Hot Gas in Groups: NGC 5328

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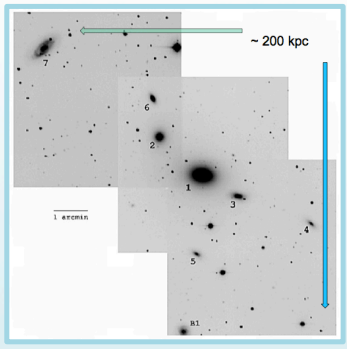
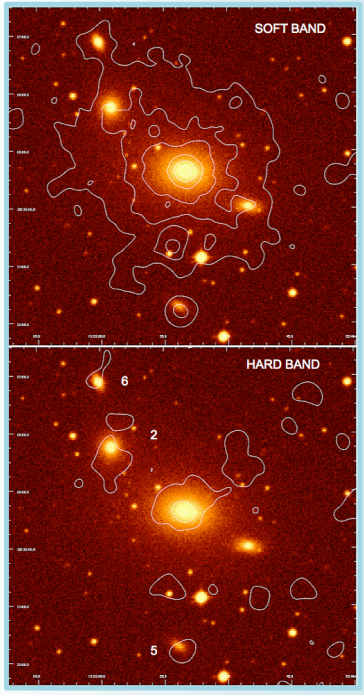


The X-ray picture

The X-ray content of early-type galaxies is expected to be tightly connected with the galaxy mass, via the ejecta of the stellar evolution, although no clear correlation with mass proxy emerges from observations (eg Memola et al. 2009 and references therein). We know also from optical studies that the environment, to some extent, drives the evolution in early-type galaxies (eg Clemens et al. 2009 and reference therein). It is therefore essential to independently study the contribution to the X-ray emission coming from the galaxy and that from the surrounding environment. This is easier in small structures like galaxy groups.
We present here the X-ray view of NGC 5328, a small group that might represent a filament falling into the Abell 3754 cluster. It offers a clean view of early-type galaxy processing at the border of a rich environment.

The group NGC 5328

The group recession velocity (Vgr=4937 km/s; σ=342 km/s) is similar to that of the cluster Abell 3574 (only ~40 km/s larger than that of NGC5328). Its vicinity in projection (~1 Mpc) suggests that the group may be connected to the cluster (see Gruetzbach et al. 2005). The dominant elliptical galaxy NGC 5328 ("round or somewhat elongated"; Klemola 1969) at D=66.8 Mpc (Vgal=4785 km/s) is old: t=12.3+-3.7 Gyr (Annibali et al. 2007). The age of NGC 5328 and the evidence that any activity (SF and/or AGN) is confined to the outskirst of the group suggest that the center of the group is evolved.

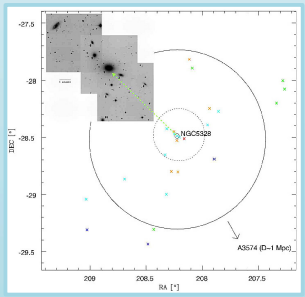


X-ray data

Previous observation from ROSAT (Beuing et al. 1999) finds 50 counts in R=16.3' for a total luminosity:
L_X = 1.1 x 10^{42} erg/s (@D=85.5 Mpc) which corresponds to
6.7 x 10^{41} erg/s (@D=66.8 Mpc ; Ho=70 km/s/Mpc)
assuming kT =1 keV and Z = Zsol

XMM-Newton observations: 28 ks for a total "cleaned" time (free of background flares) of 12.7/10.4 ks for pn/MOS

Smoothed contours are plotted on the DSS images for the soft (0.3-2 keV) and the hard (2-5 keV) band.
Size of the image is ~6'x6' (the central part of the group)
Other galaxies in the group are labeled
2: NGC 5330 (E1)
[4: 2MASX J13523852-2830444 (star forming) → outside the image]
5: 2MASX J13525393-2831421 (star forming)
6: 2MASX J13530016-2827061 (S0)
[7: MCG-5-33-29 is a low luminosity Sy2 → outside the image]
Lx ~ $10^{39\text{-}40}$ erg/s for the detected members



Kinematics & Dynamics:
Dashed circle: values are luminosity weighted for the contribution of each member galaxy (color runs according to regression velocity; group members are in cyan)
M_{vir} = 2.1 x 10^{14} Msun
r_{vir} = 0.31 Mpc
σ = 211 km/s (27 members)

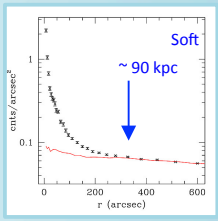
Solid circle: Values are unweighted:
M_{vir} = 17.3 x 10^{14} Msun
r_{vir} = 1.06 Mpc
σ = 326 km/s (27 members)

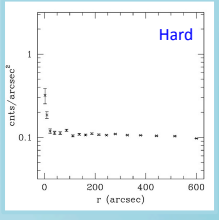
Crossing time ~ 0.2 Hubble times

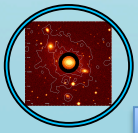
The group is bound but possibly not yet virialized in the outskirts. It remains possibile that it is falling onto A3574.

Profiles in the Soft and Hard band

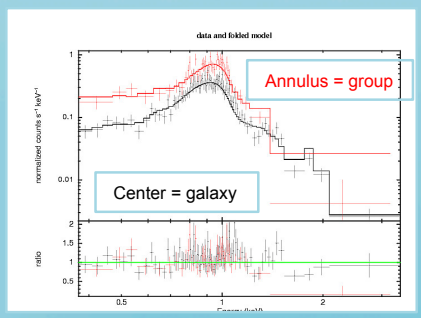
The source extend to at least 90 kpc in the soft band





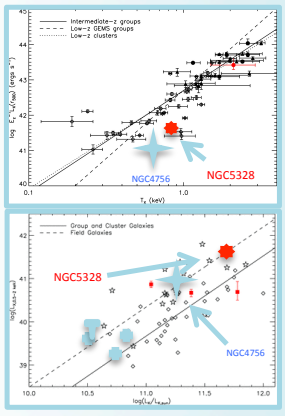


Blue circles indicate the extraction areas to derive the spectra:
Center: R=40", galaxy D25
Annulus: R=300", group total extent from profile

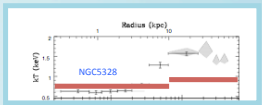


Spectra are extracted in two different spatial regions (shown pn spectrum only): the center (in BLACK) – for which we use the annulus as the background; and the annulus (in RED) – for which the background is taken in large circles around the source chosen to avoid bright sources and the CCD boundaries. Although very similar the two temperature are quite distinct in the spectra. Low energy absorption is consistent with Galactic.

Comparison with other sources



L_X vs kT and L_X vs L_K for field and cluster galaxies. NGC 5328 is the red symbol, while the green ones are the other galaxies in the group. NGC 4756: see poster by Trinchieri et al. X-ray luminosity and temperature of the gas are in good agreement with what is expected from poor groups. Adapted from Jeltema et al. (2008; 2009).



We compare NGC5328 by rescaling extraction radii to the distance of the galaxy NGC 4261 (D=31 Mpc), which exhibits a cool core and a raising temperature profile. In NGC5328 this effect is small and might indicate that the resolution is not sufficient to separate a cooler galactic corona from the group environment.
The group temperature seems however consistent with other low-z groups. Figure adapted from O'Sullivan et al 2011.

Fit with phabs*apec (abund=grsa)

kT = 0.83+/-0.04 keV
kT = 0.89+/-0.04 keV

L_X(0.5-10keV) = 1.7 10^{41} erg/s
L_X(0.5-10keV) = 3.9 10^{41} erg/s

For a total L_X=5.6 10^{41} erg/s consistent with previous ROSAT results (kT is in fact close to 1 keV !!)

Conclusions

The properties of NGC 5328 and the other galaxies of the group are consistent with findings in other groups. The central part of the group is bound; the X-ray gas emits at ~ 1 keV.
Clear signatures of activity, from AGN to recent star formation, lurk in the faint companions at the outskirts suggesting an on-going galaxy processing which is shaping the group before the ingestion by Abell 3754.

References
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