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A search of new samples of active galactic nuclei with low-mass black holes from SDSS

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Abstract. We report on the progress of our on-going work to search for low-mass black holes (LMBHs) in active galactic nuclei. The masses of black holes are estimated using the broad line width and luminosity obtained from one-epoch optical spectra. As the first step, we fitted the spectra of 1263 objects in the quasar catalog of the SDSS DR10 and obtained accurate measurement of the emission lines. Two AGNs are found to have $M_{\rm BH} \sim 10^6\,{\rm M}_\odot$. The next step is to analyze the spectra of the DR10 galaxy sample, from which a much larger sample of low-mass AGNs is expected to be obtained.

Keywords. galaxies:active, galaxies:nuclei, quasars:emission line

1. Introduction

As the link between stellar mass black holes and supermassive black holes, low-mass black holes (LMBHs) at the center of galaxies with masses ranging from $10^3\,{\rm M}_\odot$ to $10^6\,{\rm M}_\odot$ are important for research on black hole formation and co-evolution with galaxies. Current models indicate that low-mass black holes can give insight into the evolution of the first seed black holes (e.g. Volonteri *et al.* 2008). The common practice is to estimate the black hole masses of AGNs from the width and luminosity of the broad emission lines using the empirical scaling relation (Kaspi *et al.* 2000). A systematic search of LMBHs has been pioneered by Greene & Ho (2004, 2007) from the SDSS data finding more than 200 candidates. Recently we (Dong *et al.* 2012) carried out a systematic and homogeneous search from the SDSS DR4 data, resulting in 309 LMBH AGNs, many with low Eddington ratios. According to Yuan *et al.* (2014), a large population of low-mass black hole may exist in the local universe awaiting discovery. To enlarge the sample size, we perform an extended search for more LMBH AGNs from the SDSS DR10 data.

2. Preliminary results

It is difficult to search for AGNs with low-mass black holes since their spectra are dominated by starlight in general. Careful subtraction of the starlight and the continuum is essential for reliable measurement of the emission lines. It is also important to precisely separate the broad and narrow components of the Hα and Hβ lines as the broad lines in the spectra of LMBHs are relatively narrow and weak. To reach this goal, we have designed a set of elaborate codes and broad-line selection procedures as detailed in Dong *et al.* (2012).

As the first step, we start with objects classified as quasars with redshift $z \leqslant 0.5$ in the DR10 data, which have 1263 objects (Pâris *et al.* 2014). The spectra are analyzed

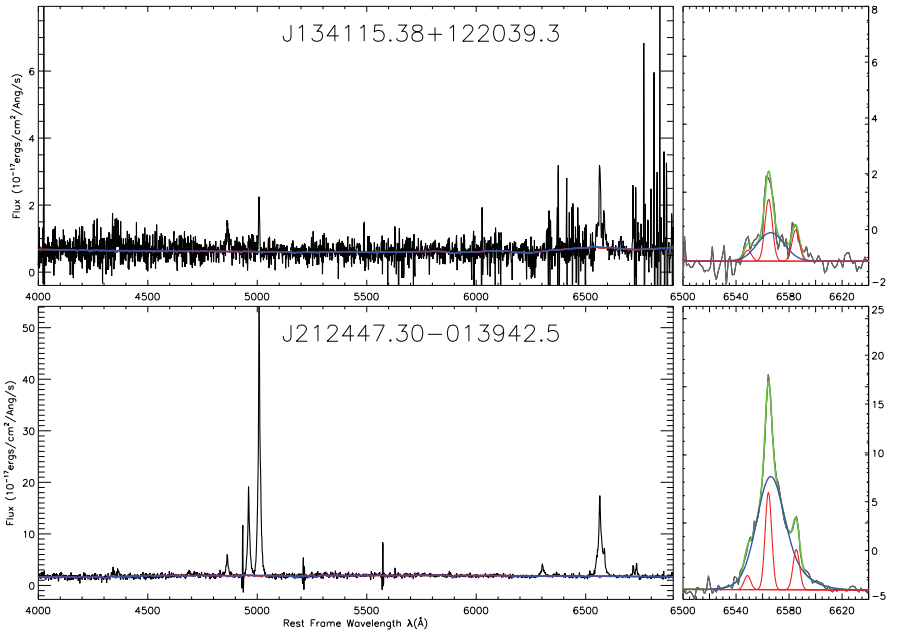

Figure 1. Emission line spectra and model fits for the spectra of two candidate AGNs with $M_{\rm BH} \sim 10^6$ M$_\odot$

Table 1. The basic parameters of LMBH candidates.

SDSS name	**Redshift**	**FWHM(Hα)** **km s^{-1}**	**L(Hα)** **10^{41} erg s^{-1}**	$M_{\rm BH}$ **10^6 M$_\odot$**	L_{bol}/L_{Edd}
J134115.38+122039.3	0.386	1094	1.535	1.53	0.22
J212447.30-013942.5	0.131	1180	1.245	1.63	0.17

following the procedures in Dong *et al.* (2012) and accurate measurements of the emission lines are obtained. Given the high luminosities of quasars, only two AGNs with $M_{\rm BH} \sim 10^6$ M$_\odot$ are found (Table 1), which is not surprising. Fig. 1 shows the best-fit for the emission line spectra of these two objects. Our next step is to analyze the spectra for the DR10 galaxy sample which have ~ 460000 objects with redshift $z \leqslant 0.5$. We expect that a large sample of LMBH AGNs can be obtained.

Acknowledgements

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References

Dong, X.-B., Ho, L. C., Yuan, W., *et al.* 2012, *ApJ*, 755, 167
Greene, J. E. & Ho, L. C. 2004, *ApJ*, 610, 722
Greene, J. E. & Ho, L. C. 2007, *ApJ*, 670, 692
Kaspi., S. Smith, P. S., Netzer, H., *et al.* 2000, *ApJ*, 533, 631
Pâris, I., Petitjean, P., *et al.* 2014, *A&A*, 563, A54
Volonteri, M., Lodato, G., & Natarajan, P. 2008, *MNRAS*, 383, 1079
Yuan, W., Zhou, H., Wang, L., Dou, *et al.* 2014, *ApJ*, 782, 55

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