HOT GAS IN GROUPS AND THEIR GALAXIES

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1. Introduction

It is clear that there is an important interplay between galaxies and the group environment. At the velocity dispersions ($\sim 100\,\mathrm{km\,s^{-1}}$) characteristic of groups, the galaxies interact strongly, leading to triggering of star formation, and galaxy merging. We can expect to see evidence of such processes through differences in the properties of galaxies in groups compared to field galaxies. Conversely, the galaxies affect their environment, as is apparent from the presence of heavy elements in the hot intergalactic medium (IGM) in groups, which emit characteristic X-ray lines.

In the present contribution, we will examine the X-ray properties of galaxies within groups, and the distribution of heavy elements in the IGM revealed by imaging X-ray spectrometers.

2. Properties of galaxies in groups

Much of the evidence regarding the peculiarities of galaxies in groups has been derived from the study of *compact* groups. Some of the effects seen are: morphological and dynamical peculiarity (Mendes de Oliveira & Hickson 1994), HI deficiency in spirals (Williams & Rood 1987), lowered velocity dispersion in ellipticals (Zepf & Whitmore 1993) and an anti-correlation of spiral fraction with velocity dispersion (Hickson *et al.* 1988) and X-ray luminosity (Ponman *et al.* 1996). However, any enhancement in star formation rates appears to be very limited, and few galaxies look like the remnants of recent mergers (Zepf 1993).

K. Koyama et al. (eds.), The Hot Universe, 61-64.

What of the X-ray properties of the galaxies? In the field, many ellipticals have hot gaseous halos (Fabbiano *et al.* 1992), whilst spirals show complex emission from sources within the body of the galaxy, and where active star formation is present, also from hot coronae or winds (Read *et al.* 1997). The ROSAT PSPC is an excellent instrument for detecting X-ray emission from the hot IGM, but is not well suited to separating this from emission associated with individual galaxies. In contrast, as can be seen in Fig.1, the ROSAT HRI, with its much higher spatial resolution, is able to study the emission from group galaxies, with little impact from the IGM. We have analysed ROSAT HRI observations of 11 Hickson compact groups

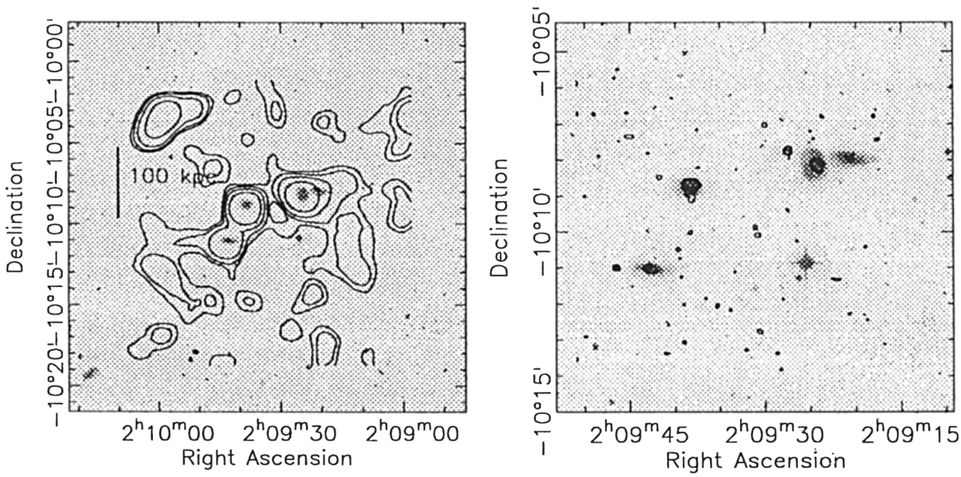

Figure 1. The X-ray emission from the compact group HCG16 (contours) overlaid on an optical image, as viewed (left) by the ROSAT PSPC, and (right) by the HRI.

(HCGs), detecting emission from a total of 27 galaxies and deriving X-ray upper limits for a further 20. The properties of the late type (spiral and irregular) galaxies in this sample are shown in Fig.2. The detected systems, which include almost all of the galaxies with $L_B > 4 \times 10^{10}\, L_\odot$, all lie above the field spiral line. This provides clear evidence that late type galaxies in these systems are X-ray overluminous. This is *not* a random sample of HCGs, but a set chosen in part because of the presence of disturbed and infrared-bright galaxies. Nonetheless, it is clear that in these systems at least, the galaxies show enhanced X-ray activity.

In the case of early type galaxies, one might expect to see a *reduction* in L_X relative to field galaxies, since dark halos, which are required to retain the hot gas halos of ellipticals, should be stripped by tidal interactions in such tight groups, as shown by simulations. The results (Fig.2) show little sign of any such reduction in L_X, even if one disregards the high values for the dominant central ellipticals. This suggests that dark halos have not

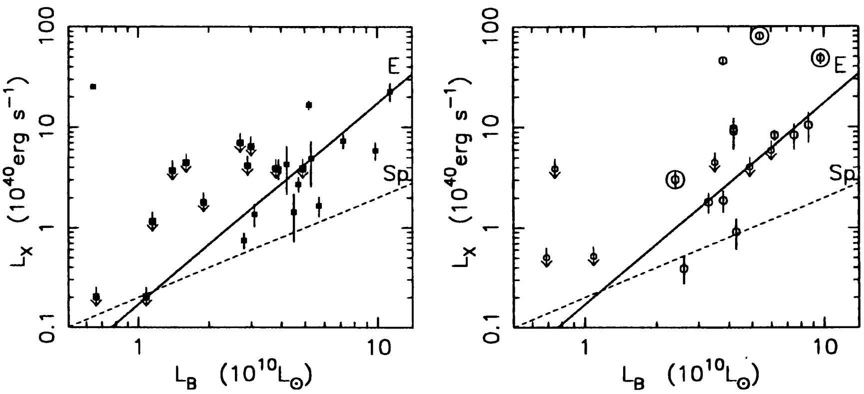

Figure 2. X-ray vs blue luminosity for a sample of (left) late type galaxies and (right) early type galaxies in HCGs (2σ upper limits are denoted with down arrows), compared to the relations (from Fabbiano *et al.* 1992) for field spirals and ellipticals. Elliptical galaxies marked with a double circle are dominant central ellipticals, whose luminosity may well be enhanced by a contribution from the group IGM.

been stripped in many of these galaxies, a result which offers a challenge to theorists.

3. Heavy elements in the intergalactic medium

The ASCA SIS provides an opportunity to map the strength of the emission lines from a number of elements within the IGM in groups and cool clusters. The best determined abundances are those of Fe and Si. Since the Si/Fe ratio is very different in the ejecta from supernovae of types Ia and II, the distribution of these elements gives strong clues to the processes which have contaminated the primordial IGM.

Fukazawa *et al.* (1997) have studied a sample of 40 clusters and groups with ASCA, deriving abundances for Fe and Si in an inner and outer region in each case. Finoguenov & Ponman (in preparation) have studied a much smaller sample, of three groups plus one poor cluster, but have mapped the radial distribution of the elements in detail – allowing for the effects of projection and the blurring of the instrument psf. The results of these two studies are consistent (cf Fig.3) and show that

- Abundance gradients are common in cool systems
- Abundance ratios are ~solar in the inner regions of both groups and clusters, indicating a mixture of SNIa and SNII ejecta
- In clusters the abundance ratio is tilted towards SNII abundances (high Si/Fe) at larger radii
- It appears that the total iron mass-to-light ratio may be lower in groups than clusters (though observations do not yet extend out to the virial

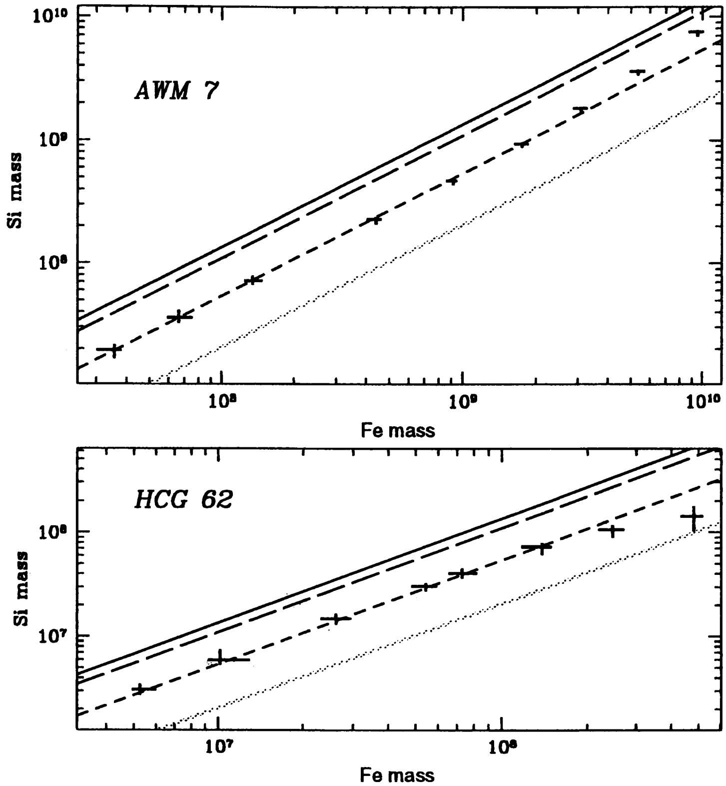

Figure 3. Cumulative mass of Si from the centre of the system is plotted against that of Fe, for the poor cluster AWM7 and the compact galaxy group HCG62. In each plot, the short dashed lines corresponds to solar abundance ratio, the grey line to SNIa (Thielmann *et al.* 1996), and the two uppermost lines to two models for SNII (Woosley & Weaver 1995, Tsujimoto *et al.* 1995).

radius in such small systems)

These results support a picture in which SNIa play a larger role in groups than in clusters, due to the loss of much of the SNII ejecta from the relatively shallow potential well in these smaller systems.

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