X-raying Close Pairs of Interacting Galaxies: Activation of Quiescent AGN?

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Abstract: We report XMM-Newton and Chandra observations of a sample of 11 interacting pairs of similar sized galaxies. X-rays can unveil hidden active nuclei, providing a method to discover binary AGN and to characterize the galaxies activity in function of the pair separation, their morphology, and other parameters that indicate the stage of the merging process.

The scenario at work could be the one proposed by Mortlock et al. (1999, MNRAS, 309) for binary quasars activation, in which the gas accretion triggered by encounters of galaxies could refuel a quiescent nuclear black hole, powering the AGN.

Introduction

Galactic interactions are thought to be effective in driving the gas from the circumnuclear region into the inner nuclear regions. An empirical model (Mortlock et al. 1999) suggests that when the galaxies reach a certain distance, tidal interactions cause gas flowing into the cores of galaxies *switching on* the BH. Mortlock et al. estimated this *activation distance* to be in the range of 50-100 kpc.

X-raying the galaxy pairs

We observed 11 pairs of nearby galaxies (Table 1) in order to investigate the enhancement of SF or AGN activity as triggered by the interaction. There might be interaction stages in which if both galaxies of the pair have similar sizes and morphologies both galaxies can show AGN activity, like was the case for AM1331-231 (Guainazzi et al. 2005, A&A 429, L9). The scenario at work could be the one proposed by Mortlock et al. (1999, MNRAS, 309) for binary quasars activation, in which the gas accretion triggered by encounters of galaxies could refuel a quiescent nuclear black hole, powering the AGN. The galaxy pairs of Our sample were previously classified as HII galaxies, based on optical and IR data (Sekiguchi & Wolstencroft 1992, MNRAS, 255).

Table 1. Observed Pairs of Galaxies

Name	z	Pair separation		Observ.
		arcsec	kpc	
AM 1211-465	0.018	268	100	XMM-Newton
AM 2040-674	0.034	48	30	XMM-Newton
AM 0545-453	0.042	24	20	Chandra
AM 0316-573	0.028	20	12	Chandra
AM 0707-273	0.010	47	10	XMM-Newton
AM 0630-353	0.027	17	10	Chandra
AM 2049-691	0.037	12	10	Chandra
AM 0127-524	0.054	9	10	Chandra
AM 0117-412	0.017	23	9	Chandra
AM 0337-711	0.049	9	9	Chandra
AM 0302-274	0.022	16	7	Chandra

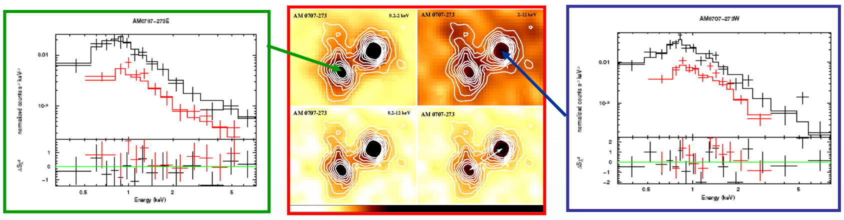

Figure 1 *Center*: Smoothed pn images of the AM0707-273 pair in the 0.2-12 keV, 0.2-2 kev, 2-12 keV bands and the optical image with surface brightness contours superimposed. AM0707-273E is more extended than its companion. Both galaxies have intense nuclear emission in the hard band. *Left:* Observed spectrum (pn in black and MOS12 in red), best fit model and residuals for AM0707-273E [power law with Γ=1.4±0.3 and an absorbed (nH=8±0.3×10^{21} cm^{-2}) thermal (kT=0.18±0.12 keV) emission]. The resulting luminosities are $L_{0.5-2\ keV}$ = 1.82±0.11×10^{41} and $L_{2-10\ keV}$=1.53±0.05×10^{40} erg/s. *Right:* Spectrum of AM0707-273W. The best fit model consists of an absorbed (nH=1.7±1.3×10^{21} cm^{-2}) power law (Γ=2.2±0.6) and an absorbed (nH=4±3×10E^{21} cm^{-2}) thermal (kT=0.4±0.2 keV) emission. The resulted luminosities are $L_{0.5-2\ keV}$ = 2.08±0.15×10^{40} and $L_{2-10\ keV}$ =8.4±0.2×10^{39} erg/s.

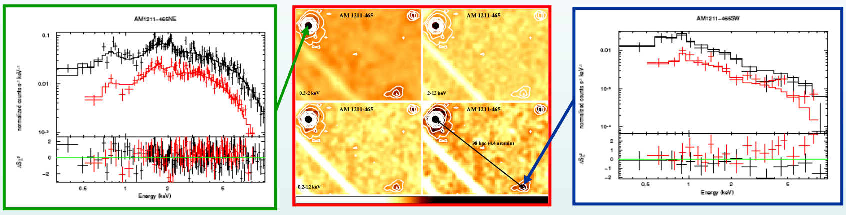

Figure 2 Same as in Fig. 1 for AM1211-465. Both members show extended emission. The hard band image shows very intense emission in AM1211-465NE. For AM1211-465SW the best fit model is a power law (Γ=1.0±0.2) with an absorbed (nH=8.3±0.9×10^{21} cm^{-2}) thermal (kT=0.11±0.06 keV) emission. The resultant luminosities are $L_{0.5-2\ keV}$ = 3.49±0.09×10^{42} and $L_{2-10keV}$ =1.5±0.3×10^{41} erg/s

For AM1211-465NE the best fit model consists of an absorbed (nH = 2.16±0.15×10^{22} cm^{-2}) power law (Γ=1.66±0.14) and an absorbed (nH=5±3×10^{21} cm^{-2}) thermal (kT=0.21±0.15 keV) emission. The resulted luminosities are $L_{0.5-2keV}$ =1.3±0.2×10^{42} and $L_{2-10keV}$ =1.9±0.2×10^{42} erg/s. A neutral FeKα line is also marginally (98% according to the F-test) detected.

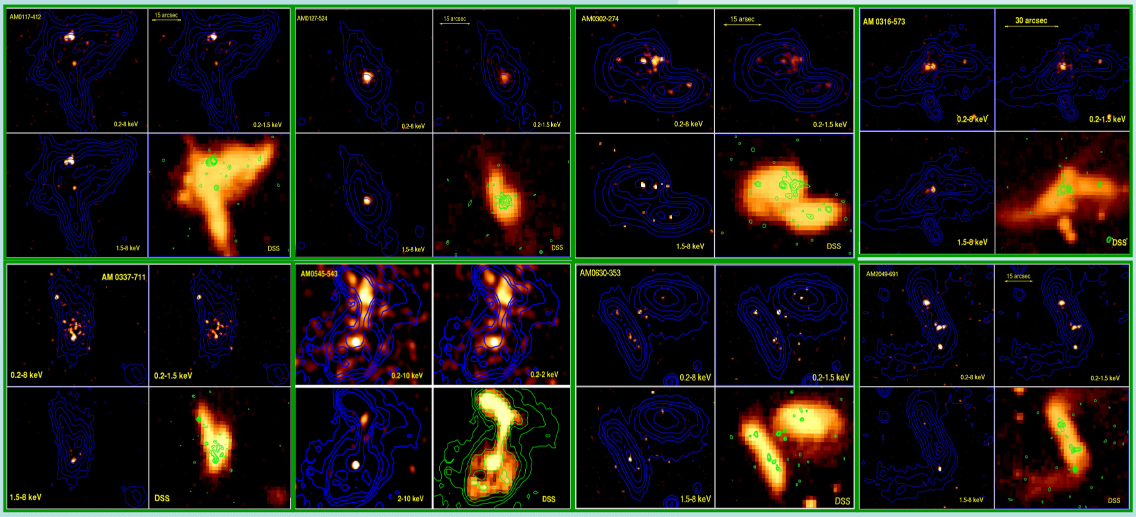

Figure 4. Chandra observations of 8 pairs of galaxies in the bands 0.2 to 1.5 keV and 1.5 to 8 keV showing different behavior of nuclei and disc components

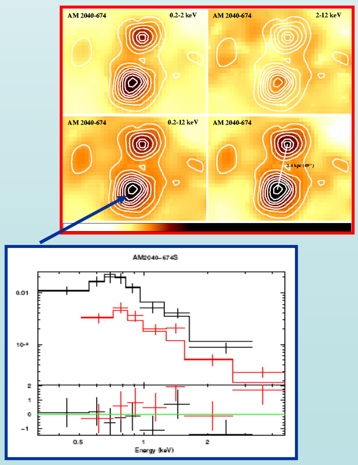

Figure 3 Same as in Fig.1 for AM2040-674. The north component is not visible in the hard band. For AM2040-674S the best fit model consists of a power law (Γ=1.7±0.3) and a thermal (kT=0.34±0.09 keV) emission. The resultant luminosities are $L_{0.5-2\ keV}$ = 5.3±0.06×10^{40} and $L_{2-10\ keV}$ =5.6±1.0×10^{40} erg/s.

Conclusions

❖- The X-ray spectra of some of the galaxies of our pairs show strong evidences of AGN activity, like AM1211-465NE. We have measured a luminosity of 1.9±0.2x10^{42} erg/s in the 2-10 keV band and the presence of a neutral Fe-Kα line with a significance level of 98%. The high nH value measured, 2.16±0.15x10^{22} cm^{-2}, would explain the previous misclassification of the source as HII. Marginal evidence of AGN nature was also found in the X-ray spectra of AM1211-465SW and AM0707-273E. The X-ray emission of other galaxies can be explained with starburst activity. Partial results of the XMM-Newton data have been already published (Jiménez-Bailón et al. 2007, A&A in press). The analysis of the Chandra data and the global conclusions for the sample will be submitted for publication in the near future. Apart from the nuclei it is observed enhanced X-ray emission in the disc of the galaxies, including possible ULX.

❖- Our results agree with the scenario of the activation of quiescent black holes through the gas accretion triggered by encounters of galaxies. This type of analysis probes the importance of X-ray studies of galaxy pairs to accurately determine the nature of their nuclei, in particular in those suffering high absorption.

❖- For the next decade of XMM-Newton we would like to widen the sample of galaxy pairs, basing their selection on the results of these observations, in order to unveil new binary AGN and characterize them.