The Interplay among Black Holes, Stars and ISM in Galactic Nuclei
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Host bulge properties: The key to SMBH mass estimates?

Dan Batcheldor[1]†, D. Axon[2] and M. Hughes[1]

[1]University of Hertfordshire, College Lane, Hatfield, AL10 9AB, UK email: dpbpci@cis.rit.edu
[2]Rochester Institute of Technology, 85 Lomb Memorial Drive, Rochester NY, USA

Abstract. Results gathered to anchor the $M_{BH} - \sigma_*$ relation raise concerns in the methods of measuring of σ_* used for the original slope determinations. We present these preliminary results to demonstrate the problem and briefly outline where the discrepancies arise. IFS is a valuable tool in addressing this area and will allow us to remove systematics before tightening the $M_{BH} - \sigma_*$ relation and end the "aperture arguments".

1. Introduction and Data

Super-massive Black Holes (SMBHs) are accepted to be present in most hot spheroids. Primary SMBH mass estimators have drawbacks not present in secondary methods (e.g. they take along time to complete, involve complex modelling or can only be applied to a few objects). However, these secondary estimators, the most celebrated of which is the stellar velocity dispersion ($M_{BH} - \sigma_*$) relation, are yet to be fully secured and cannot be used for confident SMBH mass determinations yet. Some suggest the relations may not even be linear (Laor, 2001). At present all secondary methods do not fully sample masses below $10^8 M_\odot$, so for further constraints we have observed 54 spirals using STIS and Integral Field Spectroscopy (IFS). The preliminary IFS results are presented here and raise a number of fundamental concerns over the $M_{BH} - \sigma_*$ relation. Our data (see figure 1) show spatial asymmetries and departures from 2D symmetry in the line-of-sight velocity distributions (LOSVD). We see σ_* varying through different aperture radii ("curves of growth", hereafter COG) and in cases where dust interrupts the line of sight (e.g. NGC5005). COGs are seen to remain constant in low dust cases until a break radius, demonstrating the σ_* dependence on position and aperture size. Similar results are noted in the SAURON survey (de Zeeuw *et al.* 2002).

2. The $M_{BH} - \sigma_*$ Relation

The results from our IFS survey have sparked interest in the slope of this relation, which has ranged from 3.75 to 5.3 (Tremaine *et al.* 2002). The discrepancies are not understood but are attributed to various systematic effects; inconsistent aperture corrections, heterogeneous galaxy samples, unclear rotation treatments. We also note that observed COGs differ from the σ_c empirical correction (Ferrarese & Merritt, 2000), and the strong dependence of σ_e (the "luminosity-weighted line-of-sight dispersion inside a radius") on slit orientation (Gebhardt *et al.* 2000). These differences are most alarming in respects of the large amount of work based on this relation (e.g. Marconi *et al.* 2003).

† Present address: Rochester Institute of Technology, 85 Lomb Memorial Drive, Rochester NY

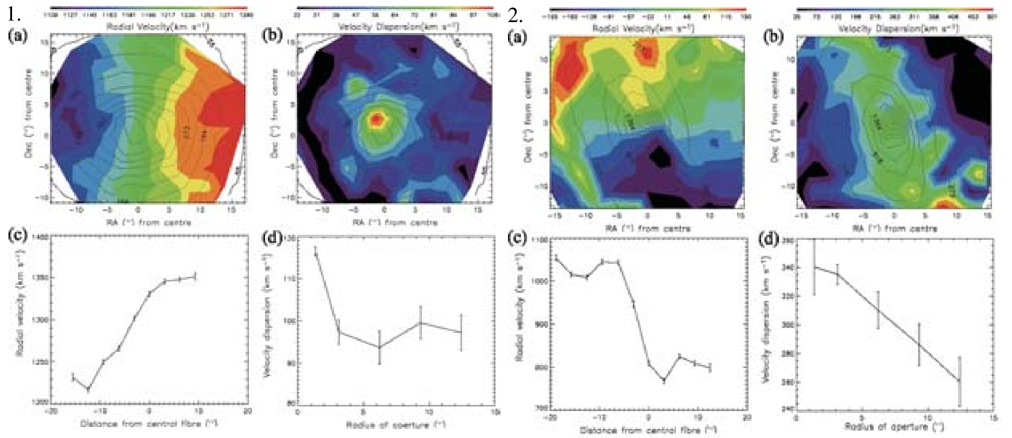

Figure 1. Left (1) NGC4041, IFS. Right (2) NGC5005. In both cases: a) Radial velocity field, and b) σ_* field over-laid with isophotes, c) stellar rotation curve taken along the rotational major axis, d) Curves of Growth. NGC4041 demonstrates a typical COG with a central kick. NGC5005 shows the problems introduced in a dusty edge on system.

3. The Value of IFS on $M_{BH} - \sigma_*$

In order to eliminate the concerns raised we have initiated a homogenous IFS survey of the Tremaine et al.(2002) sample last used to evaluate the $M_{BH} - \sigma_*$ relation. We are analysing sigma through arbitrary apertures to re-evaluate and tighten the relation. This work will end the "aperture arguments" and remove the systematics from the $M_{BH} - \sigma_*$ relation. Dust contributions are at present being folded into state-of-the-art dynamical models which have been adjusted to investigate the dynamical effects of rotation on σ_*. This work will have a fundamental impact in the confidence of the $M_{BH} - \sigma_*$ slope.

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