An Investigation of the nuclear black hole mass and global properties of NGC 4552

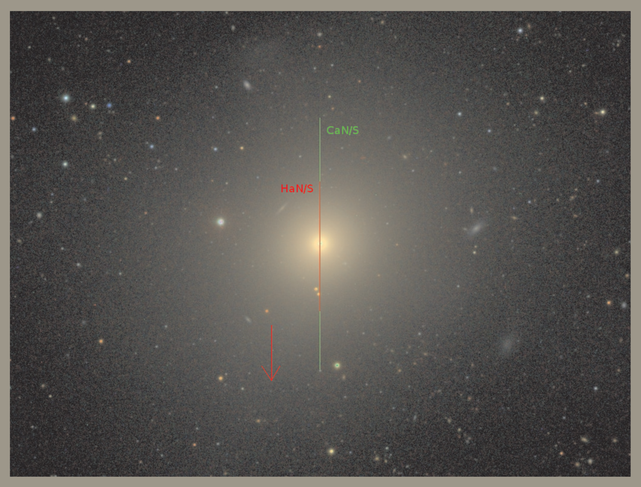
Peter Kircher (Ohio Northern University) **Jason Pinkney**

p-kircher@onu.edu j-pinkney@onu.edu

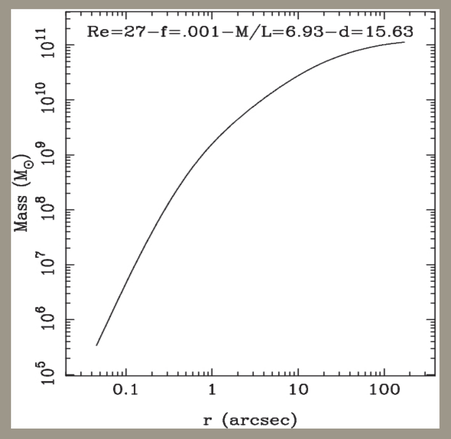
Abstract

In previous papers, we presented the spectroscopic and photometric data needed to estimate the mass of the supermassive black hole in NGC 4552. Now we have a new, refined black hole mass estimate from gas disk kinematics. We plot our galaxy on the key demographic scaling relations of M_{BH} vs. sigma and M_{BH} vs. Luminosity. Since black hole formation appears to be intertwined with galaxy formation, we also compare the global properties of our galaxy (effective radius, luminosity, effective surface brightness, ellipticity) to other gallaxies, including views of the "fundamental plane". Our elliptical is relatively compact, low in ellipticity, with almost no rotational support and with a "core" surface brightness profile. We also consider the gas/dust morphology which nevertheless produces an (apparently) accurate M_{BH} using gas kinematics.

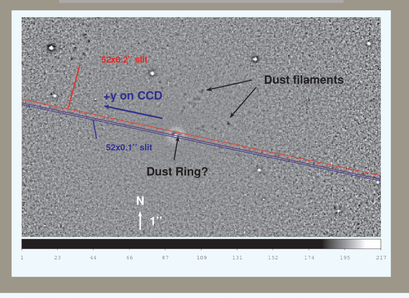
SDSS Image

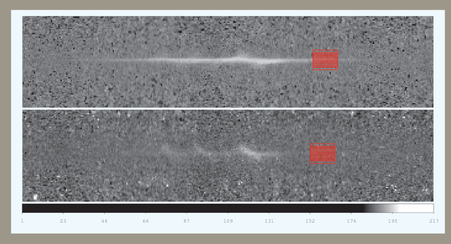


Enclosed Mass Profile

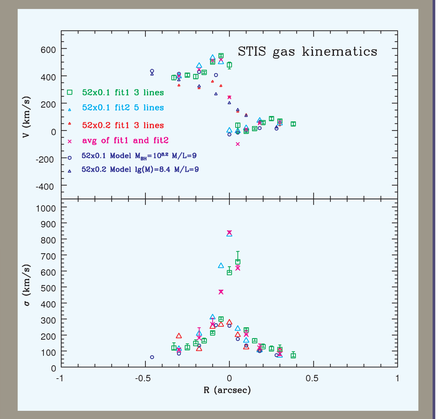


Spectroscopy





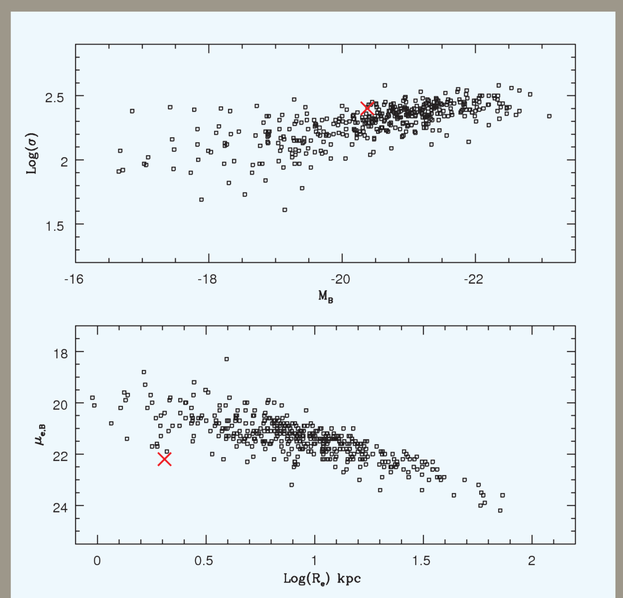
Model Kinematic Profiles



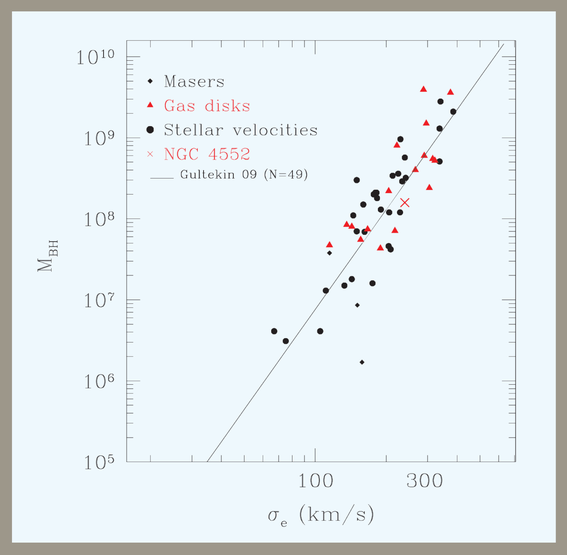
Properties of NGC 4552

- Distance = 15.63 Mpc
- Scale = 75.6 pc/arcsec
- σ_e = 250±5 km/s
- sersic parameter n = 4.36
- AGN Sp. Type = Sy2
- M_V = -21.36
- M_Z = -27.33
- b/a = 0.95
- e = 0.05
- R_e = 27"
- M_{BH} = 2.0x10^8 M_{sol}
- M_{BH} (from σ = 250km/s) = 3.2x10^8 M_{sol}

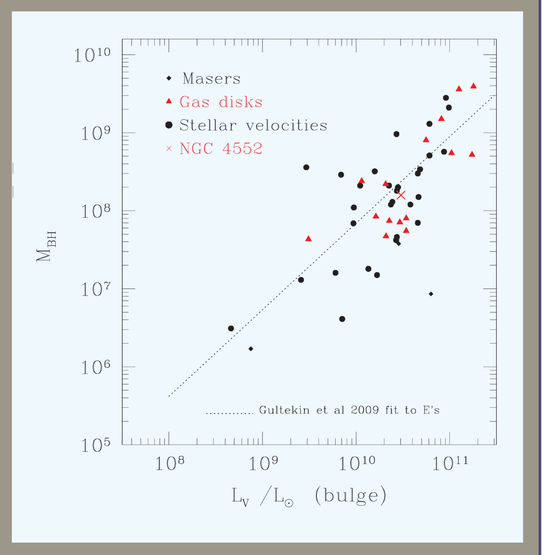
(Above) Faber-Jackson Relation (Below) Kormendy Relation



MBH vs. sigma



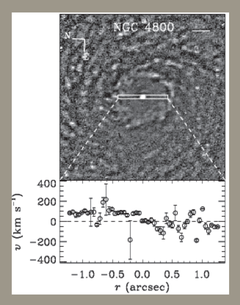
M_{BH} vs. L_V or L_B

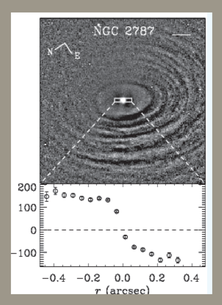


Dust Morphology

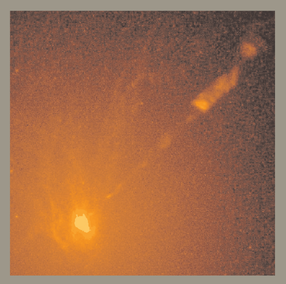
From Ho et al 2001

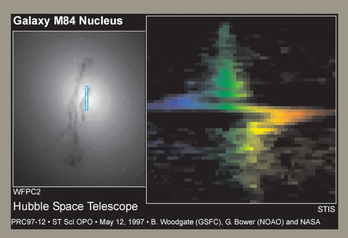
Ho et al. found that even organized looking dust morphology could sometimes have irregular gas rotation curves (e.g. NGC 4800, below left). They warned that only very well-organized dust rings & disks (e.g. NGC 2787, below right) should be trusted for gas disk kinematics.



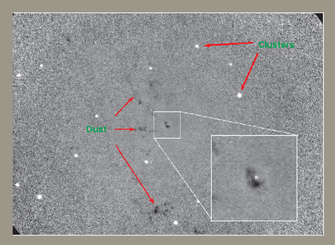


Early, secure, M_{BH} measurements (from STIS) in Ellipticals with erratic dust (but fairly disky gas near center).





NGC 4552 (lower right) is like M87 (above) & M84 (upper right) in that the dust morphology is not ideal but it seems to have a well-behaved gas disk.



Conclusions

*** We have measured the SMBH mass in NGC 4552 using gas kinematics and found 2.0x10^8 M_sol.**

*** We have measured the velocity dispersion of NGC 4552 (sigma = 250 km/s) and it suggests a SMBH mass (from the Mbh -- sigma relation) of 3.2x10^8 M_sol. Given that the scatter in Mbh--sigma is about 0.35 in dex (implying Mbh = 1.4-7.1 x 10^8 M_sol), our measurement is consistent with the Mbh-sigma relation.**

*** Our galaxy is a little low in surface brightness for its effective radius, R_e. But, in general, our measurements are consistent with Fundamental Plane parameters.**

*** Despite the dust morphology of NGC 4552 not being a clean disk, our gas disk model provides a BH mass consistent with expectations. This has been seen in other galaxies like M87 (NGC 4486), M84 (NGC 4374), and M105 (NGC 3379).**

*** Future work: in collaboration with K. Gultekin, we will be measuring the BH mass in N4552 using stellar kinematics, providing a useful comparison.**

References

Capellari et al. 2006, MNRAS 360, 1126. "The SAURON project -- IV. The mass-to-light ratio, the virial mass estimator and the fundamental plane of elliptical and lenticular galaxies"

Dressler, et al 1987, ApJ 313, 42. "Spectroscopy and photometry of elliptical galaxies. I - A new distance estimator"

Gultekin et al. 2009, ApJ 698, 198. "The M-sigma and M-L Relations in Galactic Bulges, and Determinations of Their Intrinsic Scatter"

Mo, H., Van den Bosch, F., & White, S. 2010 in "Galaxy Formation and Evolution", Cambridge University Press

Acknowledgments

This research made use of NED the NASA Extragalactic Database. It also used archival data from the Sload Digital Sky Survey (SDSS). Funding for the SDSS has been provided by the Alfred P. Sloan Foundation, the Participating Institutions, the National Science Foundation, the U.S. DoE, cASAiety, and the Higher Education Funding Council for England. We thank the STIS Instrument Definition Team (ID.T) for allowing use of their data and we look forward to future collaboration.