

Galactic nuclear off-centerings: the innermost accretion mechanism?

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Abstract. In the current scenario of galaxy evolution, supermassive black holes (SMBH) are present in almost all galaxies. To trigger nuclear activity, large amounts of material have to fall from kpc to pc and even smaller scales. Hence, an efficient angular momentum removal mechanism is needed. A growing black hole could still not be fixed in the gravitational potential well of the galaxy. This can be observed as a break in the symmetry between the global structure of the galaxy and the central source and could be part of the mechanism that drives material from the last hundred parsecs onto accretion in the SMBH. We present spatial profile decomposition of 16 galaxies observed with GNIRS (Gemini North) in the K_{long} band. We have been able to measure off-centerings in 3 of 16 galaxies. We found a possible correlation between the presence of an off-centering and the SMBH mass.

Keywords. galaxies: nuclei, galaxies: evolution, galaxies: Seyfert, techniques: spectroscopic

1. Context

Numerical simulations have shown that there exists a phase in Active Galactic Nuclei (AGN) growth where the SMBH is decoupled from the global gravitational potential of the host galaxy (Miller & Smith (1992); Taga & Iye (1998); Emsellem *et al.* (2015)). Observational works have presented evidence of AGN that do not reside in the center of the host galaxies (Díaz, *et al.* (1999); Côté *et al.* (2006); Combes *et al.* (2019)).

The frequency of off-centerings in galactic nuclei and the correlation with other nuclei parameters such as SMBH mass, activity type and X-ray luminosity could shed light onto the sub-10 pc accretion mechanism. It is important to separate the underlying red stellar population, a good tracer of the distribution of mass, from the discretized components such as ionized, atomic, and molecular gas, young star clusters and massive star clumps. This characteristic is achieved in the K band of the Near Infrared (NIR).

The fitting

In this work we used spectra obtained by Mason *et al.* (2015), taken with GNIRS in the K_{long} band. In order to perform the spatial component fitting we extracted continuum spatial profiles in two wavelength ranges: $\lambda 2.097 - 2.104 \mu\text{m}$ and $\lambda 2.247 - 2.254 \mu\text{m}$. To model the profiles we used 2 components: a *gaussian* for the nuclear source and a Sérsic profile to represent the larger structure leaving as a free parameter the off-center between them. In Table 1 we present the results of the fitting. Two of the off-centered nuclei found were discarded due to obscuration near the slit as seen in HST/NICMOS images.

Table 1. Parameters of the spatial profile fitting for the 16 galaxies of the sample. Column 2 lists the *fw_g* of the nuclear *gaussian* function, column 3 corresponds to the scalelength radius of the Sérsic component and column 4 is the Sérsic index. Columns 5 and 6 present the Off-centerings in arc seconds and parsecs respectively.

Galaxy	<i>fw_g</i> ["]	<i>R_e</i> ["]	<i>n</i>	Off-center ["]	Off-center [pc]
NGC 2273	0.67	2.25	1.5	—	—
NGC 3031	0.92	6.3	1.6	—	—
NGC 3718	1.13	3.45	1.6	0.06	4.95
NGC 3998	0.56	4.5	2.2	—	—
NGC 4258	0.77	6.9	1.59	—	—
NGC 4388	0.56	6.75	2.8	—	—
NGC 4450	0.78	4.35	2	—	—
NGC 4548	0.6	4.2	2.09	—	—
NGC 4565	0.91	3.45	1	—	—
NGC 4594	—	10.5	2.8	—	—
NGC 4725	1.23	4.27	1.2	—	—
NGC 5005	0.7	2.1	0.79	—	—
NGC 5033	0.7	7.8	2.2	0.21	19.62
NGC 5194	1.06	49.35	1	—	—
NGC 7331	0.63	21.45	2.9	0.11	7.26
NGC 7743	0.7	5.25	1.4	—	—

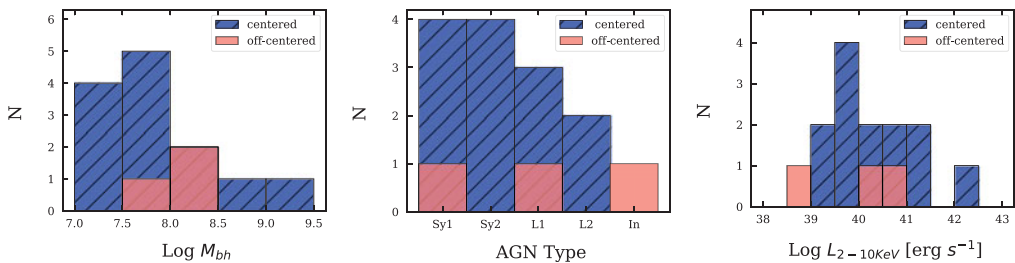


Figure 1. Histograms of 3 nuclei parameters for the 16 galaxies of the sample: black hole mass in the left panel, AGN type in the middle panel and X-ray luminosity in 2-10 keV in the right panel. Blue represents the galaxies with centered nuclei, in pink galaxies with off-centered nuclei are differentiated

2. Results

We have found off-centerings in 3 of the 16 galaxies. In Figure 1 we present three parameter distributions of the sample. The presence of an off-centering does not correlate with X-ray luminosity nor AGN type for this sample. But, there is a suggestion that it could correlate with the SMBH mass. The three off-centered nuclei fall in the range of intermediate mass ($\text{Log}(M/M_{\text{sun}}) = 7.9, 8$ and 8.1 respectively). This result could indicate that more massive nuclei are already fixed to or dominating the gravitational potential of the galaxy and therefore are no longer causing an asymmetry in the circumnuclear material distribution.

References

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