AST 475/875 Exercise #2

Due F, September 10th

A quantity of considerable interest is the primordial helium abundance—more specifically, the mass fraction of helium, *Y*, produced by Big Bang nucleosynthesis. This quantity, along with the primordial abundances of some other elements (notably deuterium, tritium, and lithium-7) can place constraints on the baryonic density and number of neutrino species. Currently, various groups of folks are at great odds with each other, debating vigorously the value of *Y* in the rather narrow range of approximately 0.23-0.25. The determinations usually have quoted very small uncertainties (e.g., 0.238+/-0.003). Lately, it has become apparent that one needs to consider the statistical analyses of the data with as care as great as used in obtaining the data themselves. It is probably not far from the truth that different workers can use the same data sets, but arrive at different results. Let us get a flavor of this with an exercise that may serve as a cautionary note to all of us using various regressions in a rather carefree manner.

Izotov & Thuan (2004; ApJ, 602, 200) have recently presented helium abundances derived from H II regions in blue compact galaxies. The helium mass fractions are plotted versus "metal" abundances (the linear number abundance of either N or O relative to H). A regression is carried out to infer the "primordial" abundance—i.e., the *Y* value where the metal abundance is zero. In other words, the *y*-intercept gives *Y*.

1) Make this plot (*Y* versus O/H ratio) using the restricted H II region sample in their Table 7

2) Ignoring the uncertainties in each data point or other weighting methods, calculate and plot the analytical ordinary least squares (Y|X) and ordinary least squares bisector regressions to this data. What are the zero points in this case? Do they differ?

3) Calculate and plot the OLS(Y|X) and OLS lines via bootstrap and jackknife simulations. Do these values of *Y* differ from their analytical counterparts.

Tip: You can do this exercise via any means you'd like. If you're unsure, though, download and compile (with f77) the fortran code SLOPES available at the Penn State center for astrostatistics (www.astro.psu.edu/users/edf/research/stat.html). If you have trouble compiling or figuring out the file formats, please see me or speak to your classmates.