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ON THE NATURE OF HIDDEN BROAD LINE REGIONS IN SEYFERT 2 GALAXIES

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We consider the sample of Tran (2001) to study the X-ray properties of Seyfert 2 galaxies with and without polarized broad lines.

1 Introduction

Within the class of Seyfert 2 galaxies, two populations are observed: in one, polarized broad emission lines are detected in the optical band, yielding evidence of *"hidden broad-lines regions"* (HBLRs); in the spectra of the other class, such lines are not detected (non-HBLR Sy-2 galaxies). The question arises, whether the two classes are intrinsically the same or not, that is, whether HBLRs are always there, even if sometimes - in the case of non-HBLR Sy-2's - they are not seen, due e.g to obscuration. Tran (2001), on the basis of the CfA and 12 μm samples of Sy-2's, claimed that HBLR galaxies display distinctly higher radio power relative to their infrared power, and hotter dust temperature. Since the average obscuration appears to be indistinguishable between the two classes, he proposed that HBLRs galaxies harbor an energetic, hidden Sy-1 nucleus (where broad lines are produced), while non-HBLRs galaxies do not. [10]

We went through Tran's sample, searching in the literature for measurements of the intrinsic X-ray (2-10 keV) and OIII (5007 Å) luminosities (L_X, L_{OIII}), together with the column density ($n_{\rm H}$), in order to test Tran's hypothesis of an intrinsic difference between the two classes.

2 The sample

We had to exclude many Sy-2 galaxies from the sample, for which: *either* no X-ray observations have been performed with "modern" satellites (starting with *ASCA*), *or* no estimates of the OIII flux could be found, *or* any estimate of the intrinsic (nucleus) luminosity is unreliable due to Compton-thickness ($n_{\rm H} > 10^{24}$ cm^{-2}). We also considered additional galaxies, not belonging to Tran's ensemble: based on the same criteria, we could finally add only the HBLR galaxy MKN 1210 in the sample. The final sample consists of 10 HBLR and 6 non-HBLR objects. The values of the luminosities are corrected for

Source name	L_X	L_{OIII}	$n_{\rm H}$ ($\times 10^{22}$ cm^{-2})	References
IRAS 05189-2524	26.96	3.67	4.9	[2]
IRAS 22017+0319	32.7	3.6*	5.41	[9],BOA#,[3]
IC 5063	9.43	1.1	24	[2]
MCG-3-34-64	4.3	2.68	79	[2]
MKN 348 (NGC 262)	12.19	0.97	10.6	[2]
MKN 463E (UGC 8850)	8.0	7.78	16	[2], [1]
NGC 4388	7.44	0.65	42	[2]
NGC 5506	10.07	0.56	3.4	[2], [8]
NGC 6552	3.6	1.64	60	[2]
UGC 4203 (MKN 1210)	19	2.14	21.4	[2], [5]

Table 1: *Above:* Galaxies with HBLRs. The luminosities are in units of 10^{42} erg s^{-1}. A (*) near a L_{OIII} value means that from the literature it is not clear whether a correction for intrinsic absorption has been made or not. A (#) marks values obtained through newly performed data analysis, using the standard XSPEC package. *BOA* stands for the online *BeppoSAX* data archive, accessible at http://www.asdc.asi.it/bepposax/archive_browser.html, while *AOA* stands for the *ASCA* online archive *Tartarus*, at http://tartarus.gsfc.nasa.gov/. *Below:* The non-HBLRs part of the sample. Units and conventions are the same like above.

Source name	L_X	L_{OIII}	$n_{\rm H}$ ($\times 10^{22}$ cm^{-2})	References
IRAS 00198-7926	2.04	1.55*	0.26	AOA#,[3]
M51 (NGC 5194)	0.008	0.013	75	[2]
MKN 266 (NGC 5256)	0.5	0.11*	1.6	BOA,[7],[3]
NGC 3079	0.021	0.031	1.6	[2]
NGC 4941	0.1	0.11	45	[2]
NGC 7582 (Grus Quartet)	1.83	0.3	12.4	[2]

absorption. All values listed in the tables have been taken from the best-available observations. In some cases, the data have been re-analyzed.

3 Interpretation

While a systematic search with a large, complete and unbiased sample of Sy-2 galaxies is needed in order to provide a more homogeneous and reliable set of data[a], our preliminary statistical analysis seems to strengthen Tran's claim, since, as clearly shown in the plots,

[a]After this contribution was presented at the Conference, we became aware of an indipendent study by Gu & Huang (2002), in which a bigger compilation of sources is given, and whose results are consistent with ours.[4]

- while the average extinction is indistinguishable between the two classes (see also Tran[10]), the intrinsic 2-10 keV luminosity results to be sistematically smaller in non-HBLR Sy-2's, with a "critical" threshold around $\sim 5 \times 10^{42}$ erg s^{-1};
- galaxies without polarized broad lines appear to have fainter nuclei both in X and optical (see plot); in general, the X-ray vs. optical flux dependence is more or less a linear one.

How to explain the intrinsic difference? Tran (2001) claimed that HBLR galaxies are those which actually do possess nuclei of Seyfert 1 type, while non-HBLR galaxies would not, the latter being "powered" mainly by starburst.[10] If this is the case, broad lines regions simply *would not exist* in the cores of those galaxies where polarized broad lines are not observed. However, Seyfert 1 galaxies with $L_{2-10\mathrm{keV}} < 10^{42}$ erg s^{-1} *are* observed indeed, and there is no reason why Sy-1 type nuclei (i.e. hidden broad line regions) with $L_{2-10\mathrm{keV}} < 10^{42}$ erg s^{-1} should not be present in the cores of some Seyfert 2s, too.

Even if, on the base of Tran's as well as our present study, a unifying model based *only* on inclination (such as the one by Heisler et al.[6]) seems to be ruled out, nevertheless one may suppose that *the intrinsic difference originates also in some property of the reflector*. One possible explanation is, that in the so-called non-HBLR Sy-2 galaxies ($L_{2-10\mathrm{keV}} < 10^{42}$ erg s^{-1}) the irradiation from the nucleus is not strong enough to allow sublimation of dust grains and ionization of the more distant clouds (those located outside the torus). Thus, the broad lines cannot be reflected towards us, and are rather absorbed by the clouds themselves. Conversely, in the so-called HBLR Sy-2s, the irradiation efficiently ionizes the distant clouds too, so that we can observe polarized (reflected) broad lines.

References

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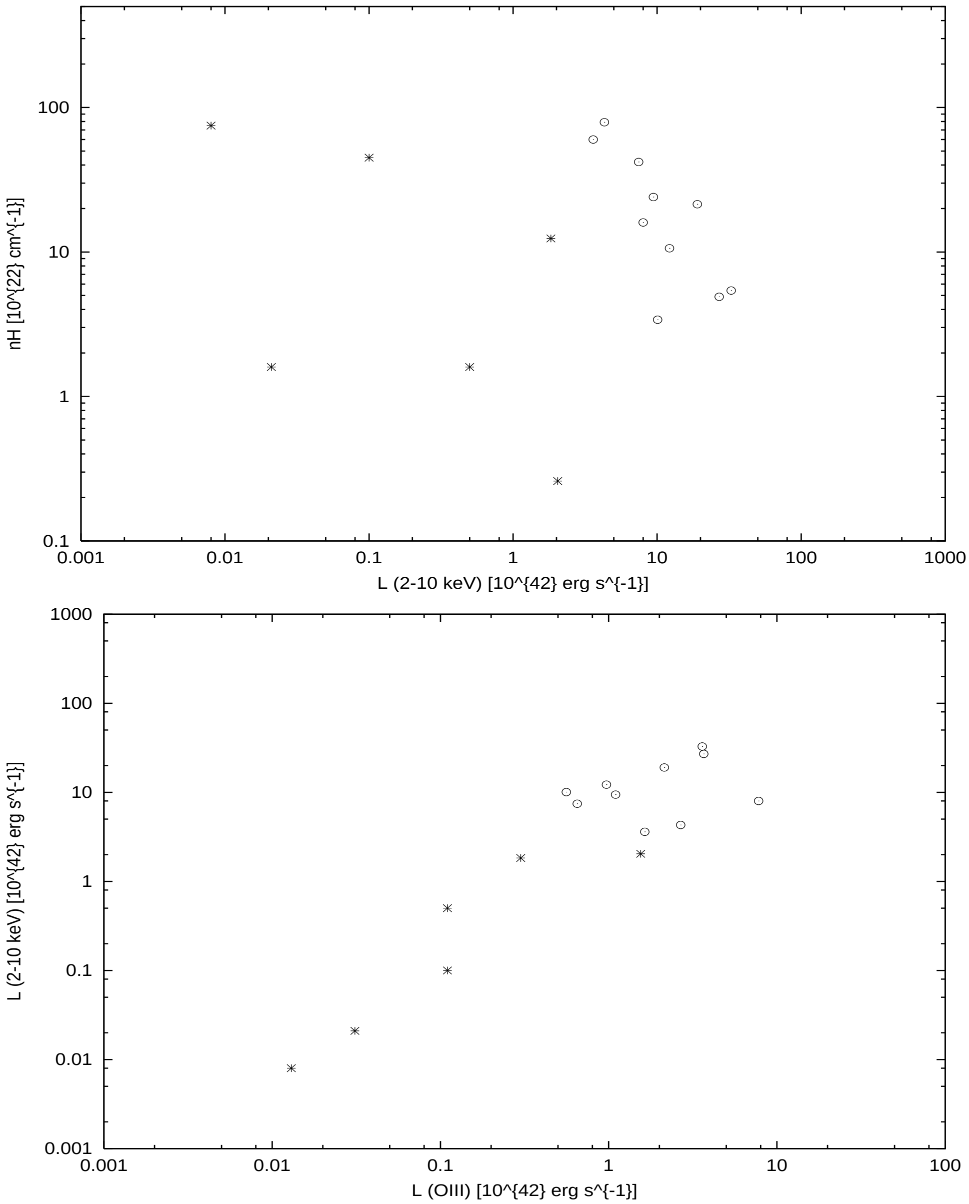

Figure 1: *Above:* Plot n_{H} versus L_X. *Below:* Plot L_{OIII} versus L_X. In the plots, the simbol (*) is used for non-HBLR galaxies, ($\odot$) for objects which do show polarized broad lines.