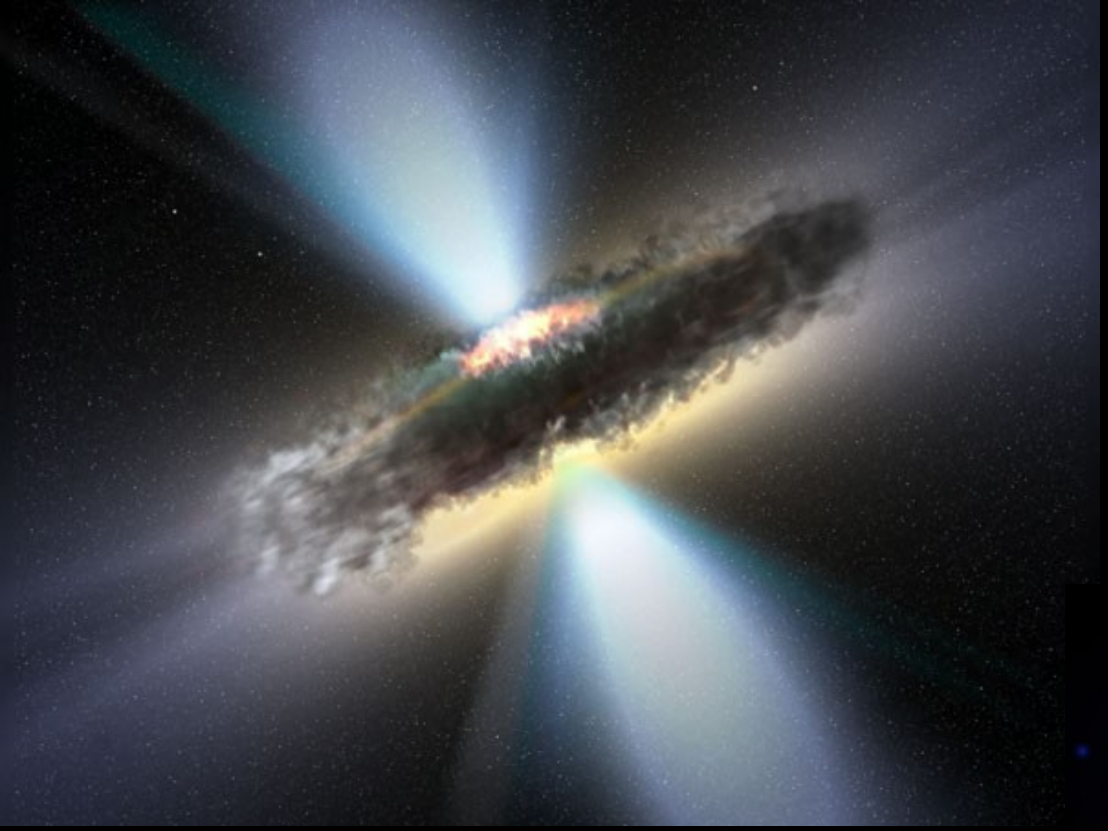
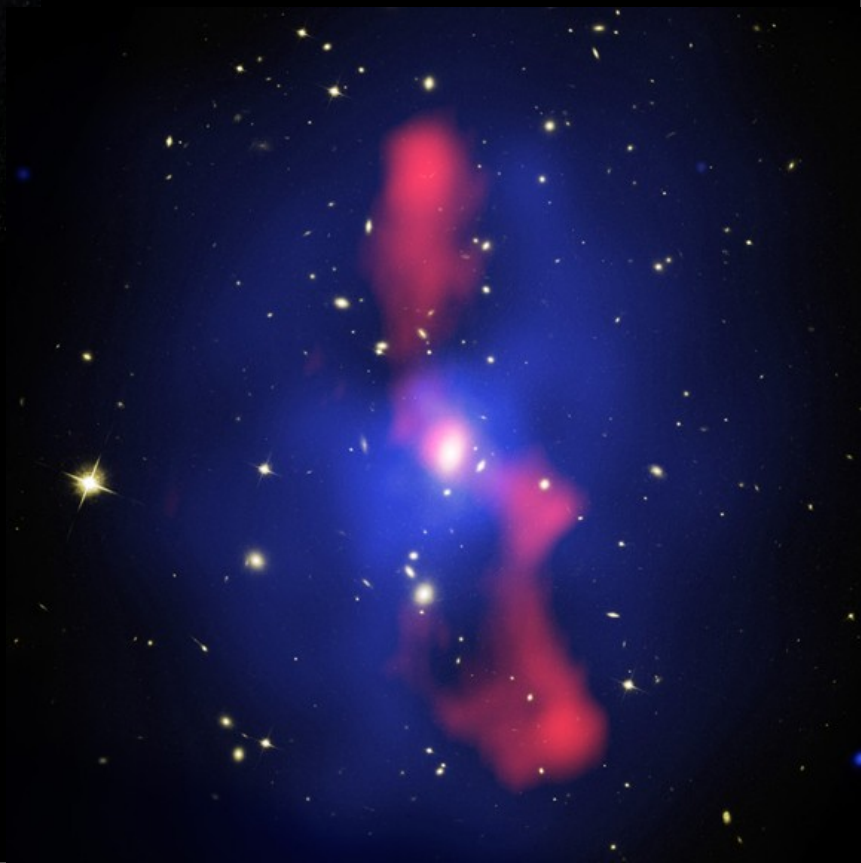


AC Fabian

Cosmic Feedback from AGN



Possible effect of central black hole on host galaxy

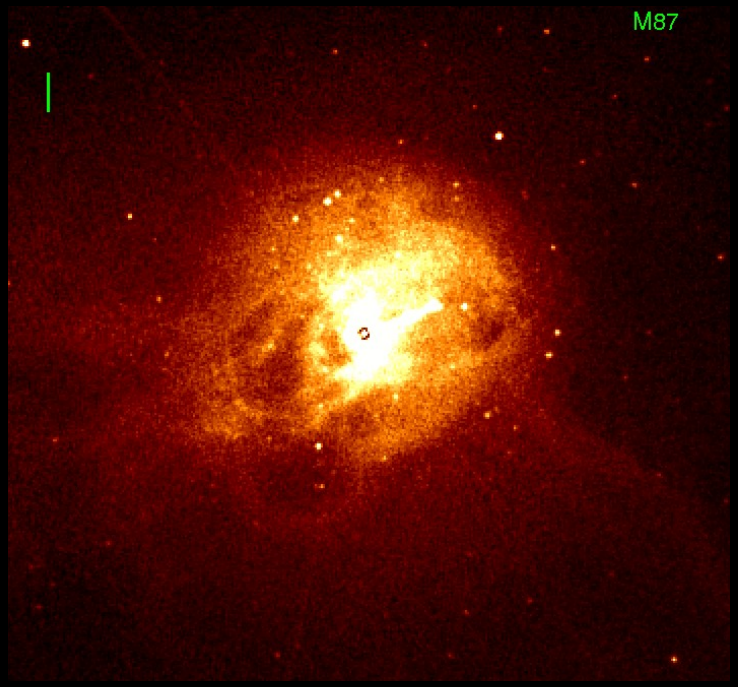
$$E_{BlackHole} > 30 \times E_{Galaxy}$$

Energy released by growth of Black Hole

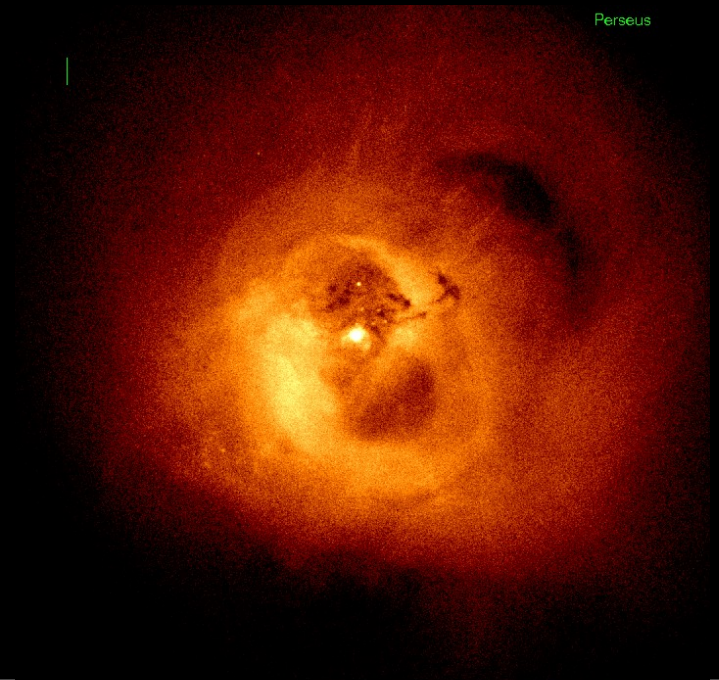
Gravitational Binding Energy of Host Galaxy

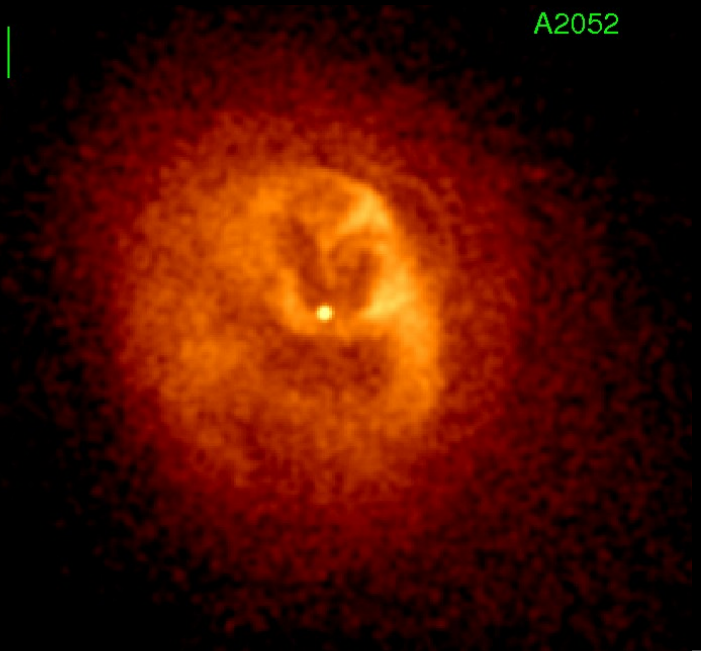
2 major modes for the interaction:

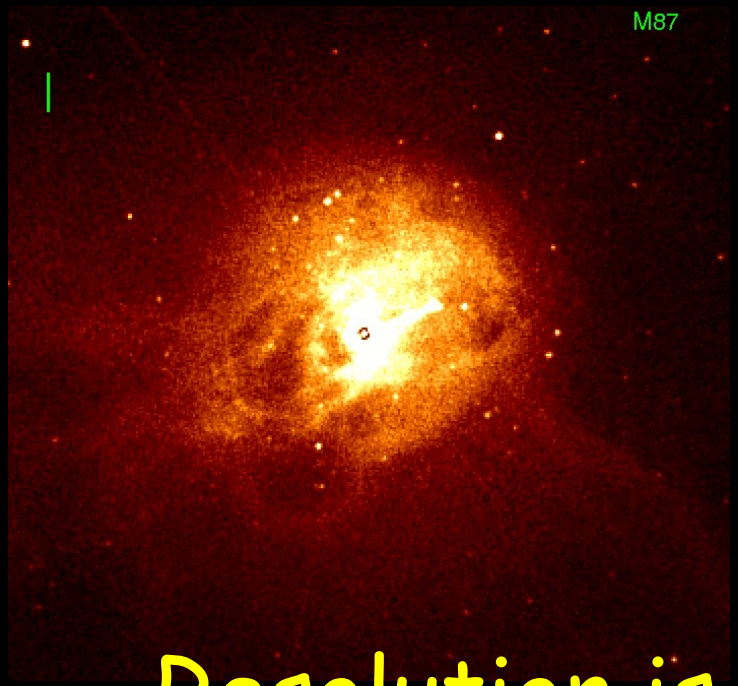
Kinetic (radio/jet) and Radiative (quasar)

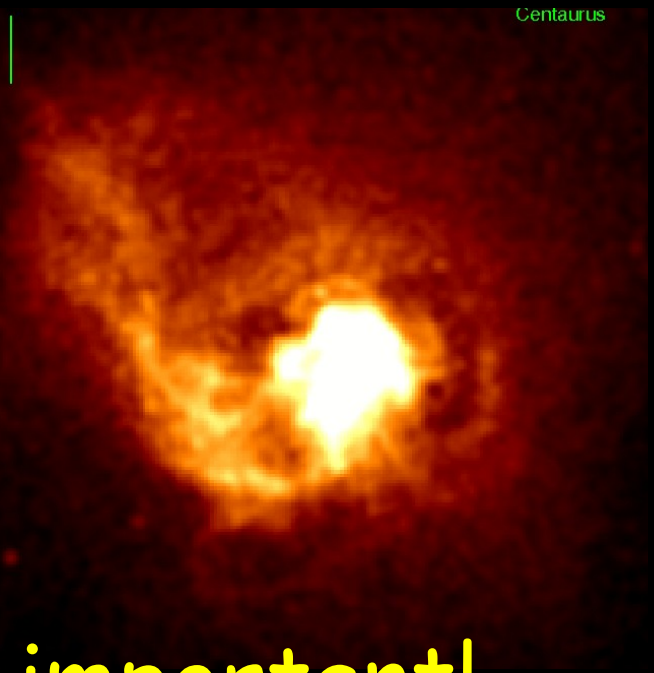

M87


Centaurus

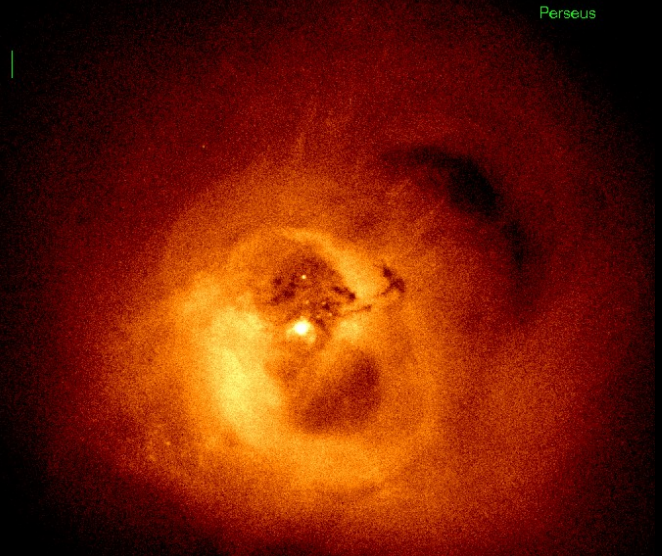

Perseus

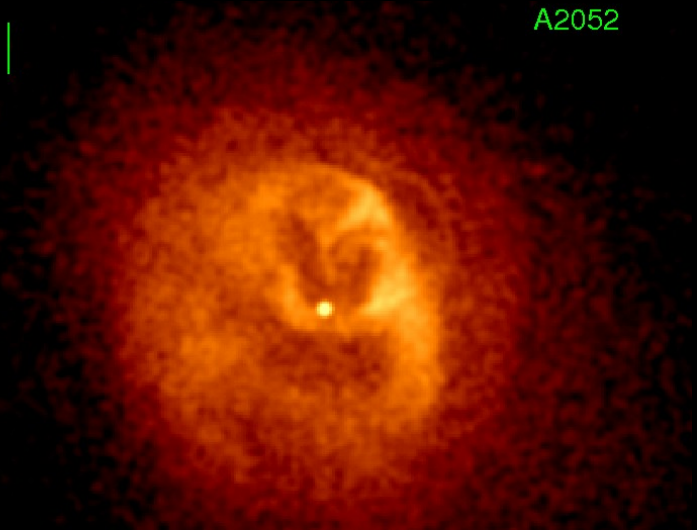

A2052





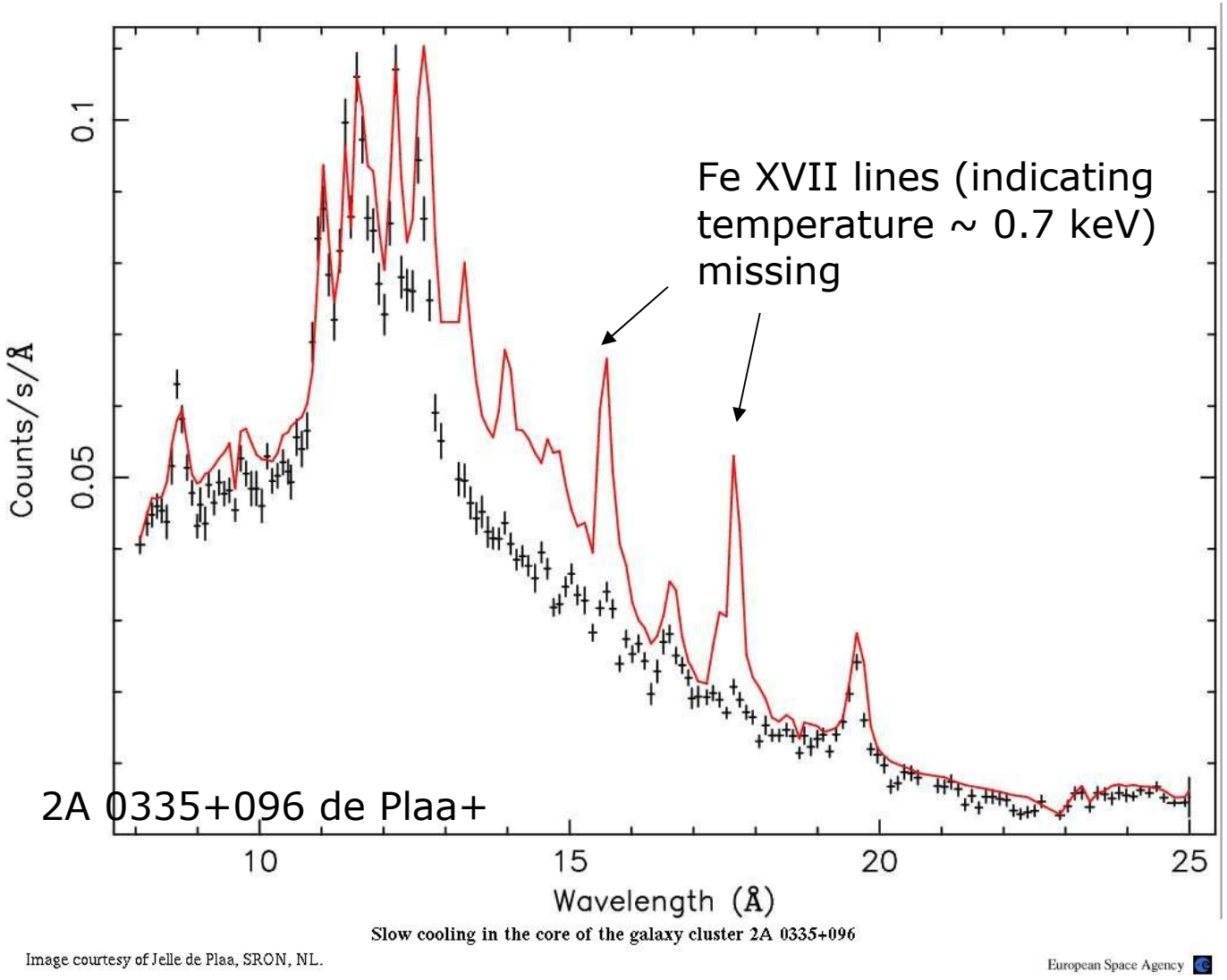
Resolution is very important!





10″ bars

Lack of cool X-ray emitting gas



Spectra imply less than 10% of cooling rates expected from luminosity profiles

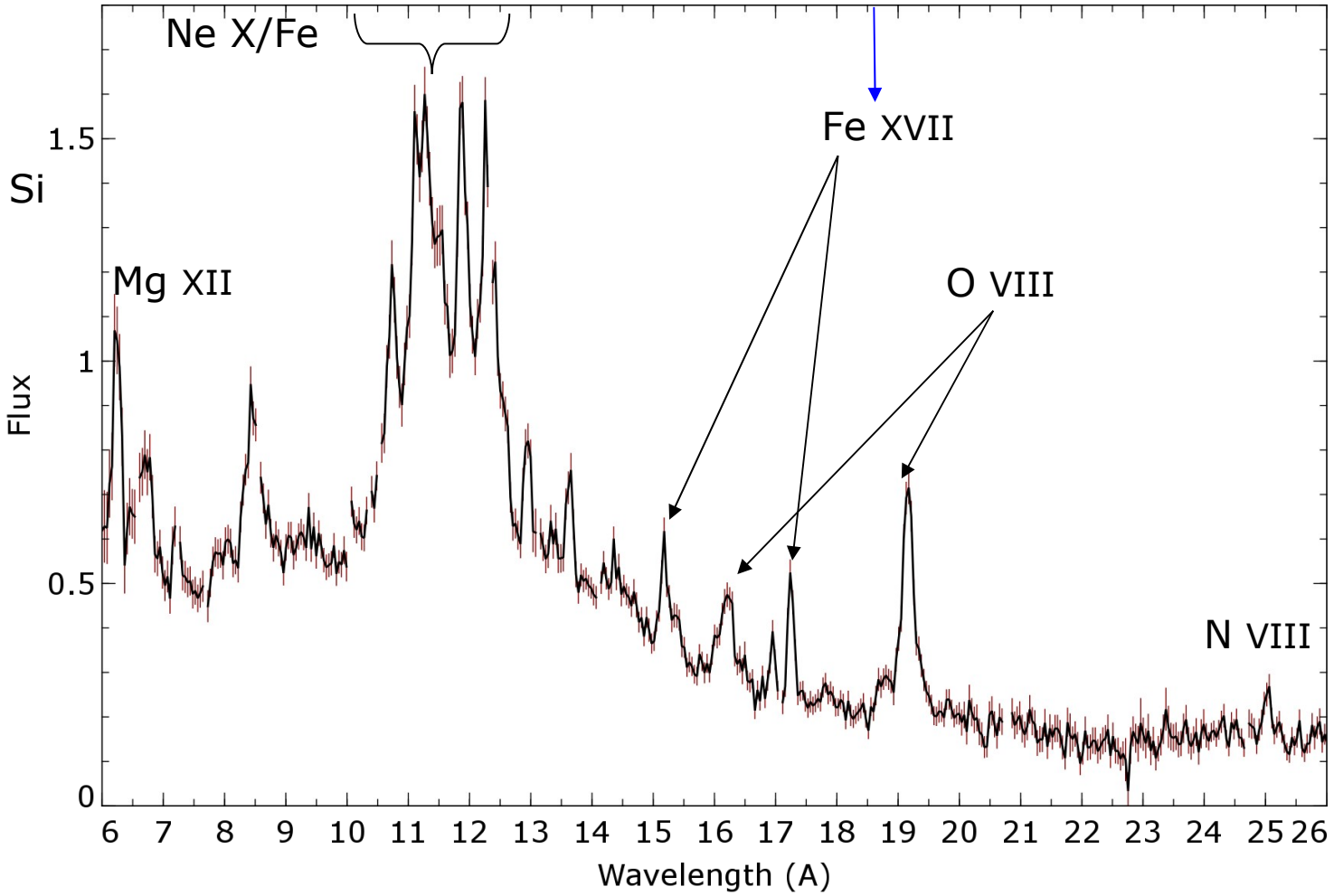
Typically temperature goes down to 1/2 to 1/3 of outer temperature

see also Peterson et al 01, 03, Kaastra et al 01, 03, Tamura et al 01,Boehringer+..

Cool gas in the Centaurus cluster

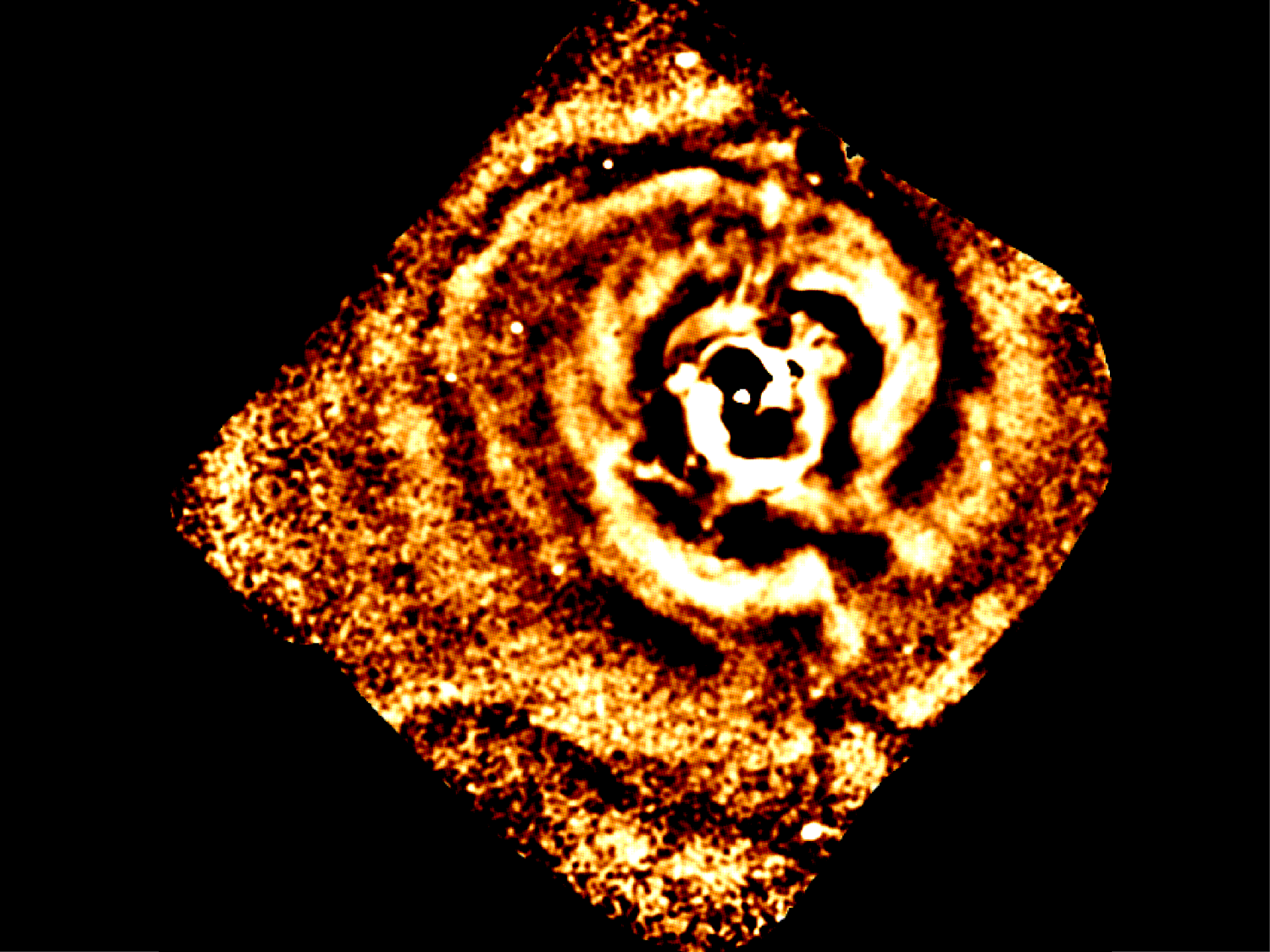
Factor 10 temp range

T-sensitive lines: indicate gas around ~0.4 keV compared to >4 keV in outer parts of cluster



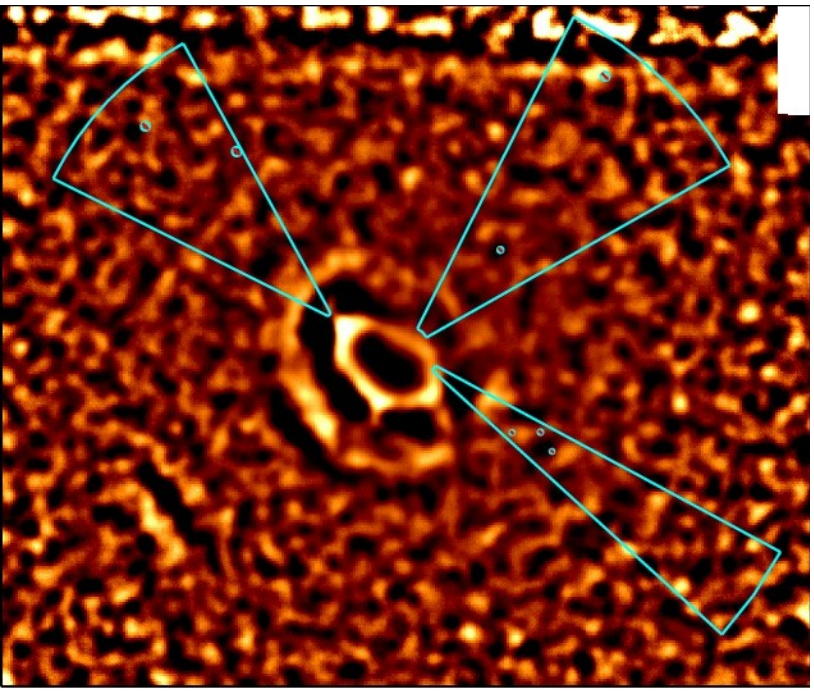
170 ks XMM-Newton RGS exposure
Sanders +07

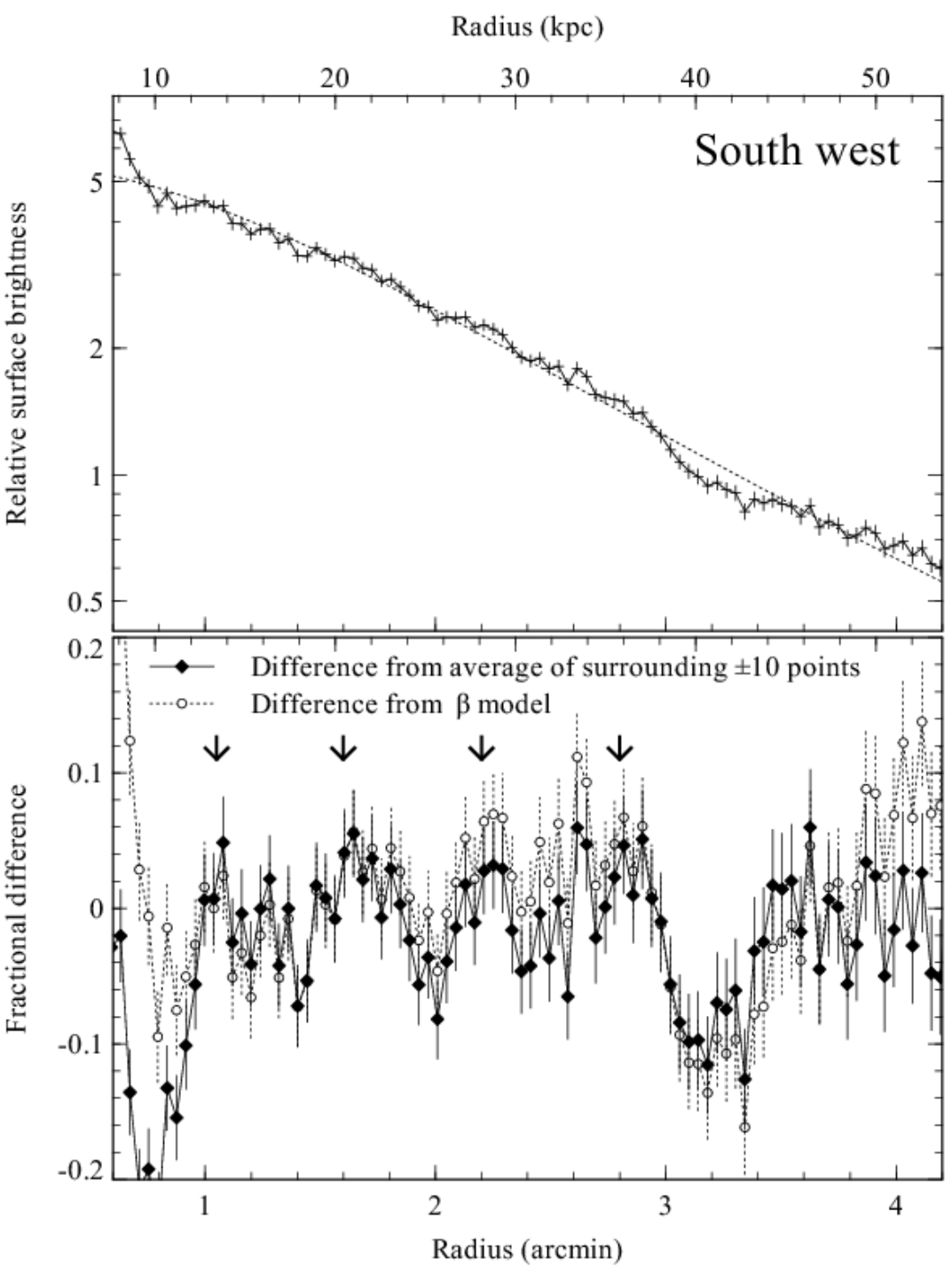
IXO will greatly improve on such spectra



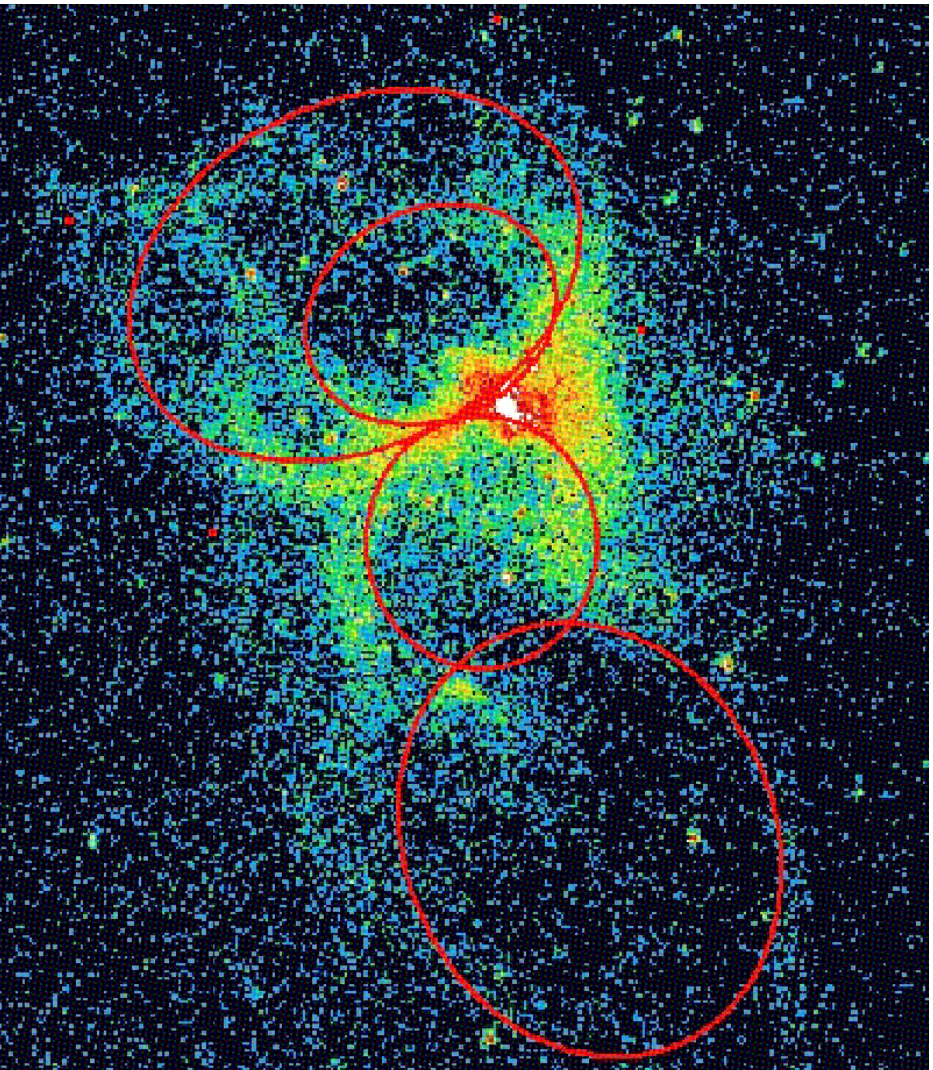
Discovery of Ripples in Centaurus Cluster

Sanders & Fabian 08



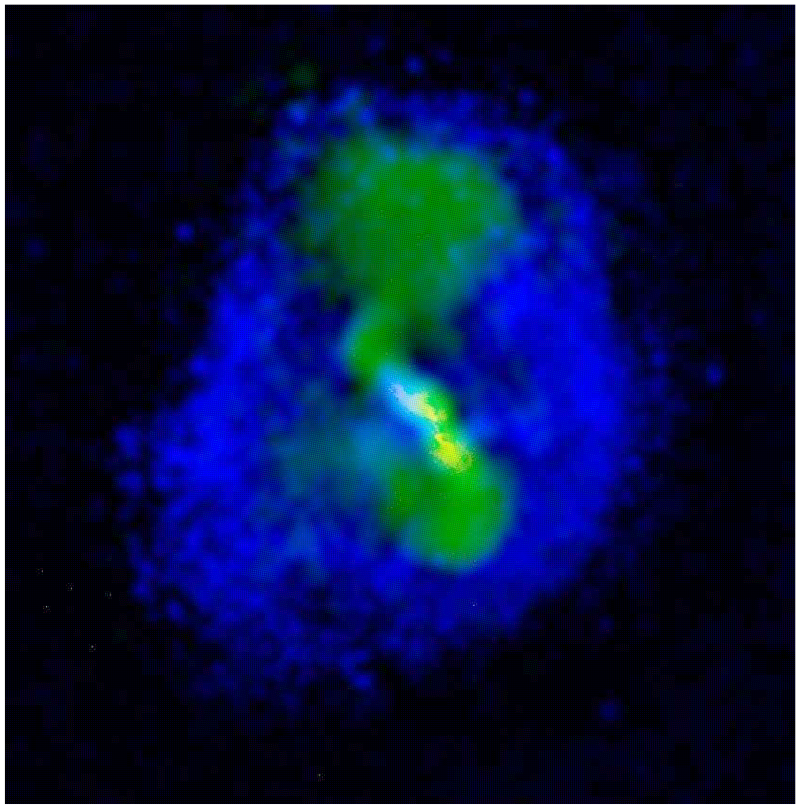


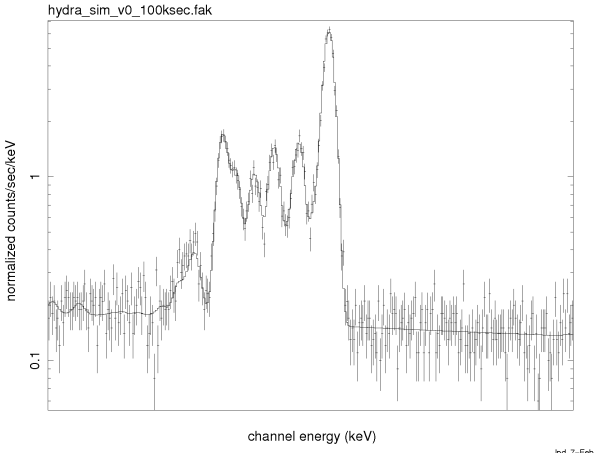
M84 Finoguenov+08

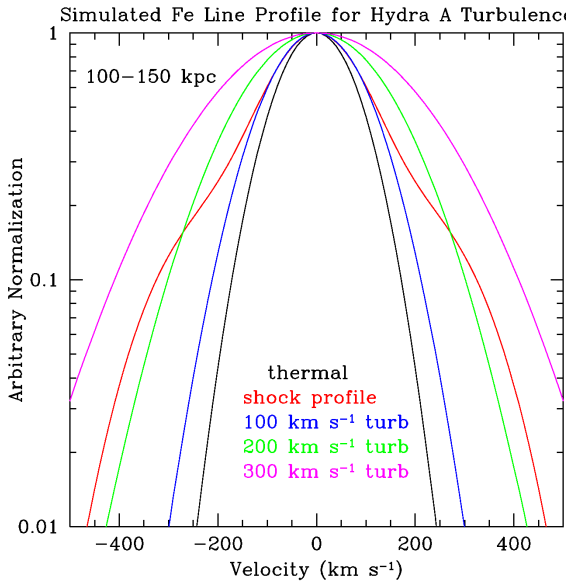


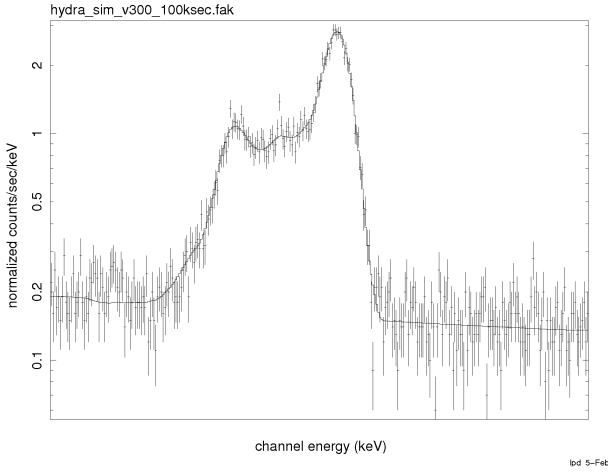
Hydra A

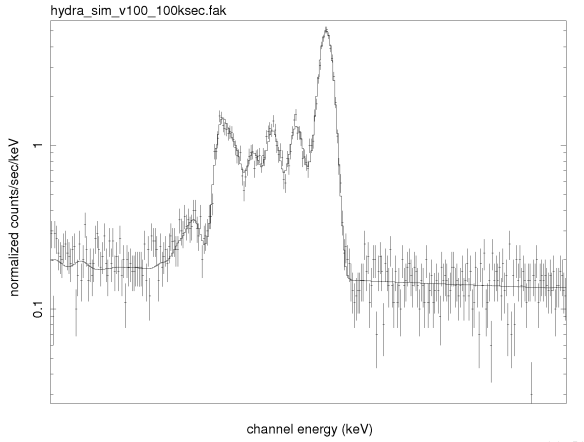
Larry David



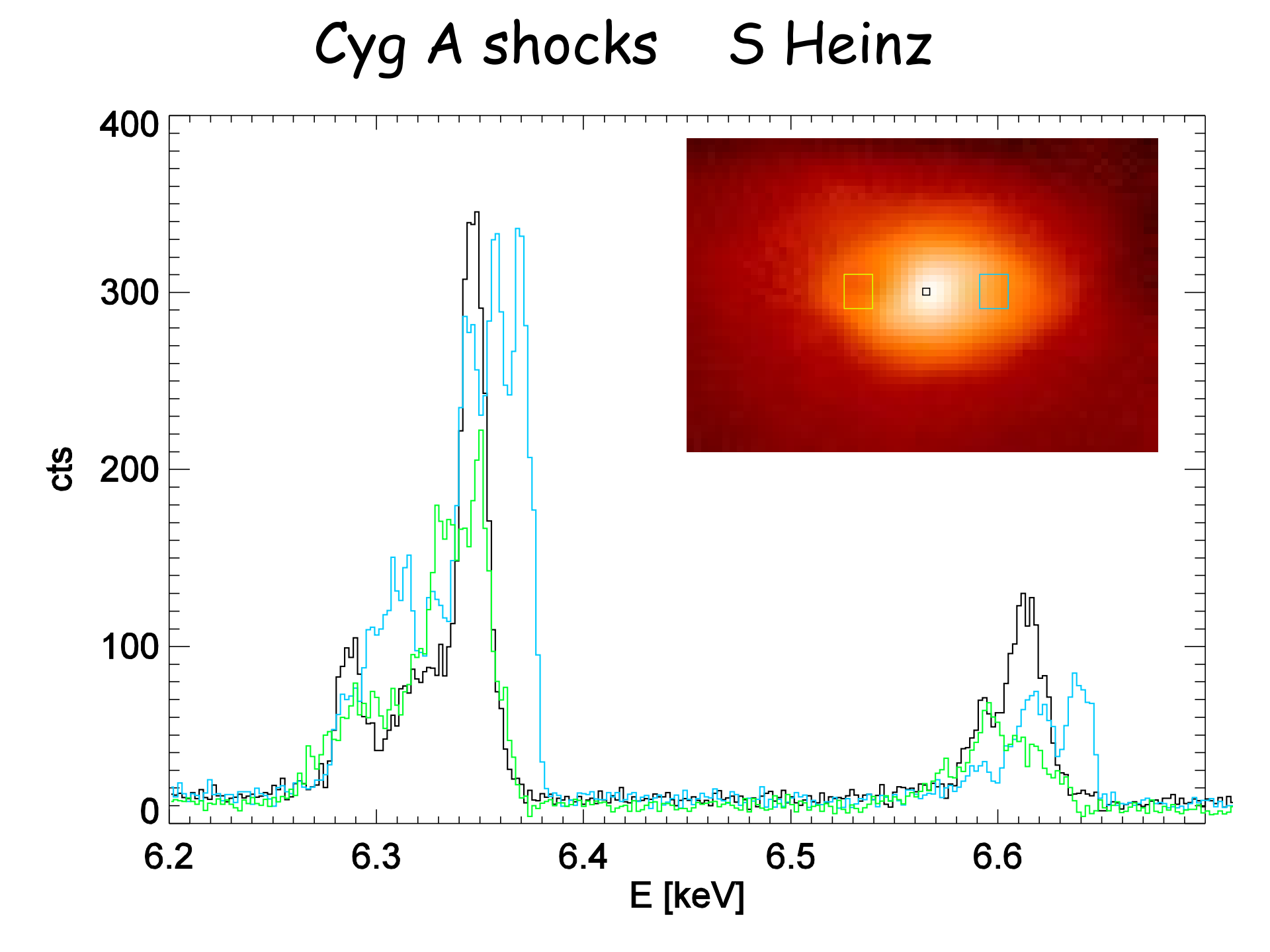




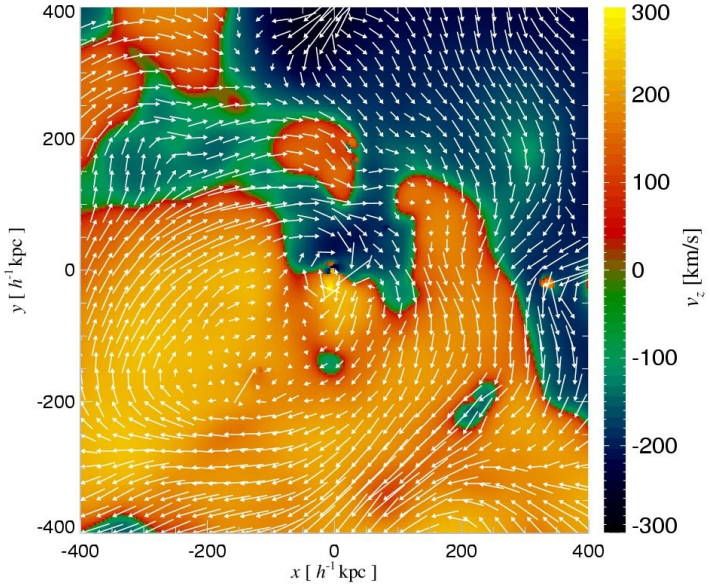


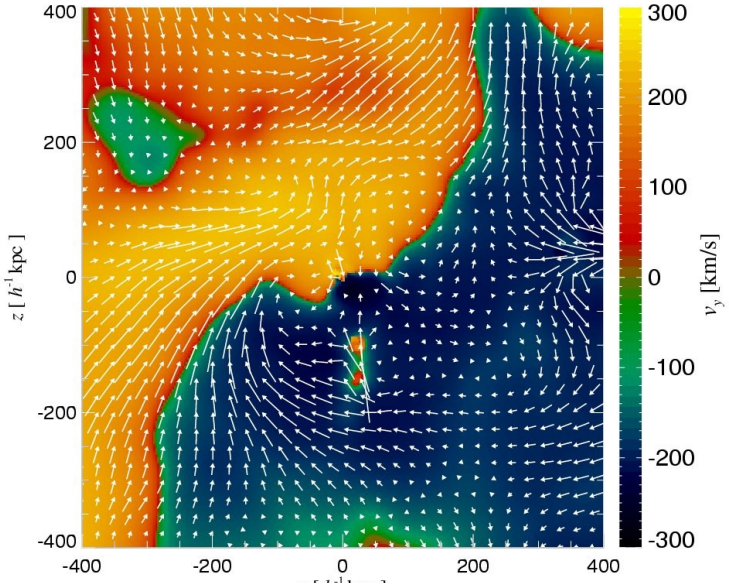


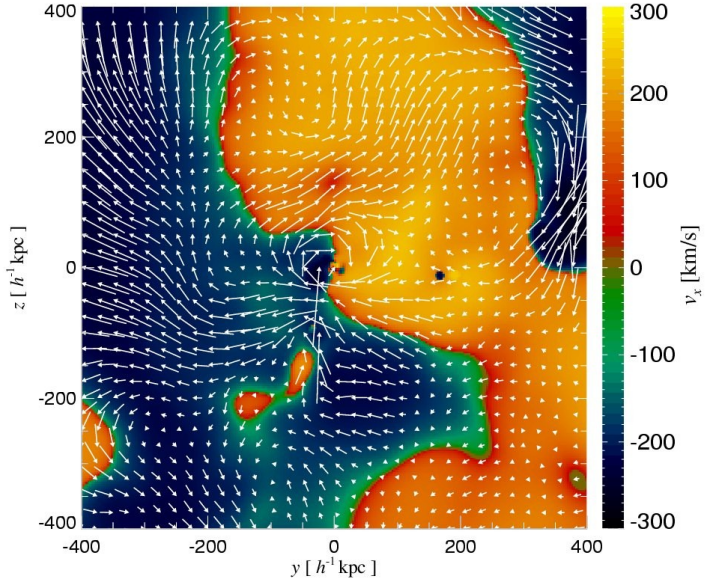
Cyg A shocks S Heinz

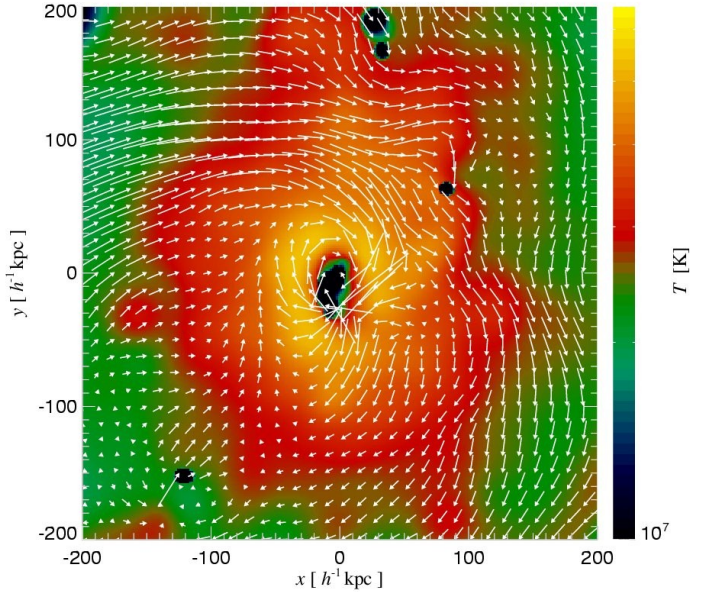


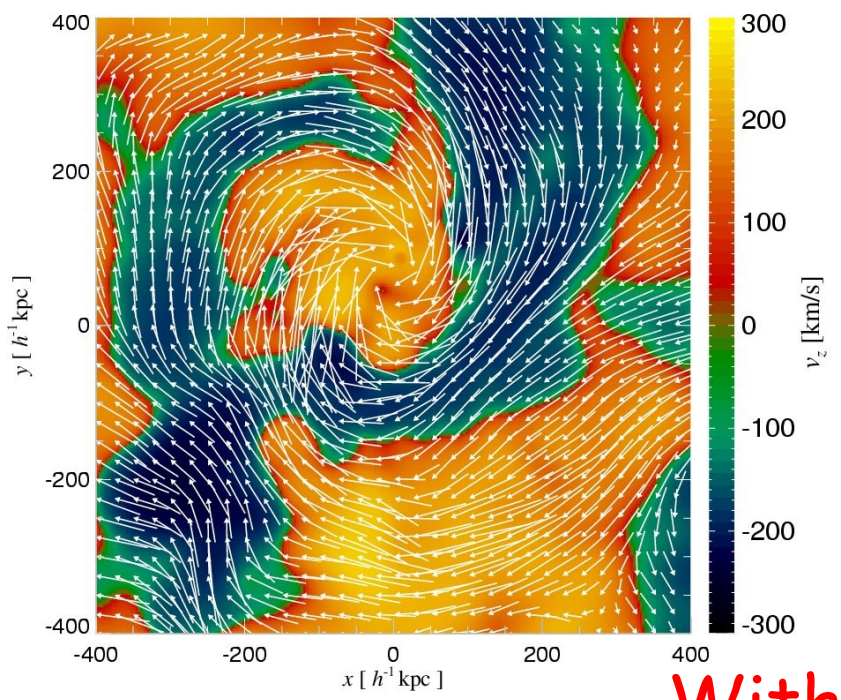
Cluster Velocity Field with No Feedback (D Sijacki)

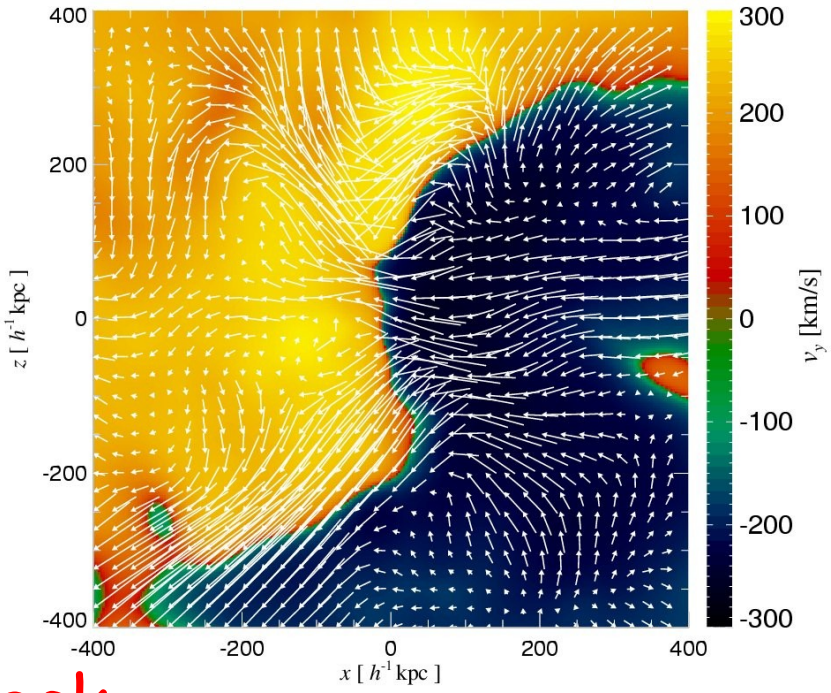




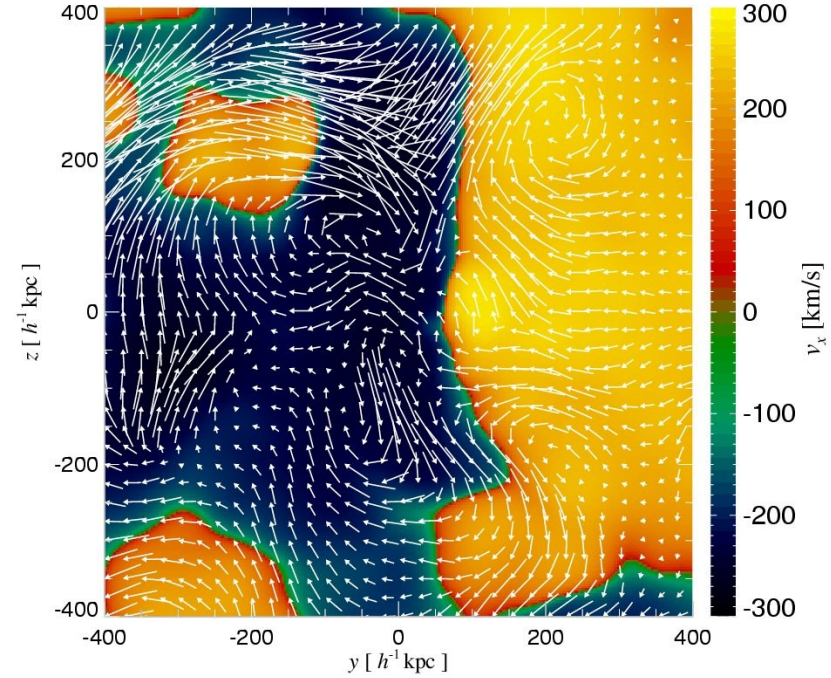


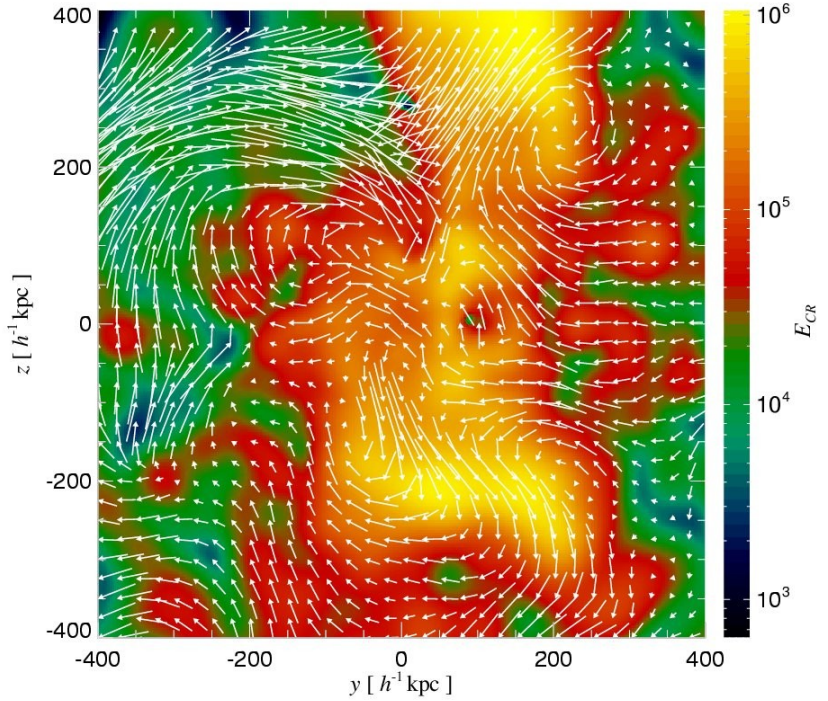




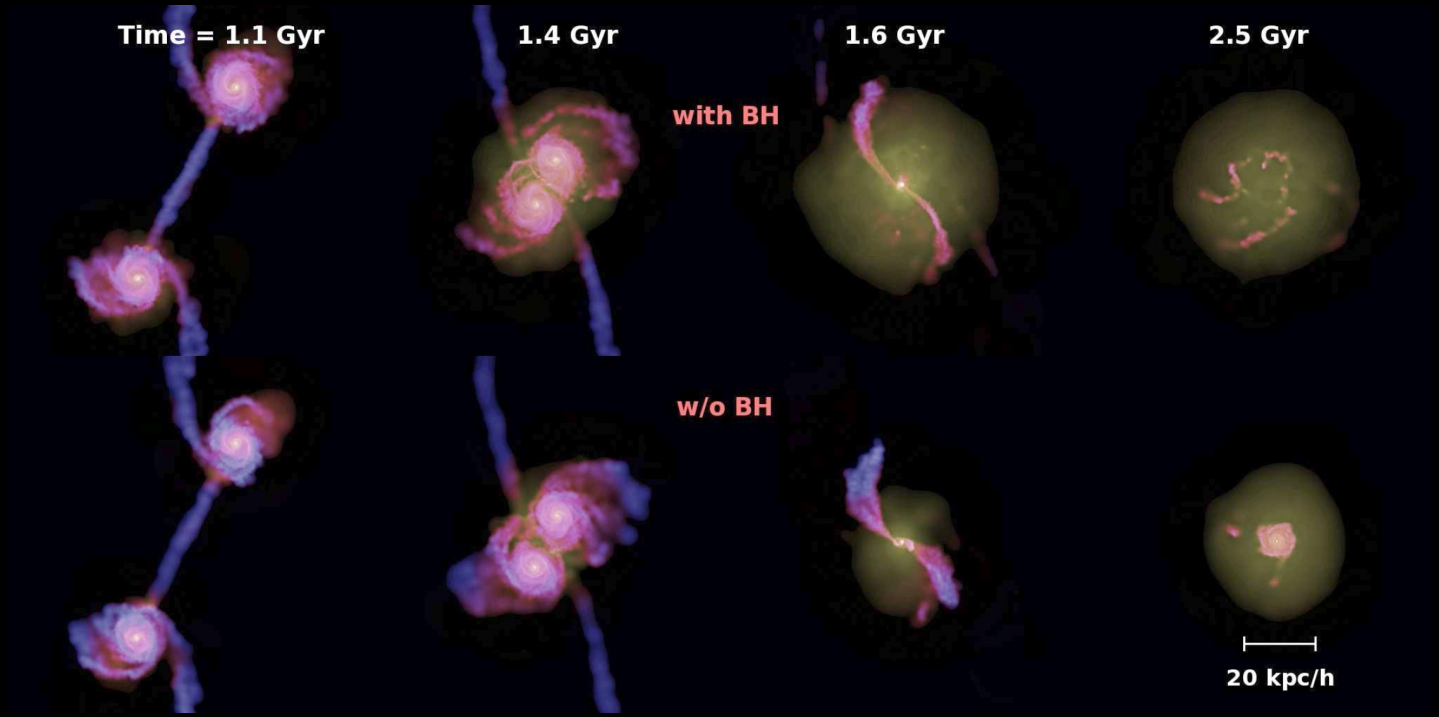


With Feedback

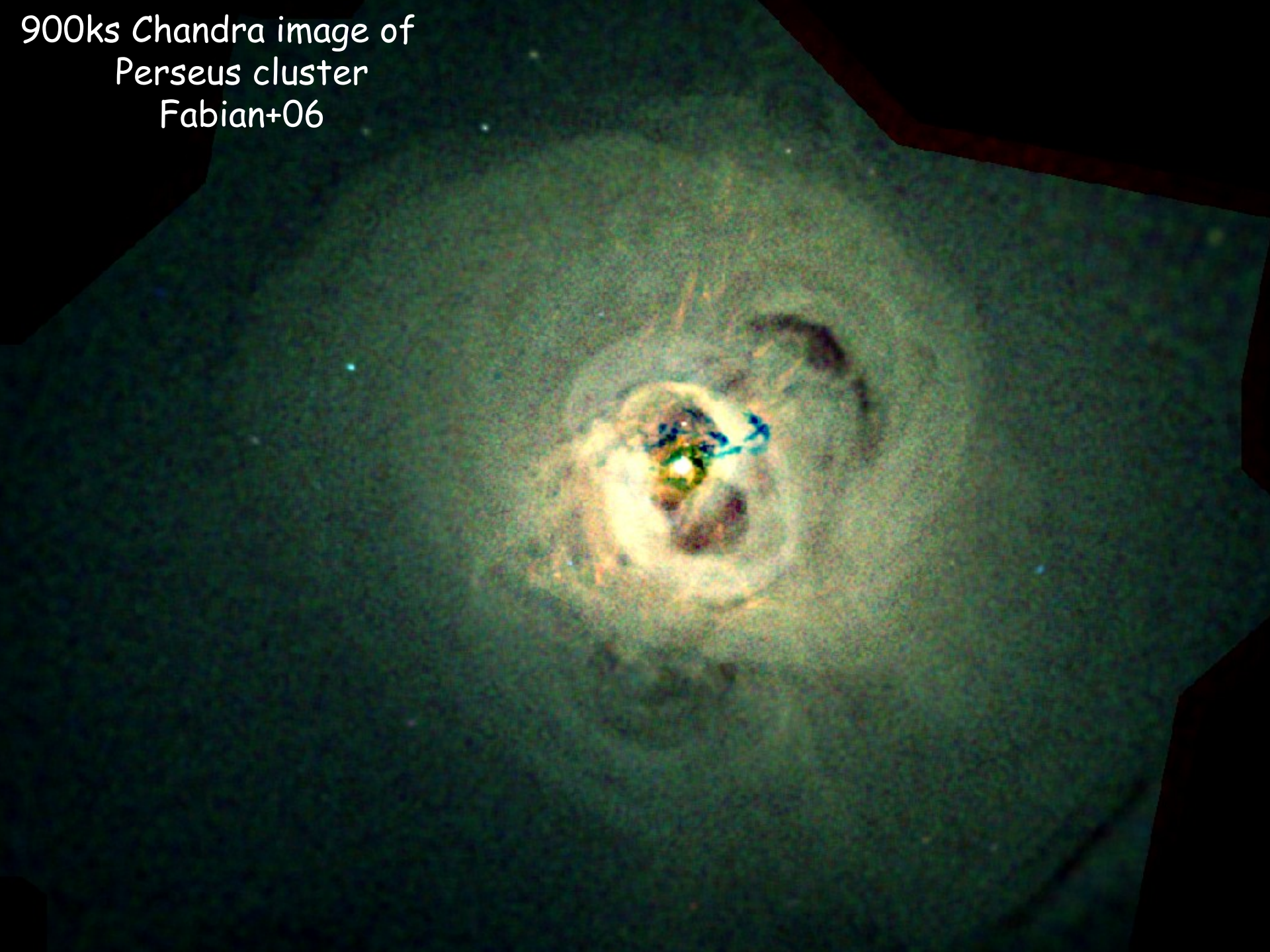


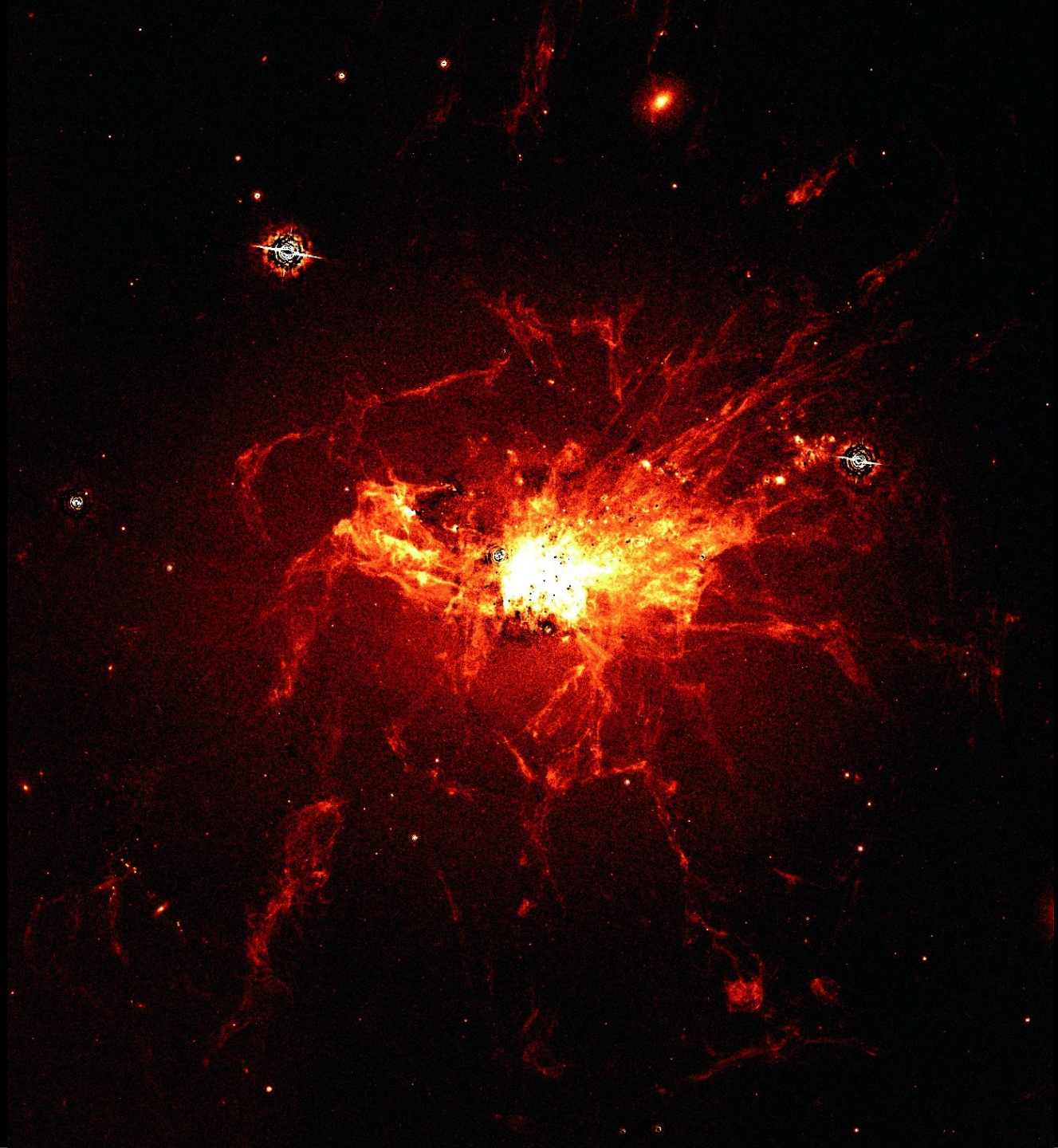


Quasar Outflows

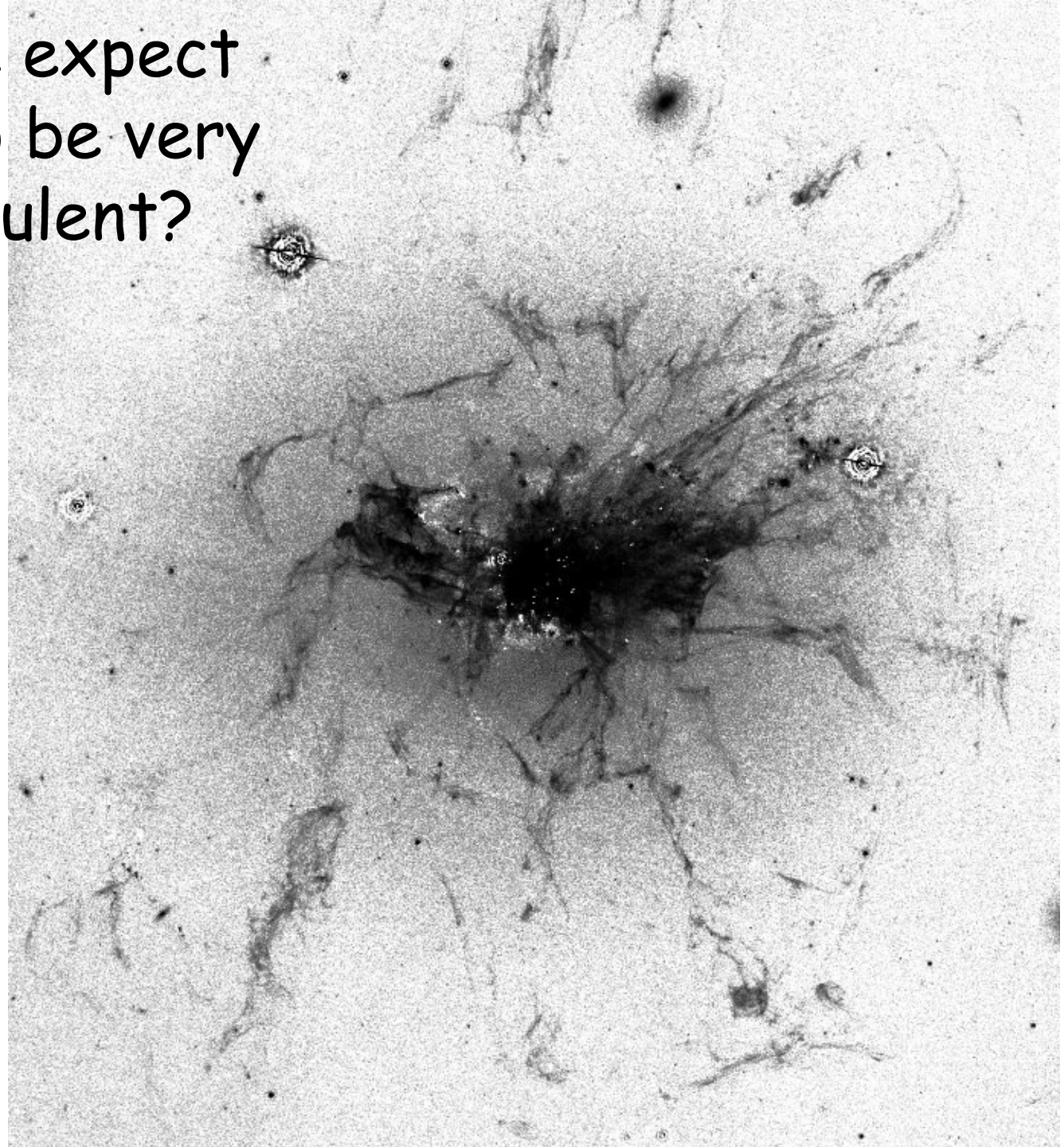


Simulations from di Matteo, Springel & Hernquist, 2005


900ks Chandra image of
Perseus cluster
Fabian+06



Do we expect this to be very turbulent?

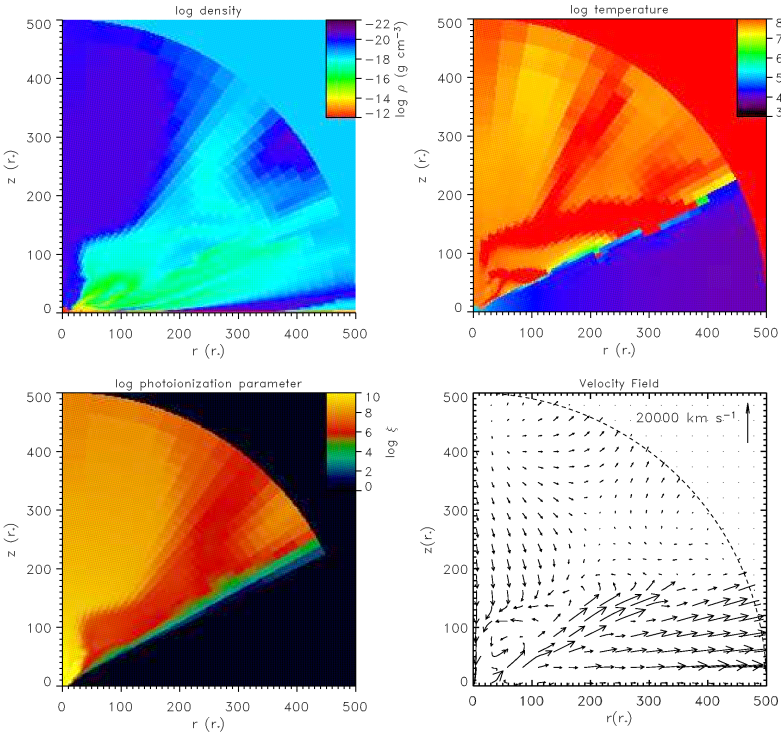


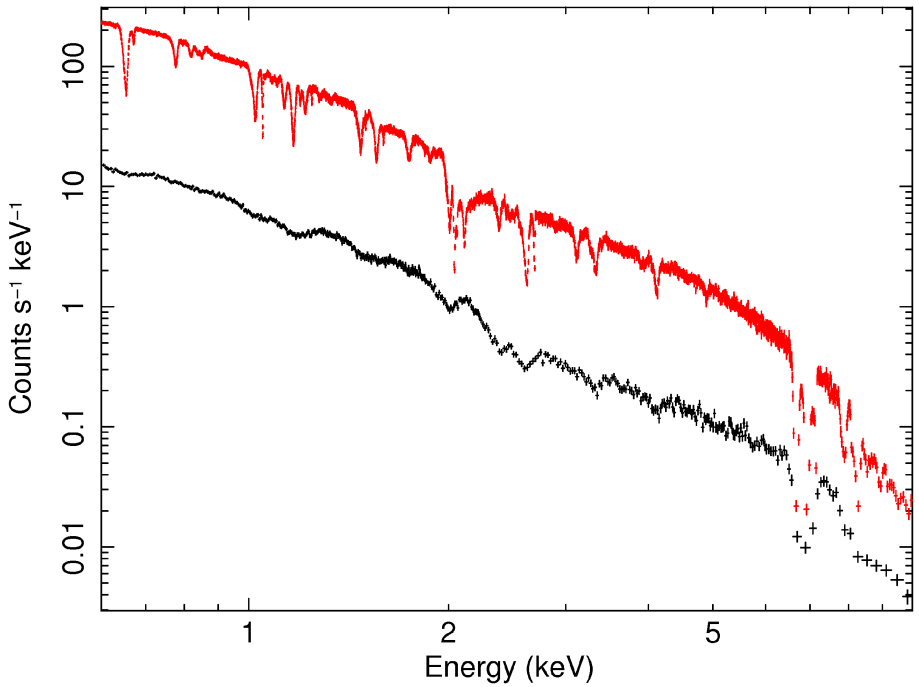

Images have
wider appeal
than spectra

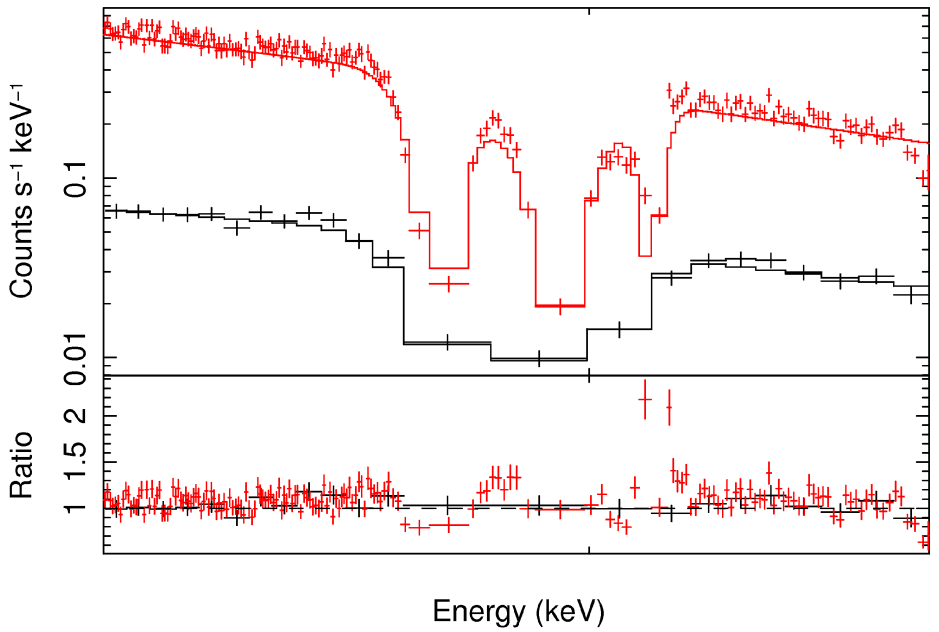
Wind Outflow

(Model by Proga & Kallman04, Spectrum by N Schurch, at 62 deg)

Con-X in red, XMM in black







AGN with reported fast outflows

			v/c	
APM 08279+5255	BALQSO	3.91	0.2 and 0.4	(Chartas et al. ApJ, 2002, ApJ, 579, 169)
H 1413+117	BALQSO	2.56	0.23 and 0.67	(Chartas et al. ApJ, 2007, 661, 678)
•PG 1115+080	BALQSO	1.72	0.1 and 0.4	(Chartas et al. ApJ, 2003, 595, 85)
PDS 456	RQ QSO	0.184	0.15	(Reeves et al. ApJ, 2003, 593, 65)
PG 1211+143	NLS1	0.081	0.13	(Pounds et al. MNRAS, 2003, 345, 705) (1) (2)
PG 0844+349	Sey 1	0.064	0.2	(Pounds et al. MNRAS, 2003, 346, 1025) (3)
Mrk 509	Sey 1	0.034	0.1-0.2	(Dadina et al. A&A, 2005, 442, 461)
IRAS13197-1627	Sey 1.8	0.0165	0.11	(Dadina and Cappi, A&A, 2004, 413, 921)
IC 4329a	Sey 1	0.016	0.1	(Markowitz et al. 2006, ApJ, 646, 783)
MCG-5-23-16	Sey 1.9	0.0085	0.1	(Braito et al. 2006, AN, 327, 1067)
MCG-6-30-15	Sey 1.2	0.0077	0.007	(Young et al. 2005, ApJ, 631, 73)
NGC 1365	Sey 1.8	0.0055	0.017	(Risaliti et al. 2005, ApJ, 630, 129)

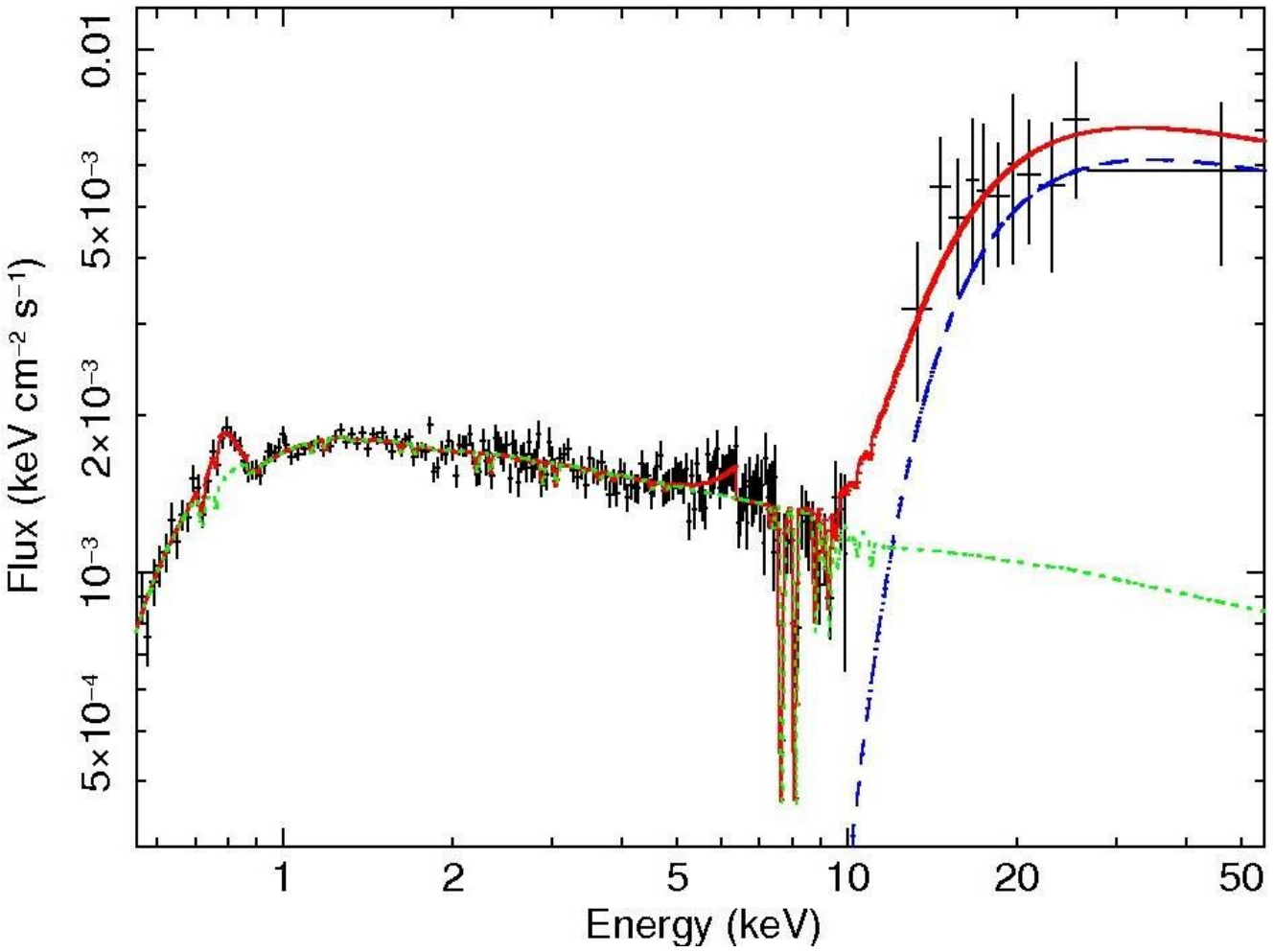
(1) Disputed by Kaspi et al., who claim the outflow may arise from a lower velocity, depending on the specific identification of lines in the spectrum.

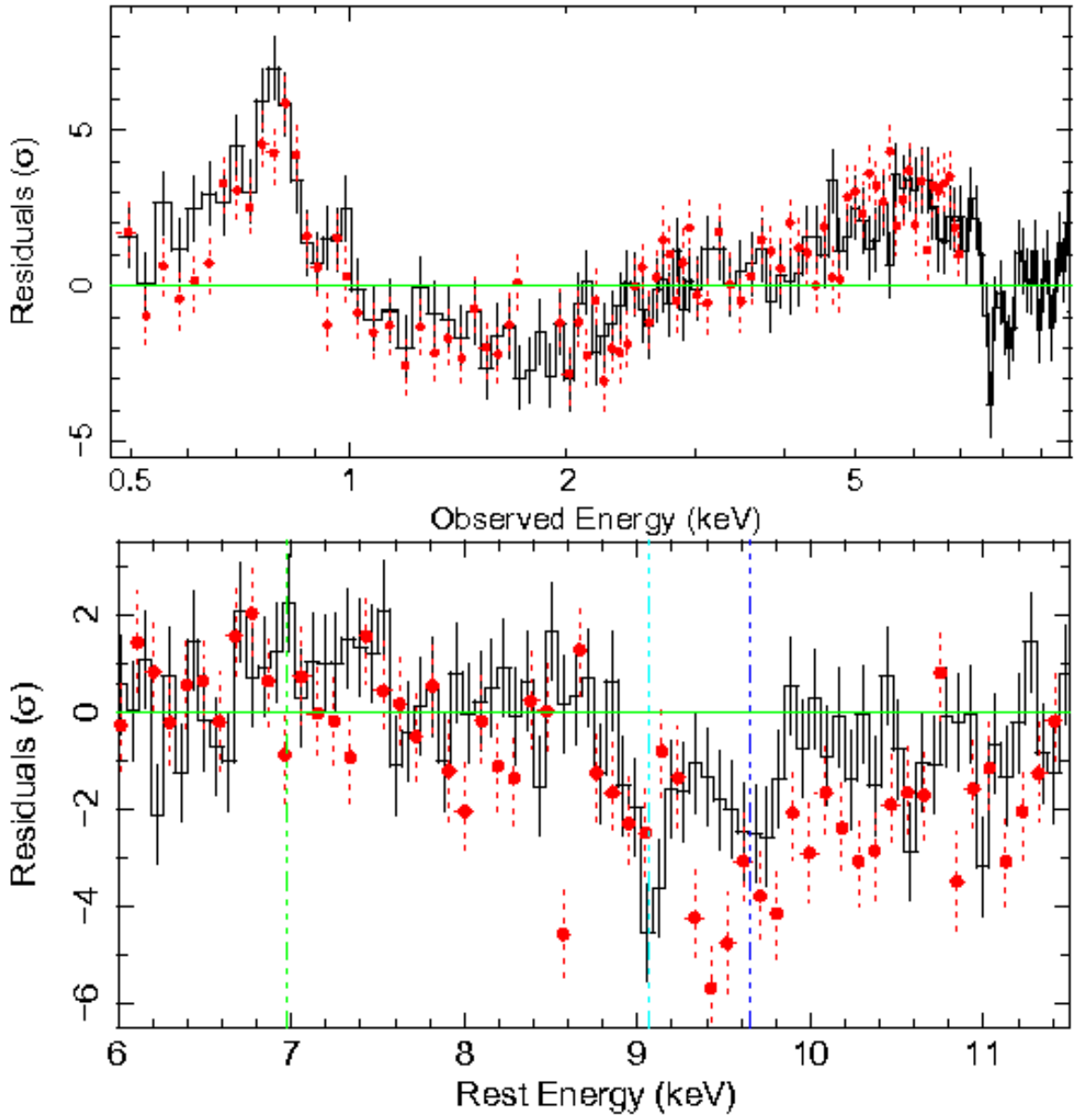
(2) Pounds & Page 2006 (astro-ph0607099) confirm the high velocity outflow in PG 1211+143.
Reeves et al 2008 (astro-ph08011578) use a variability argument to show that the iron K shell absorption in PG 1211+143 is not due absorption from local IGM gas but is most likely associated with a fast outflow.

(3) Disputed on the basis of background subtraction in the EPIC/PN spectrum (Brinkman et al. 2005)

Likely that ALL AGN have outflows but influence at present unclear

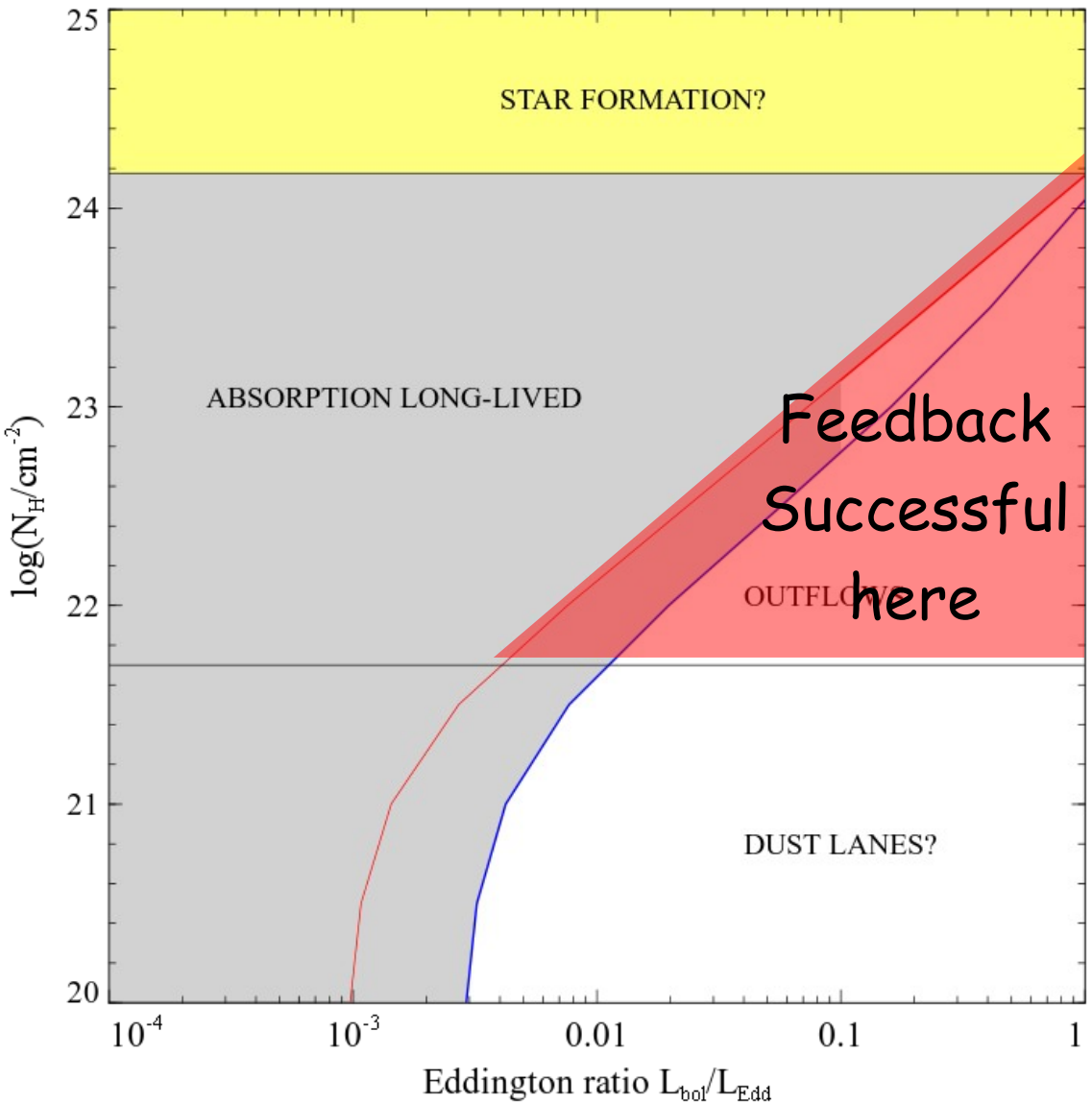
PDS456 (Suzaku: J Reeves+)





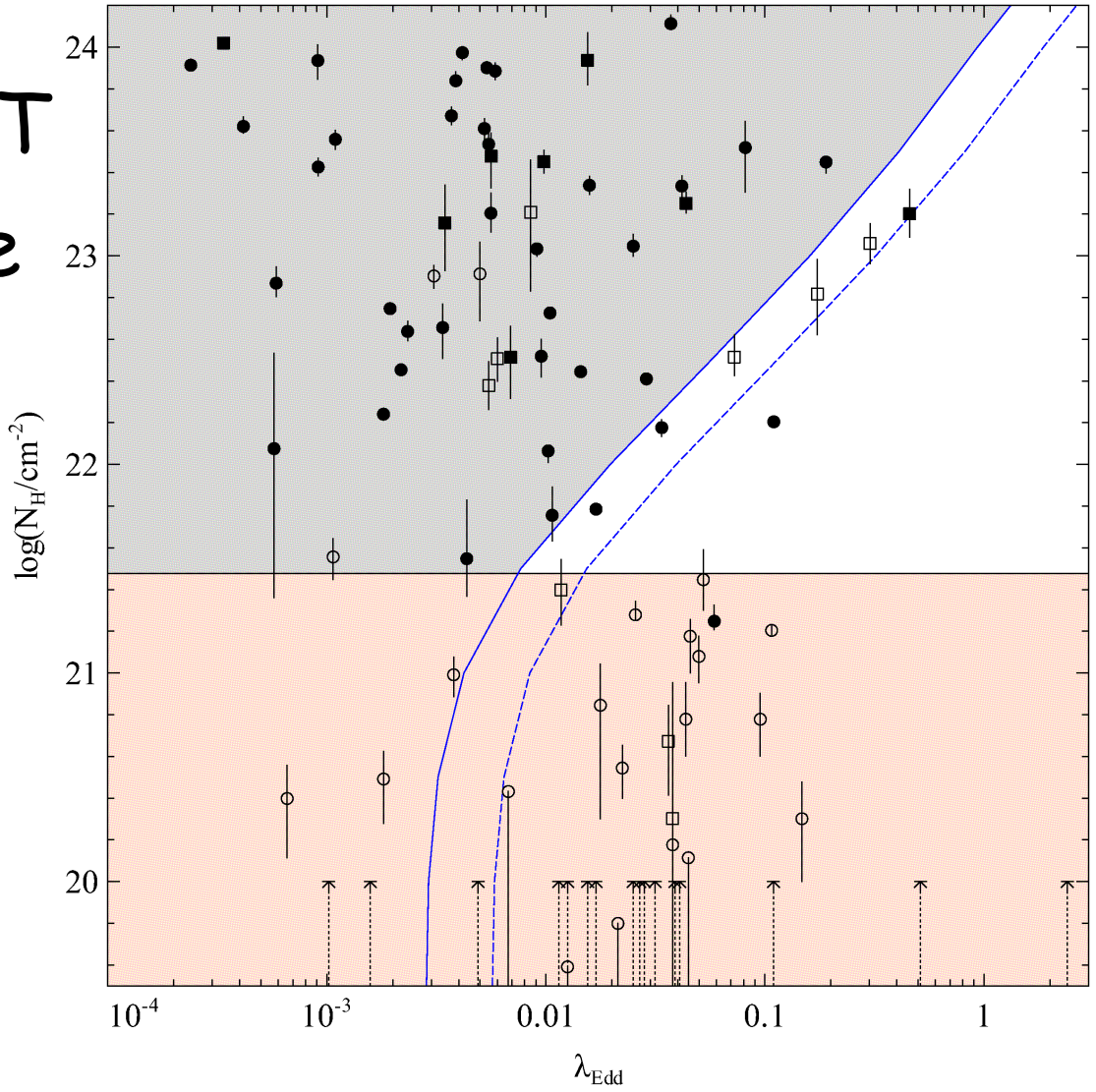
XMM 2001
in red

Effect of radiation pressure on dusty gas



Fabian, Vasudevan, Mushotzky, Winter, Reynolds

Swift-BAT catalogue



KEY QUESTIONS

1) Understanding the energy flow in cool cores of clusters, groups and ellipticals:

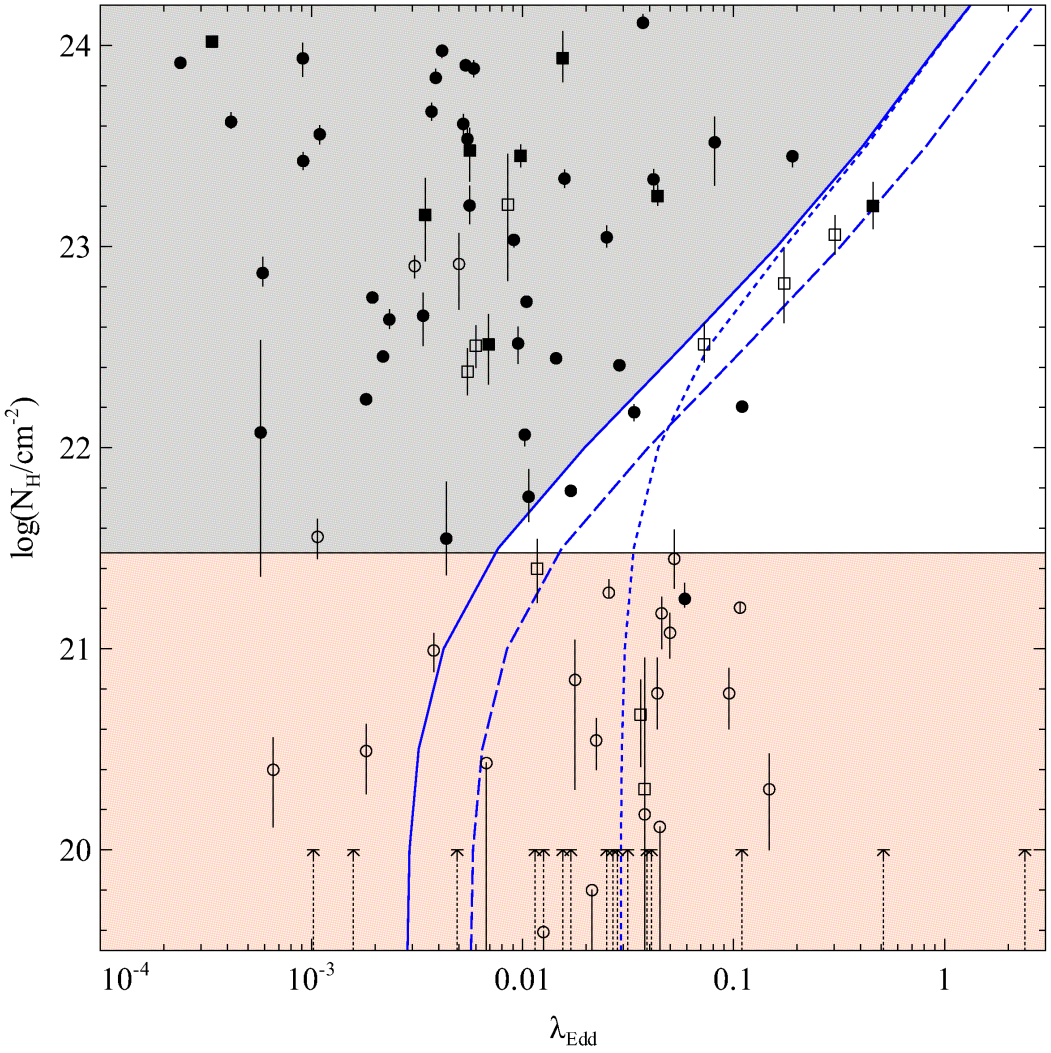
(Velocity field, bulk motions, shocks, turbulence...)

2) Understanding the energy and mass flow of AGN outflows:

(Mass and energy components, velocity structure, variability, ionization structure...)

X-rays are most direct probe of crucial volume-filling component

Grains = 0.1



- X-ray absorption lines can be used to constrain the properties of quasar outflows (N_H, n_e, ξ , v, f_c, n_e, $Mdot$, ε_k)

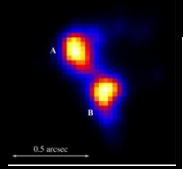
- Mass outflow rates in APM08279 (~5 M_s/y) and PG 1115 (~5 M_s/y) is found comparable to their accretion rates.

- Fraction of bolometric energy released in the form of kinetic energy

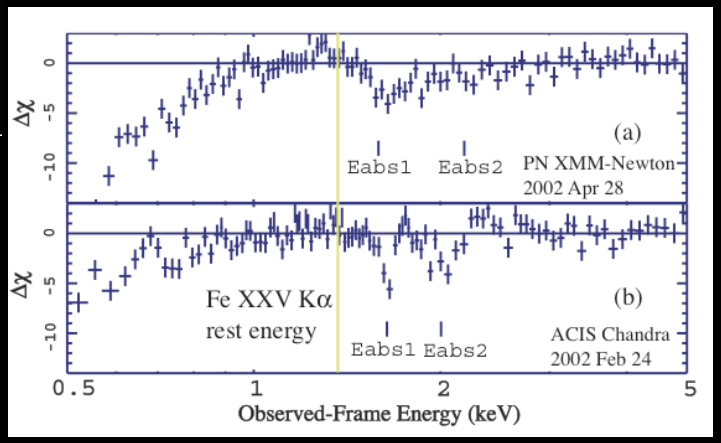
  ε_K ~0.09 (-0.05,+0.07), APM 08279+5255

  ε_k ~ 0.64 (-0.40,+0.52), PG1115+080

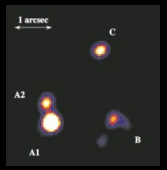
Quasar Outflows: Observations



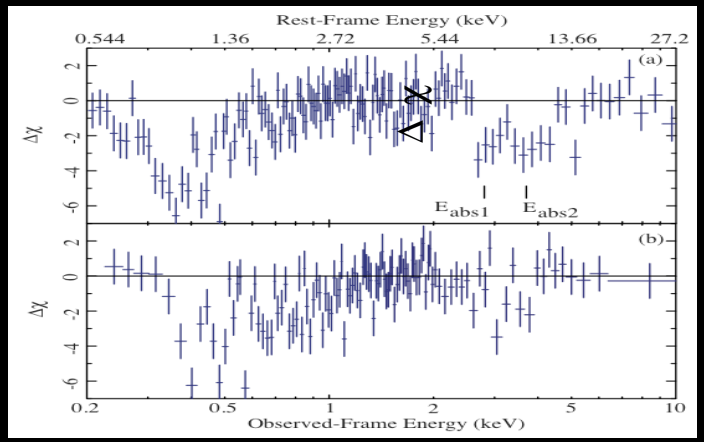
$z = 3.91$



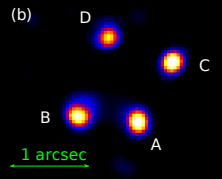
APM 08279+5255 (Chartas et al. 2002)



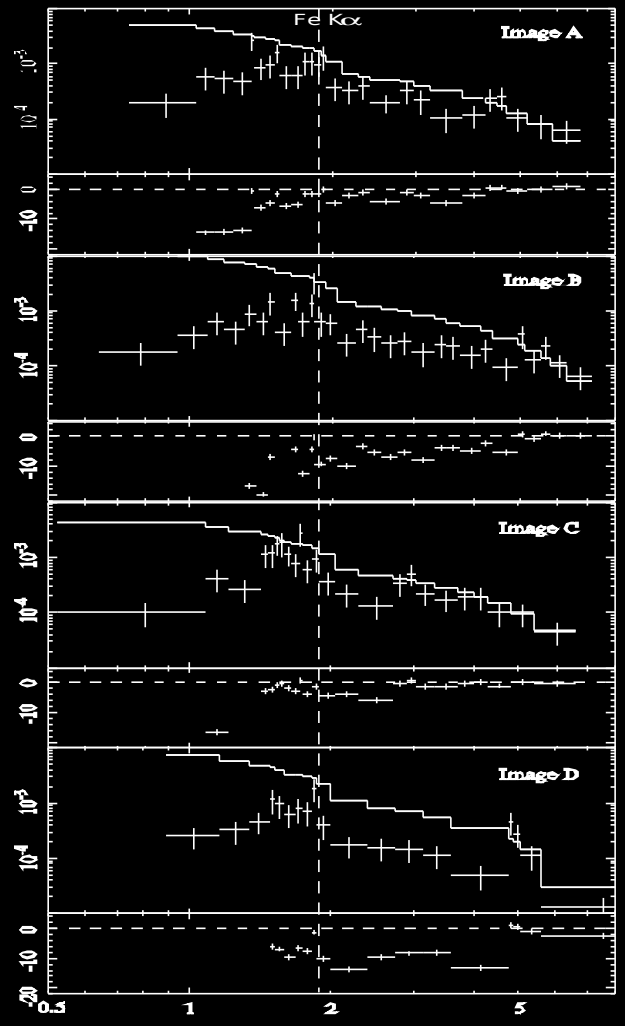
$z = 1.72$



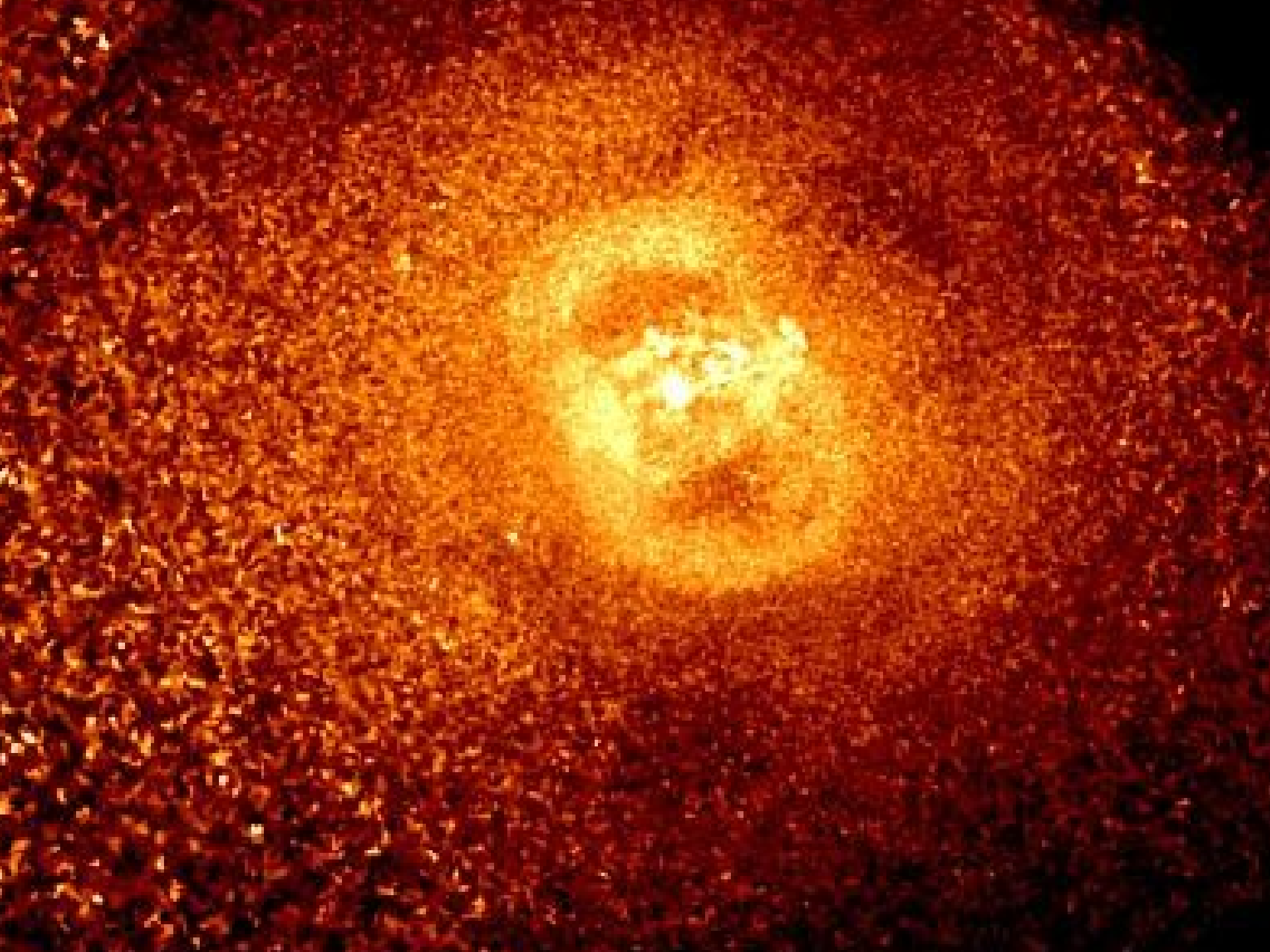
PG 1115+080 (Chartas et al. 2003)



$z = 2.56$



H 1413+117 (Chartas et al. 2007)



0.75c so flow within 25deg of l.o.s. (George Chartas)