Ay190 – Worksheet 05
Donal O Sullivan
Date: January 25, 2014

1 $M_{BH} - \sigma_*$ Relation

The linear regression fit without error was quite easy to fit to, setting $\sigma = 1$ and simply coding the equations for $a1$ and $a2$ as given in Equations $III.6.8$ and $III.6.7$ of the Lecture notes.

To take both σ and M_{BH} errors into account, equation $III.6.10$ tells us to convert the x_i into extra errors on the y_i by using the formula $\sigma_{i,extra} = |\frac{\delta y}{\delta x}|\sigma_i^x$ and then using $\sigma_{i,total}^2 = \sigma_i^2 + \sigma_{i,extra}^2$. The issue here is finding a reasonable value for $|\frac{\delta y}{\delta x}|$. Using the data itself in a simple numerical differentiation yields very large and wildly varying slope values, along with a number of 'division by zero' errors arising from overlapping σ_i. Most of the points were fine and the slope could be calculated numerically. However, for those that resulted in a division by zero, I used the slope of the error-free linear regression model as a best estimate.

The final results show decent enough fits, but there are slight differences in how the data is presented between here and how it is presented in ADS [1] in that their σ is divided by a value $\sigma_0 = 200kms^{-1}$. Since I'm not sure how that would affect the error propagation, I left it, but it is still clear to see that with the inclusion of error bars in the fit, my slope value gets slightly closer to their value of 4.02.

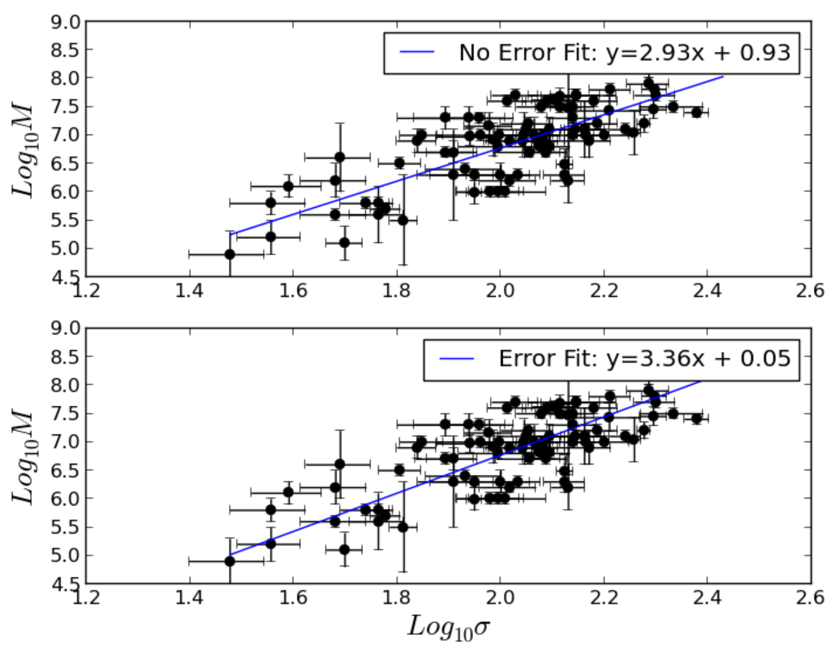

Figure 1: Two linear fits for the $M_{BH} - \sigma_*$ data. The top plot shows a linear regression fit made without taking error into account, while the bottom shows the same with error taken into account.

References

[1] J. E. Greene and L. C. Ho. The M_{BH}-σ_* Relation in Local Active Galaxies. , 641:L21–L24, April 2006.