

AGNs from the field of Clusters of Galaxies

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OUTLINE

Large Scale Structures of the Universe

Composition of Clusters

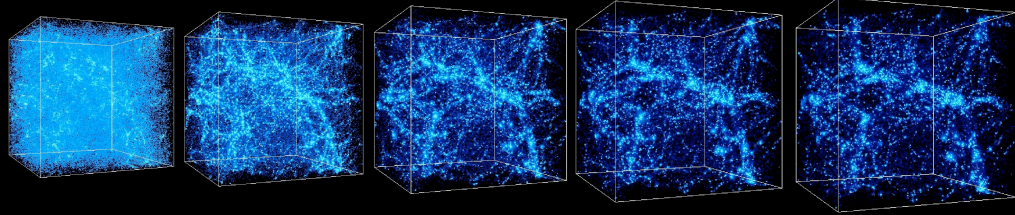
- Galaxies
- IntraCluster Medium (ICM)
- Dark Matter



Mice galaxy (NGC 4676A and NGC 4676B) pair of spiral
locates in Coma Cluster at 300 million ly away

**Nature of galaxies
in Clusters!...**

Structural Formation



bigbang

--->

today

if the universe expanded
uniformly, the matter
would be homogenous
--> But sky is full of
galaxies !...

intersection points are
clusters of galaxies

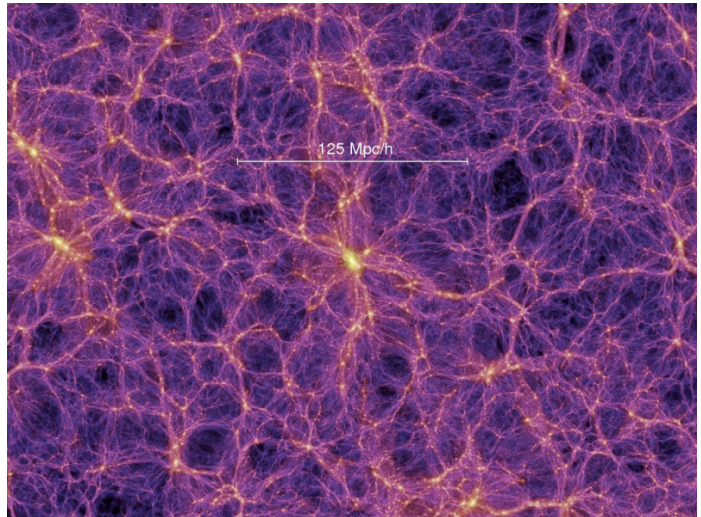
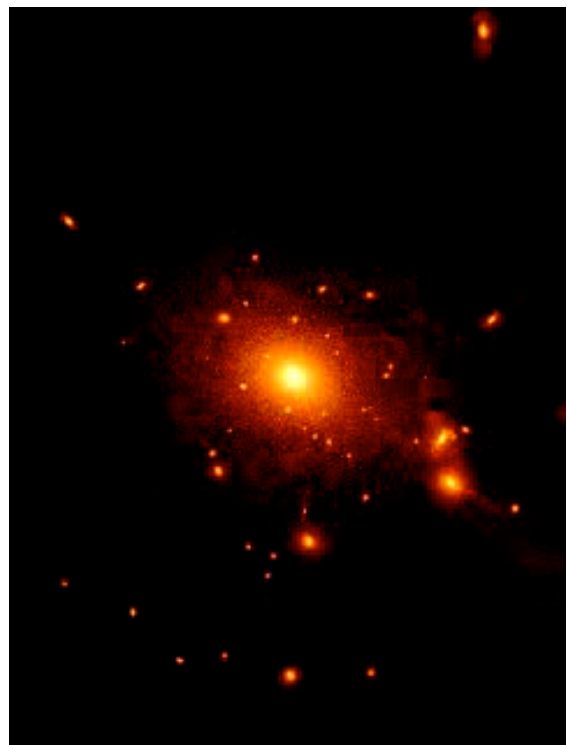


Image credits: Virgo Consortium

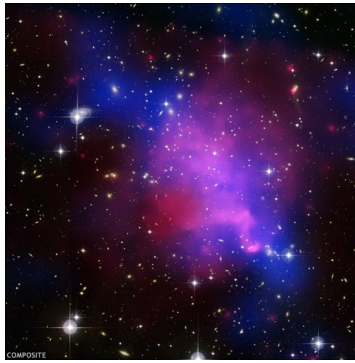
Clusters of Galaxies

Properties

- ~100s of galaxies
- $M_x > M_{opt}$.
- Total mass 10^{14} - $10^{15} M_{\odot}$
- Typical size of 2~5 Mpc
- Separation ~10 Mpc
- Density $\sim 10^{-3} \text{ cm}^{-3}$
- Temperature $\approx 10^7$ - 10^8 K
- $kT_x \sim 2$ -14 keV
- Fe abundance $\sim 0.3 Z_{\odot}$
- $L_x \sim 10^{43}$ - 10^{45} ergs/s



Clusters of Galaxies



- Galaxies
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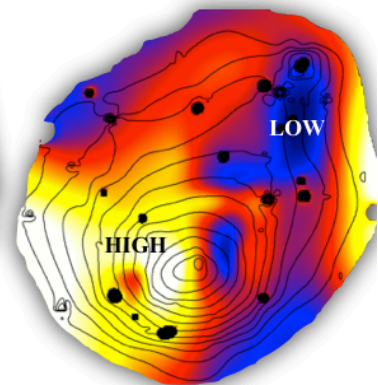
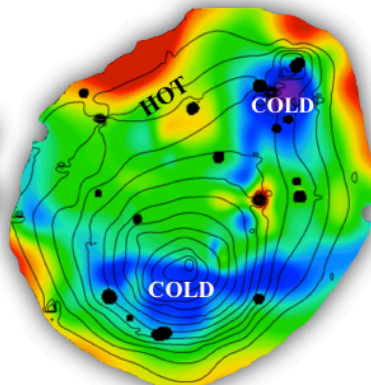
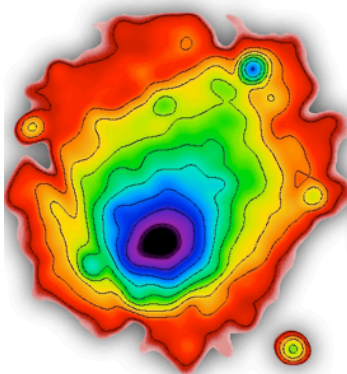
A3560, member of Shapley

PLASMA

TEMPERATURE

METAL

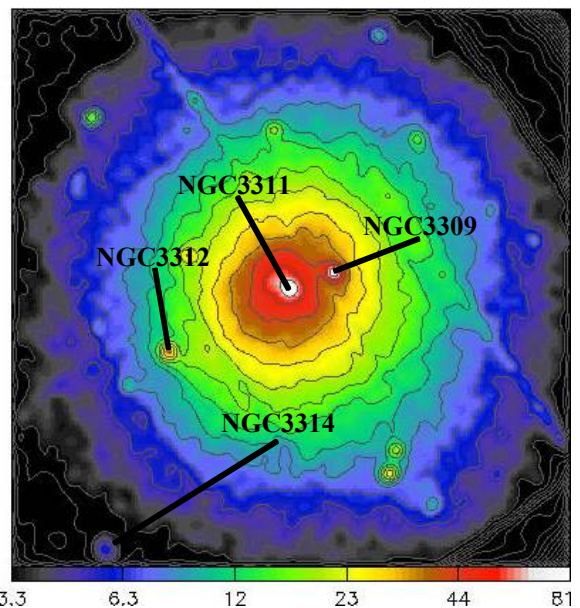
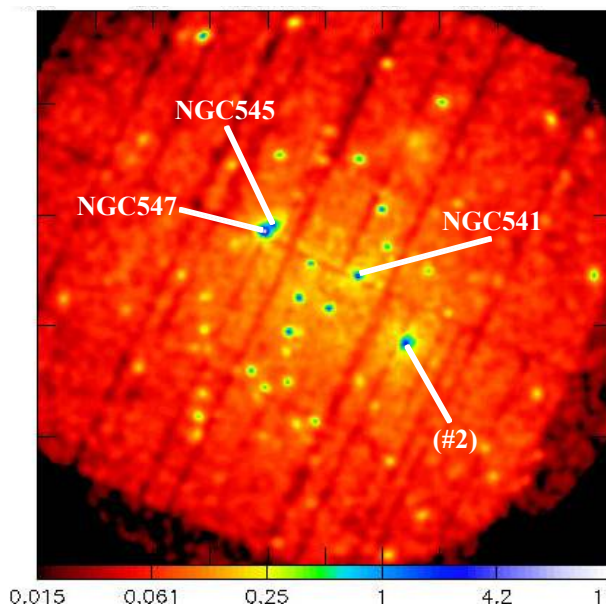
(Hudaverdi et al. 2010, ASPC)



Clusters of Galaxies

A194

A1060



Source Detection

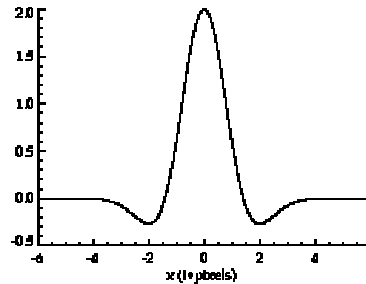
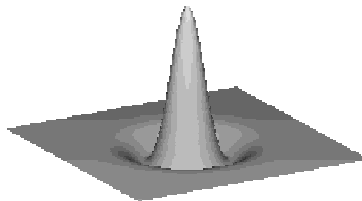
2 methods applied for comparison

EBOXDETECT

EWAVELET

$$L = -\ln P$$

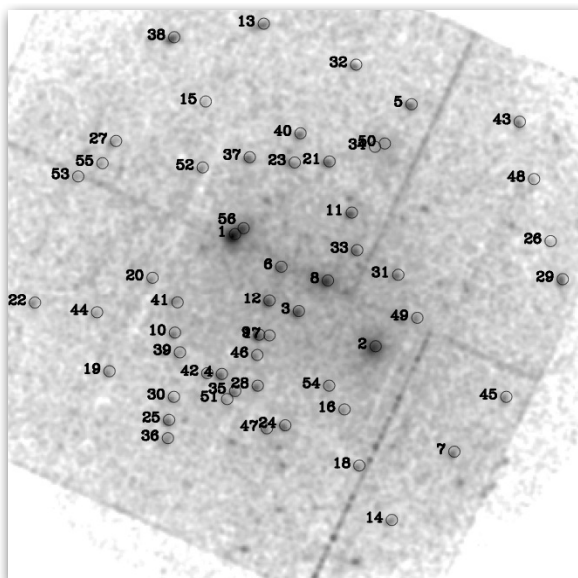
$$L = 10 \sim P = 3.2E-5 \sim 4\sigma$$



3 different band images (soft, medium, hard)
sources show different properties

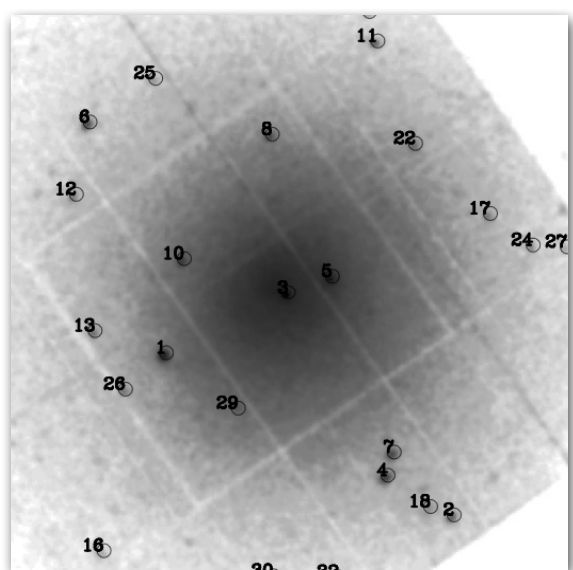
Clusters of Galaxies

A194



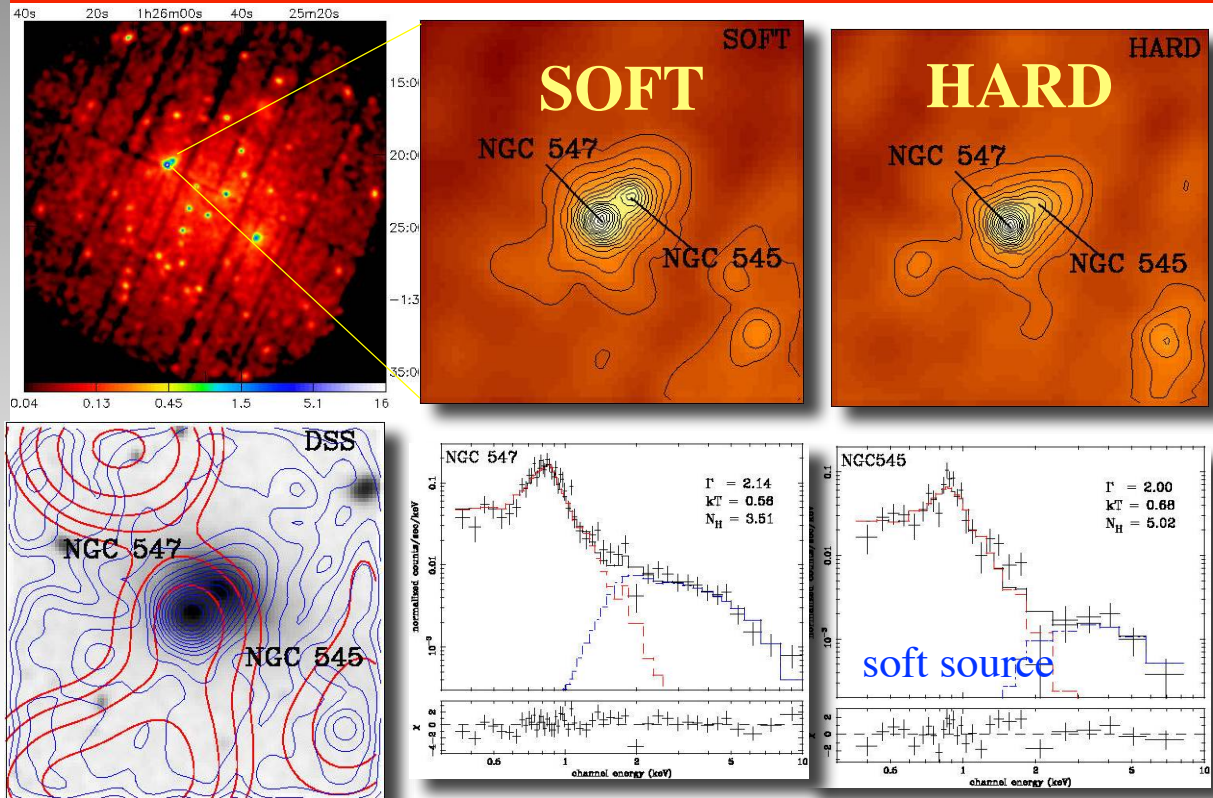
56 sources

A1060



32 sources

spectral properties



UZAY



3rd WORKING GROUPS MEETING 12 - 13 April 2011 Bologna / Italy

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COSMIC OFFICE

X-ray emission from galaxies

X-rays from galaxies
Nature of early-type galaxies



Hot Halo + **LMXB** + **AGN**

$\log L_x$ 37 ~ 39 erg/s

[Blanton et al. Apj, 552, 106, 2001]

38 ~ 40 erg/s

[Randall et al. Apj, 636, 200, 2006]
[Blanton et al. Apj, 552, 106, 2001]

39~40 erg/s <



UZAY

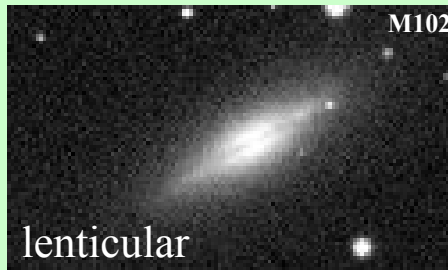


3rd WORKING GROUPS MEETING 12 - 13 April 2011 Bologna / Italy

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COSMIC OFFICE

source properties

- Morphological type**

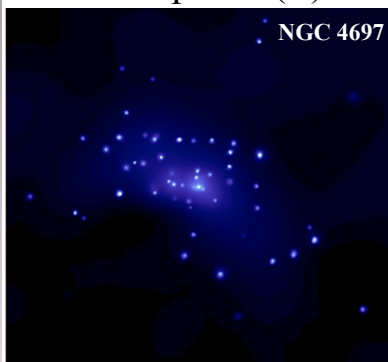


- Viewing angle**



fraction of X-ray emission

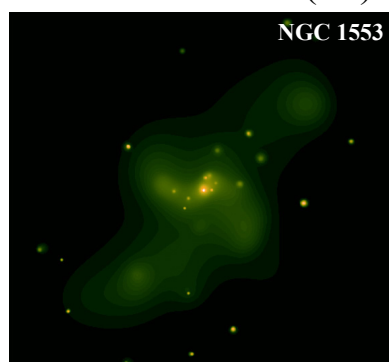
Elliptical (E)



Sarazin et al. 2000, ApJ

**Most of X-rays
(if not all) are from
point sources
(LMXBs)**

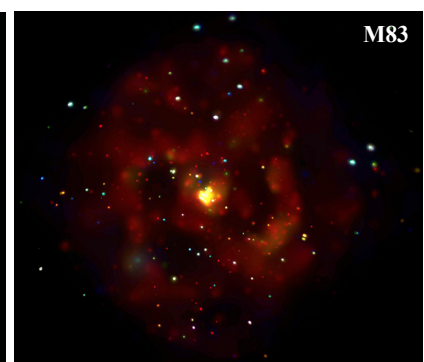
LENTICULAR (S0)



Blanton et al. 2001, ApJ, 552, 106

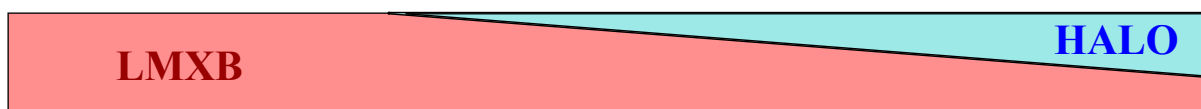
**SOFT -- Diffuse gas
HARD -- LMXBs**

SPIRAL



R.Soria & K.Wu 2000

**diffuse soft : halo + LMXB
Diffuse hard: unresol. LMXB**

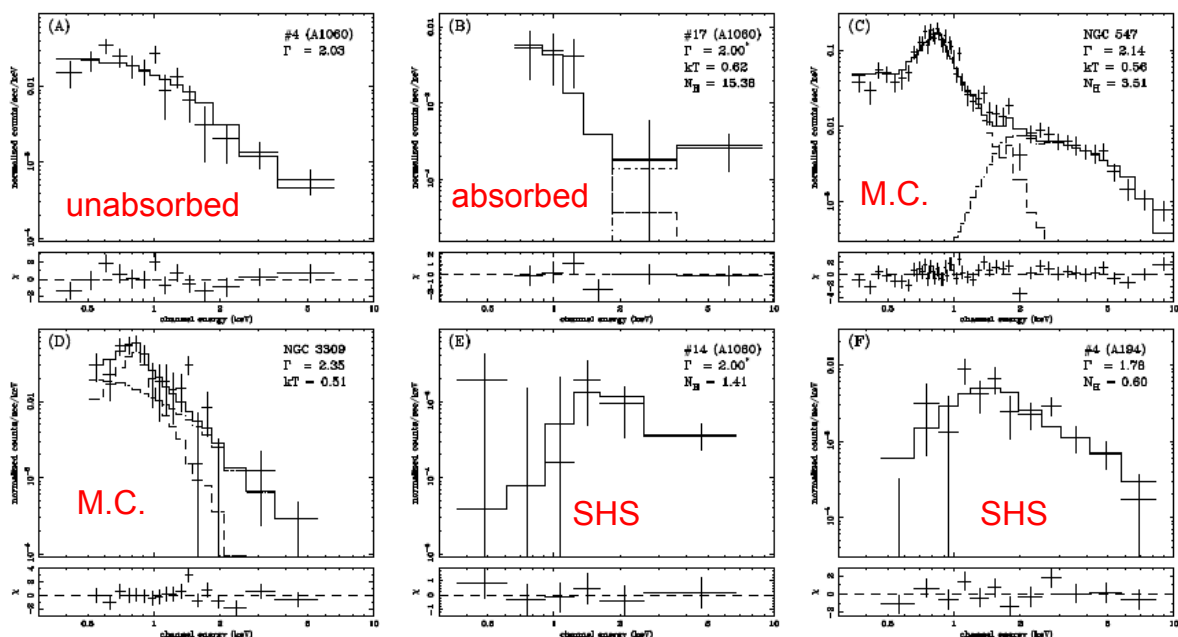


morphological fraction

cluster type	E	S0	Sp	E+S0/Sp
Regular clusters	35%	45%	20%	4.0
Intermediate clusters	20%	50%	30%	2.3
irregular clusters	15%	35%	50%	1.0
Field	10%	20%	70%	0.5

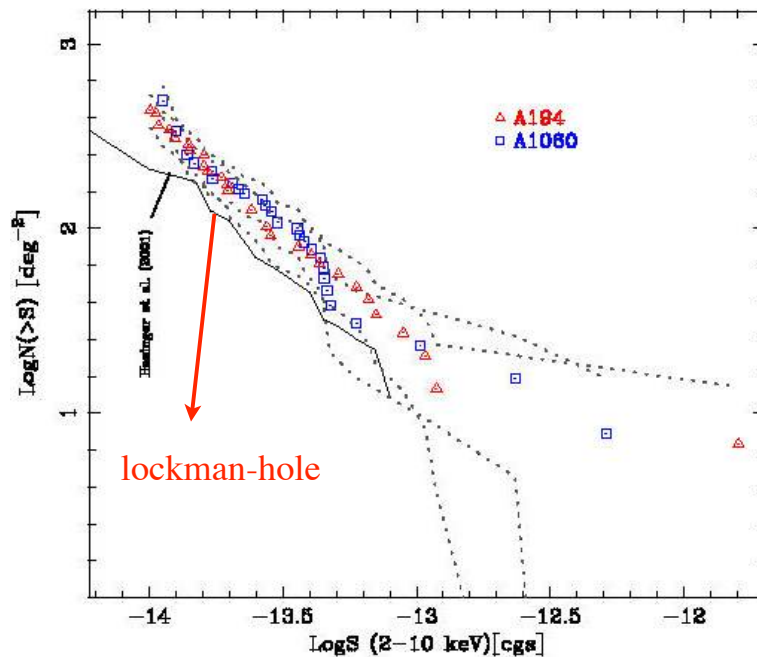
typical galactic content of clusters
($R < 1.5$ Mpc) for A1060

source properties



There are various types of sources
Spectral shapes gives the clue about the physical properties

LogN-LogS



Source number density of clusters is higher than the field in **X-rays** band (~170 times)

radial distribution of AGNs

Luminous ($\sim 10^{43}$ erg/s) AGNs are at the edges

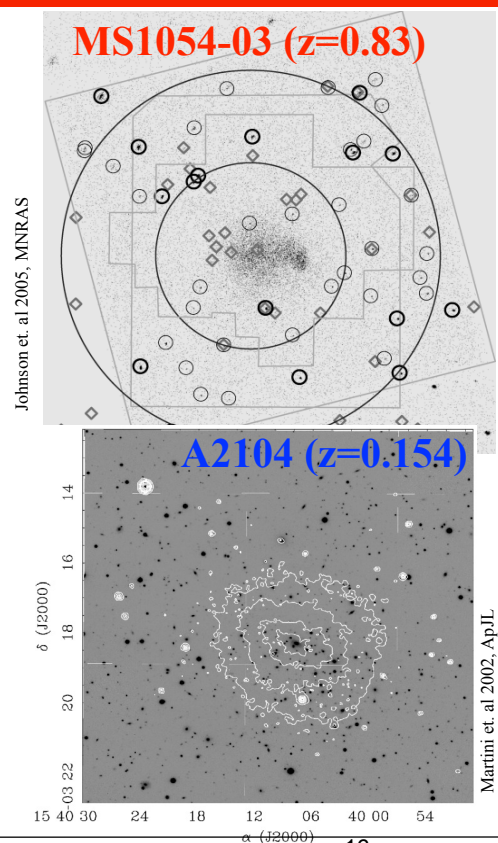
several excess cases reported:

Cappi et al. (2001) reported an excess from 3C 295 and RX J0030 fields in these high redshifts ($z \sim 0.5$)

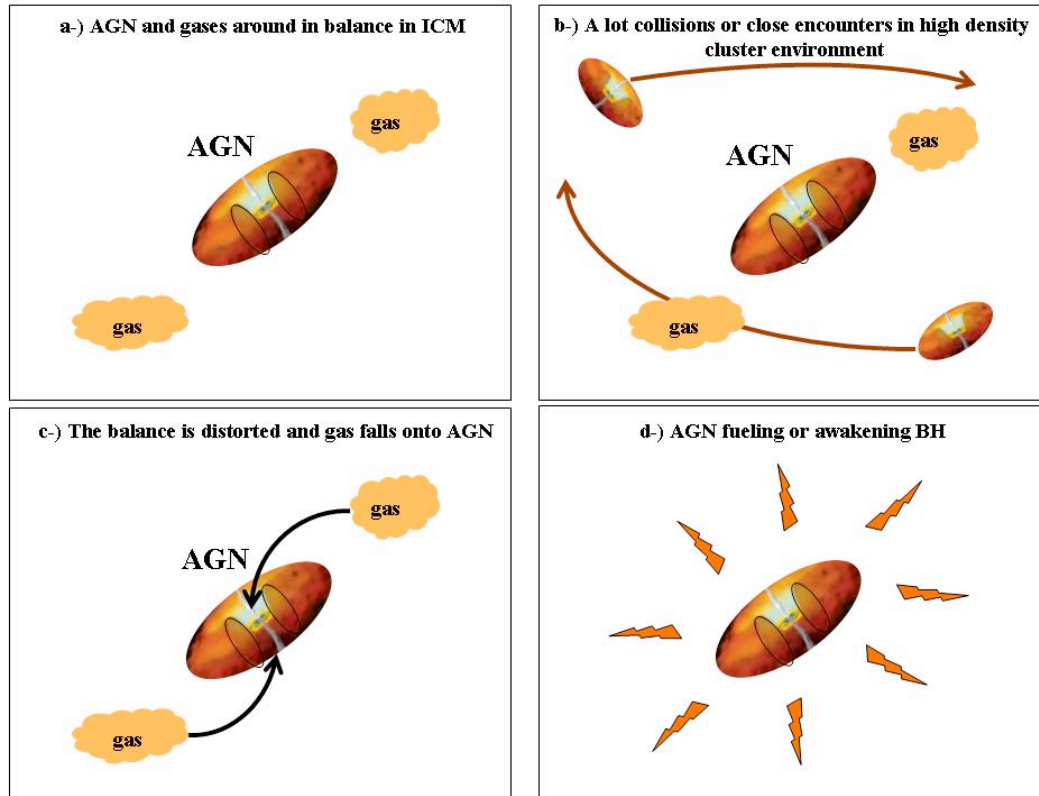
Molnar et al. (2002) from Abell 1995 ($z = 0.32$)

Johnson et al. (2003) found MS1054-03 to have a $\sim 2\sigma$ excess

Cappelluti et al. (2005) reported $> 2\sigma$ excess @ ($0.24 \leq z \leq 1.2$)

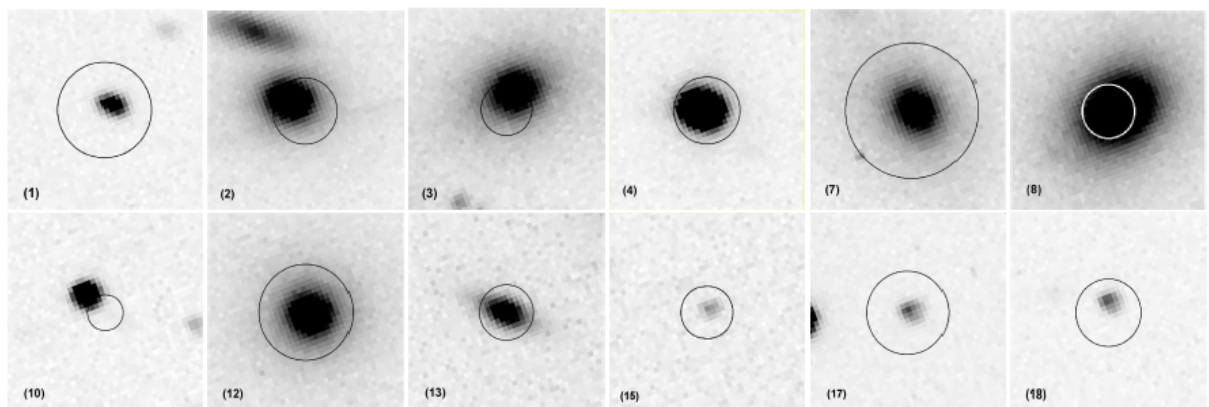


clustering fuels AGN



dynamical implications

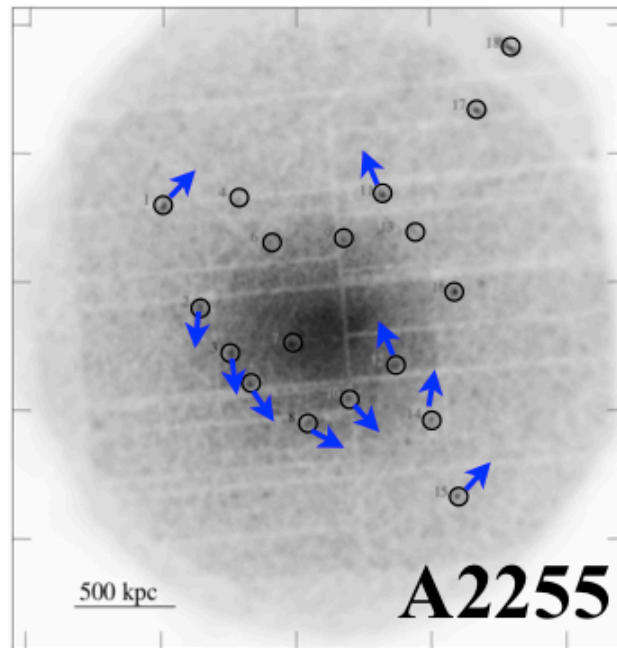
galaxies of A2255, optical counterparts



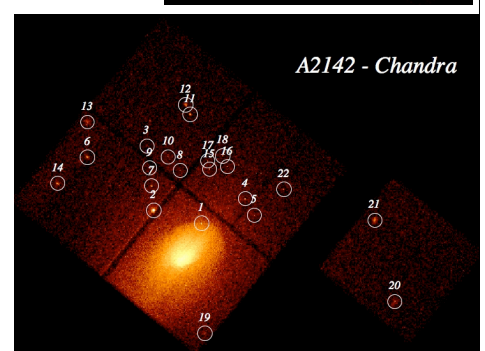
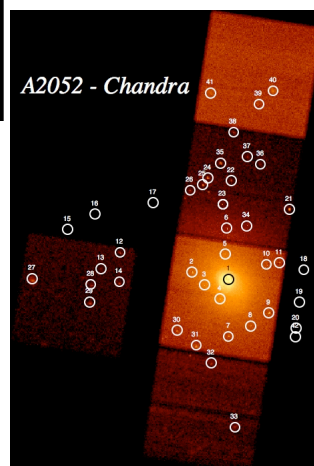
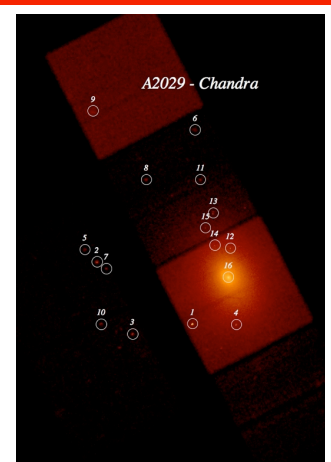
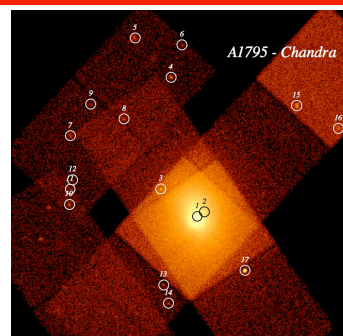
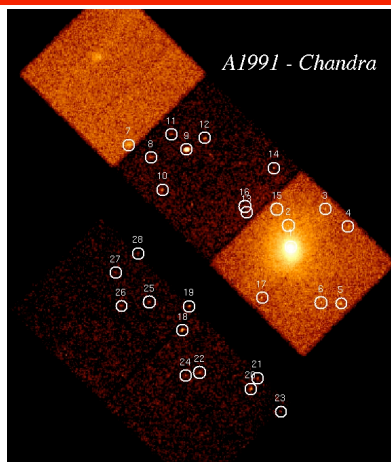
X-ray selected optical follow-ups of A2255 cluster members.
X-ray from XMM, optical images are from TFOSC.
1.5m Turkish optical telescope in Antalya

dynamical implications

The X-ray and optical peak shifts are intriguing for galaxy dynamics within the clusters?!....



ongoing research



Collaboration with
IKI-RUN

nature of X-ray
AGNs with
Chandra

SUMMARY

- excess emission from X-ray sources from cluster outskirts
- clustering and infalls triggers AGN activity

low velocity dispersions on outskirts

--> galaxies are more likely to form bound-pairs

Let's meet where the continents meet..



THANK YOU

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