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The nature of the "Composite" Seyfert/Star-forming Galaxies

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Abstract

We present the results obtained with *Beppo*SAX observations of the three Composite Seyfert/star-forming galaxies: IRAS 20051-1117, IRAS 04392-0123 and IRAS 01072+4954. These sources belong to an enigmatic class of X-ray sources detected in the ROSAT All-Sky Survey (Moran et al. 1996) which is composed of 6 low redshift galaxies. Their optical spectra are dominated by the features of HII galaxies while their X-ray luminosities ($\geq 10^{42}$ ergs/s) are typical of Seyfert galaxies. IRAS 20051-1117 shows a 2-10 keV spectrum well described by a power-law with $\Gamma = 1.9$ and low intrinsic absorption. This result, the ratio Flux(2-10 keV)/Flux([OIII]λ5007) and the significant X-ray variability detected, clearly rule out a Compton thick nature of this source. IRAS 04392-0123 and IRAS 01072+4954, instead, have a *Beppo*SAX flux a factor of $\sim$ 50-80 smaller than in the previous ROSAT observations, resulting in poor statistics, that prevents detailed modeling.

1.1 Introduction

A large spectroscopic optical survey of bright IRAS and X-ray selected sources from the ROSAT All Sky Survey revealed an enigmatic class of 6* low redshift galaxies with optical spectra dominated by the features of HII galaxies but X-ray luminosities typical of AGNs, ranging from 1.5×10^{42} erg/s to 5×10^{43} erg/s in the ROSAT band (Moran et al. 1996; see table 1.1). These galaxies were named "Composite". The diagnostic emission line ratio diagrams (Veilleux & Osterbrock 1987) classify these objects as star-forming galaxies. Yet, some of them present [OIII]λ5007 lines significantly broader than all other narrow lines in the spectrum and weak and elusive broad Hα wings. Both evidences suggest the presence of a weak or "obscured" AGN. An X-ray spectrum is available only for IRAS 00317-2142 observed by ASCA (Georgantopoulos 2000). Its X-ray spectrum can be well reproduced by a single power-law with $\Gamma = 1.7$, with low absorption and no detected iron line at 6.4 keV.

* The original Moran et al.'s list was composed of 7 objects, but IRAS 10113+1736 is no longer a valid candidate, since infrared and X-ray emission originate from different sources (Condon et al. 1998).

Table 1.1. *Moran et al. (1996) Composite sample*

Name	N_{HGal} $10^{20}cm^{-2}$	$F_{0.1-2.4keV}$ $10^{-12}(cgs)$	$F_{[OIII]}$ $10^{-14}(cgs)$	F_{IR} $10^{-10}(cgs)$
IRAS 00317-2142	1.47	3.88	2.26	2.31
IRAS 00374+5929	7.84	2.95	0.85	0.61
IRAS 01072+4954	13.95	1.64	6.39	0.50
IRAS 01319-1604	1.39	1.00	1.75	1.13
IRAS 04392-0123	5.62	2.13	1.83	0.49
IRAS 20051-1117	6.53	1.30	1.27	1.20

Other similar galaxies (i.e. with bright X-ray emission but weak or absent AGN features in the optical band) have been found also in deep ROSAT fields (Boyle et al. 1995, Griffiths et al. 1996) and in the *Chandra* and XMM-*Newton* deep-fields (Rosati et al. 2001, Fiore et al. 2000, Severgnini et al. in preparation). Although these sources usually lack evidence for strong starburst emission, the main problem is the same as for the Moran et al. (1996) sources, i.e., to be able to explain the optical weakness/disappearance of the AGN in these X-ray luminous sources.

It is not likely that the starburst could overpower a Seyfert optical nuclear spectrum, since the starburst component in these objects is not particularly strong (Moran et al. 1996). To explain the absence of optical Seyfert lines we consider three different scenarios: I) the nucleus is heavily obscured and also the NLR is obscured, II) the absorber surrounds almost completely the AGN preventing the UV flux from ionizing the matter otherwise responsible for optical lines and diminish the strength of the Seyfert emission lines, III) The BLRs and the NLRs are absent (Panessa & Bassani 2002). Furthermore it is worth note that HST observations of a galaxy previously classified as starburst/HII on the basis of ground-based observations, have recently revealed a low luminosity Seyfert 2 nucleus hidden by a strong nebular emission from HII regions near the nucleus (Gezari et al. in preparation).

1.2 Results

We have obtained *Beppo*SAX observations for three sources. Their fluxes and luminosities are listed in table 1.2. In the following sections we discuss each source.

1.2.1 IRAS 20051-1117

The 2-10 keV spectrum of this source is well described by a single power-law model with $\Gamma = 1.9 \pm 0.1$ and intrinsic absorption $\leq 1.2 \times 10^{21}$ cm^{-2} in excess to the Galactic value. An iron Kα line at 6.4 keV is not statistically significant; we measure an upper limit for the equivalent width of 226 eV (90%). The 4-10 keV lightcurve shows a significant variability (a factor of ~ 3 in a time scale of ~ 3.6 ks).

The X-ray, infrared and optical properties of this object are similar to NGC 7679 (Della Ceca et al. 2001) and IRAS 00317-2142 (Georgantopoulos 2000): unabsorbed X-ray emission but possible absorbed (or intrinsecally weak) optical emission from

Fig. 1.1. MECS23 1-10 keV spectrum of IRAS20051-1117

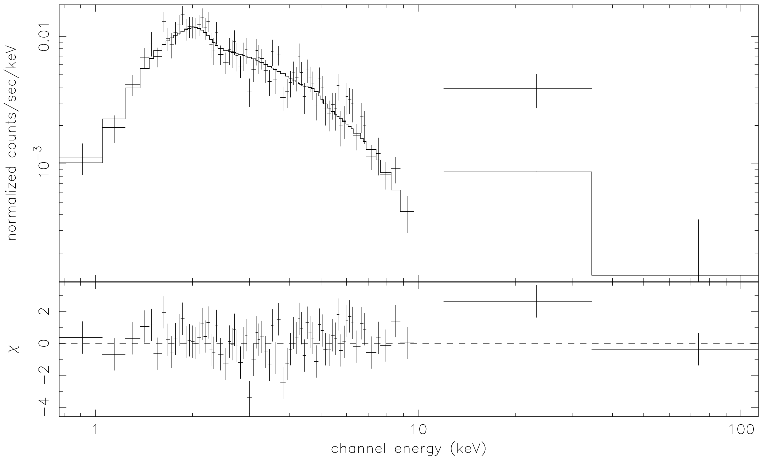


Table 1.2. *BeppoSAX fluxes and luminosities*

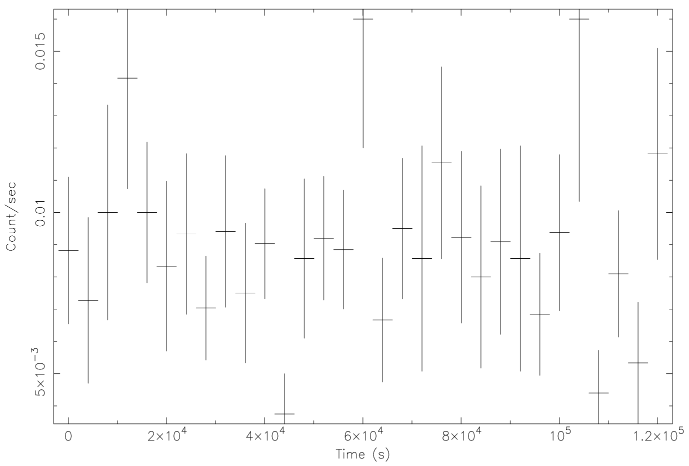
Name	$F_{0.1-2.4keV}$ $10^{-12}(cgs)$	$F_{2-10keV}$ $10^{-12}(cgs)$	$F_{10-50keV}$ $10^{-12}(cgs)$	$logL_{2-10keV}$
IRAS 20051-1117	1.68	2.25	3.6	42.57
IRAS 04392-0123	0.03	0.19	-	41.46
IRAS 01072+4954	0.02	0.17	-	41.24

an AGN. It is likely that in these objects the central Seyfert nucleus produces the strong X-ray emission while the surrounding star-forming region produces the strong Far-Infrared emission, but it is not clear why we cannot see the Seyfert emission lines. The surrounding starburst could provide sufficient obscuration to cover the optical emission regions (Levenson et al. 2001). It is also possible that the starburst and/or the absorber completely surrounds the nucleus with almost spherical geometry thus preventing the UV nuclear flux from ionizing the matter. However, the ratio Flux(2-10 keV)/Flux([OIII]λ5007) = 177.2, the lack of a strong iron line and the steep slope of the power-law all suggest a Compton thin nature for IRAS 20051-1117, supporting the scenario of the lack of NL and BL regions.

1.2.2 IRAS 04392-0123

The spectrum of this object has very poor statistics ($\leq$ 116 counts for the MECS). The 2-10 keV spectrum is well described by a single power-law with Γ = 1.7 $\pm$0.6. The absorption is here only poorly constrained with an upper limit of 7.6 $\times$ 10^{22} cm^{-2}. The 0.1-2.4 keV flux is lower by a factor of $\sim$ 50 with respect to the ROSAT flux. The Flux(2-10 keV)/Flux([OIII]λ5007) ratio is 10.4.

Fig. 1.2. MECS23 4-10 keV lightcurve of IRAS20051-1117



1.2.3 IRAS 01072+4954

Due to the small number of counts ($\leq$ 40 counts for the MECS) for this source we assume a power law model with Galactic absorption to estimate the 0.1-2.4 keV and 2-10 keV fluxes. The 0.1-2.4 keV flux is lower by a factor of $\sim$ 80 compared to the ROSAT flux. The ratio Flux(2-10 keV)/Flux([OIII]λ5007) is 2.7.

1.3 Future work

Chandra observations of 4 composites of the Moran et al. (1996) sample have been awarded to our group (Cycle 4, PI: A. Wolter). Thanks to the *Chandra* high resolution it will be possible to resolve the nuclear X-ray emission and investigate the presence of a diffuse soft thermal component which could be associated with the starburst.

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