Transit-Depth Metallicity Correlation: Bayesian Approach

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Introduction

A negative correlation was previously reported between the transit depth of *Kepler*'s Q1-Q12 gas giant candidates and the stellar metallicity. In the present work, we revisit this correlation which is crucial for the giant planet formation theory. We present the first hierarchical Bayesian regression model to revise this correlation. Our sample consists of the latest updated *Kepler* giant planets based upon 4 years of high precision photometry (i.e. Q1-Q17).

Sample Selection

For this analysis we considered the cumulative catalog of planets detected by the *NASA Kepler* mission to construct our sample of gas giant planets ($5R_\oplus \leq Rp \leq 20R_\oplus$). We chose $\mathrm{SNR} > 7.1$ to avoid KOIs with noisy lightcurves. The metallicities were taken from Huber et al. (2014). This leaves us with a sample of 373 planets of which 82 are confirmed gas giant exoplanets.

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Hierarchical Bayesian Regression Model

This method allows us to derive the uncertainties on the model parameters and to relate the observed data to the *true* unobserved data. We constructed the likelihood function in a simple way to relate the parameters of interest to the observed data taking into account the measurement uncertainties. We used this method to study the correlation between the transit depth and the metallicities. Markov Chain Monte Carlo was performed using PyStan.
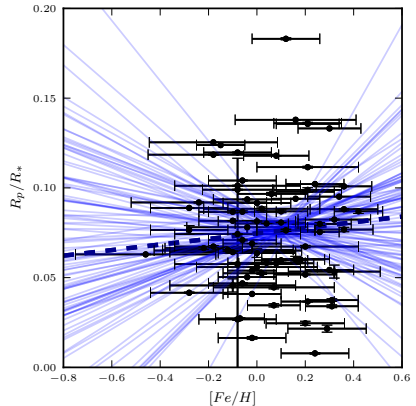
Preliminary Results

Figure 1: Confirmed gas giant planets and the best fit line. The light blue lines are samples from the MCMC chain.

Conclusion

One can clearly see from a statistical point of view, the graph does not show any significant correlation between the transit depth of giant exoplanets and the stellar metallicity. This result shows how crucial understanding those discrepancies. Thus, they are directly related to the models of planetary structure and formation.

Future Work

- Would the transit depth planet metallicity correlation hold for elements other than Fe?

- Gaidos & Mann (2013) reported the importance of including systematic errors and biases in large scale surveys. What is the contribution of the selection effects and biases present in the *Kepler* survey?

References

- Dodson-Robinson, S. E. 2012, ApJ, 752, 72
- Gaidos, E., & Mann, A. W. 2013, ApJ, 762, 41