Mini-Survey of SDSS [OIII] AGN with Swift: 
Testing the Hypothesis That \( L_{[\text{OIII}]} \) Traces AGN Luminosity 

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Introduction & Overview

The number of AGN and their luminosity distribution are crucial parameters for our understanding of the AGN phenomenon. Recent work (e.g. Fender and Maris 2000) strongly suggests every massive galaxy has a central black hole. However, of these most objects are not well studied or have been very difficult to detect.

We are now in the era of large surveys, and the luminosity function (LF) of AGN has been estimated in various ways. In the X-ray band, Chandra and XMm surveys (e.g., Burrows et al., 2005; Heinz, et al. 2008) indicate a break in the XLF of the AGN population at a luminosity of \( L_{X} \approx 10^{41} \) erg s\(^{-1}\) that corresponds to a high luminosity.

It is seen for all types of AGN, but it is stronger for the broad-line objects (e.g., Steffen et al. 2004). In contrast, sharp, the local LF of optical-selected AGN shows no such break and no differences between narrow and broad-line objects (Hao et al. 2005).

As suggested, hard X-ray and optical emission line both can be fair indicators of AGN activity, it is important to first understand how basic Hubble characteristics are if we hope to understand the apparent discrepancy in the LFs.

The SDSS and Swift

The Spectroscopic data from the Sloan Digital Sky Survey (SDSS) provides a rich resource for detecting & studying the properties of AGN. Several large & related studies such analyses have already been performed by the MPAJHU group led by Kauffmann.

We present the results from a simple comparison between two classic indicators of AGN activity: luminosity luminosity of the [OIII] emission line \( L_{[\text{OIII}]} \) and that in the X-ray band (\( L_{X} \)). Unified schemes predict a simply linear relationship between \( L_{[\text{OIII}]} \) and \( L_{X} \), and such a relationship has been suggested in several studies (e.g., Kaspi et al. 2004; Heckman et al. 2006; Piiro et al. 2006; Netzer et al. 2006; Panessa et al. 2006).

We recognize neither are perfect indicators. Indeed, one of our motivations was to study the scatter around any relationship. For \( L_{[\text{OIII}]} \), we have used data from a subset of SDSS AGN catalog kindly made public by the MPA Team. For \( L_{X} \), we have used data collected with the XRT onboard Swift. Through both pointed and serendipitous observations, Swift provides a shallow but wide survey complementary to other X-ray surveys.

About Swift

Swift is a dedicated satellite to detect Gamma Ray Bursts and their afterglows. The initial detection of the GRB is made with the BAT detector. The follow-up observations then centered on the UVOT (optical/UV) and XRT (3-10 keV) detectors. The typical Swift observation strategy for a GRB is to observe a cluster of a few minutes. Depending on the evolution of the flux, the sensitivity of each instrument, and the required science, the same object may be observed several times as for in a monitoring campaign. The satellite on average monitors the same position for about a month. While waiting for new GRBs or return to a position constraint by the sun, Swift observes "blind" targets. This sample of sources is selected using all the observations made with the Swift XRT operation on the Photon Counting mode which provides image and spectral information.

Sample Selection

There are 88178 objects in the DR4 release of the MPAJHU AGN catalog (http://www.mpa-garching.mpg.de/SDSS). These were cross-correlated with all Swift observations taken up to May 2007. This resulted in 3738 objects within the XRT field of view (20 arcmin). Further screening excluded the few objects with a problematic [OIII] measurement, and all exposures <10 in PC mode. We also exclude all objects that do not satisfy the conservative emission line ratio criteria to be indicative of AGN activity outlined by Kewley et al. (2001), with a redshift \( >0.1 \), and those >10 arcmin from the XRT nominal pointing.

Finally, here we only include objects for which the sum of the exposure times is at least 200 s. This gives a sample of 108 objects.

All data were calibrated and screened using the latest procedures, routine part of the Swift software and the latest calibration data. For each observation, an image and an exposure, and a recipe used to process the data. A sliding box detection algorithm was then run on the summed images. For all sources the flux or upper limit estimates were calculated using an extinction correction. The larger objects are used to estimate background. The exposure map was analyzed after any objects larger than 2 arcmin were taken into account during the analysis.

Example Datasets

An example SDSS image, Swift XRT image and Swift exposure map for the sample, shown above. The location of the SDSS source is indicated in the top right corner. The largest objects are used to estimate the background. The exposure mask is shown only for objects smaller than 2 arcmin. All data were taken into account during the analysis.

Caveat

We have treated the value of \( L_{[\text{OIII}]} \) using the (continuum-subtracted) luminosities supplied in the MPAJHU catalog. We have not made any attempt to correct and fit the SDSS sources correctly.

Conclusion and Future Work

Swift is proving to be a valuable resource for more than just GRB research. Here we have taken advantage of the isotropic distribution of GRB to conduct a relatively unbiased study of the isotropic distribution of AGN.

We conclude that \( L_{[\text{OIII}]} \) alone is unlikely to provide a robust prediction of the X-ray luminosity in AGN and on the other hand, the limited parameter-space investigated does tell us why this is.

We intend follow-up X-ray observations for the detected sources to determine the spectra.

We plan to extend this analysis as to include more sources as both the Swift and SDSS archives grow. We also plan to extend our study to include other parameters associated with the AGN and host galaxy.

References