Host Galaxies of Hard X-ray Selected Type-2 AGNs at Intermediate Redshifts (2006, ApJ, 647, 892)

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Introduction

Background

➢Masses of super-massive black holes (SMBHs) correlate with masses (or luminosities) of host galaxies (BS-relation) in local universe (e.g., Kormendy & Richstone 1995). The tightness of this correlation suggests an evolutional link between SMBHs and their host galaxies

➢Local black hole mass function derived from spheroid luminosities of local galaxies with the local BS-relation agrees with the BH mass function expected from AGN relics estimated from the history of mass accretion onto SMBH of AGN phases (Marconi et al. 2004)

➢Cosmic history of mass accretion onto SMBHs has similar redshift dependence with that of star formation history (Marconi et al. 2004)

➢These results suggest the co-evlution of SMBHs and their host galaxies on cosmological time scale.

Aim

➢We want to examine the coevolution of SMBHs and their host galaxies

➢A direct approach to examine the co-evolution is to derive the BS-relation at z > 0 and compare it with the local relation

➢Host galaxies of type-1 AGNs have been studied extensively, but the presence of dazzling nucleus prevents us from examining a host galaxies precisely.

➢*Type-2 AGNs make a suitable sample to study host galaxies thanks to intrinsic obscurations of a bright nucleus.*

➢According to the AGN unification model, difference between type-1 and type-2 is only viewing angle.

➢In this work, we examined evolution of the BS-relation using the type-2 AGNs.

1. Sample

➢We use two hard X-ray (> 2 keV) selected samples

➢the ASCA Large Sky Survey (ALSS)

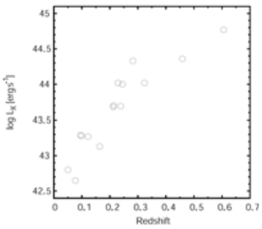
➢the ASCA Medium Sensitivity Survey in the northern sky (AMSSn)

➢ *These samples are selected in hard X-ray band, hence they are not biased to unabsorbed AGNs, except for Compton thick AGNs*

➢The definition of our type-2 AGNs is absence of Hα and Hβ broad emission line in optical spectra.

➢Although absence of broad line emission could depend on S/N, these AGNs show absorption of $N_H > 10^{22}$ cm^2 in the X-ray band, which supports the identification of type-2 AGNs

➢SEDs in optical wavelength are similar to those of elliptical or Sbc galaxies, suggesting that the contribution of nucleus components is small.

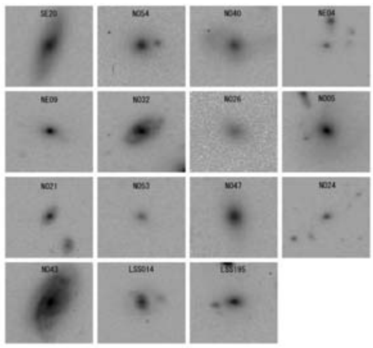


Absorption-corrected X-ray luminosities in the rest-frame 2-10 keV band vs. redshifts of our sample.

2. Observations

➢R-band observations were made during the period from 2004 April to on December with the OPTIC (Tonry et al. 2004) on University of Hawaii 2.2-m telescope(UH-88), and 2005 May with Tek2048 CCD on UH88.

➢Seeing size is 0".8-1".3(4.5 – 5.9 kpc @ z=0.3) of FWHM, and exposure time is about 20 min per object.

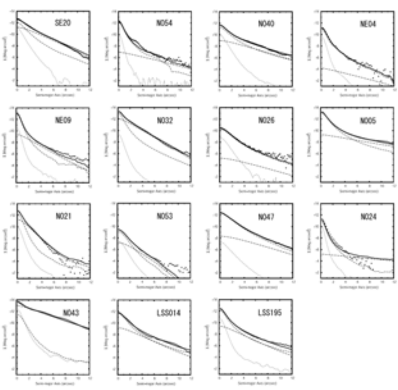


R-band images of the targets. Each image covers 25" × 25".

3. Surface Brightness Fitting

➢In order to determine spheroid and disk magnitudes, we performed two-dimensional fitting to the R-band images by GALFIT (Peng et al. 2003)

➢The fitting model consists of a de Vaucouleurs $r^{1/4}$ bulge, an exponential disk, and a nuclear point like component



Azimuthally averaged radial profiles of surface brightness. The vertical axis is arbitrary. Dots are data points. Dotted, dashed, dot-dashed, and solid lines show PSF, de Vaucouleurs $r^{1/4}$ spheroid, exponential disk, and total components of the best-fit model, respectively.

4. Relation between the AGN and Host Properties

4.1. Correlation between X-ray Luminosity and Spheroid Luminosity

➢*As seen in Figure A, spheroid luminosities correlate with X-ray luminosities.*

➢High (low) X-ray luminosity AGNs reside in more (less) luminous spheroid components

➢If we assume that the Eddington ratio is constant, this correlation indicates the presence of a BS-relation at z~0.3.

➢We estimate Eddington ratio by using type-1 AGNs from the ALSS and AMSSn sample.

➢According to the unified scheme, we can expect that Eddington ratio of type 1 and type-2 AGNs should be same on average.

➢BH Masses of type-1 AGNs are estimated by Kaspi relation from the velocity width of Hβ broad line and the continuum luminosity.

➢Derived average of Eddington ratio is 0.24, which is consistent with other studies (e.g., Kollmeier et al. 2006).

➢*Significant difference between derived BS-relation and that in local universe are not seen.*

➢Derived BS-relation with the Eddington ratio of 0.24 is indicated by the solid line in Figure A, and is not significantly different from the local relation.

➢BS-relation does not evolve between z~0.3 and z~0 ?

➢ In recent studies, Woo et al. (2006) showed evolution of a ratio of BHs masses to spheroid masses between z~0.3 and z~0: the ratio is larger than that of local universe. This result could not be consistent with our result if M/L does not change between z~0.3 and z~0. Therefore, in order to confirm our result, estimation of spheroid masses of our type-2 AGNs sample would be needed.

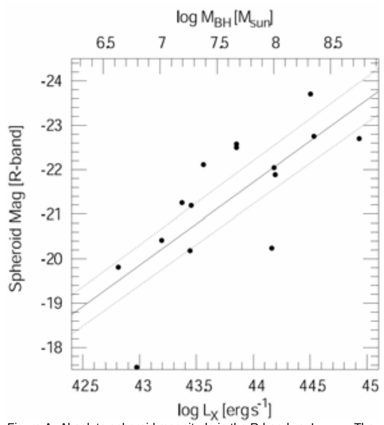


Figure A- Absolute spheroid magnitude in the R-band vs. $L_{2\text{-}10keV}$. The upper ordinate indicates masses of SMBHs estimated from $L_{2\text{-}10keV}$ by assuming Eddington ratio of 0.24. Solid line and dotted line lines represent the best-fit model and 1σ uncertainty, respectively.

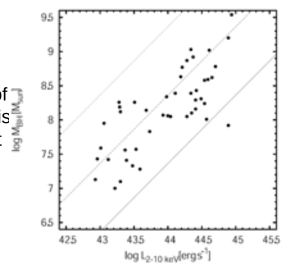


Figure B- Plot of M_{BH} vs. $L_{2\text{-}10keV}$ for type-1 AGNs in ALSS and AMSSn. Solid, dashed, and dotted lines represent Eddington ratios of 1, 0.1, and 0.01, respectively.

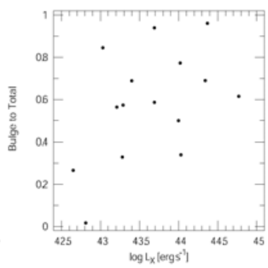


Figure C- Spheroid to total luminosity ratio(B/T) vs. $L_{2\text{-}10keV}$

4.2. Correlation between B/T and Nuclear Luminosities

➢As seen in Figure C, high X-ray luminosity AGNs reside in only high B/T, while low X-ray luminosity AGNs reside in those with B/T=0-1.0.

Summary

➢We study properties of the host galaxies of 15 hard X-ray selected type 2 AGNs at z ~ 0.3, and found that

➢derived BS-relation at the redshifts using the average Eddington ratio of type-1 AGNs is consistent with that in local universe

➢ B/T of X-ray luminous AGNs are large and close to 1, and those of less luminous AGNs are 0-1

➢In this study, we demonstrate the effectiveness of using type-2 sample in examining hosts.

➢ AGNs/QSOs survey at higher redshift have been in progress with the Chandra satellites and their optical and NIR follow-up. In near future, we will obtain samples of type-2 AGNs/QSOs in high redshift universe. For such targets, NIR imaging with AO is expected powerful tool for studying host galaxies of high redshift AGNs/QSOs.