X-ray properties of isolated galaxies

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SEE poster Hot/cold gas phases in Isolated galaxies
X rays in elliptical galaxies: a puzzle since their discovery

Large spread in the \(L_x/L_B\) plane:

- **Discrete sources**
  - @ low \(L_x\)
  - \(~\) prop to mass/GCs
  - Predictable!

- **Hot gas**
  - @ high \(L_x\)
  - large scatter (>100x @ \(L_B\))
  - correlation with galactic properties?

- \([\text{AGN}]\)
HIGH LUMINOSITY SYSTEMS
Gas dominated: extended and complex
Regular at large radii
Tails
Structures at small radii

Trinchieri et al ‘07

Grützbauch et al ‘07
INTERMEDIATE LUMINOSITY SYSTEMS

Ex: NGC 1553 - $L_x = 1 \times 10^{41}$ erg/s:
- 30% resolved [49 sources $\rightarrow$ LMXB]
- 70% diffuse: 25% unresolved sources
- 75% hot gas

discrete sources:
uniformly distributed

gas:
irregular

Blanton et al. 2001

Chandra data
Virtually no gas:

In NGC4278: 180 sources within $D_{25}$

In NGC3379: 98 sources within $D_{25}$

$L_x^{(TOT)} \sim 3 \times 10^{39}$ erg/s

$L_x^{(gas)} \sim 4 \times 10^{37}$ erg/s

$\Rightarrow 1\%$

How do we interpret the scatter?

Modeling for gas component. For ex: **Inflow/outflow (winds)** (Ciotti et al '91)

Inflow $\Rightarrow$ keep gas in system
$\Rightarrow$ high $L_x$

Outflow $\Rightarrow$ clean out the gas
$\Rightarrow$ low $L_x$

Note: winds are hard/impossible to detect!

1 case so far: NGC3379 (Trinchieri et al 08)
$L_x \sim 4 \times 10^{37}$ erg s$^{-1}$ $M_{\text{gas}} \sim 3 \times 10^5$ $M_\odot$
Gas in an outflow phase?

- Hydrodynamical simulations tailored to NGC 3379
- Assume passive evolution and age=9 Gyr
- Use: observed $L_\text{\textalpha}$, velocity dispersion, total stellar mass
- Time evolving inputs:
  - stellar mass loss
  - SNIa heating

$\Rightarrow$ Predicted profiles for 2 SNIa decay rates

- Gas in **outflow** phase:
  
  \[ L_\text{\textalpha} \sim 4 \times 10^{37} \text{ erg s}^{-1} \]  
  \( (0.5-2.0 \text{ keV}) \)  

  \[ M_{\text{gas}} \sim 3 \times 10^5 M_\odot \]  

\[ \text{vs 2} \]

\[ \text{vs 5} \]
How do we interpret the scatter?

Select sample “appropriately”

Select galaxies according to:

- Morphology [E/S0] eg. Eskridge et al. ’95
- Shape [Bender et al.’89, Pellegrini ‘94, Kormeny et al.’09]
- Total / luminous Mass
- Evolutionary history (Samson 2000, Nolan et al. 2004, Brassington et al. 2007)
- Central velocity dispersion
- Environment
Isolation: is this a guarantee of a more homogeneous behaviour?

EVIDENCE FOR ENVIRONMENTAL EFFECTS ON X-RAY HALOS: contradictory results ....
✓ massive galaxies nearby $\Rightarrow$ systematically lower $L_x/L_B$ (White & Sarazin 91, Henriksen & Cousineau 99)
✓ positive correlation $L_x/L_B$ and the local galaxy density Brown & Bregman 2000

Central group galaxies are brightest – and brightest galaxies are at group centers.

EXGs are surrounded by hot intragroup medium

✓ scatter at high $L_x$
✗ the whole scatter
Other members?
Stripping vs confinement
Isolation:

Is this a guarantee of a more homogeneous behaviour?

Problem: overlap with X-ray datasets!

XMM proposal for a sample of isolated galaxies (Focardi & Kelm ’09 – see Memola et al ’09):

from Updated Zwicky Catalog (UZC, Falco et al. 1999)

a) minimum B luminosity
   \[ L_B > 1.3 \times 10^{10} \, L_{\odot} \]

b) velocity range
   \[ v_r \in [2500-5000] \, \text{km/s} \]

c) \[ |b_{II}| \geq 15^\circ \]

d) no companions in 3-D space
   \[ (R_{iso}=1.3 \, \text{Mpc}; \Delta v=1000 \, \text{km/s}, \Delta m) \]

8 early-type galaxies
(Smith et al, Reda et al, AMIGA …)

5 observed in X rays (so far)

Added literature ▲ archival ● data
Isolation: is this a guarantee of a more homogeneous behaviour?

Other quantities?
Isolation:

is this a guarantee of a more homogeneous behaviour?

No "observational bias" from X rays.

M > M⊙ or L_B > L⊙ → galaxies “hold on” to the hot gas produced
Gas masses consistent with accumulation from stellar mass loss

M < M⊙ or L_B < L⊙ → galaxies “can” loose the hot gas produced
Isolation: is this a guarantee of a more homogeneous behaviour?

“Less extreme” yet “poor” environments
**ISOLATION IS NOT THE FULL ANSWER!**

Scatter in the Lx-Lb relation is not entirely due to environment – some must be intrinsic !?

**ginMerging histories : a lot more work needs to be done!**

**AGN : what role do they play? Is feedback important at regulating “gas retention”?**

More complex than simple presence of a [now active] AGN