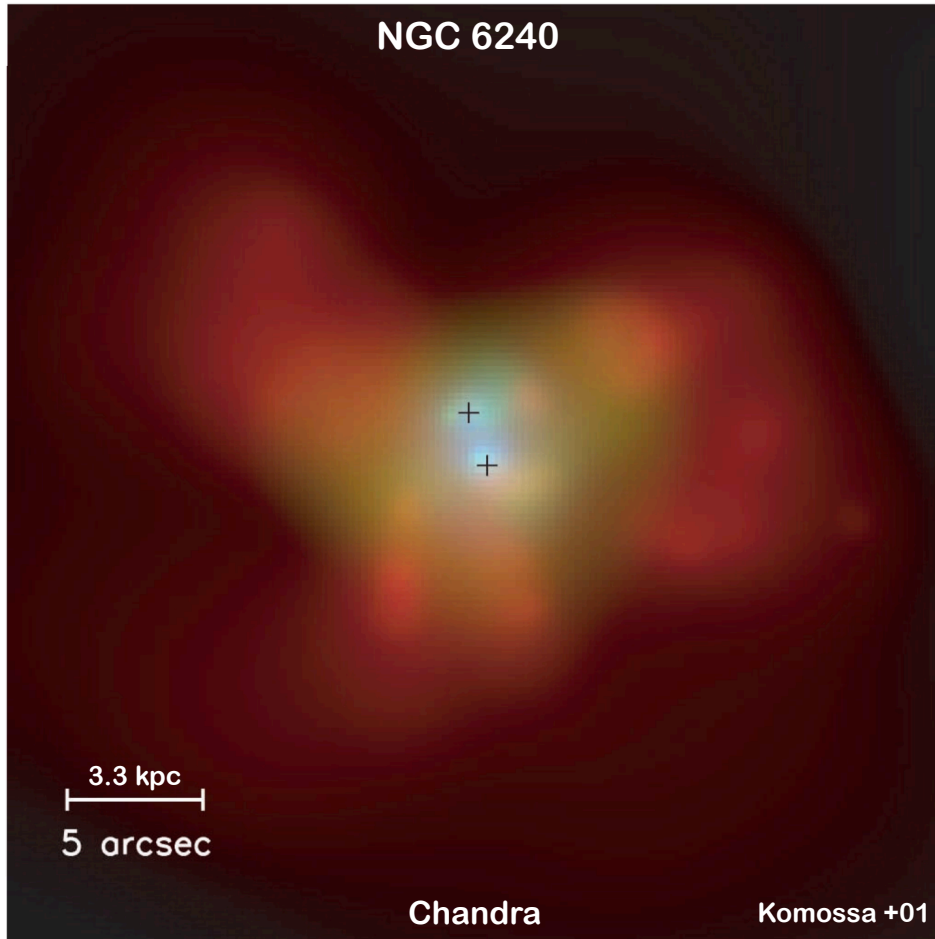
X-ray: Chandra
Optical: HST
Radio: VLA

→ See Sera Markoff's talk

20 kpc

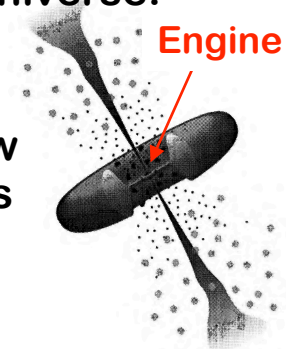
20 kpc

Discovery of double AGN

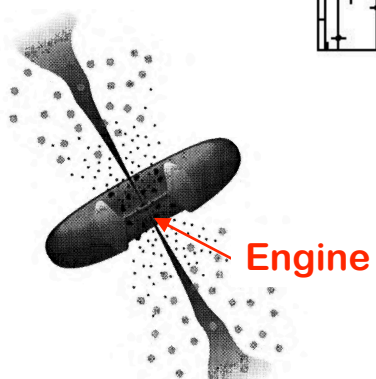
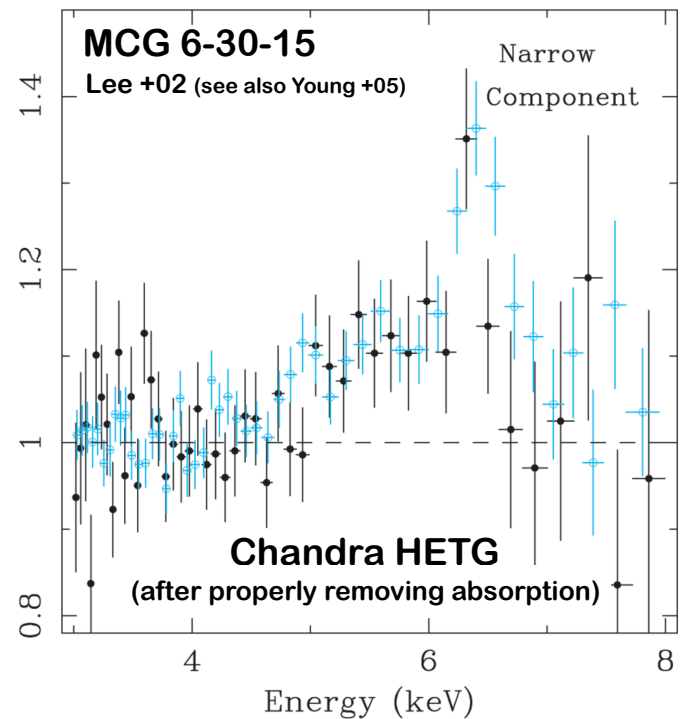
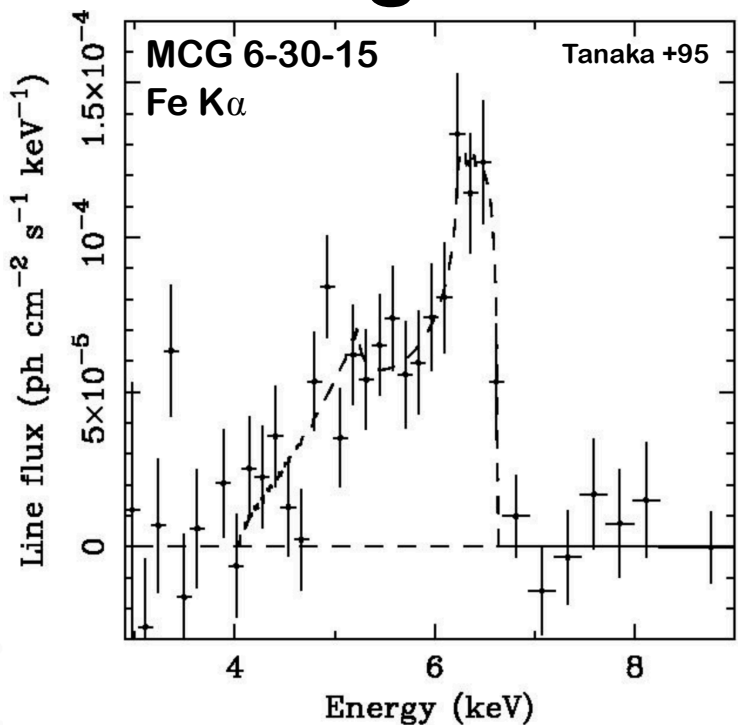


Necessary byproduct of structure formation in a hierarchical Universe!

Progenitor population of low frequency (LISA) GW sources



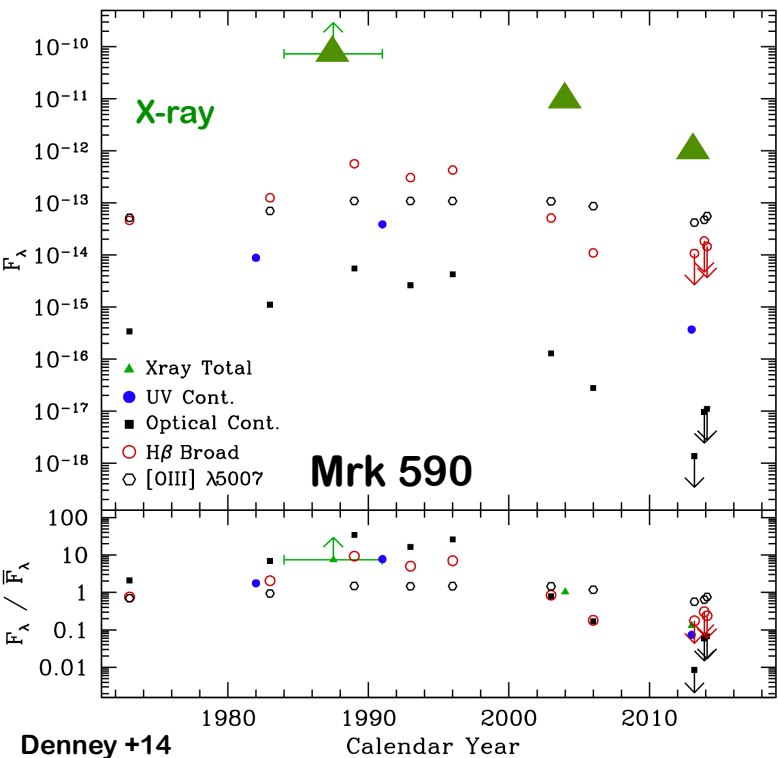
Central engine → Test of strong gravity



Broad lines → Powerful probe of strong gravity

Athena → exploit their full potential!

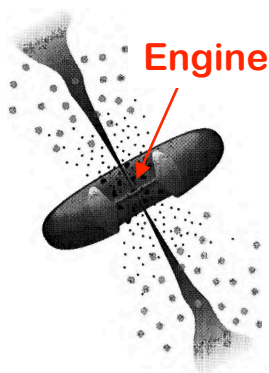
AGN (weird) variability: Recurrent outbursts?



→ Switched off

But currently awakening

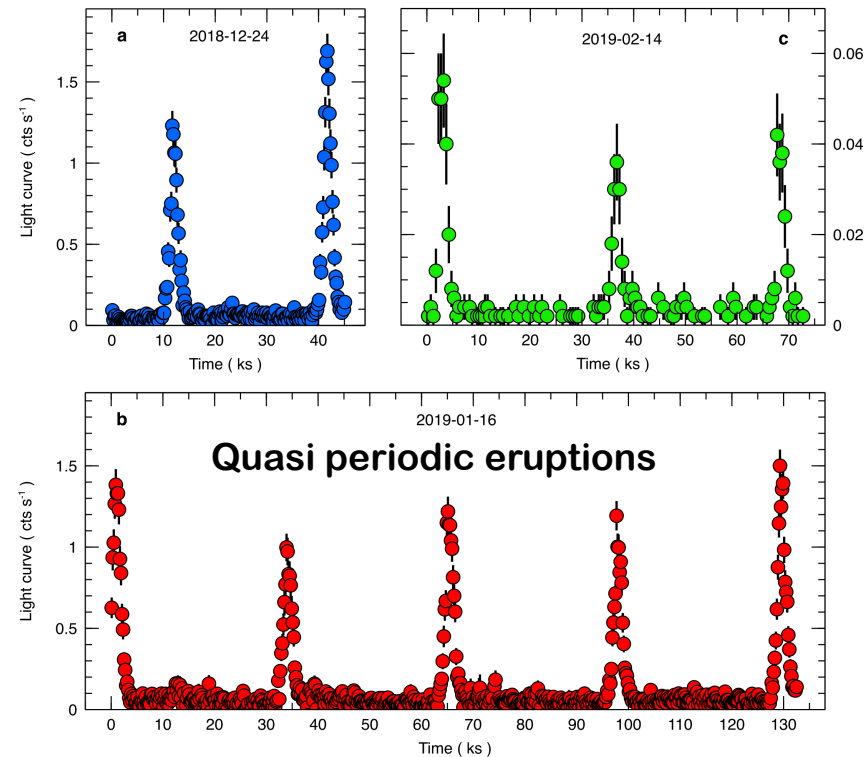
Mathur +18



GSN 069

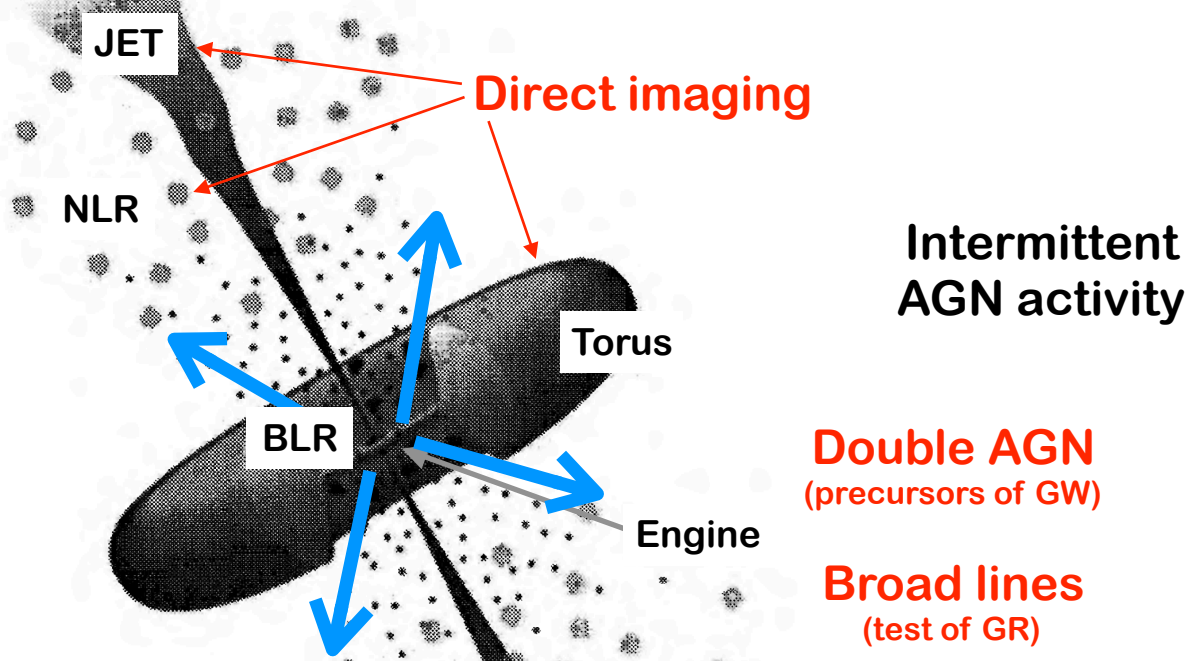
240 times brighter ($L_x \sim 10^{43}$ erg s^{-1}) than ROSAT in 2010 (TDE?)

Exponential decay → 8 years after weird variability



Miniutti +19

Conclusions: What have we learned?



Winds!

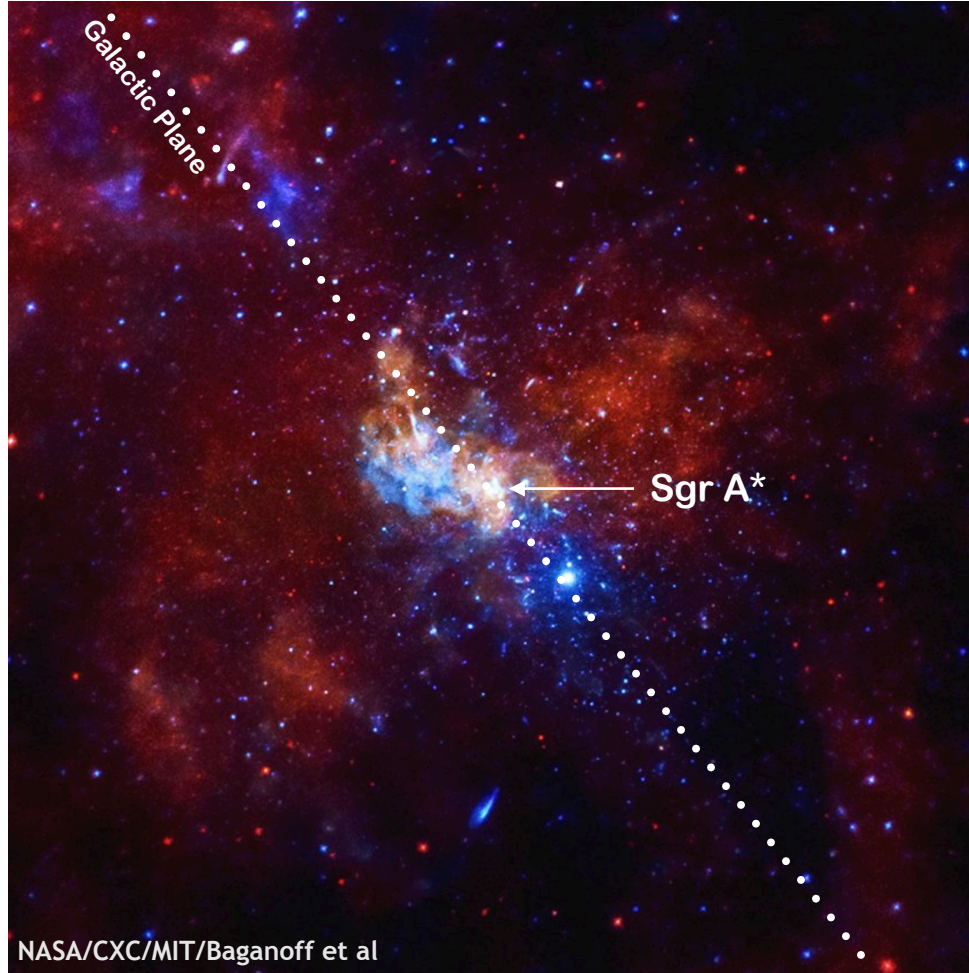
(warm absorber, BLR clouds, obscurers)

Powerful winds!

(Ultra-fast)

→ Feedback

Sgr A*: A quiescent AGN?



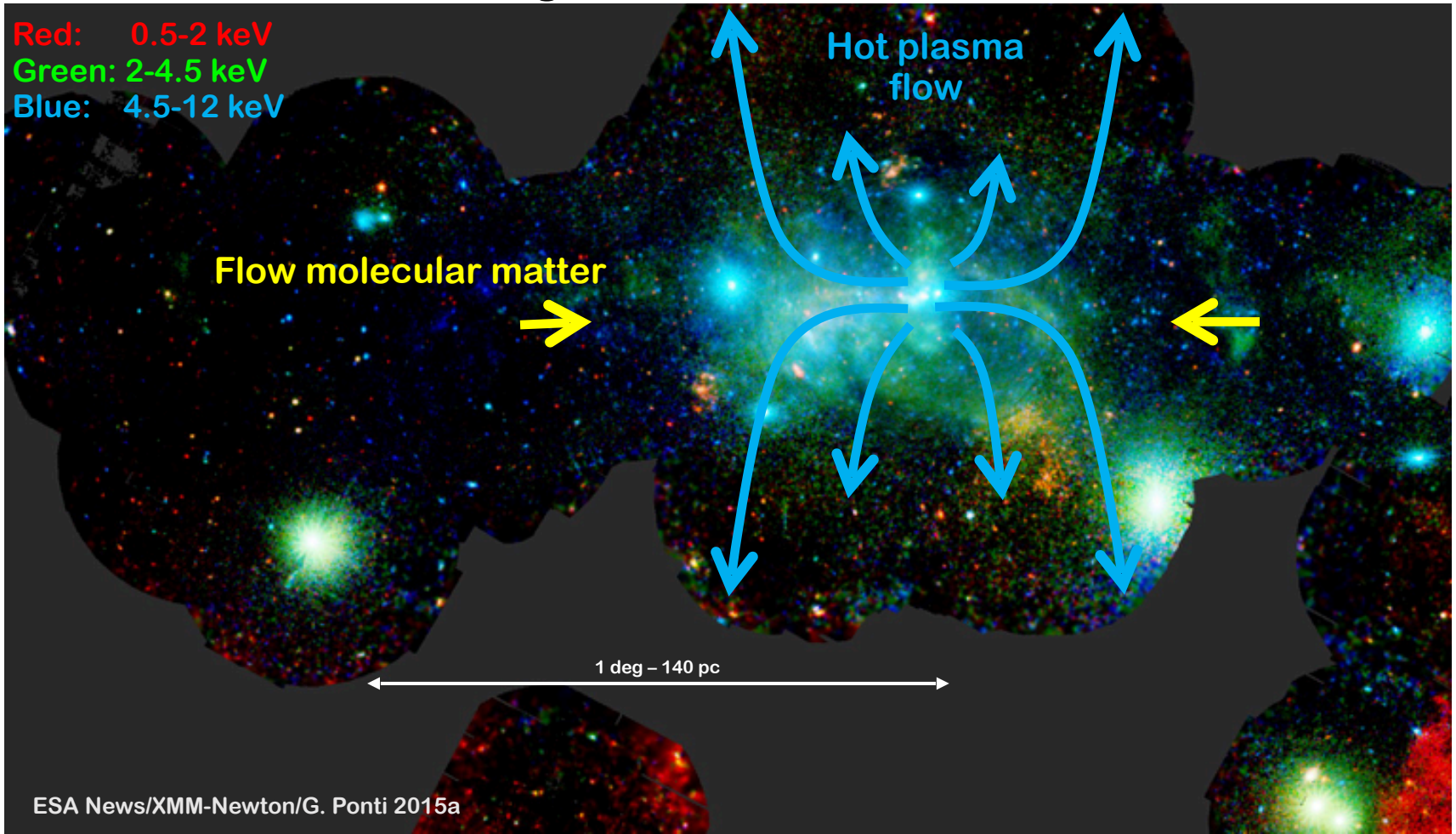
$L_{\text{Sgr A}^*} \sim 10^{-9} L_{\text{Edd}}$

That's faint!

Was Sgr A* brighter in the past?

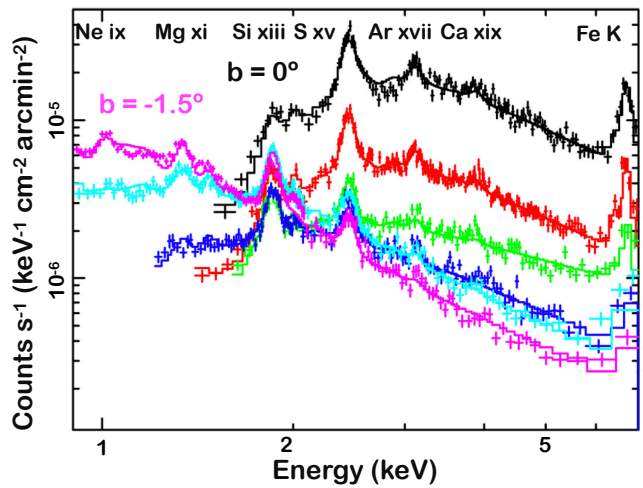
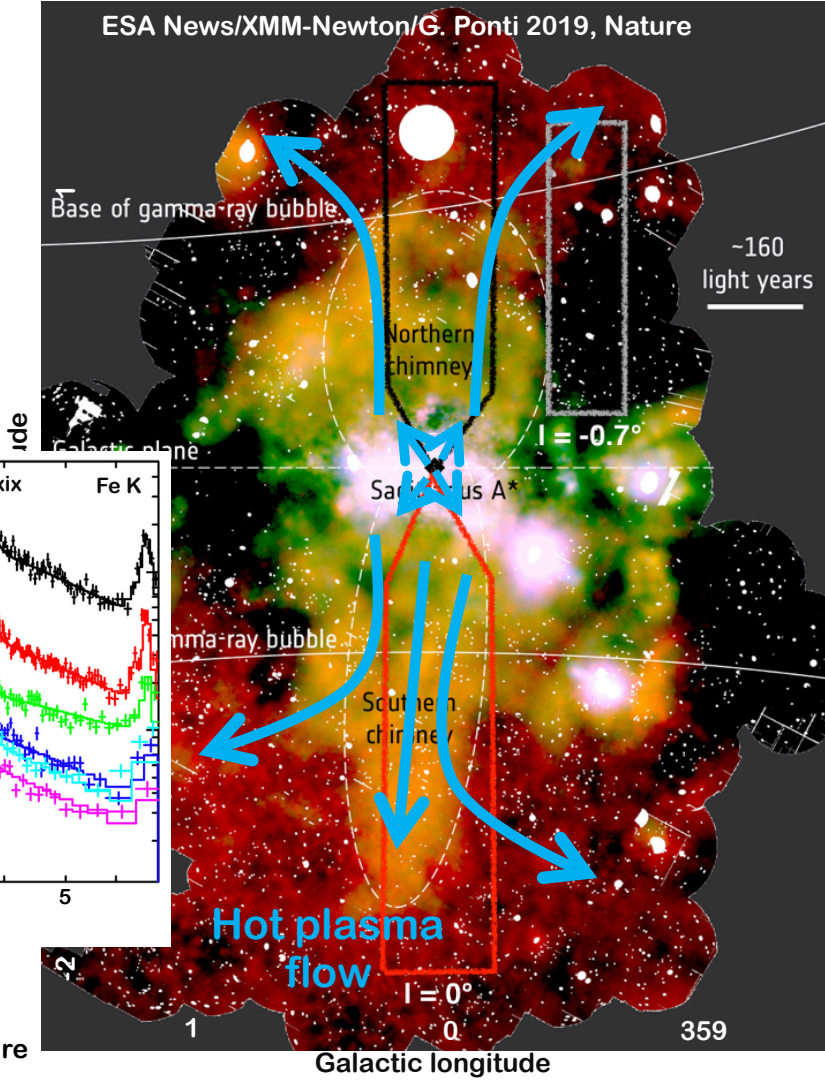
Flows of hot Baryons at the Galactic center

Red: 0.5-2 keV
Green: 2-4.5 keV
Blue: 4.5-12 keV

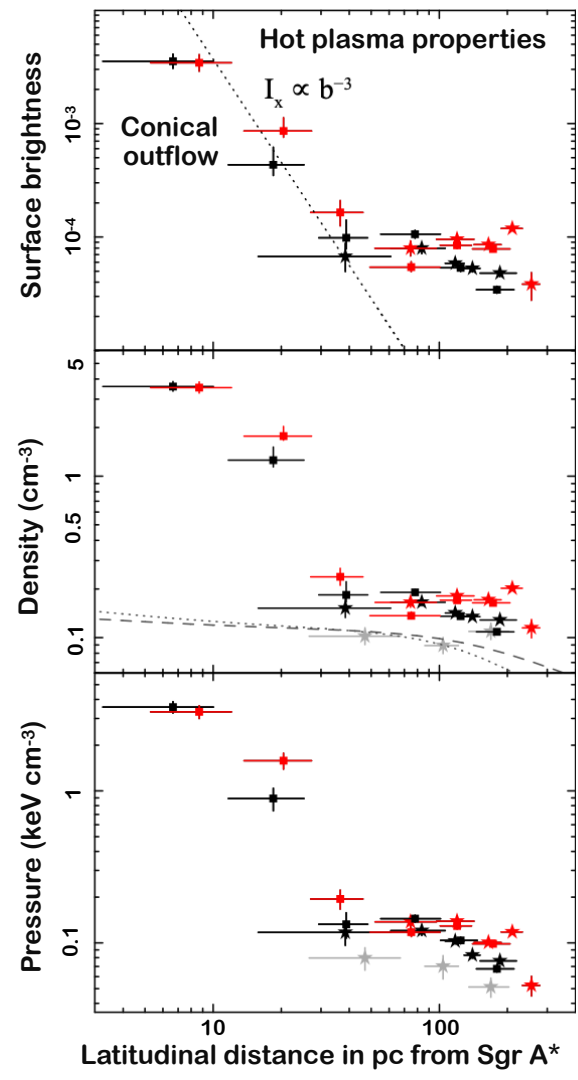


The Galactic center Chimney

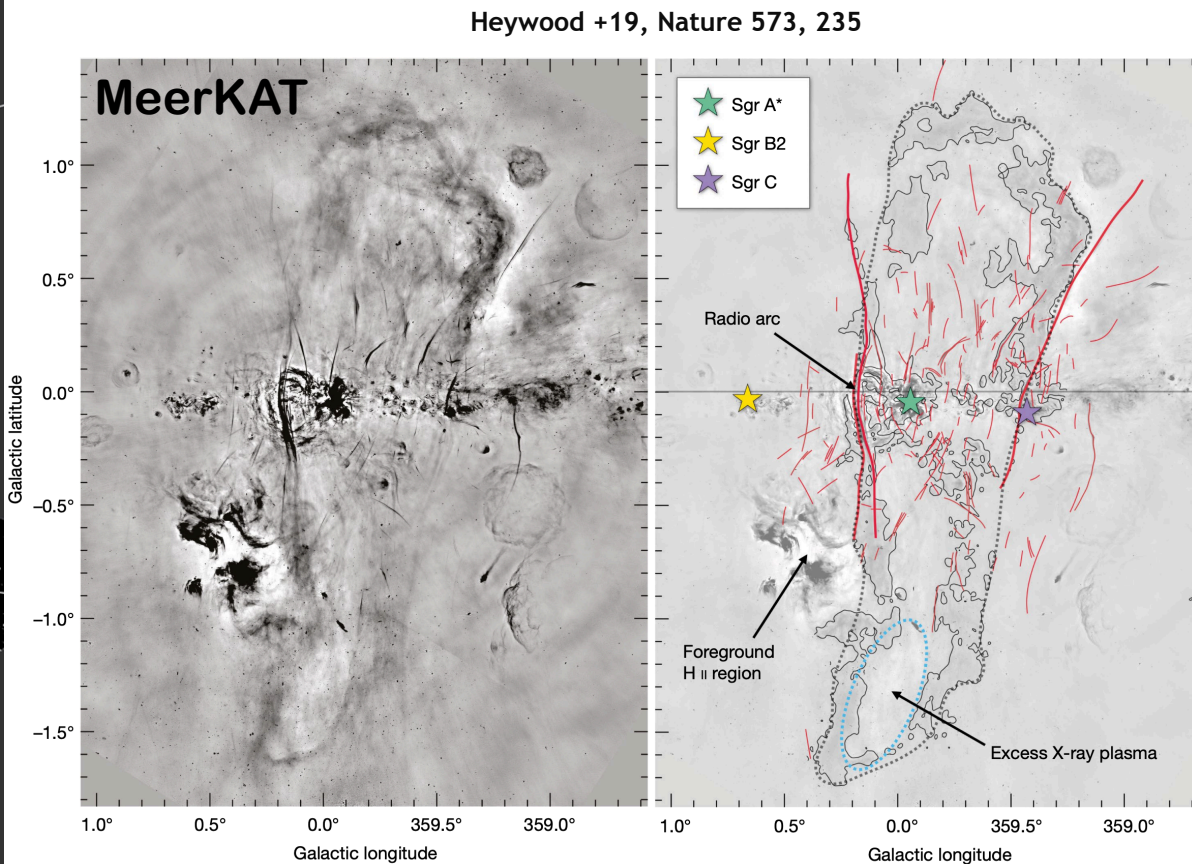
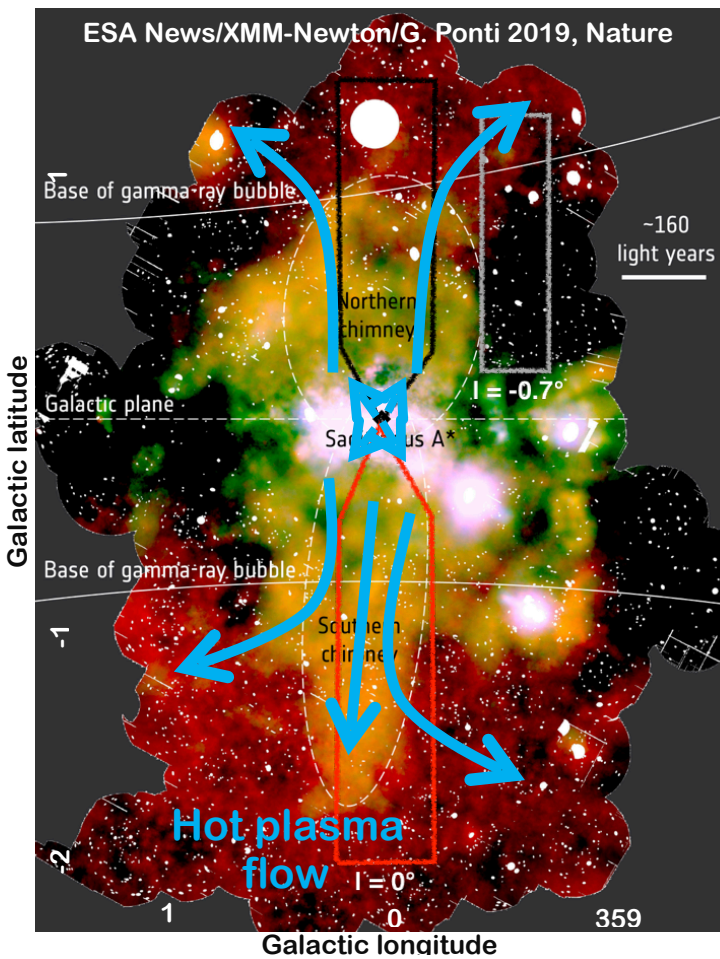
ESA News/XMM-Newton/G. Ponti 2019, Nature



Ponti +2019, Nature



The radio counterparts of the Chimneys



Confined bubbles or Galactic outflow?

Map the flows of hot Galactic Baryons

The ROSAT soft X-ray all sky survey (1990-1997)

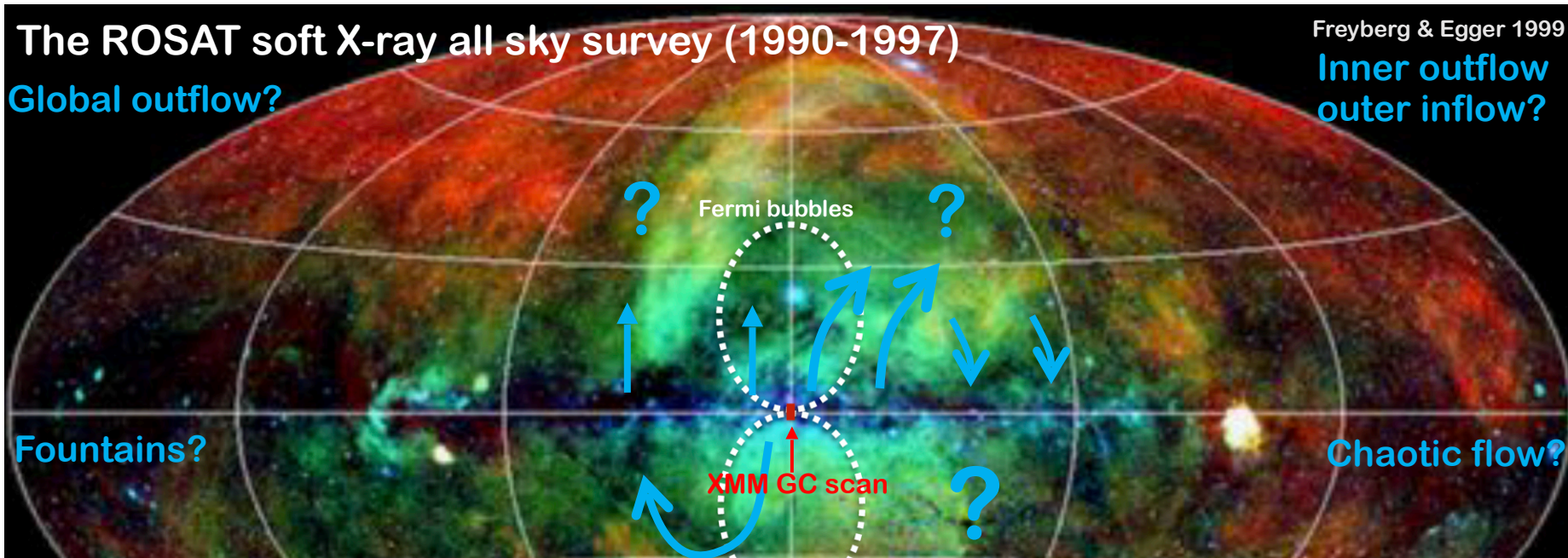
Freyberg & Egger 1999

Global outflow?

Inner outflow
outer inflow?

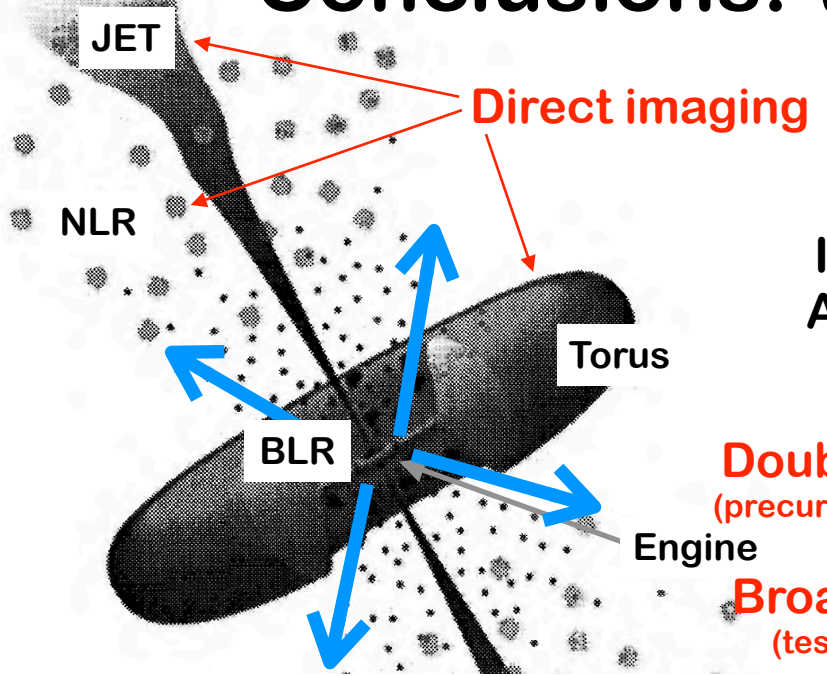
Fountains?

Chaotic flow?



Flows of hot Baryons connecting the Milky Way center to the corona, halo and beyond

Conclusions: What have we learned?



Intermittent AGN activity

Double AGN
(precursors of GW)

Broad lines
(test of GR)

Winds!
(warm absorber, BLR clouds, obscurers)

Powerful winds!
(Ultra-fast)
→ **Feedback**

