# Investigating the High-Luminosity End of the Active Galaxy $M_{\rm BH}$–$\sigma_*$ Relation

**C. J. Grier[1], L. C. Watson[1], B. M. Peterson[1,2], P. Martini[1,2], M. C. Bentz[3], K. M. Dasyra[4], K. D. Denney[1], M. Dietrich[1], L. Ferrarese[5], R. W. Pogge[1,2], and L. J. Tacconi[6]**

[1] Department of Astronomy, The Ohio State University, Columbus, OH 43210, USA
Email: grier@astronomy.ohio-state.edu

[2] Center for Cosmology & AstroParticle Physics, The Ohio State University [3] Department of Physics and Astronomy, University of California at Irvine [4] Spitzer Science Center, California Institute of Technology [5] Herzberg Institute of Astrophysics, National Research Council of Canada [6] Max Planck Institut fur extraterrestrische Physik

**Keywords.** galaxies: active, galaxies: nuclei, quasars: emission lines

While characterization of the $M_{\rm BH}$–$\sigma_*$ relationship in AGNs has improved due to the increase in available data and the improvement in accuracy of both $M_{\rm BH}$ and $\sigma_*$ measurements, additional data at the high-luminosity end of the distribution of quasars are needed, as recent studies indicate that perhaps the relation steepens in this regime. To this end, we present three new measurements in objects at the high-luminosity end of the relation.

We show results of a recent reverberation-mapping campaign undertaken to improve $M_{\rm BH}$ measurements in the quasar PG 2130+099. Our recent measurements yield $M_{\rm BH} = 3.8 \times 10^7\ M_\odot$ (see Grier *et al.* 2008). We also present stellar velocity dispersion measurements for two quasars observed using the NIFS instrument and Altair laser guide star adaptive optics system on the Gemini North 8m telescope. Watson *et al.* (2008) measured $\sigma_*$ in PG 1426+015 to be $217 \pm 15\ {\rm km\,s^{-1}}$. We measured $\sigma_*$ in Mrk 509 to be $199 \pm 20\ {\rm km\,s^{-1}}$. With these new measurements, PG 1426+015 remains an outlier on the $M_{\rm BH}$–$\sigma_*$ relation; both of the other objects lie very close to the relation. Our new measurements constitute a substantial improvement in the AGN $M_{\rm BH}$–$\sigma_*$ relation by increasing the number and accuracy of measurements used in the calibration at the high-luminosity end.

## References

Dasyra, K. M., *et al.* 2008, *ApJ*, 657, 102
Grier, C. J., *et al.* 2008, *ApJ*, 688, 837
Tremaine, S., *et al.* 2002, *ApJ*, 574, 740
Onken, C. A., *et al.* 2004, *ApJ*, 615, 645
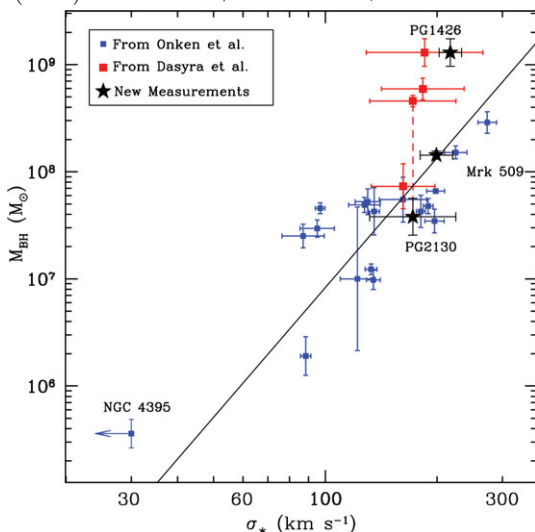Watson, L. C., *et al.* 2008, *ApJ*, 682, 21

**Figure 1.** The AGN $M_{\rm BH}$–$\sigma_*$ relation. The solid line shows the relationship measured by Tremaine *et al.* (2002). Our new measurements are shown as large stars.