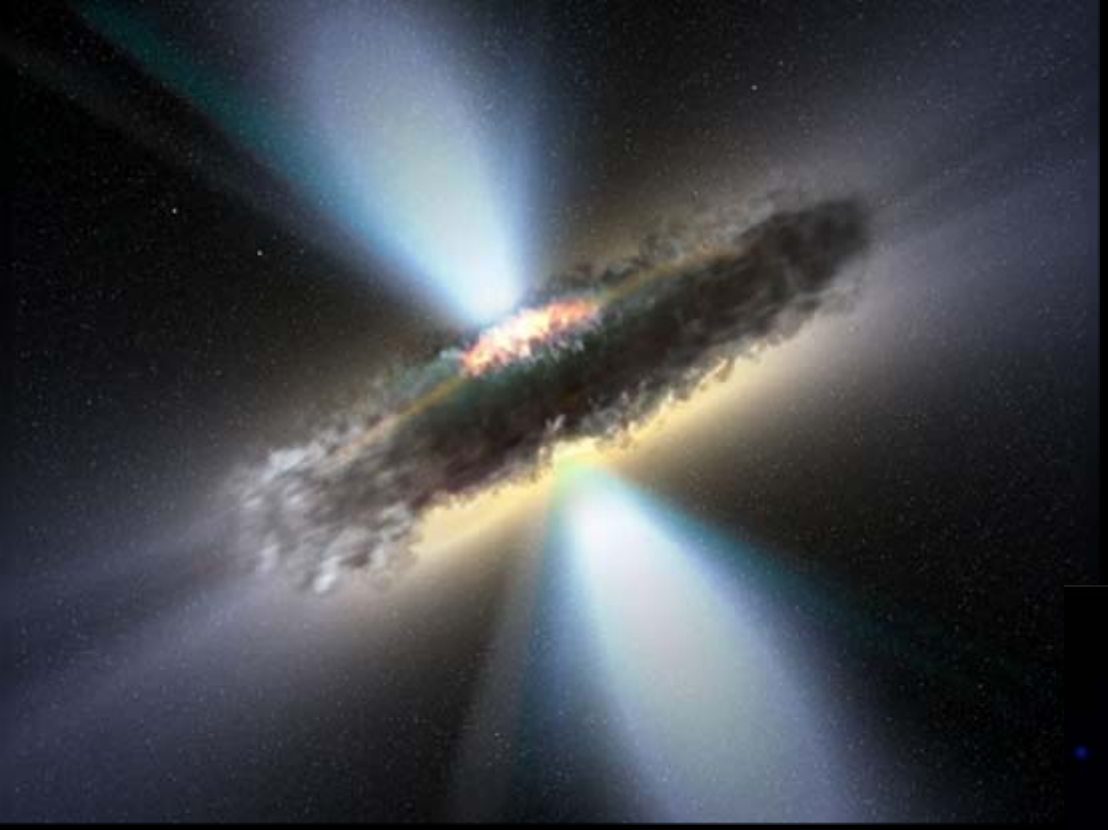
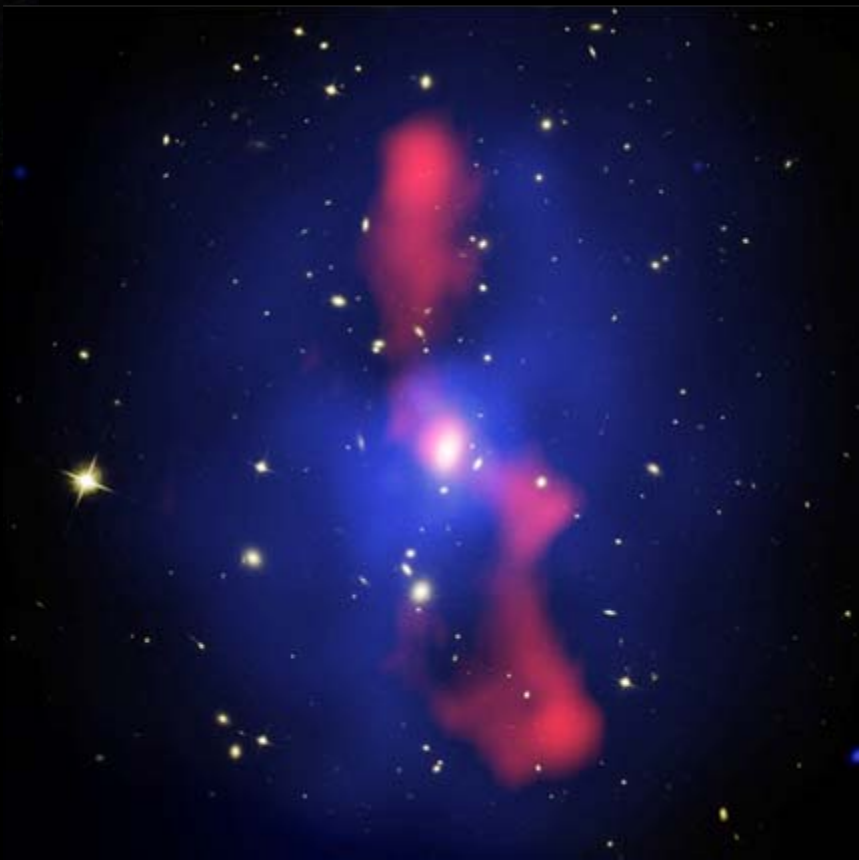


AC Fabian, G Chartas, L David
S Gallagher, S Heinz, B McNamara
E Perlman, D Proga, P Ogle,
G Richards, D Worrall

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)

KEY QUESTIONS

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

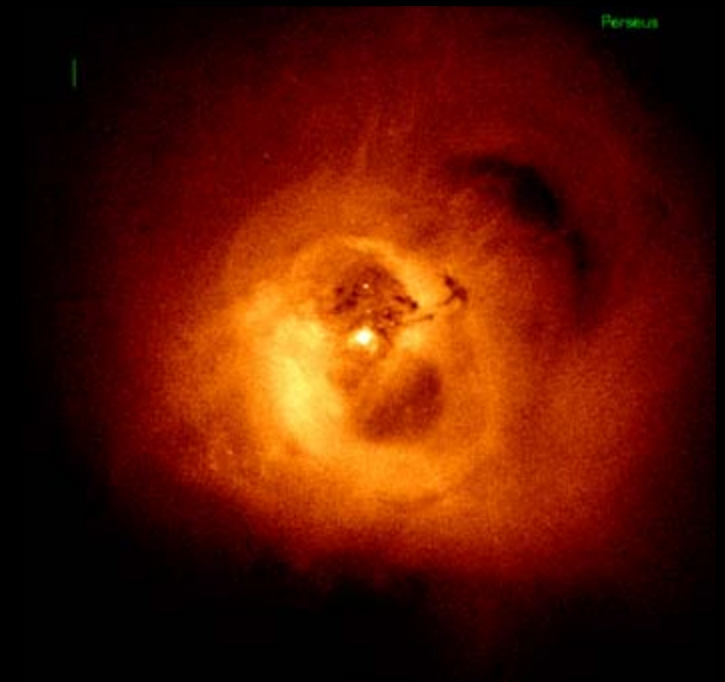
(Velocity field, bulk motions, shocks, turbulence...)

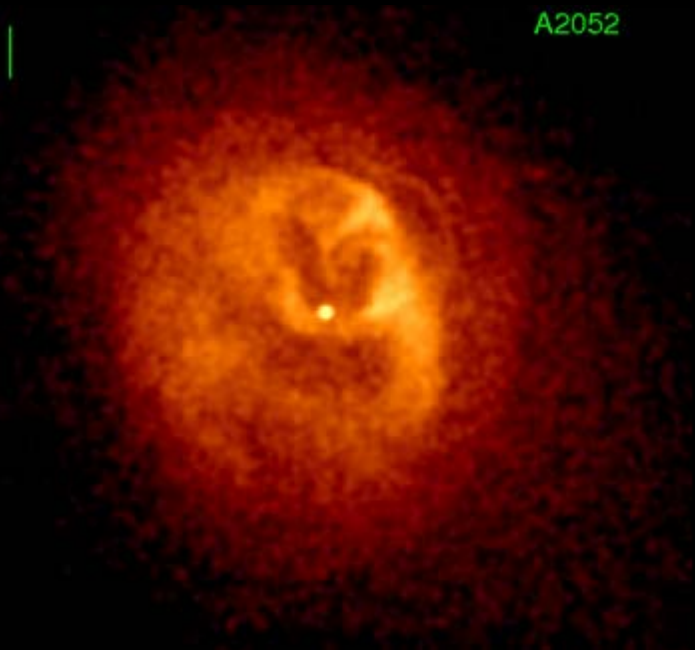
2) Understanding the energy and mass outflow of AGN:

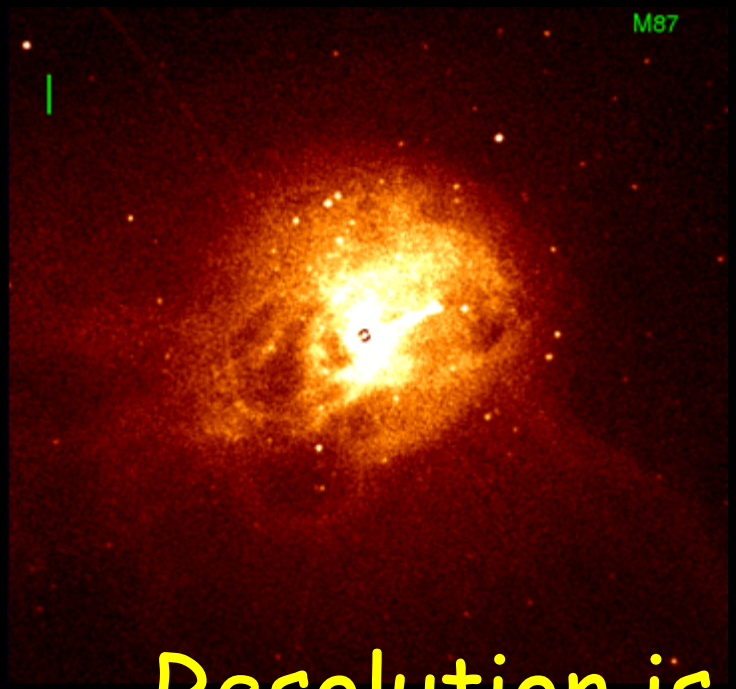
(Mass and energy components, velocity structure, variability, ionization structure...)


M87

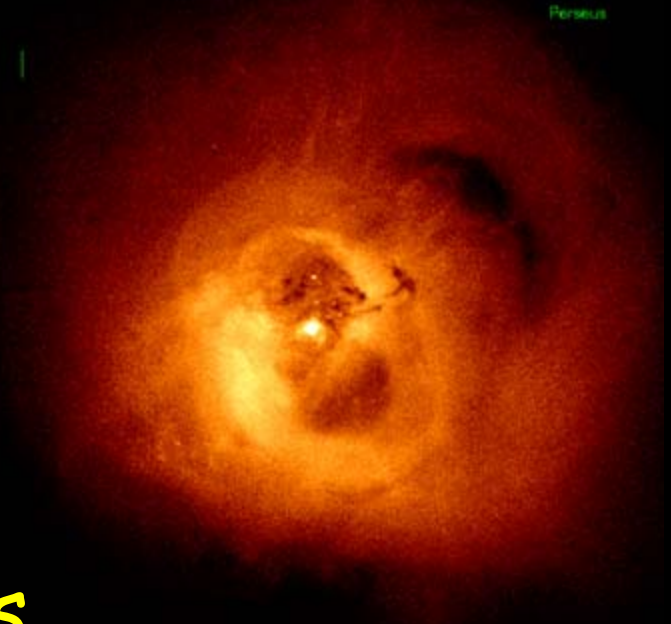

Centaurus

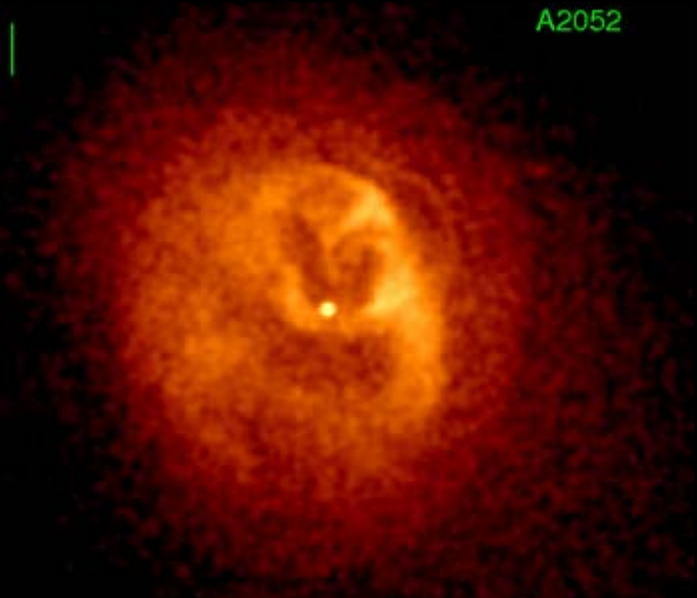

Perseus


A2052

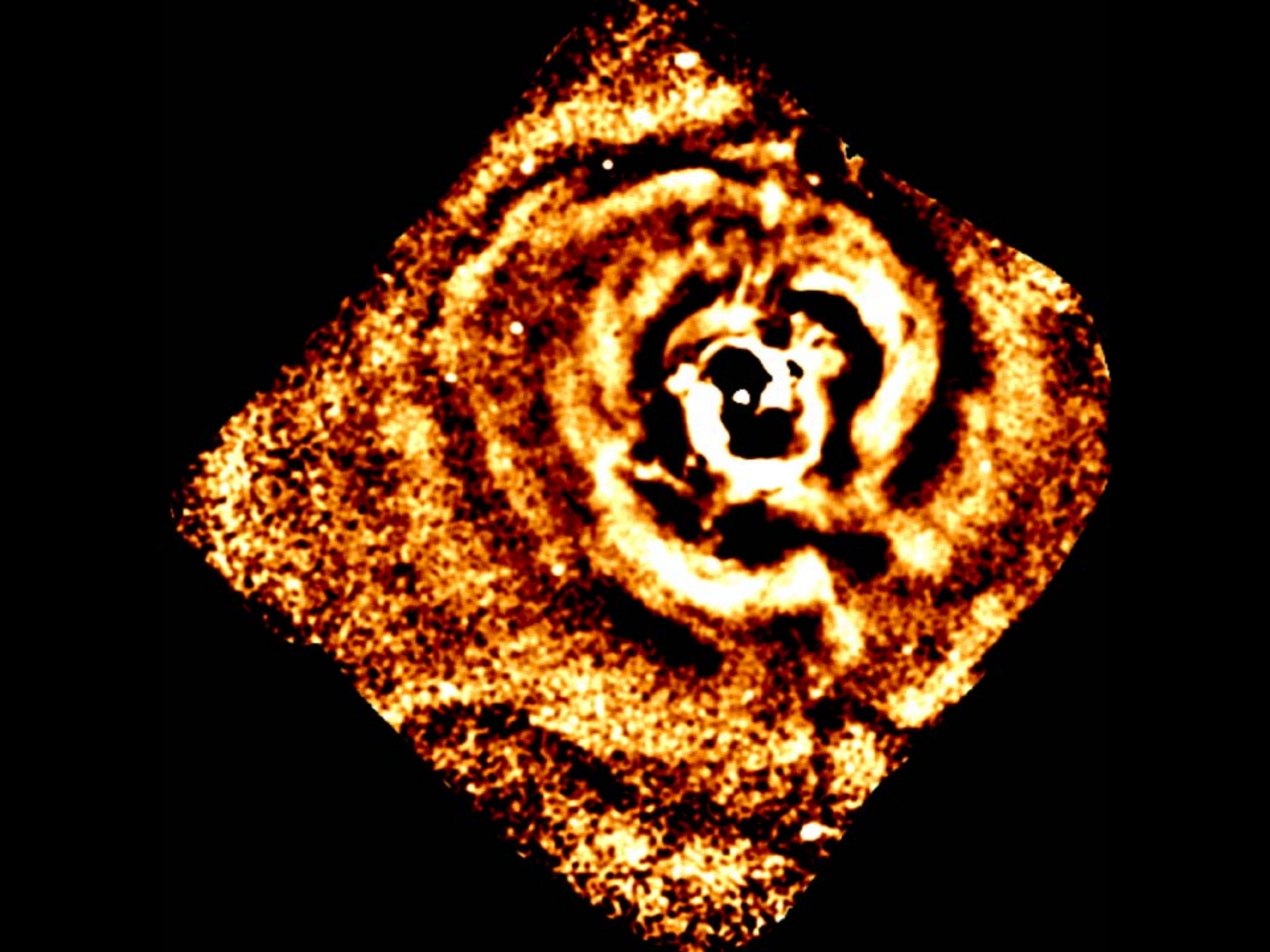


Resolution is very important!



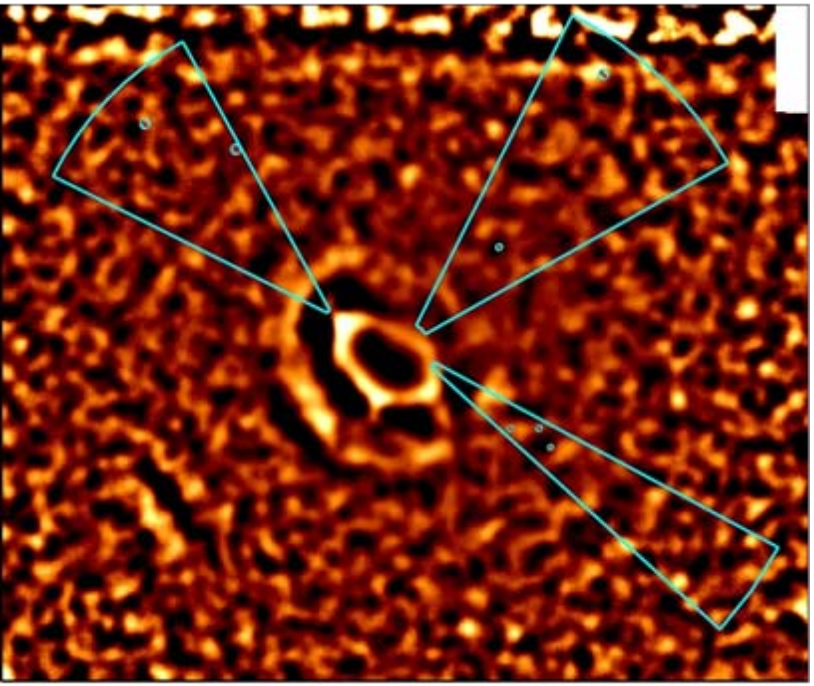


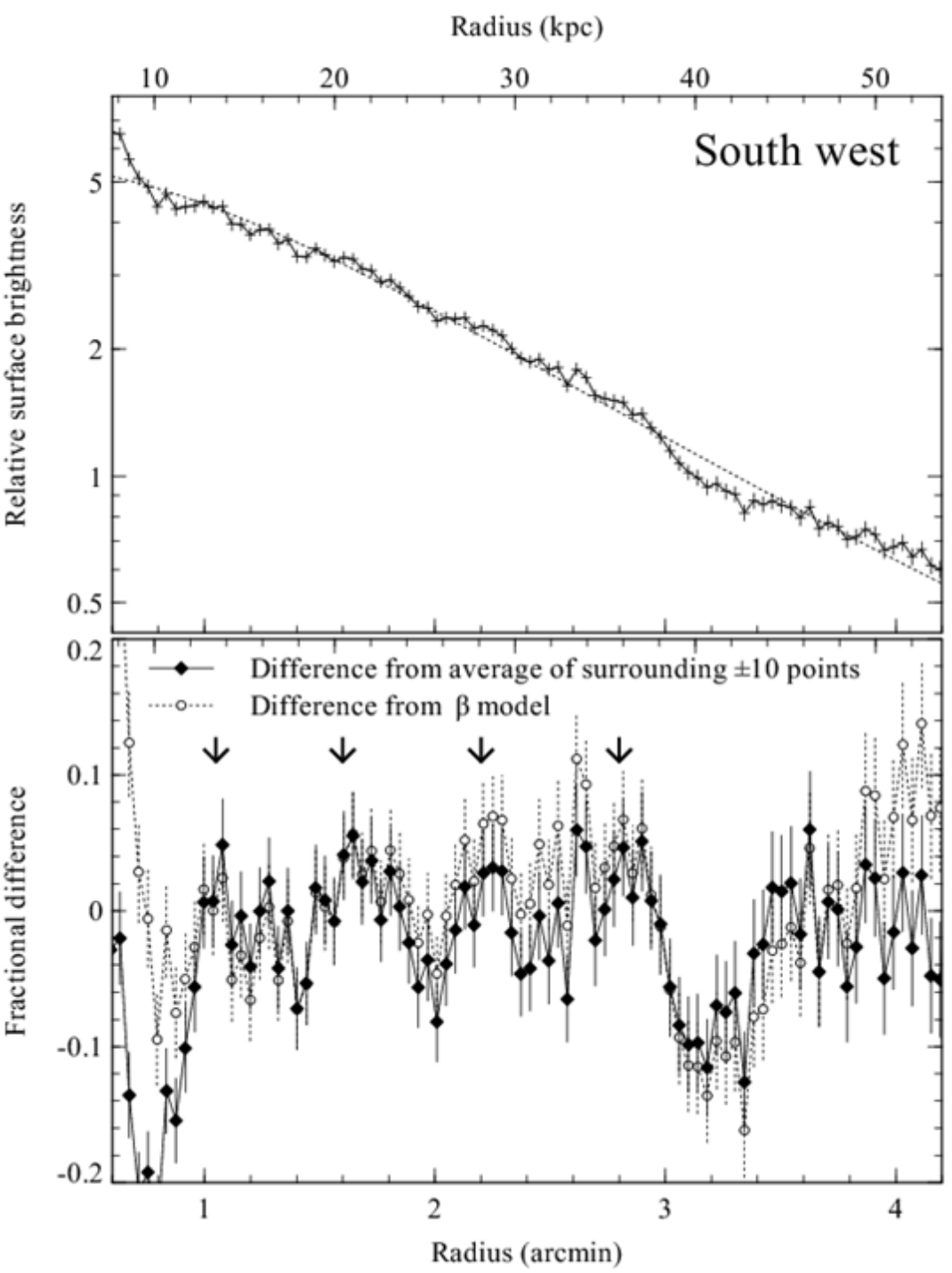
10″ bars



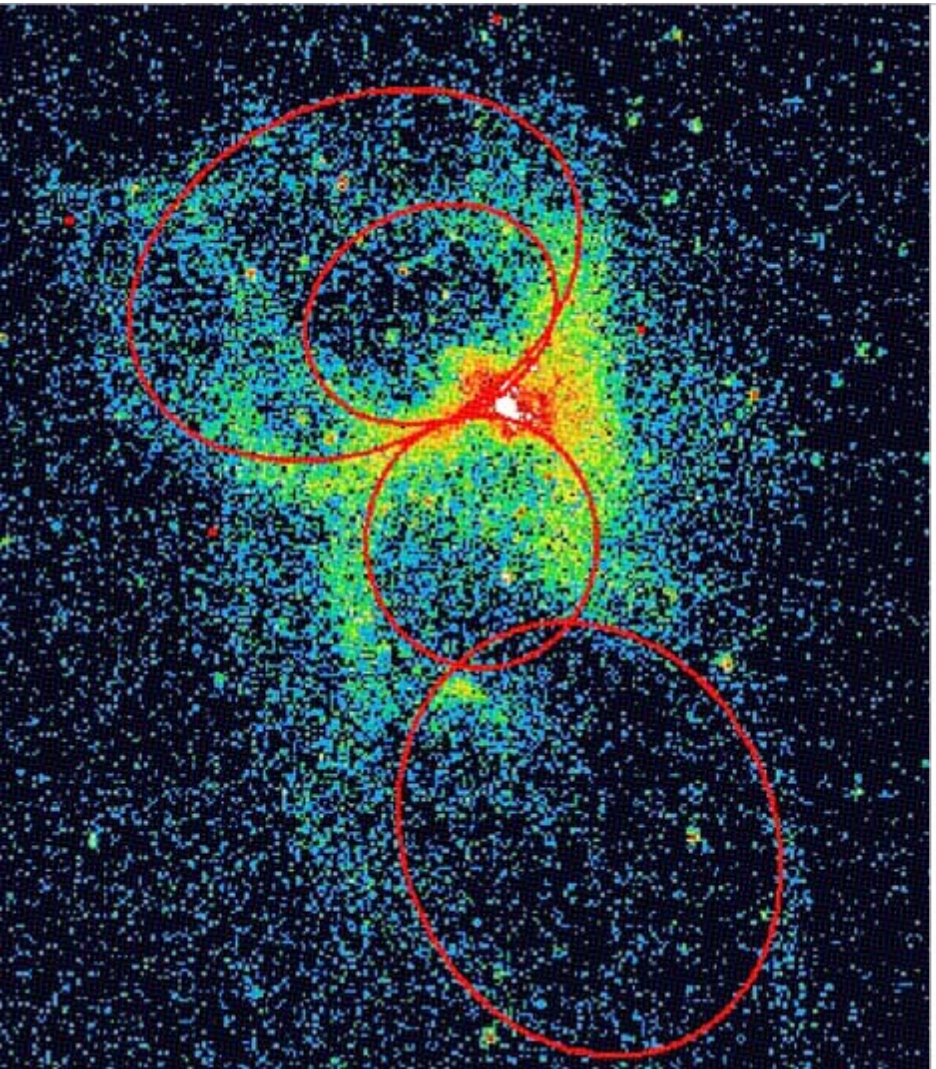
Discovery of Ripples in Centaurus Cluster

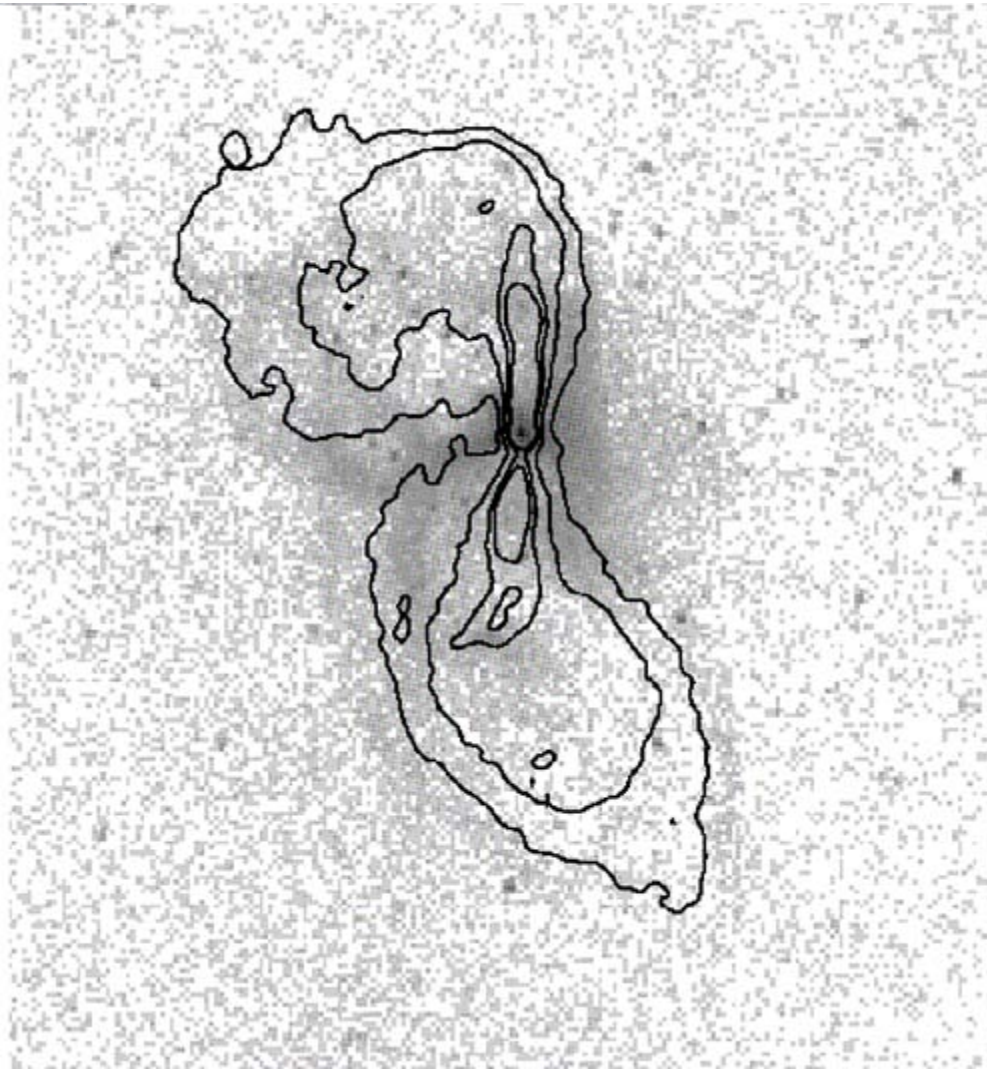
Sanders & Fabian 08





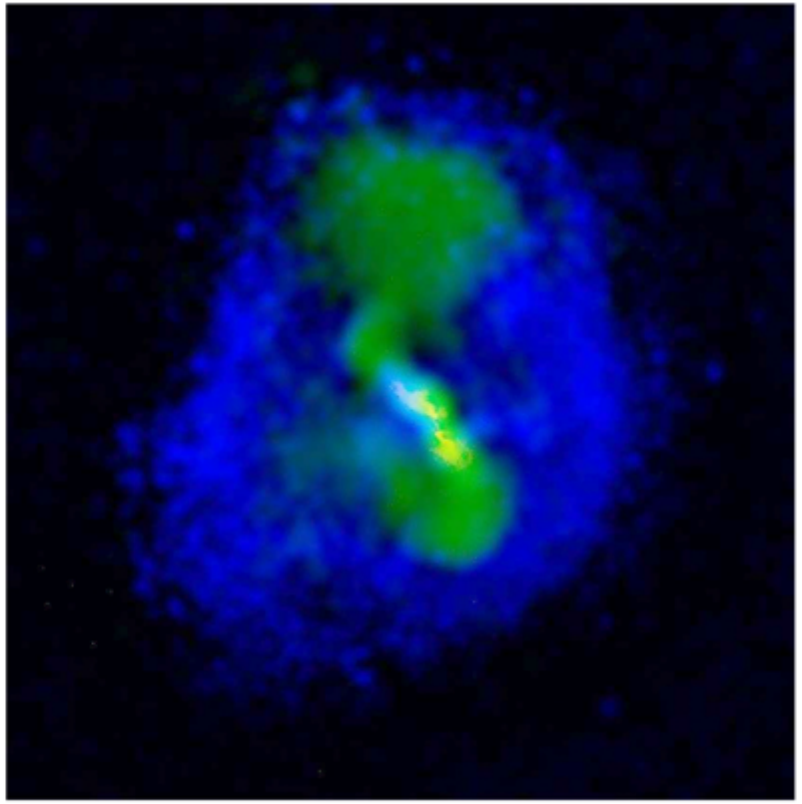
M84 Finoguenov+08

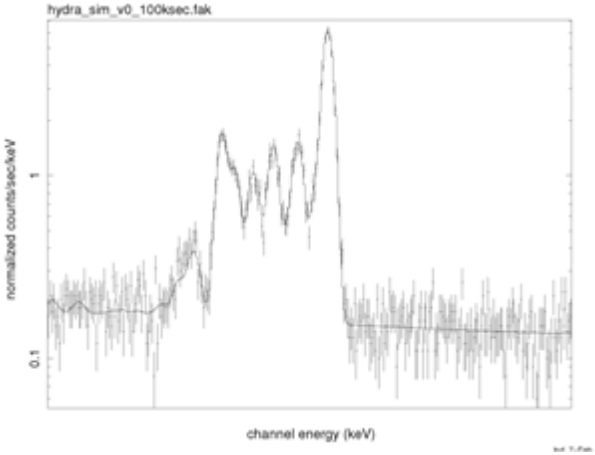


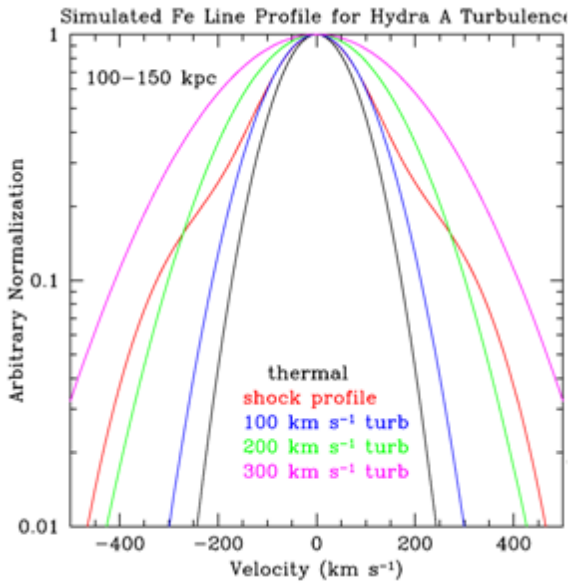


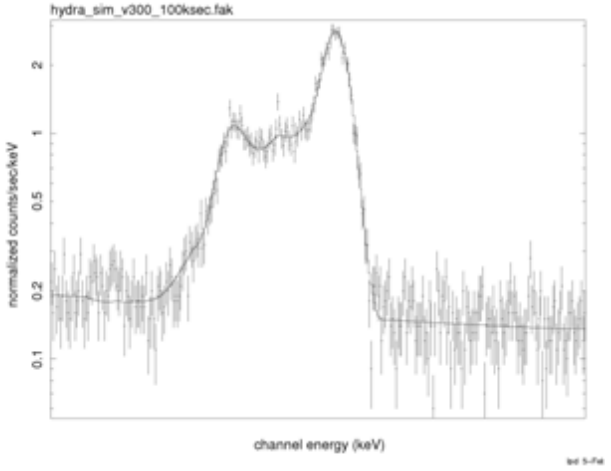
Hydra A

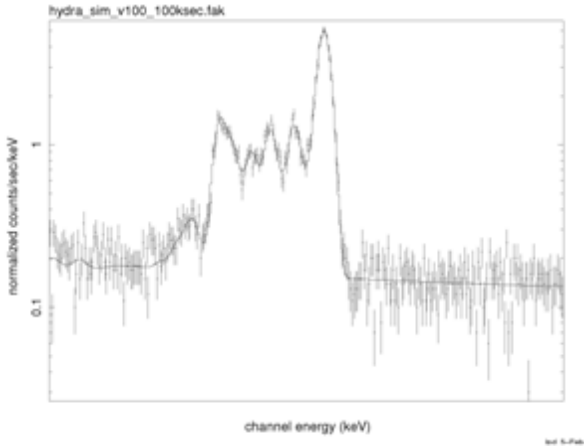
Larry David

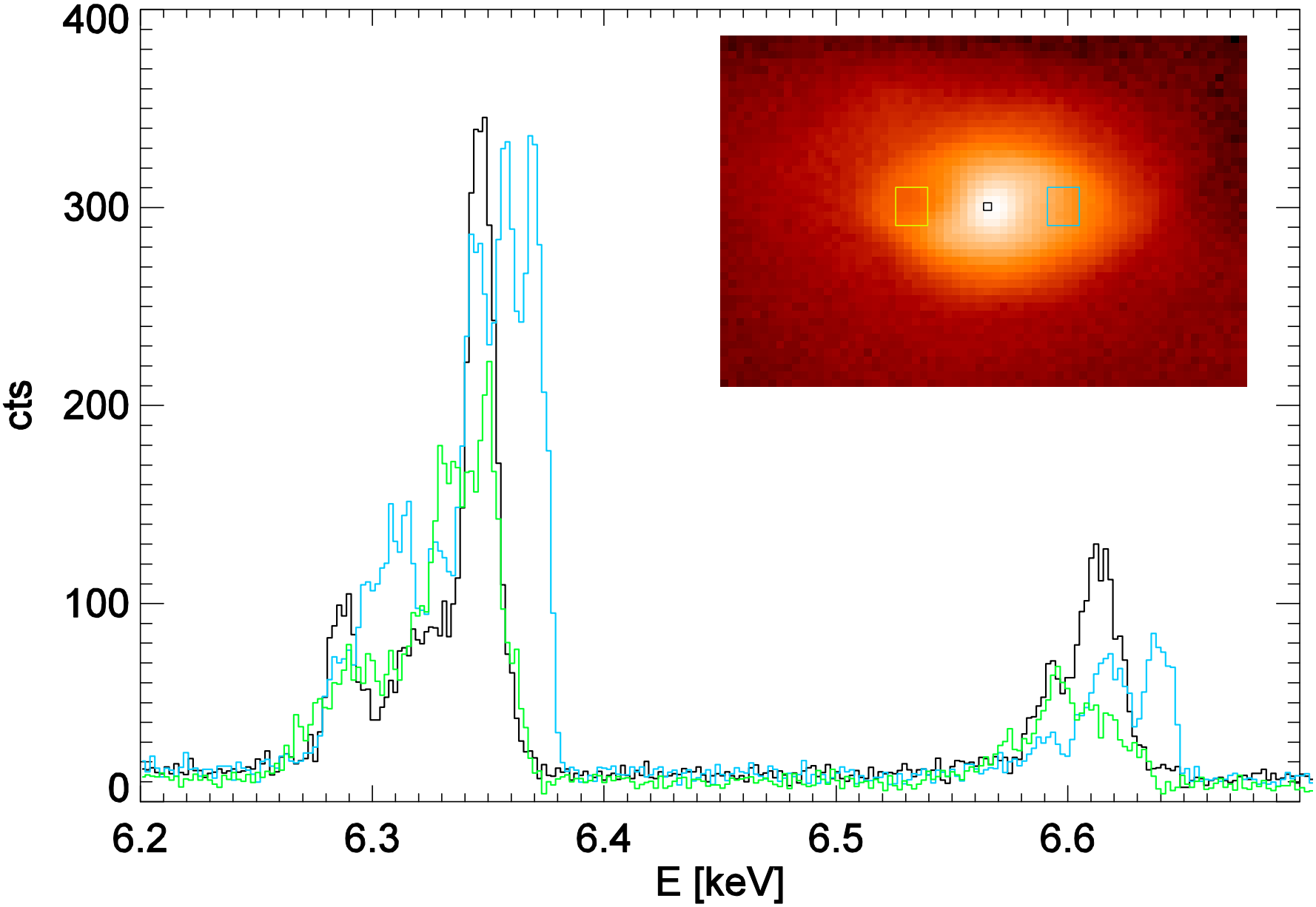


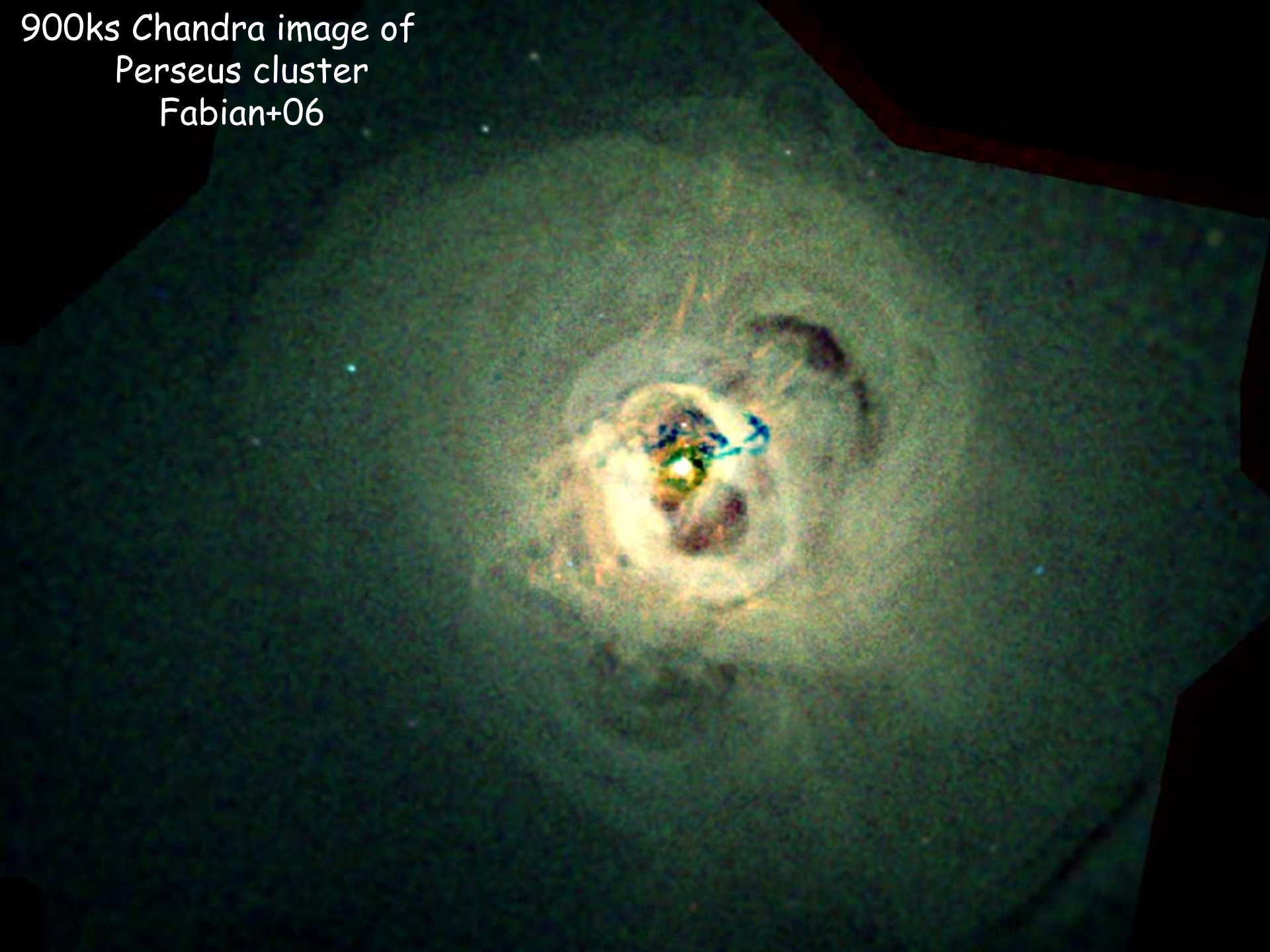






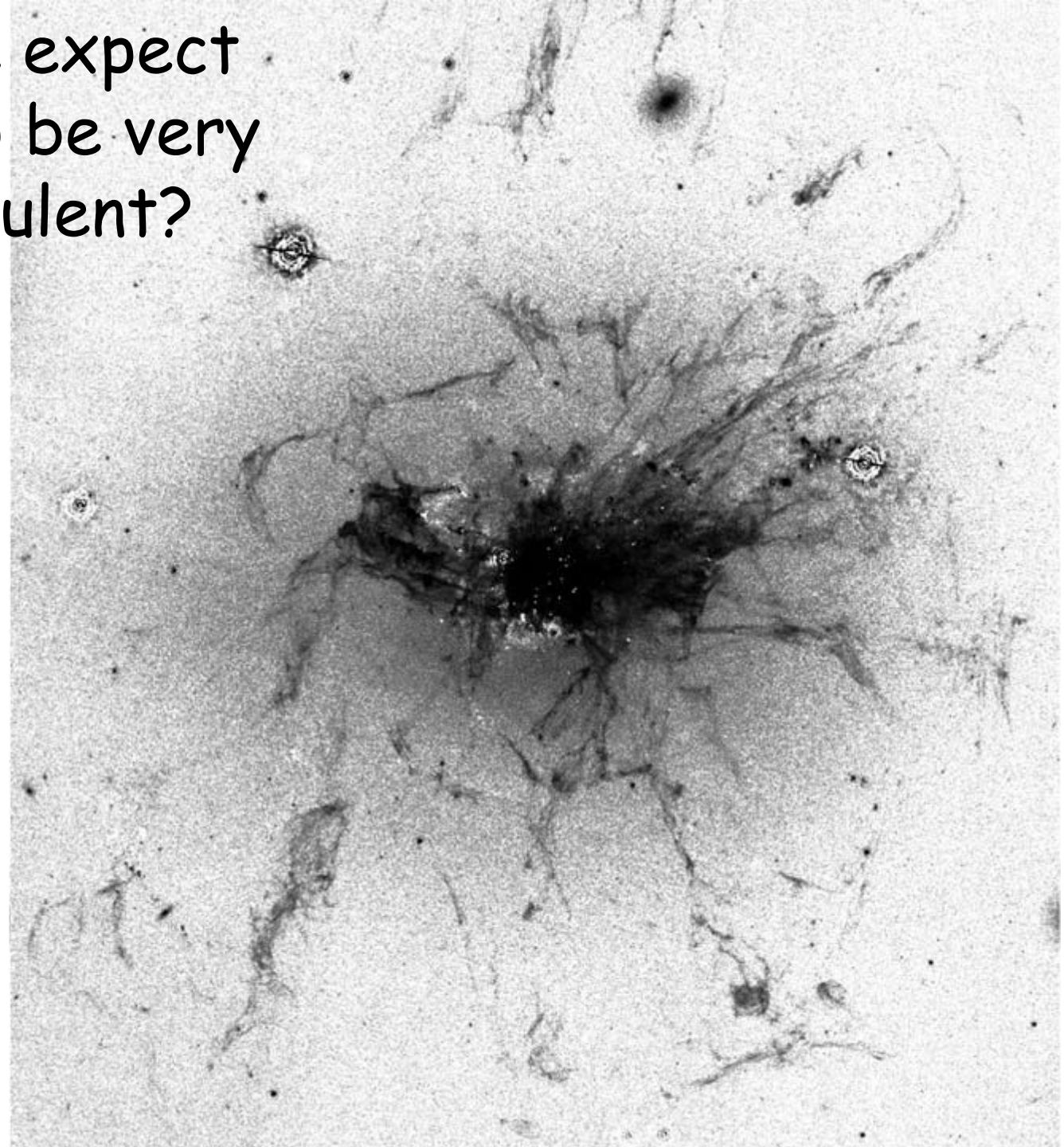


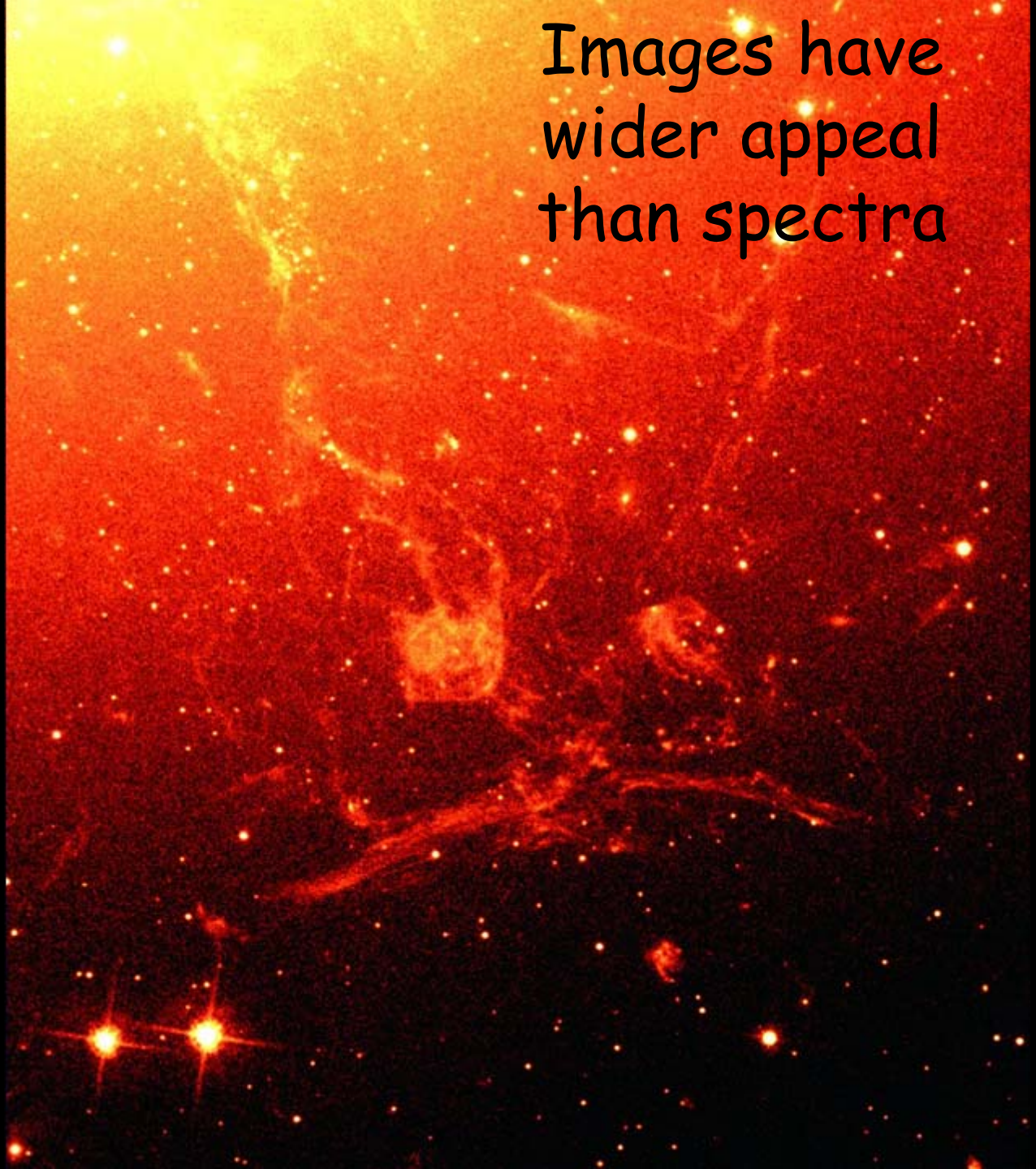

400
300
200
100
0
cts
6.2
6.3
6.4
6.5
6.6
E [keV]


900ks Chandra image of
Perseus cluster
Fabian+06

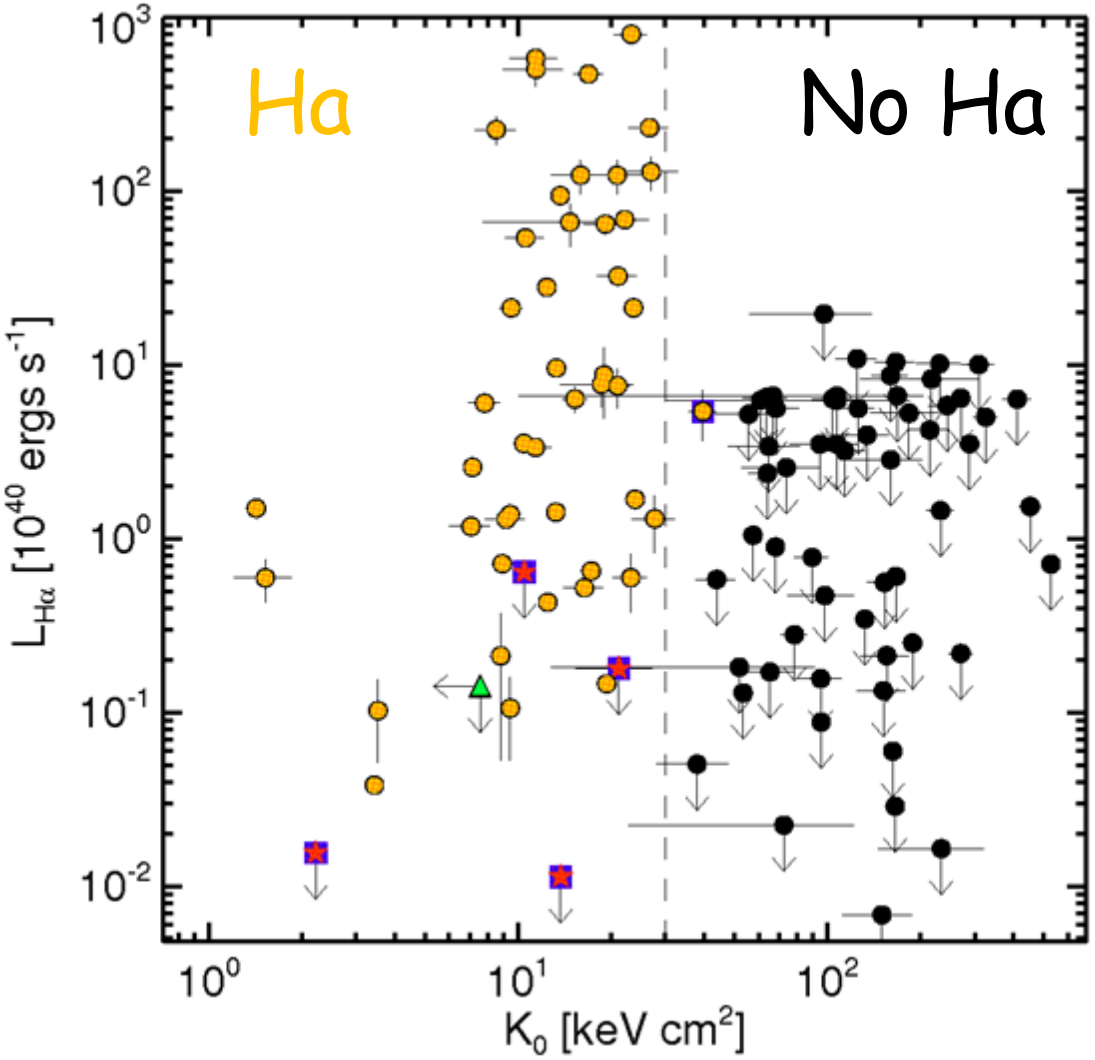
Today's Nature

Do we expect this to be very turbulent?




Images have
wider appeal
than spectra

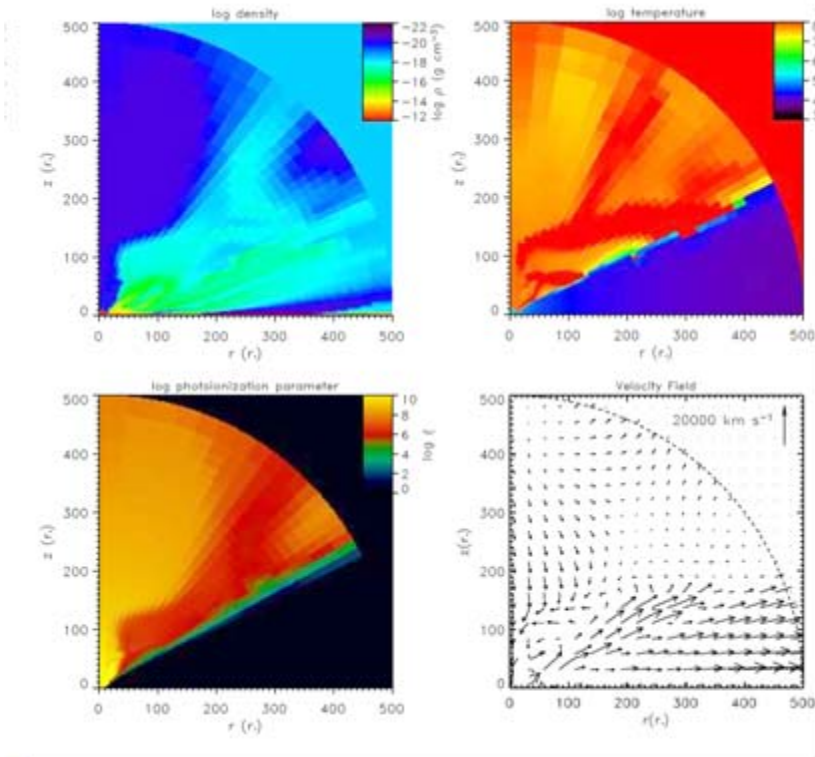
Cavagnolo+08

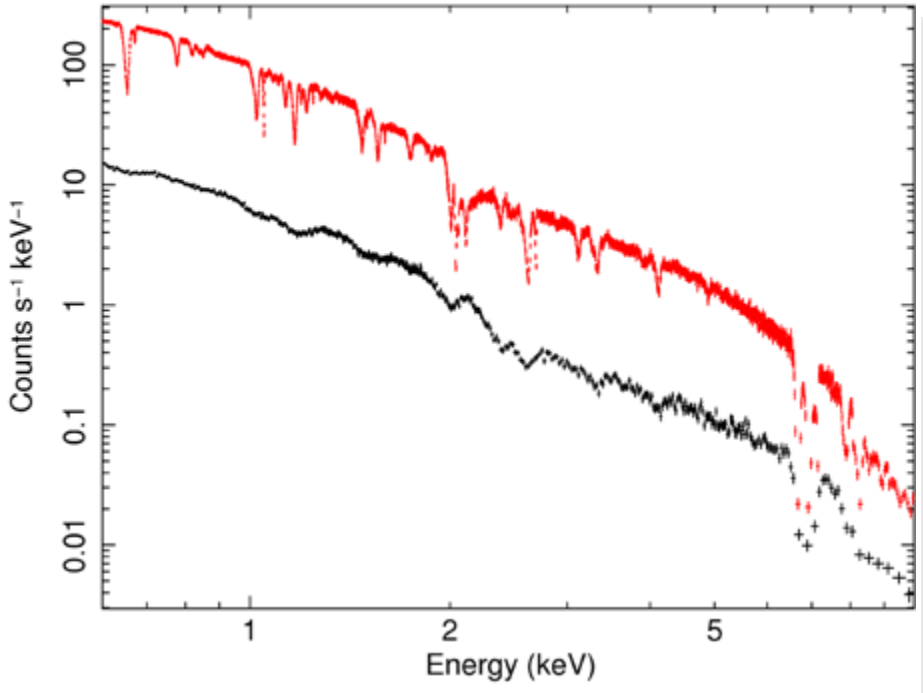


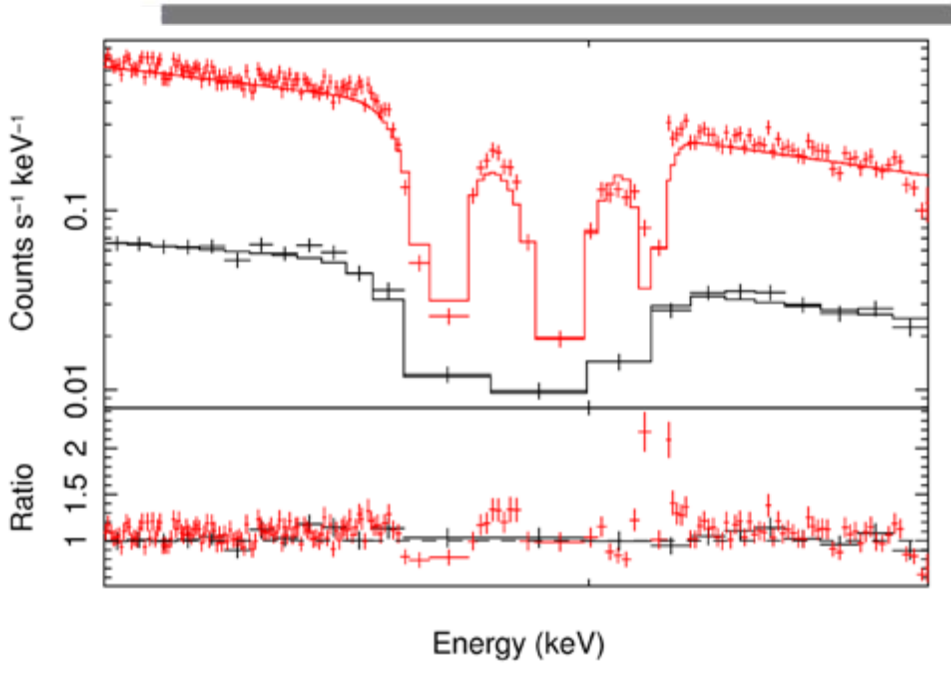
Wind Outflow

(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)

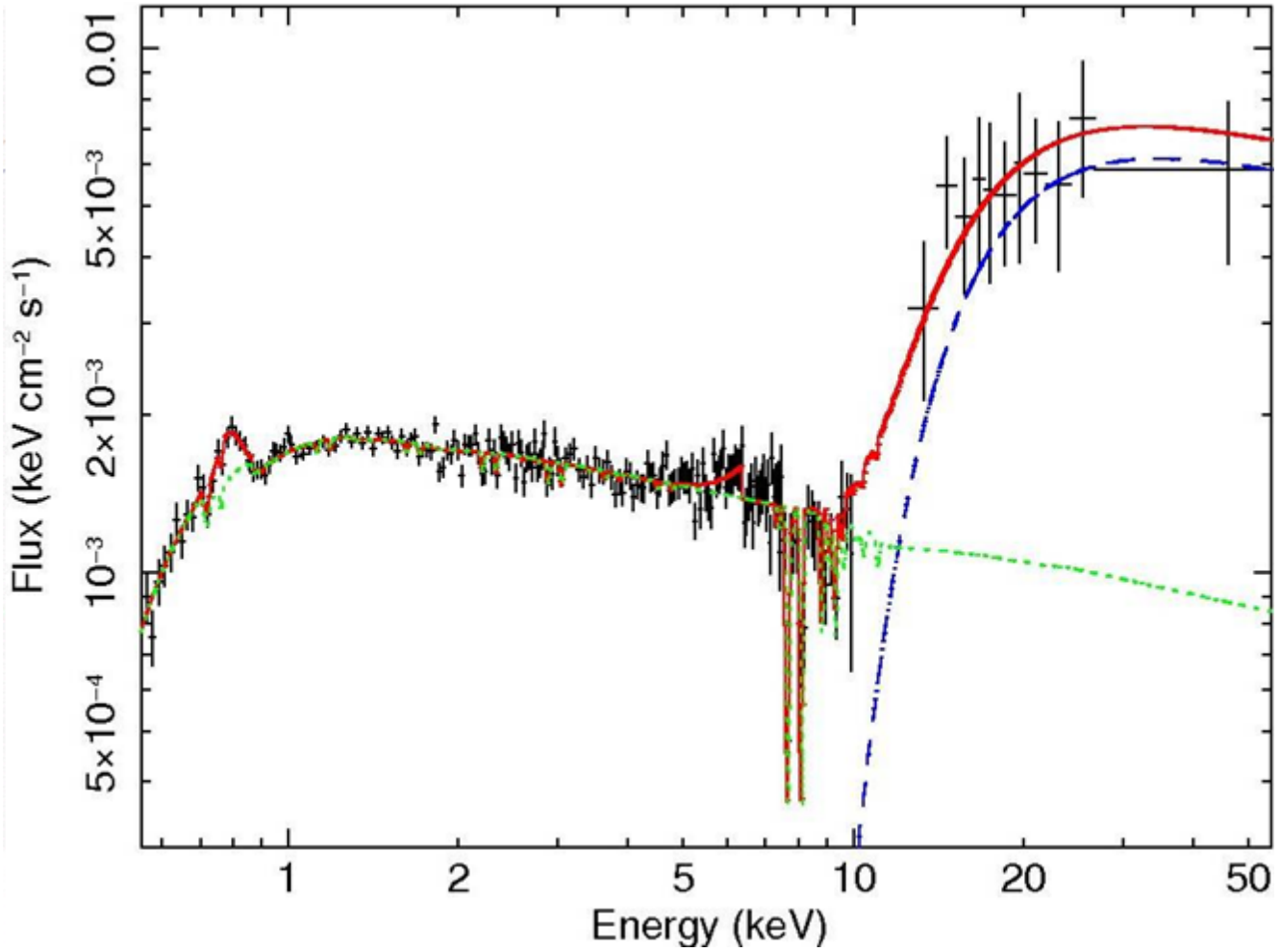
(1) Disputed by Kaspi et al., who claim the outflow may arise from a lower velocity, depending on the specific identification of lines in the spectrum.

(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.

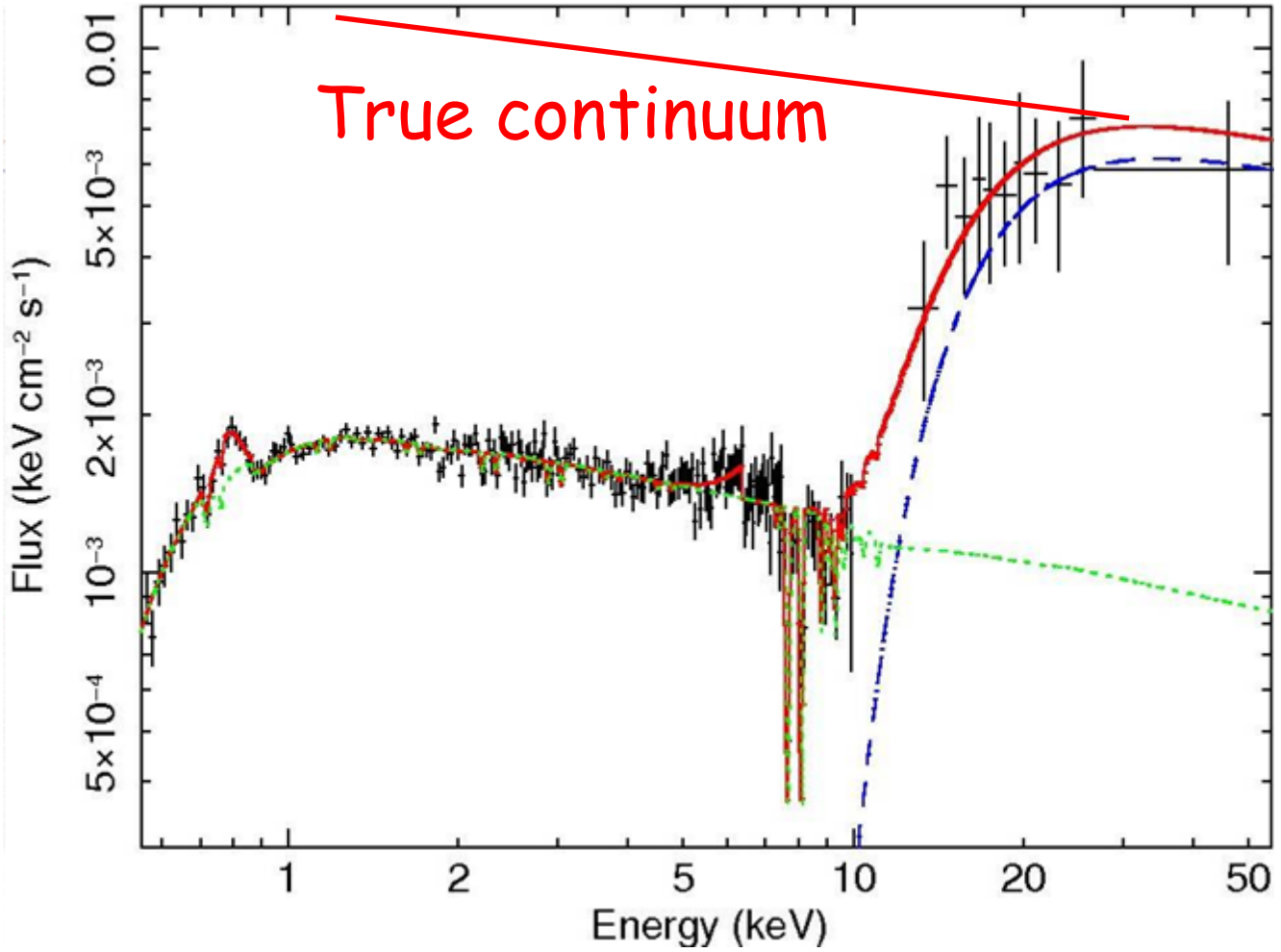
(3) Disputed on the basis of background subtraction in the EPIC/PN spectrum (Brinkman et al. 2005)

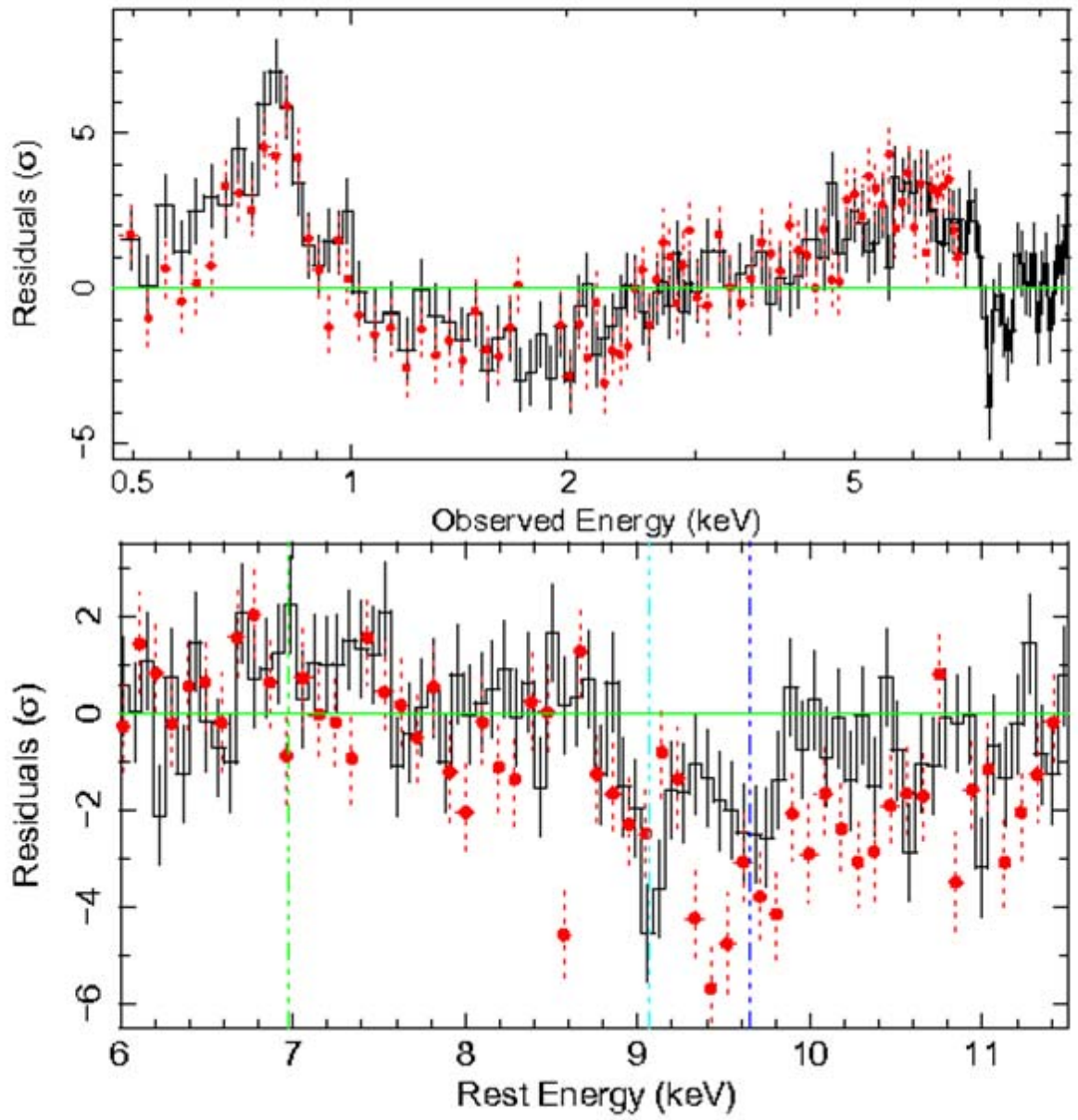
Likely that ALL AGN have outflows but influence at present unclear

PDS456 (Suzaku: J Reeves+)



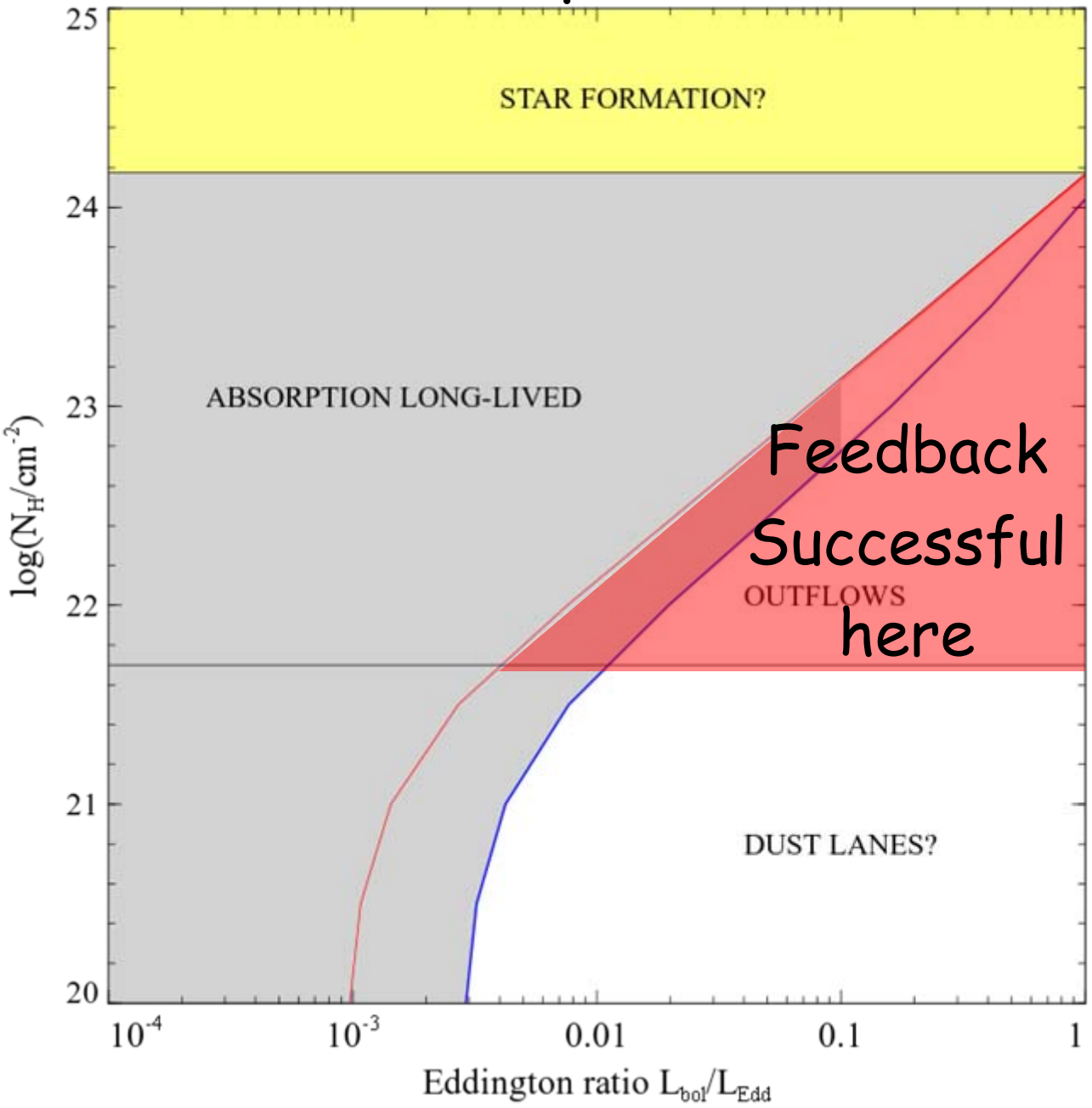
PDS456 (J Reeves+)



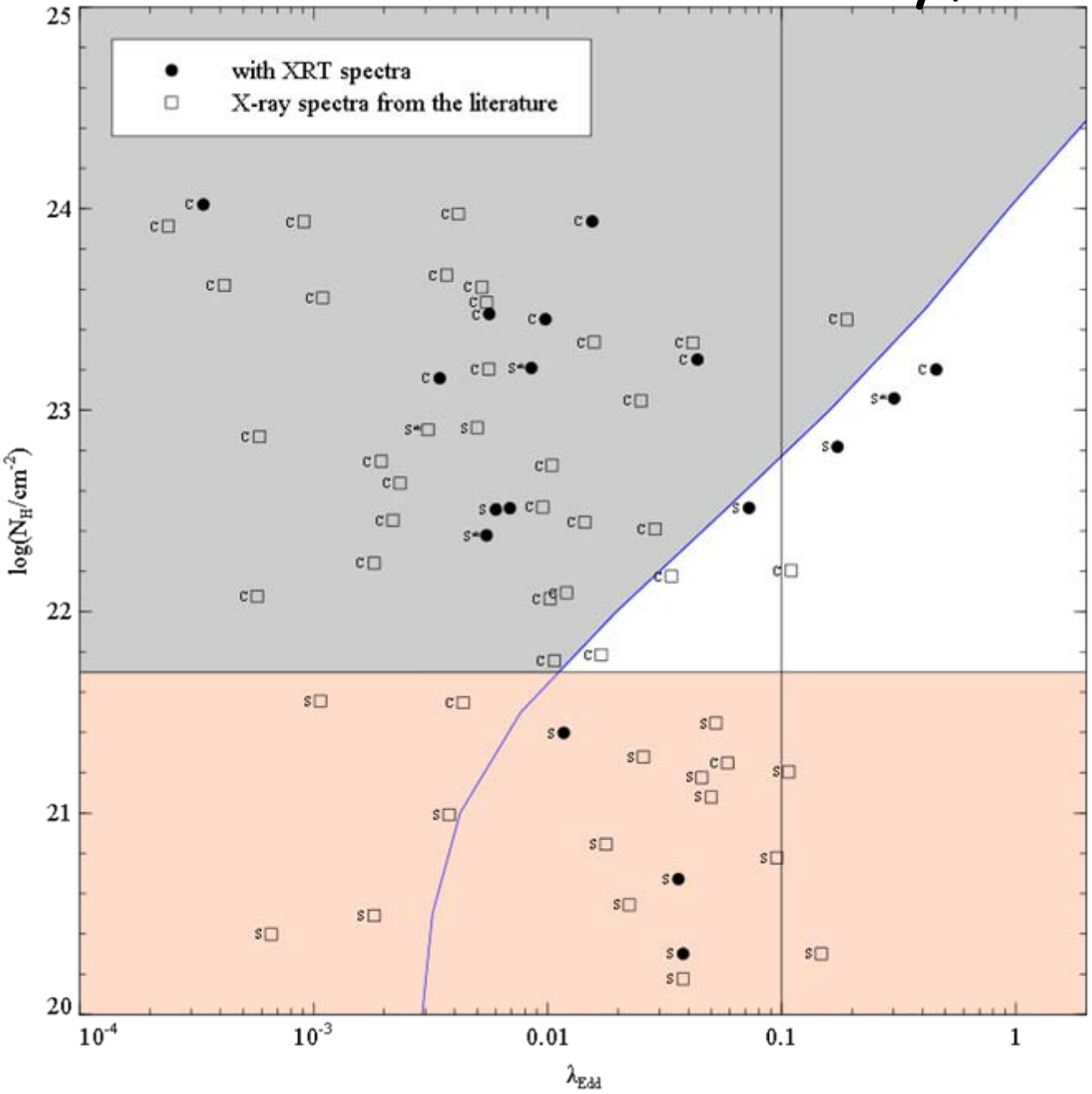


XMM 2001
in red

Effect of radiation pressure on dusty gas



SWIFT-BAT data from Mushotzky, Winter+



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

- 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)

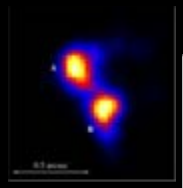
- Mass outflow rates in APM08279 (~5 M_s/y) and PG 1115 (~5 M_s/y) is found comparable to their accretion rates.

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

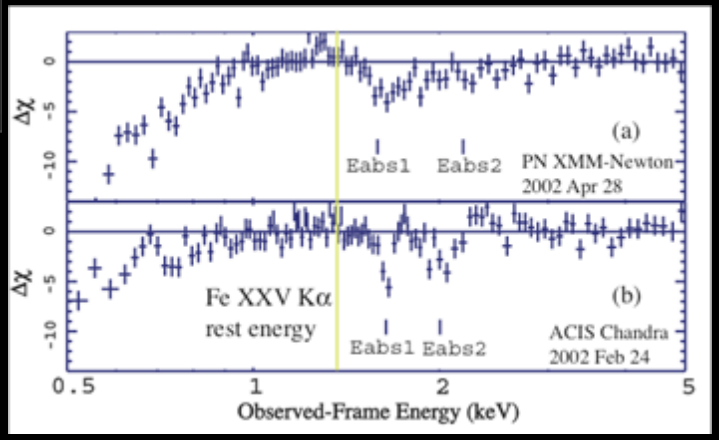
  ε_K ~0.09 (-0.05,+0.07), APM 08279+5255

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

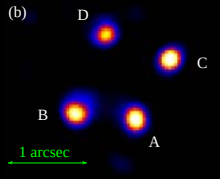
Quasar Outflows: Observations



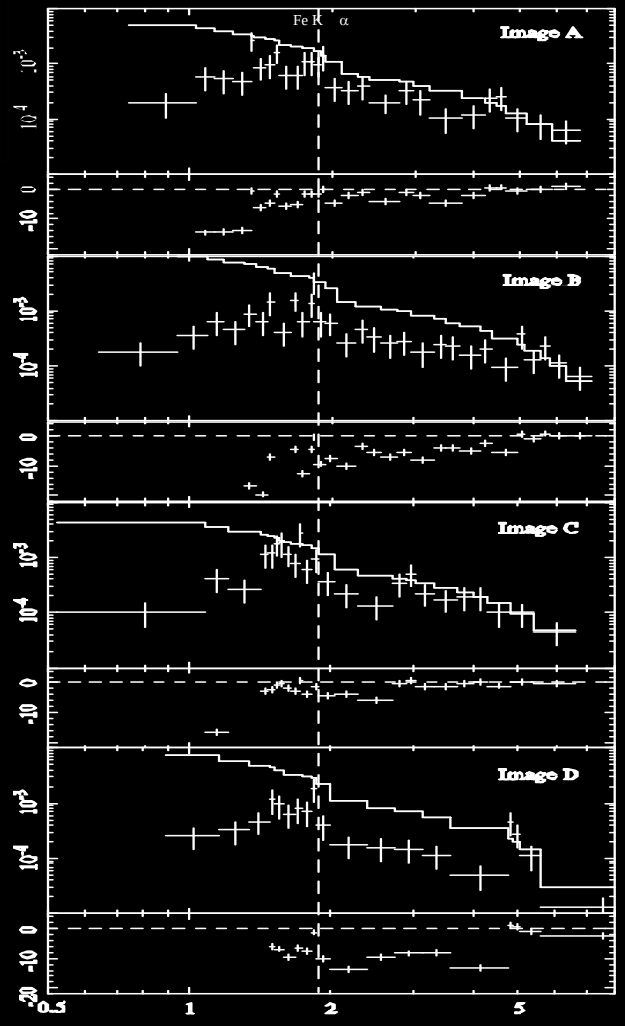
$z = 3.91$



APM 08279+5255 (Chartas et al. 2002)

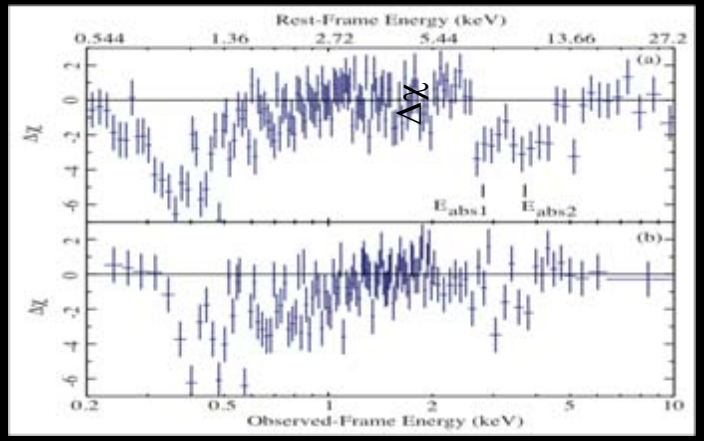


$z = 2.56$

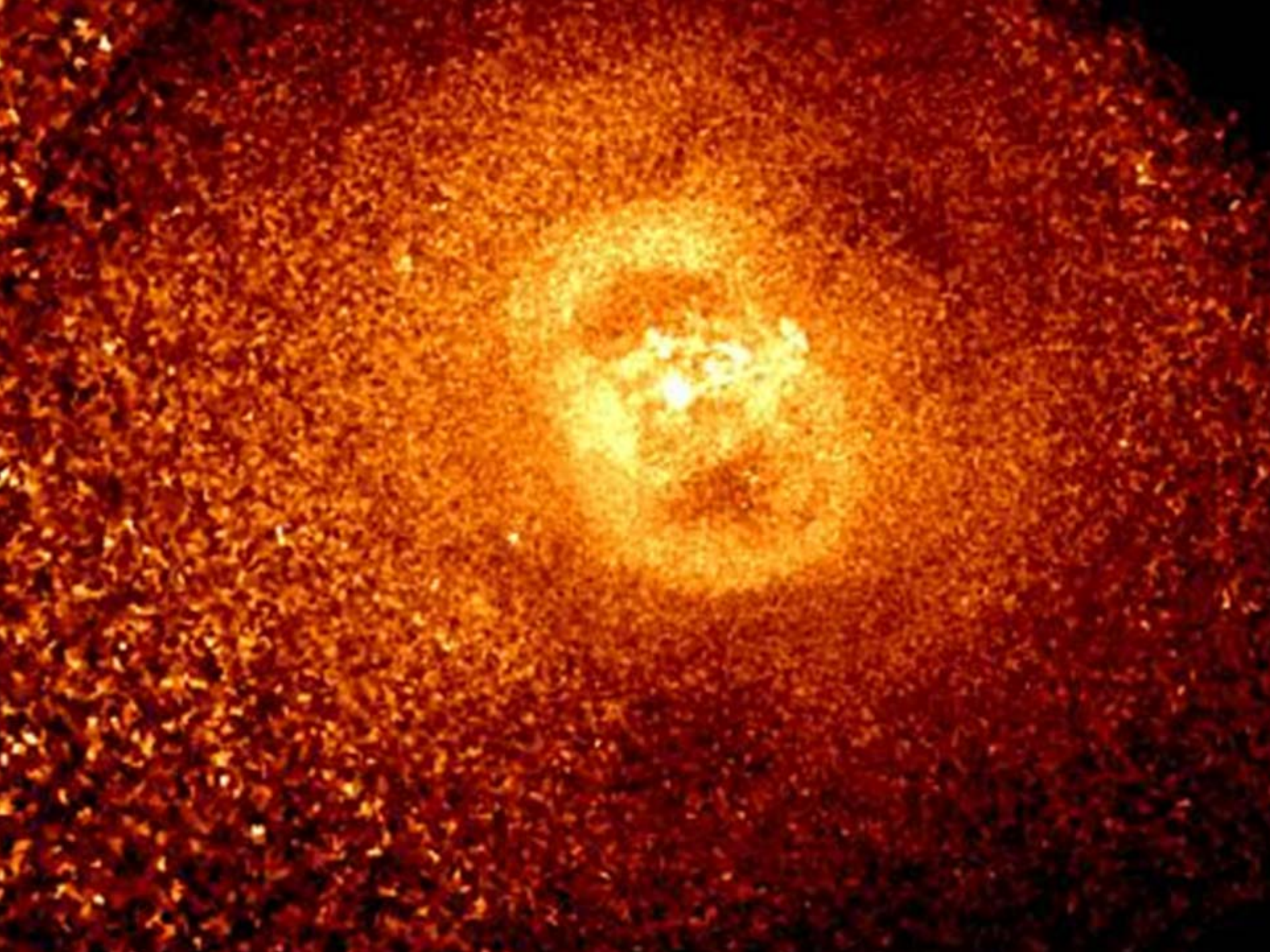


H 1413+117 (Chartas et al. 2007)

$z = 1.72$



PG 1115+080 (Chartas et al. 2003)



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