Computational Astrophysics
2019
Exercises 08. Curve Fitting

1. **Curve Fitting: The $M_{\rm BH} - \sigma_*$ Relation**

   In 2006, Greene and Ho [1] studied the characteristics of 88 galaxies to show that there is an apparent relationship between the stellar velocity dispersion σ_* in a galaxy bulge and the mass $M_{\rm BH}$ of the supermassive black hole at its center, as shown in Figure 1 . This is known as the $M_{\rm BH} - \sigma_*$ relation and is not yet completely understood.

   The dataset used by Greene and Ho is available online in various formats at http://vizier.cfa.harvard.edu/viz-bin/VizieR?-source=J/ApJ/641/L21.

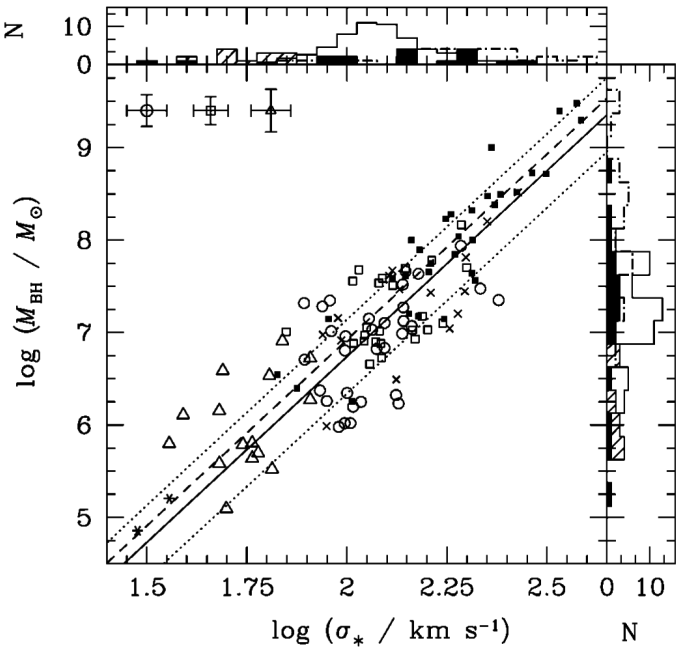

Figure 1: Figure taken from Greene & Ho, ApJ 641:L21 (2006).

(a) Go to
http://cdsarc.u-strasbg.fr/viz-bin/cat/J/ApJ/641/L21
In the tab "FTP" you can download the data files of the paper by Greene and Ho:
- ReadMe
- table1.dat

The ReadMe file describes the data stored in the table1.dat file.

In order to read the .dat file it can be used the `AstroPy` package or it is also possible to write a code to read it and store it in `NumPy` arrays.

In the code directory of this lecture you can find a sample file (`astropy_reading.py`) using `AstroPy` to read the data.
Make a plot of point (no lines !) showing $\log_{10} M_{\rm BH}$ as a function of $\log_{10} \sigma_*$.

(b) Compute a linear regression fit to the data (ignoring errors). Make a plot of data and fit. Compare your fit results to that of Greene & Ho (2006) in Figure 1. (Maybe you will need some rescaling for a direct comparison.)

(c) Include the errors in $\log_{10} \sigma_*$ and $\log_{10} M_{\rm BH}$ in your fit. There may be multiple errors given, use your judgement which ones to pick. How does this change your fit?

Happy Coding :) !

References

[1] Greene, J. E. and Ho, L. C. *The $M_{BH} - \sigma_*$ Relation in Local Active Galaxies*. ApJ 641 L21 (2006) https://ui.adsabs.harvard.edu/abs/2006ApJ...641L..21G/abstract