Mem. S.A.It. Suppl. Vol. 3, 230

Memorie della
Supplementi

The BH-bulge relation for Narrow-Line Seyfert 1 and Seyfert 1

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Abstract. We have studied a sample of NLS1 in order to understand thoroughly these active galaxies. Our preliminary results suggest that a BH-bulge relation exists also for NLS1 but conclusions are still in conflict. $M_{BH} - M_B$ and $M_{BH} - \sigma$ let us think of opposite scenarios about the nature of NLS1. We show that, in order to make clear if NLS1 do fill the lower ranges of the BH-bulge relation, it is necessary a direct measure of the stellar velocity dispersion in the nuclei of these galaxies.

Key words. galaxies: active–galaxies

1. Introduction

Narrow-Line Seyfert 1 galaxies (NLS1) form a particular group of Seyfert 1 galaxies (S1) with peculiar properties. In the optical they have narrower permitted lines, *e.g.* full width at half maximum (FWHM) of $H\beta$ emission line ≤ 2000 km s^{-1}, while classical S1 galaxies show usually FWHM larger than 3000 km s^{-1}. NLS1 show also high ionization emission lines, like [Fe VII] λ6087, [Fe X] λ6375, and strong Fe II (Fig.1), while the low-ionization lines are intrinsically less luminous. In the soft X-ray band they have generally a much steeper continuum slope and show often rapid variability (Boller et al. 1997). Moreover the UV luminosity of NLS1 tends to be smaller than the one observed in S1, and their Far-Infrared luminosity is in average brighter, almost comparable to that of Seyfert 2 galaxies.

⋆ Based on observations made with the Asiago 1.82 m telescope of the Padova Astronomical Observatory

2. Our project

We are currently conducting a comparative study on a sample of NLS1 and S1 galaxies with the aim of shading more light on the nature of NLS1.
Taking advantage from the recent discovered BH-bulge relations in active and non active galaxies we want to make clear if NLS1 do fill the lower ranges of BH-bulge relation and represent a separate class of type 1 AGN, or instead their host bulges share the same physical properties as those of S1 and we are systematically underestimating their masses.
Our sample consists of 25 NLS1 and 23 S1 galaxies. 2 NLS1 and 5 S1 are taken

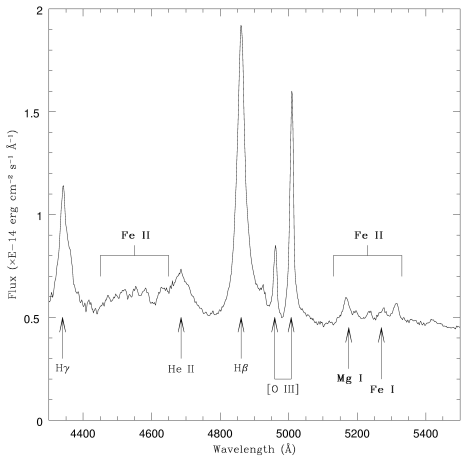

Fig. 1. Example of presence of strong Fe II emission.

from Wu & Han's sample (2001) and 2 S1 from Kaspi's one (2000). For the other galaxies (23 NLS1 and 16 S1) we have analysed optical spectra obtained at the Asiago 1.82 m telescope of Padova Astronomical Observatory and taken from the Isaac Newton Group public archive (ING archive).

3. Black Hole mass

Black hole masses have been estimated by taking advantage from the presence of the ionized gaseous clouds of Broad Line Region (BLR). With the reverberation mapping technique the sizes of the BLR can be obtained through the study of correlated variations of the lines and continuum fluxes (Peterson 1993).
For most Seyfert galaxies it is difficult to measure the BLR size using this method because of the lack of long term variability monitoring. It can be estimated by the empirical relationship between the size and the nuclear continuum luminosity at 5100$\mathring{A}$

$$R_{BLR} = 32.9^{+2.0}_{-1.9}\left[\frac{\lambda L_\lambda(5100\mathring{A})}{10^{44} ergs^{-}1}\right]^{0.700\pm0.033} \quad (1)$$

(Kaspi et al. 2000)
One can argue that a significant fraction of optical light may come from the host galaxy; Wang & Lu (2001) have suggested that the stellar contribution to the measured optical lminosity should be much less (or less) than that from the nuclear emission.
To estimate the M_{BH} of the NLS1 we need to assume that the BLR is viralized and the motions of the clouds is dominated by gravity:

$$M_{BH} = R_{BLR}V^2G^-1 \quad (2)$$

where G is the gravitational constant; V can be estimated from the emission-line width, in particular $H\beta$:

$$V = (3/2)FWHM(H\beta) \quad (3)$$

4. M_{BH} vs. B-band absolute bulge magnitude

For NLS1 and S1 in our sample B_T magnitudes were taken from literature. When for a single source were available more than one value we have taken the average (Winkler 1997; MacKenty 1990; Granato et al. 1993; Schmitt & Kinney 2000; Prugniel & Heraudeau 1998). The B_T magnitudes were corrected for non-stellar lines and continuum emission ($\Delta(m_A)$), for internal absorption ($\Delta(m_i)$) and for Galactic absorption ($\Delta(m_G)$). The redshift (K) correction ($\Delta(m_K)$) was ignored because our sources have $z < 0.07$. The conversion to bulge magnitude, ($\Delta(m_{bul})$) was obtained from Simien & de Vaucouleurs (1986), who found a relation with Hubble stages through which we could apply a bulge-disk separation.
In Fig.2 we have plotted the log BH mass vs. B-band absolute bulge magnitude (M_B). The solid line represents the least squares fit for all galaxies.

5. M_{BH} vs. stellar velocity dispersion

Stellar velocity dispersion (σ) have been directly measured only for a few AGN. In

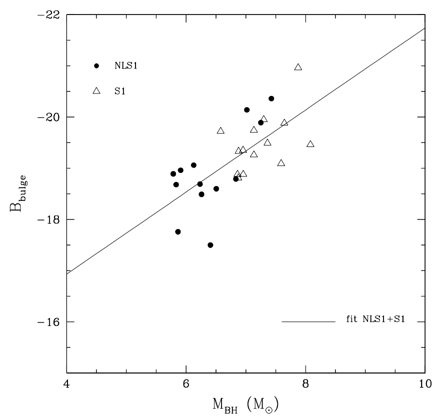

Fig. 2. The logarithmic values of M_{BH} plotted against M_B bulge. NLS1 are represented by filled dots, S1 by empty triangles.

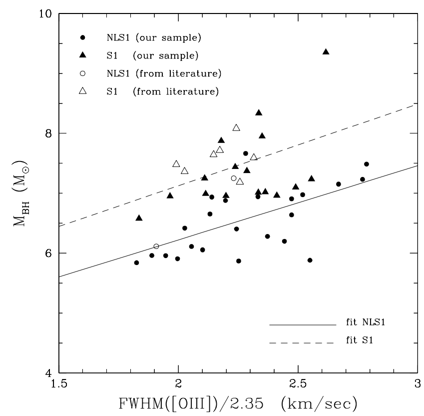

Fig. 3. Relation $M_{BH} - \sigma$. The NLS1 are represented by dots, S1 by triangles: filled dots for galaxies of our sample, empty for literature data. The solid and dashed line represent the relations for the NLS1 and S1 galaxies respectively.

the optical spectrum of NLS1 the presence of large and bright Fe II multiplets suppress completely the stellar absorption lines typically used in measurements of σ (*e.g.* Mg I λ5175 and Fe I λ5269, see Fig.1). Nelson (2000) have shown that the width of narrow emission line [O III] λ5007, is a good representation of the velocity dispersion with:

$$V = FWHM([\mathrm{O\,III}])/2.35 \tag{4}$$

We have collected from literature and from our optical spectra the values of $FWHM([OIII])$ for both NLS1 and S1 galaxies. In Fig.3 we have plotted the log BH mass vs. $FWHM([OIII])/2.35$. The solid and the dashed lines represent the least squares fits for NLS1 and S1 galaxies respectively.

6. Conclusions

Our preliminary results show that in NLS1 also exists a BH-bulge relation:

- NLS1 and S1 follow the same M_{BH}-M_B relation. This result favours the simple evolutionary scenario proposed by Mathur (2000): NLS1 should have smaller BH mass because they should be younger than S1.
- NLS1 follow a similar, about paralle $M_{BH} - \sigma$ relation. This suggests that NLS1 and S1 are hosted in similar bulges, and can be explained by means of orientation effect of a geometrically flat BLR respect to our line of sight.

Anyway in order to give a definitive answer to this question it is mandatory to directly measure σ in the nuclei of NLS1 in order to verify whether it assumes or not values lower in average than those measured for S1 (150-300 km s^{-1}), as the $M_{BH} - M_B$ relation and the evolutionary scenario predict.

Acknowledgements. This research is partially based on data from the ING Archive.
In this work we have used the NASA/IPAC Extragalactic Database (NED) which is operated by the Jet Propulsion Laboratory, California Institute of Technology, under con-

tract with the National Aeronautics and Space Administration.

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