Ricerca di galassie in interazione/fusione in un campione di oggetti selezionati in raggi X di alta energia

Search for galaxies in interaction/merging in a sample of hard X-Ray selected objects

Part 1

Francesco Bonora[1], A. Malizia[2], L. Bassani[2]

[1] Liceo Scientifico Augusto Righi - Bologna
[2] IASF – INAF - Bologna

Report N. 658/2015

Student Stage June-July 2015

ISTITUTO DI ASTROFISICA SPAZIALE E FISICA COSMICA – BOLOGNA
Area della Ricerca di Bologna – via Piero Gobetti, 101 – 40129 Bologna – ITALY
e-mail: segreteria@iasfbo.inaf.it – PEC: inafiasfbo@pcert.postecert.it– www.iasfbo.inaf.it
Tel. (+39) 051.6398688 – Fax (+39) 051.6398724 - Cod. Fisc. 97220210583 – Part. Iva 06895721006

Introduction

An Active Galactic Nucleus (AGN) is a compact region in the center of a galaxy that has a much higher than normal luminosity and that emits more energy, as electromagnetic radiation, than the rest of the galaxy; about 100 times higher. A galaxy which hosts an AGN is an active galaxy. The radiation from AGN is believed to be the result of accretion of mass by a super massive black hole(SMBH) at the center of its host galaxy.
In the local Universe about 10% of all galaxies are active.
In order for a SMBH to shine as an AGN, it needs a supply of gas to fuel its activity. Two main mechanisms have been suggested to trigger AGN activity: an internal mechanism through a dynamical instability inside the galaxy and **an external mechanism through galaxy-galaxy interaction or merging**. However, it is not yet clear which one is the dominant mechanism, even after many observational studies have been carried out.

The internal mechanism is such that a gas inflow to the central part occurs as a result of instability in the internal structure of a galaxy. For example, a galaxy bar can move gas from the outer regions of a galaxy into its center, and then the gas inflow can trigger the AGN phase.
On the other hand, the external mechanism is represented by galaxy-galaxy encounter and collision. In such a mechanism, gas infall during a major galaxy merging triggers the AGN. There are a number of observational results that support this idea. Studies of galaxy pairs or galaxies in interaction find that the AGN fraction increases in such systems. Binary SMBH in some AGN demonstrate that two or more SMBH can merge into one SMBH. After all, many AGN host galaxies are found to be elliptical galaxies, which do not possess bars or disk instabilities and hence must have been triggered by galaxy-galaxy collisions.
One promising way to investigate the AGN and merger connection is to study objects with merging features. When two galaxies with comparable mass merge, the merging produces an early-type galaxy leaving a trace of the past merging activity in the form of tidal tails, shells, and dust lanes. In support of this theoretical expectation, very deep imaging of early-type galaxies find merging features in many cases (15%–80%, depending on the depth of the image).

Recently a large number (20-25%) of these systems has been found analyzing samples of active galaxies selected in the hard X-ray band (20-100 keV) (see Koss et al. 2010 and Cotini et al. 2013). This fraction is much higher than the one (a few percent only) seen in control samples of normal galaxies and indicates that the AGN activity can indeed be triggered by galaxy-galaxy encounters.

ISTITUTO DI ASTROFISICA SPAZIALE E FISICA COSMICA – BOLOGNA
Area della Ricerca di Bologna – via Piero Gobetti, 101 – 40129 Bologna – ITALY
e-mail: segreteria@iasfbo.inaf.it – PEC: inafiasfbo@pcert.postecert.it– www.iasfbo.inaf.it
Tel. (+39) 051.6398688 – Fax (+39) 051.6398724 - Cod. Fisc. 97220210583 – Part. Iva 06895721006

Aim of the present project is to search for interacting/merging galaxies in a similar but much larger sample of AGN compared to the ones used by Koss et al. and Cotini et al. In fact, we have made our search using the latest survey made by the instrument BAT on board Swift, a NASA satellite. The identification of a group of AGN in interaction and/or merging selected in the hard X-ray band will allow the astronomers to study in depth their properties and to understand the merging mechanism in more detail.

Data Analysis and Results

We are 4 high school students, which attended the summer stage on the "Search for galaxies in interaction/merging in a sample of hard X-ray selected objects" and divided among ourselves the work load of this project during the 3 weeks spent at IASF/INAF of Bologna. To search for interacting/merging galaxies, we have used the Swift BAT 70-Month Hard X-ray survey catalogue (http://swift.gsfc.nasa.gov/results/bs70mon):this survey contains a total of 1210 high energy objects the majority of which are of extragalactic nature; in particular 822 sources are associated with active galaxies. We divided this sample of AGN in 4 parts: my set included all objects located from RA(J2000)=165.868 Degrees, to RA(J2000)=241.469 Degrees. For each of these objects, I have analyzed the optical/infrared images available in the archives to look for signs of interaction/merger and have searched the literature to back up my findings. In this project I have used two main databases (NED or NASA/IPAC Extragalactic Database and SIMBAD or Set of Identification, Measurements, and Bibliography for Astronomical Data), as well as the Aladine software to visualize images. I have also searched these databases by coordinates to confirm that the counterpart analyzed was the same as that reported in the Swift catalogue. Sources that were found to display signs of interaction, perturbation or the presence of a nearby companion/s were then further investigated in the archives to find confirmation that they were indeed the type of systems I was looking for.
In NED I also checked notes and references to individual sources to see if someone else had already observed and studied them in order to compare our results.
Finally I checked that eventual companion to interesting sources were at the same distance or redshift. I found 37 galaxies in merger or in interaction from my initial sample of 206 galaxies. These objects are listed in Table where I report the Swift name, redshift, class, morphology and companion.

ISTITUTO DI ASTROFISICA SPAZIALE E FISICA COSMICA – BOLOGNA
Area della Ricerca di Bologna – via Piero Gobetti, 101 – 40129 Bologna – ITALY
e-mail: segreteria@iasfbo.inaf.it – PEC: inafiasfbo@pcert.postecert.it– www.iasfbo.inaf.it
Tel. (+39) 051.6398688 – Fax (+39) 051.6398724 - Cod. Fisc. 97220210583 – Part. Iva 06895721006

TABLE

Name SWIFT	**Z**	**Class**	**Morphologhy**	**Companion**
SWIFT J1104.4+3812	0.030021	BLL	Spiral	LEDA 33453 Z= 0.031288
SWIFT J1114.3+2020	0.026151	GiC	Pair	NGC 3588 NED02 Z= 0. 026852
SWIFT J1115.3+5423	0.071212	Sy2		MCG +09-19-015 NED01 Z= 0.071299
SWIFT J1125.6+5423	0.021091	Sy1	S0 pec	SDSS J112535.23+542314.3 Z= 0.020785
SWIFT J1126.7+3514	0.032268	Sy1	S0?	SDSS J112648.65+351454.2 Z= 0.032081
SWIFT J1132.7+5301	0.003312	LIN	SB(s)a pec	NGC 3729 Z= 0.00396
SWIFT J1136.0+2132	0.029717	Sy1		NGC 3758W Z= 0.02948
SWIFT J1138.9+2529B	0.219514	AGN		Several small companions Z≈ 0.2238
SWIFT J1139.8+3157	0.008933	Sy1	SAB(rs)a pec	NGC 3788 Z= 0.009003
SWIFT J1145.6-1819	0.032949	Sy1		2MASX J11454080-1827359 Z= 0.032200
SWIFT J1158.9+4234	0.031199	Sy2	Sb? edge-on	IC 0752 Z=0.030412
SWIFT J1204.9+3105	0.024997	Sy1	S?	SDSSCGB 10195.1 Z= 0.026428
SWIFT J1210.7+3819	0.022792	Sy1		2MASX J12104784+3820393 Z=0.022858
SWIFT J1214.3+2933	0.064000	Sy1		WAS 49a Z= 0.063280
SWIFT J1217.2-2611	0.039714	Sy2	Sc	ESO 505-31 Z= 0.039434
SWIFT J1219.4+4720	0.001494	Sy2	SAB(s)bc	NGC 4248 and several satellites Z= 0.001614
SWIFT J1240.2+3457B	0.023106	Sy1	SB(r)b pec?	SDSS 124134.50+350634.6 Z= 0.023623
SWIFT J1252.3-1323	0.014630	Sy1		2MASX J12521292-1324388 Z=0.014463
SWIFT J1255.0-2657	0.059114	Sy1		2MASX J12545749-2657111 Z= 0.0058260
SWIFT J1315.8+4420	0.036553	Sy2		MCG+08-24-095 Z= 0.036690

ISTITUTO DI ASTROFISICA SPAZIALE E FISICA COSMICA – BOLOGNA
Area della Ricerca di Bologna – via Piero Gobetti, 101 – 40129 Bologna – ITALY
e-mail: segreteria@iasfbo.inaf.it – PEC: inafiasfbo@pcert.postecert.it– www.iasfbo.inaf.it
Tel. (+39) 051.6398688 – Fax (+39) 051.6398724 - Cod. Fisc. 97220210583 – Part. Iva 06895721006

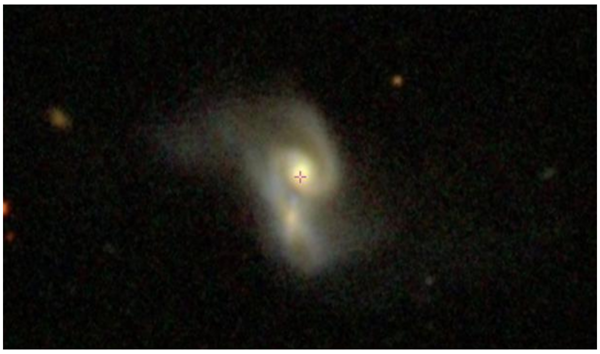
SWIFT J1321.2+0859	0.031942	LIN	Compact	NGC 5100 NED01 Z= 0.032
SWIFT J1334.8-2328	0.044600	Sy2	Pair	ESO 509-IG 066 NED02 Z= 0.033223
SWIFT J1336.0+0304	0.021759	Sy2	SBa	SDSS J133542.77+030006.7 Z= 0.022215
SWIFT J1341.2+3023	0.039861	Sy2		2MASS J13411536+3022184 Z= 0.039988
SWIFT J1352.8+6917	0.030451	Sy1	S0	MCG+12-13-024 Z= 0.031000
SWIFT J1354.5+1326	0.063480	Sy2 pair		2MASS J13542908+1327571 Z= 0.063329
SWIFT J1355.9+1822	0.050355	Sy2	S?	MRK 0463W Z= 0.051000
SWIFT J1413.2-0312	0.006181	Sy2	Sa pec edge-on	NGC 5507 Z= 0.006174
SWIFT J1419.0-2639	0.022389	Sy1	SA(rs)c pec	2MASX J14191109-2638228 Z= 0.022852
SWIFT J1421.4+4747	0.072296	Sy1		SDSS J142130.04+474728.6 Z= 0.072980
SWIFT J1434.9+4837	**0.036222**	**Sy1**	**SB0/a?(s)**	**NGC 5682 Z= 0.007581**
SWIFT J1441.4+5341	0.037726	Sy2		PGC 052445
SWIFT J1457.8-4308	0.016261	Sy2		IC 4518B Z= 0.016568
SWIFT J1515.0+4205	0.008546	Sy2	SAB(rs)c	NGC 5900 Z= 0.008519
SWIFT J1519.6+6538	0.044000	Sy2		MCG +11-19-005 0.044400
SWIFT J1542.0-1410	0.096400	Sy1		6dFGS gJ154225.0-141052 Z= 0.096020
SWIFT J1547.5+2050	0.264300	Sy1		Not Found

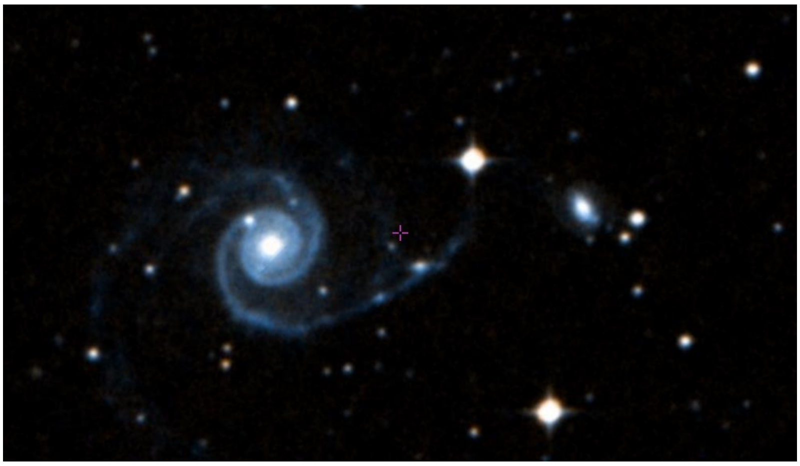
ISTITUTO DI ASTROFISICA SPAZIALE E FISICA COSMICA – BOLOGNA
Area della Ricerca di Bologna – via Piero Gobetti, 101 – 40129 Bologna – ITALY
e-mail: segreteria@iasfbo.inaf.it – PEC: inafiasfbo@pcert.postecert.it– www.iasfbo.inaf.it
Tel. (+39) 051.6398688 – Fax (+39) 051.6398724 - Cod. Fisc. 97220210583 – Part. Iva 06895721006

A few examples of the sources I found are display in the following images:

Mrk 421

Mrk 423





ESO 511-G030

NGC 3718

ISTITUTO DI ASTROFISICA SPAZIALE E FISICA COSMICA – BOLOGNA
Area della Ricerca di Bologna – via Piero Gobetti, 101 – 40129 Bologna – ITALY
e-mail: segreteria@iasfbo.inaf.it – PEC: inafiasfbo@pcert.postecert.it– www.iasfbo.inaf.it
Tel. (+39) 051.6398688 – Fax (+39) 051.6398724 - Cod. Fisc. 97220210583 – Part. Iva 06895721006

Conclusions

17.96% of the 206 galaxies analyzed by me have been found to be in interaction/merging, this number is similar to the fraction found in previous studies by Koss et al. (2010) and Cotini et al. (2013). All together the 4 students of my stage found 152 galaxies in interaction/merging in the total sample of 822 galaxies analyzed: this represents a fraction of 18.49%. Thus our research confirms in total previous studies made by the above authors and further indicates that indeed the encounter between galaxies may play a role in the activation of an AGN.

References

Koss, M. et al. (2010) Ap. J. 716, L125
Cotini et al. (2013)MNRAS 431, 266

ISTITUTO DI ASTROFISICA SPAZIALE E FISICA COSMICA – BOLOGNA
Area della Ricerca di Bologna – via Piero Gobetti, 101 – 40129 Bologna – ITALY
e-mail: segreteria@iasfbo.inaf.it – PEC: inafiasfbo@pcert.postecert.it– www.iasfbo.inaf.it
Tel. (+39) 051.6398688 – Fax (+39) 051.6398724 - Cod. Fisc. 97220210583 – Part. Iva 06895721006