Co-Evolution of Central Black Holes and Galaxies
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Limits on the Masses of Supermassive Black Holes in 105 Nearby Galaxies

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Secure measurements of the mass of the central supermassive black hole, $M_{\rm BH}$, in external galaxies are traditionally obtained through the modeling of the stellar and/or gaseous kinematics, most often derived using *Hubble Space Telescope (HST)* observations in the optical domain. The modeling of the nuclear ionized-gas kinematics has led to accurate $M_{\rm BH}$ measurements at a relatively cheap cost in terms of observation time compared to stellar-dynamical $M_{\rm BH}$ determinations. But only a handful of the objects have turned out to have sufficiently regular gas velocity fields for the purpose of modeling. Nevertheless, the *HST* archive contains a yet untapped resource that can be used to better constrain the $M_{\rm BH}$ budget across the different morphological types of galaxies, which consists of the vast number of the Space Telescope Imaging Spectrograph (STIS) spectra from which a central emission-line width can be measured. These data allow to put an upper limit on $M_{\rm BH}$ for a large number of galaxies and promise to compensate for the lack of exact measurements when studying the $M_{\rm BH}$–host galaxy relationships.

For this reason, we used STIS to obtain Hα spectra of the nuclei of 105 nearby ($D < 100\,{\rm Mpc}$) galaxies spanning a wide range of Hubble types (E–Sc) and values of the central stellar velocity dispersion, $\sigma_{\rm c}$ (58–419 km s^{-1}). We obtained stringent upper bounds on their black hole masses (Beifiori *et al.* 2009). For the vast majority of the objects, the derived upper limits on $M_{\rm BH}$ run parallel to and above the well-known $M_{\rm BH}$–$\sigma_{\rm c}$ relation, independent of the galaxy distance, suggesting that our nebular line-width measurements trace the nuclear gravitational potential rather well. For values of $\sigma_{\rm c}$ between 90 and 220 km s^{-1}, 68% of our upper limits fall immediately above the $M_{\rm BH}$–$\sigma_{\rm c}$ relation without exceeding the expected $M_{\rm BH}$ values by more than a factor 4.1. No systematic trends or offsets are observed in this $\sigma_{\rm c}$ range as a function of the galaxy Hubble type or with respect to the presence of a bar. For 6 of our 12 upper limits on $M_{\rm BH}$ with $\sigma_{\rm c} < 90\,{\rm km\,s^{-1}}$, our line-width measurements are more sensitive to the stellar contribution than to the gravitational potential, either due to the presence of a nuclear stellar cluster or because of a greater distance compared to the other galaxies at the low-$\sigma_{\rm c}$ end of the $M_{\rm BH}$–$\sigma_{\rm c}$ relation. Conversely, our $M_{\rm BH}$ upper bounds appear to lie closer to the expected $M_{\rm BH}$ in the most massive elliptical galaxies with values of $\sigma_{\rm c}$ above 220 km s^{-1}. Such a flattening of the $M_{\rm BH}$–$\sigma_{\rm c}$ relation at its high-$\sigma_{\rm c}$ end would appear consistent with a coevolution of supermassive black holes and galaxies driven by dry mergers, although more consistent measurements for $\sigma_{\rm c}$ and K-band luminosity are needed for these kind of objects before systematic effects can be ruled out.

Reference

Beifiori, A., Sarzi, M., Corsini, E. M., Dalla Bontà, E., Pizzella, A., Coccato, L., & Bertola, F. 2009, *ApJ*, 692, 856