SESW 2016 TRANSIT HANDS ON SESSION

GROUP 4: PLANETARY PARAMETERS

Sean McCloat – University of North Dakota (USA)

Clement Perrot – LESIA – Paris Observatory (France)

Diego Hidalgo – IAC (Spain)

Nestor Arsenov – LMU, University of Munich (Germany)

Eloise Birchall – Australian National University (Australia)

Ximena Saad Olivera – Observatorio Nacional (Brazil)

Tiffany Visgaitis – Kutztown Univeristy (USA)

Bernie Yuhas – Kutztown University (USA)

Kelsey Miller – University of Arizona (USA)

Martin Schlecker – Technical Uni. of Munich / European Southern Observatory

The Prompt

- Investigate how including additional parameters in your fits affects correlations and uncertainties in the planetary radius (Rp/R*) for white light curve.

- Start by including the semi-major axis (a/R*) and the inclination (i) in the set of fitted parameters, in addition to planetary radius, center of transit time T0, and linear limb darkening (u) parameters.

- How do the uncertainties change? Are the results consistent with the three parameter fit? Are there significant correlations?

- Discuss methods to limit parameter correlation and incorporate information from further observations to further constrain your results.

- Use Bayes rule to do parameter inference

Hypotheses

- Increasing the number of parameters used to fit will reduce the errors

    - But there was some dissent in the crowd ("Statistics is dark sorcery")

- Increasing the number of (chains?) in the MCMC will also reduce error

Strategy

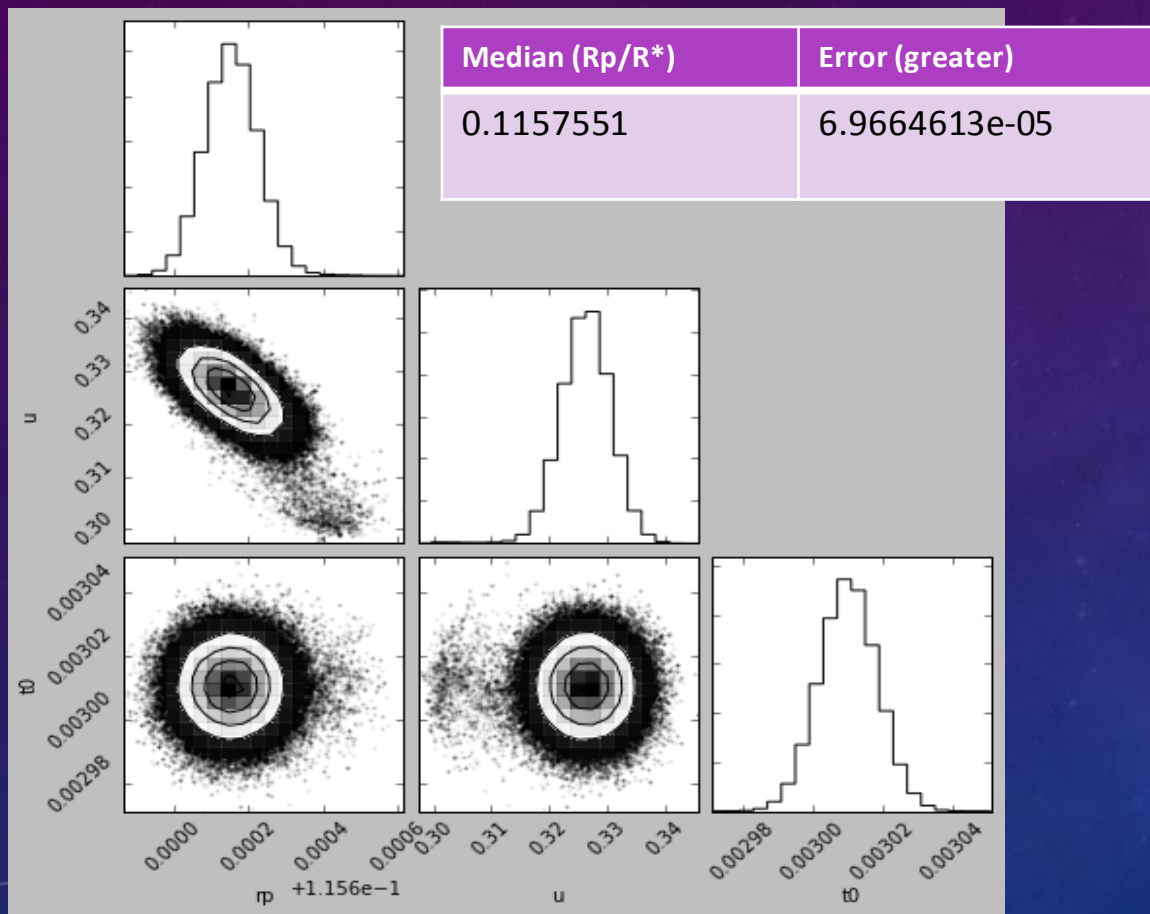| # parameters	nWalkers	Burn-in
3 (Rp/R*, u, T0)	100, 500	50
4 (**inc**, Rp/R*, u, T0)	500	50, 1000
4 (**a/R***, Rp/R*, u, T0)	100, 500, *1000*	50, *1000*
5 (Rp/R*, u, T0, **a/R***, **i**)	500	100, 1000, 4500

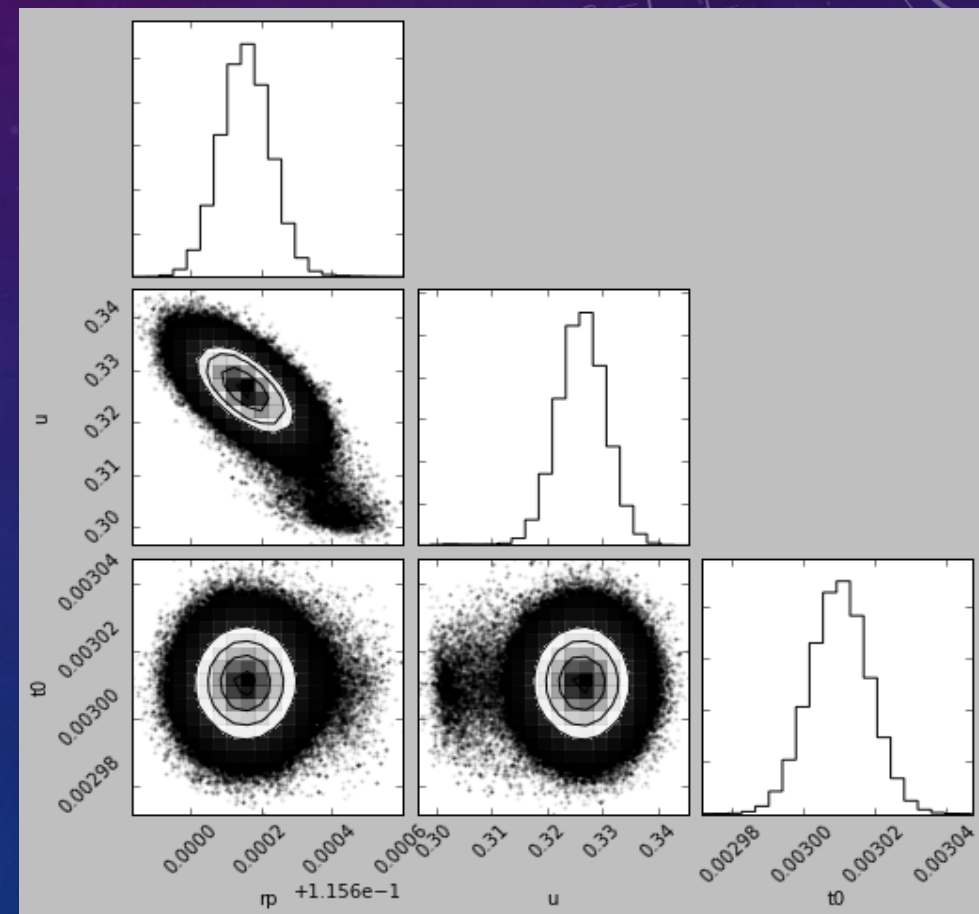- Assumed uniform distribution for priors
- Constant 5000 iterations

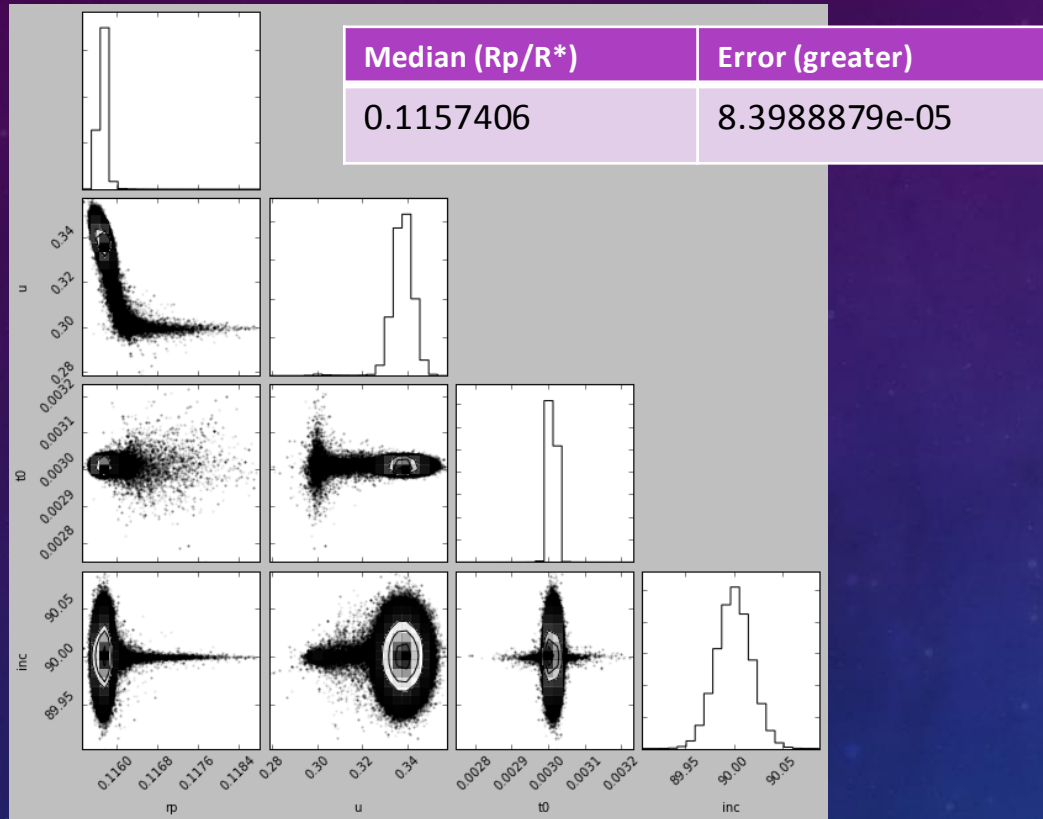# Model Fit with Three Parameters

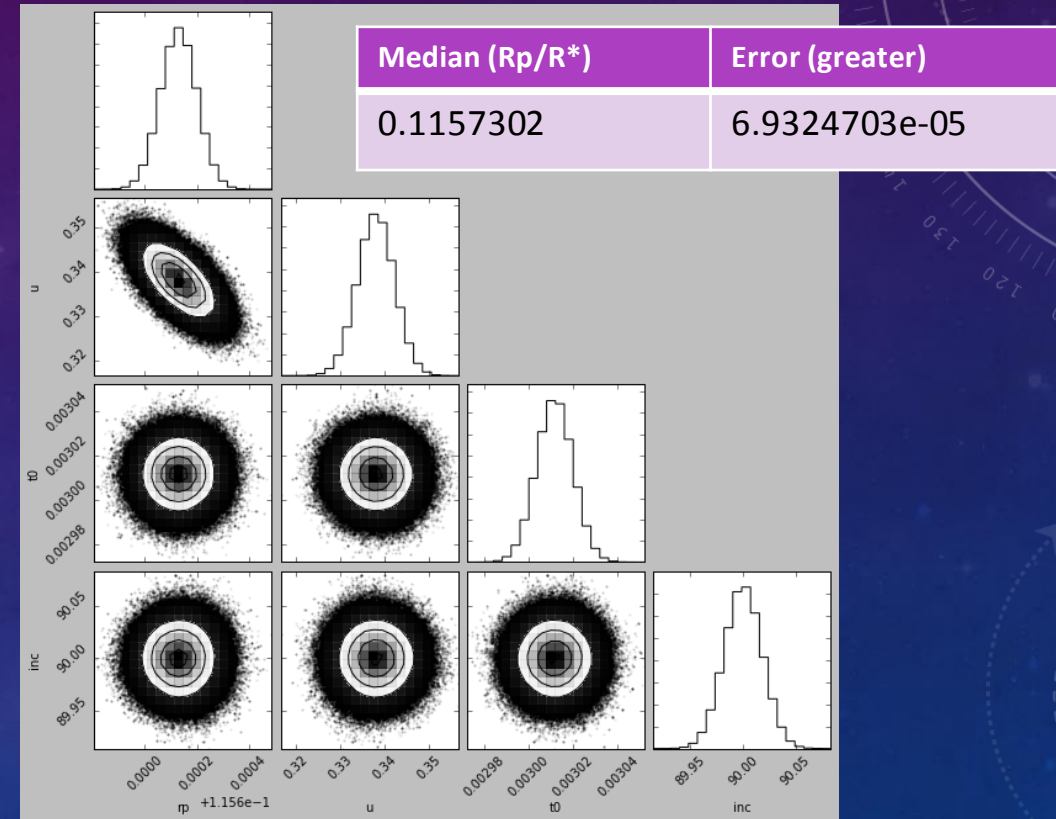nWalkers = 100
Burn-In = 50

nWalkers = 500
Burn-In = 50

Median (Rp/R*)	Error (greater)
0.1157551	6.9664613e-05

Model Fit with Four Parameters (inc)

nWalkers: 500
Burn In: 50

nWalkers: 500
Burn In: 1000

Median (Rp/R*)	Error (greater)
0.1157406	8.3988879e-05

Median (Rp/R*)	Error (greater)
0.1157302	6.9324703e-05

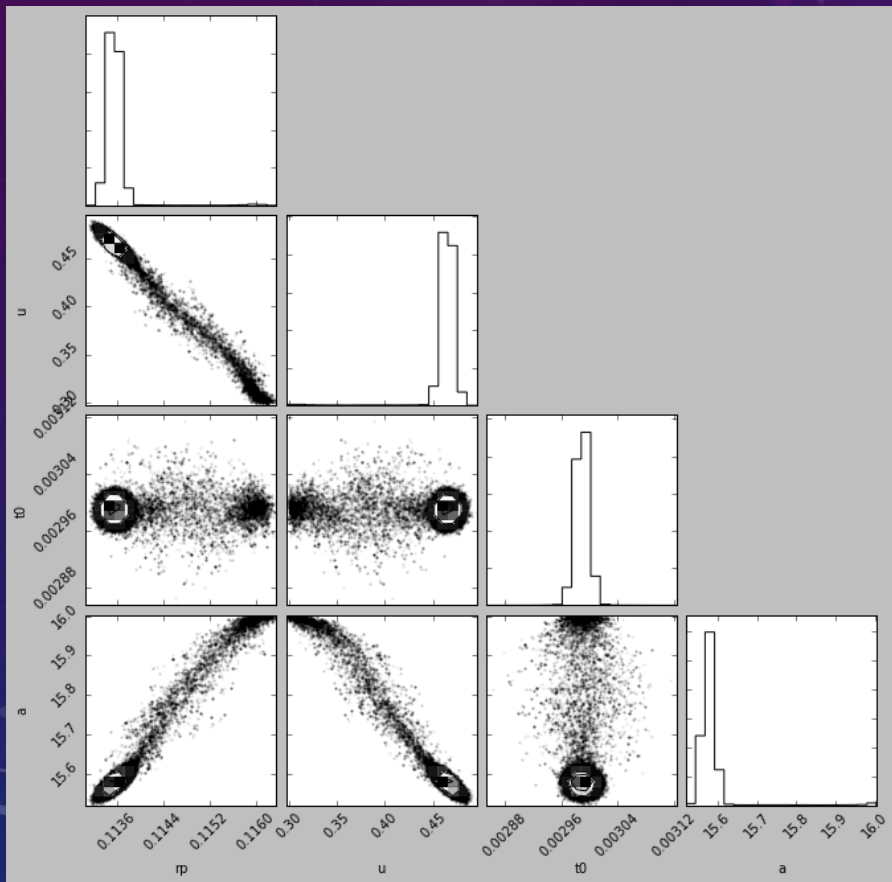All parameters we investigated were found to be uncorrelated, with the exception of planet radius and limb darkening.
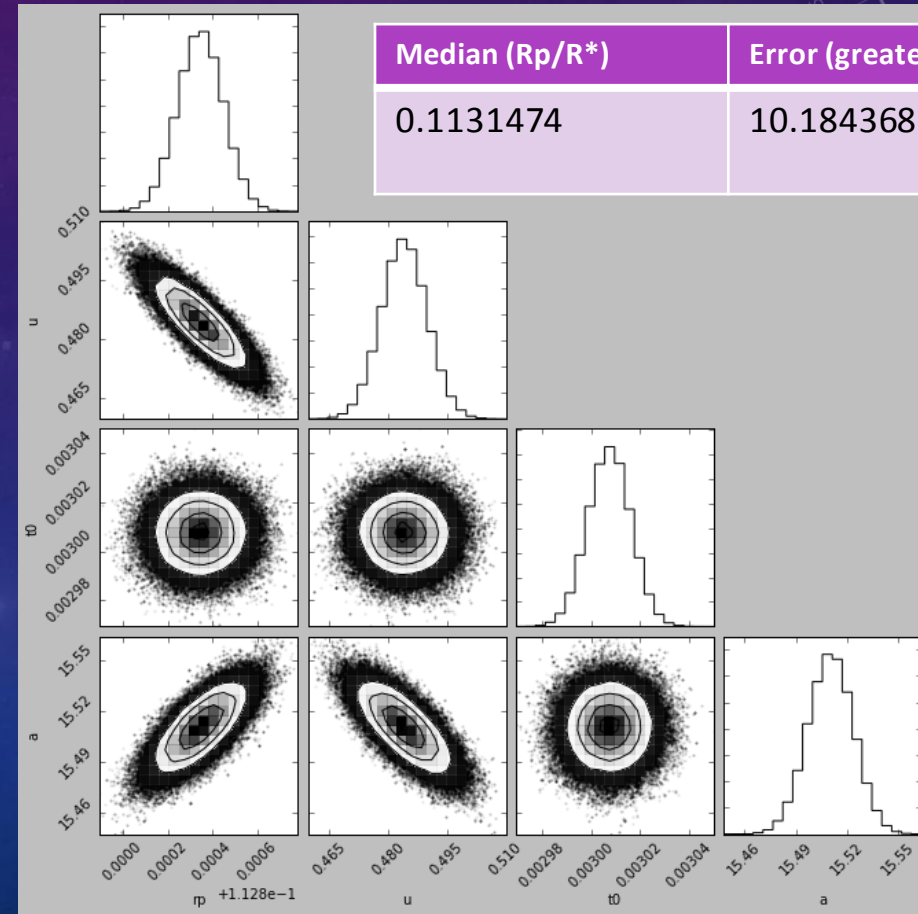
This is to be expected given that limb darkening decreases flux, which in turn affects the calculated estimate of the planet radius.
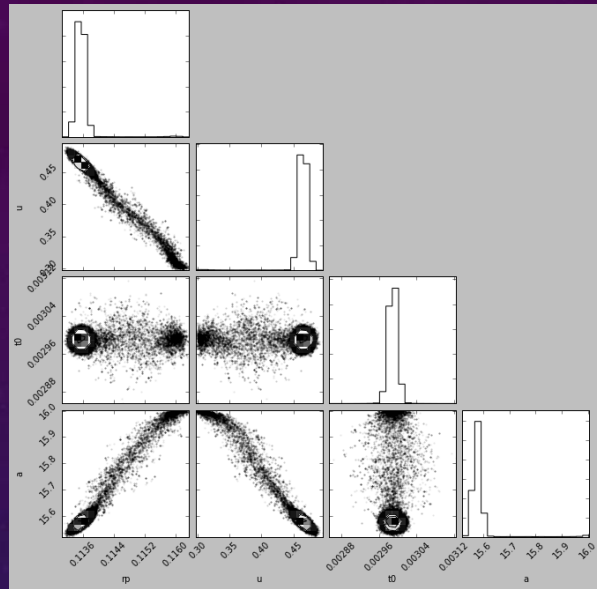
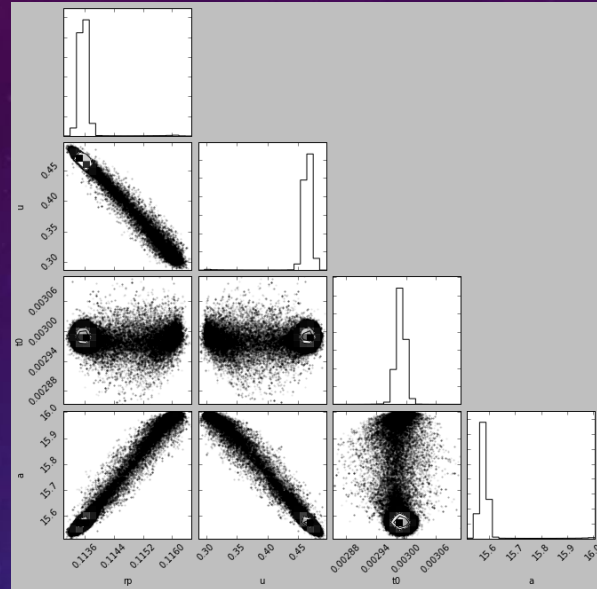# Model Fit with Four Parameters (a/R*)

nWalkers: 100
Burn In: 50

nWalkers = 100
Burn-in = 1000

Median (Rp/R*)	Error (greater)
0.1131474	10.184368e-05

Model Fit with Four Parameters (a/R*)
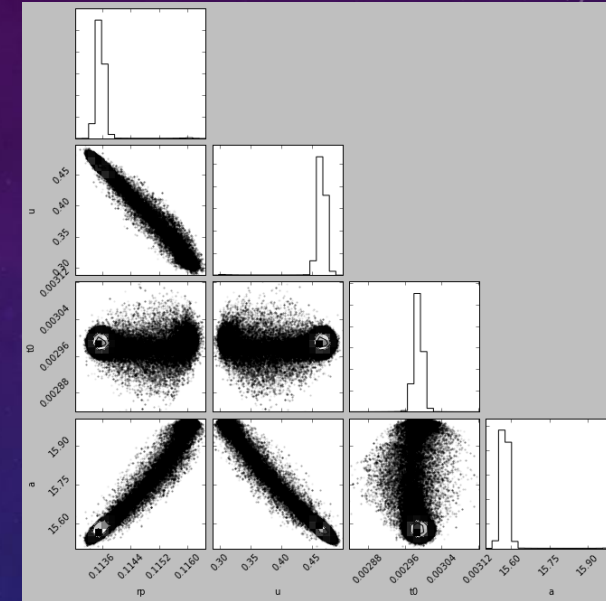

nWalkers: 100
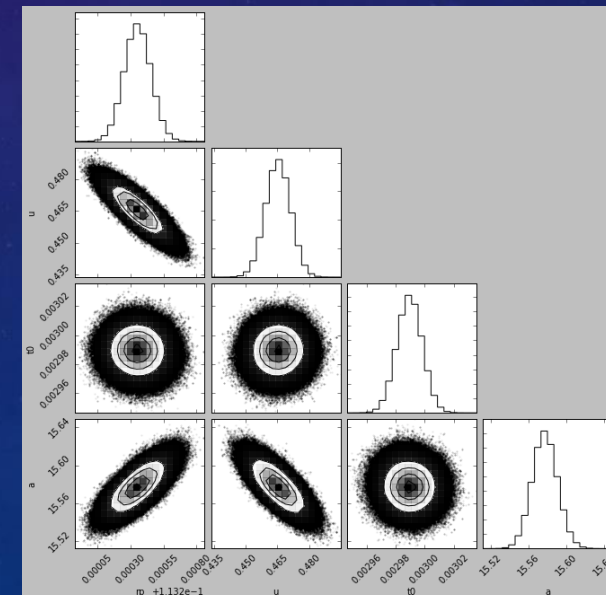Burn In: 50

nWalkers: 500
Burn In: 50

nWalkers: 1000
Burn In: 50

Interpretation: that the quality of the MCMC is not improving with more than "nwalker"=100 - instead it kind of gets oversaturated.

Burn-in=1000 shows a significant improvement of the MCMC plot (concentrated in a much smaller area), since we get rid of the first 1000 steps that are more or less random, before they finally converge in a smaller area.
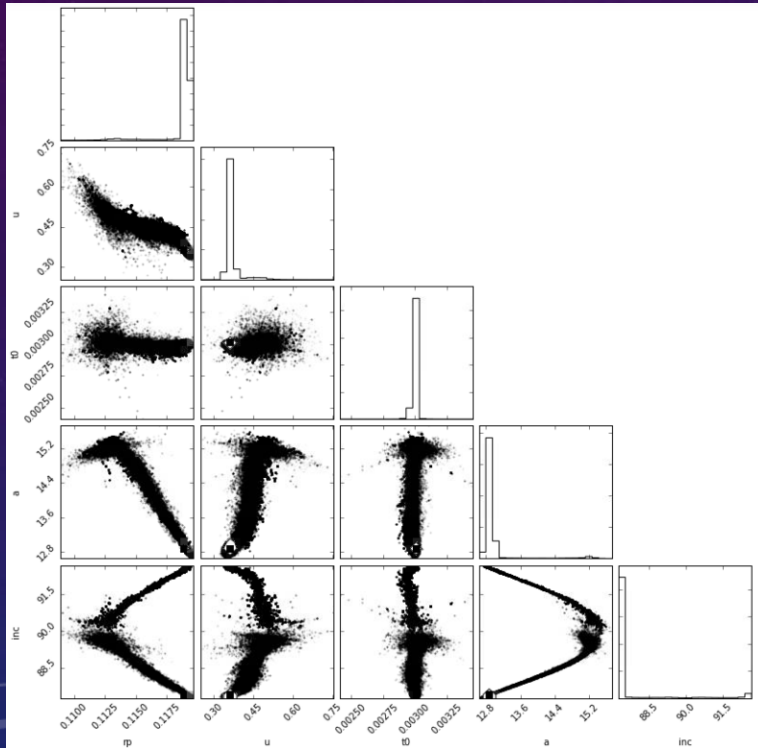
nWalkers: 1000
Burn In: 1000

Model Fit with Five Parameters (a/R*, i)
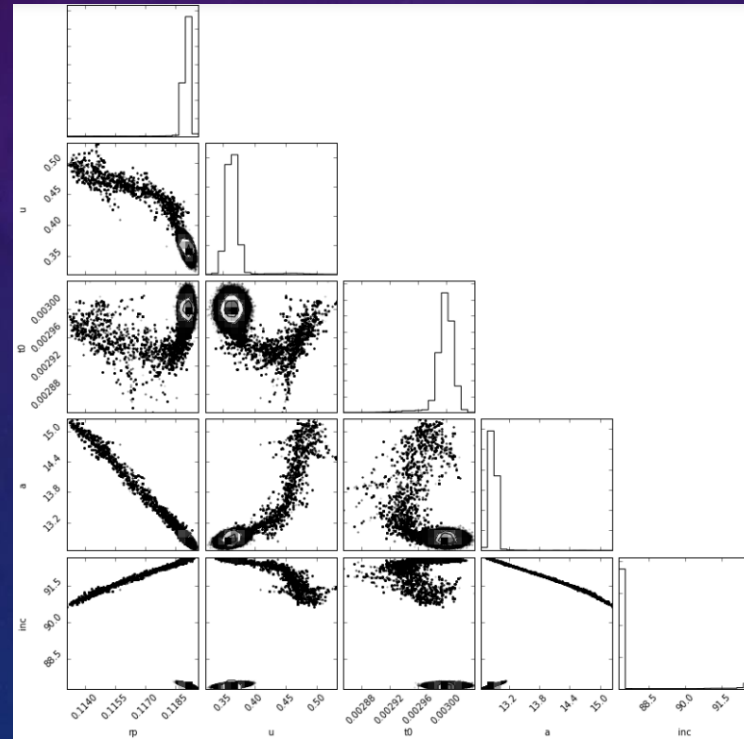
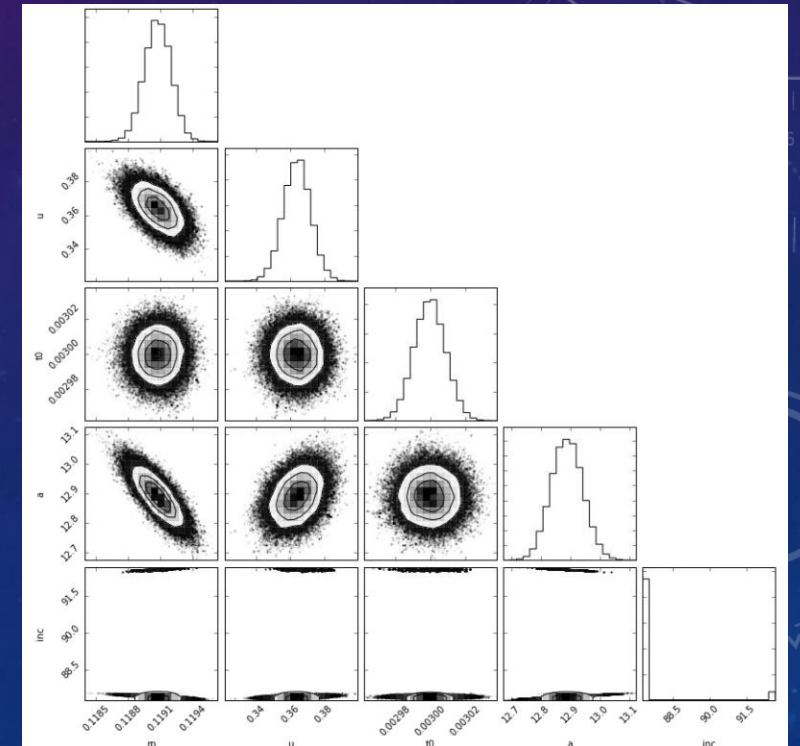| Median (Rp/R*)	Error (greater)
0.1190733	12.374173e-05

nWalkers = 500
Burn in = 100

nWalkers = 500
Burn in = 1000

nWalkers = 500
Burn in = 4500

"ALL TOGETHER NOW!"

# parameters	Median (Rp/R*)	Error (greater)
3 (Rp/R*, u, T0)	0.1157561	7.0108477e-05
4 (**inc**, Rp/R*, u, T0)	0.1157406	8.3988879e-05
4 (**a/R***, Rp/R*, u, T0)	0.1131474	10.184368e-05
5 (Rp/R*, u, T0, **a/R***, **i**)	0.1190733	12.374173e-05
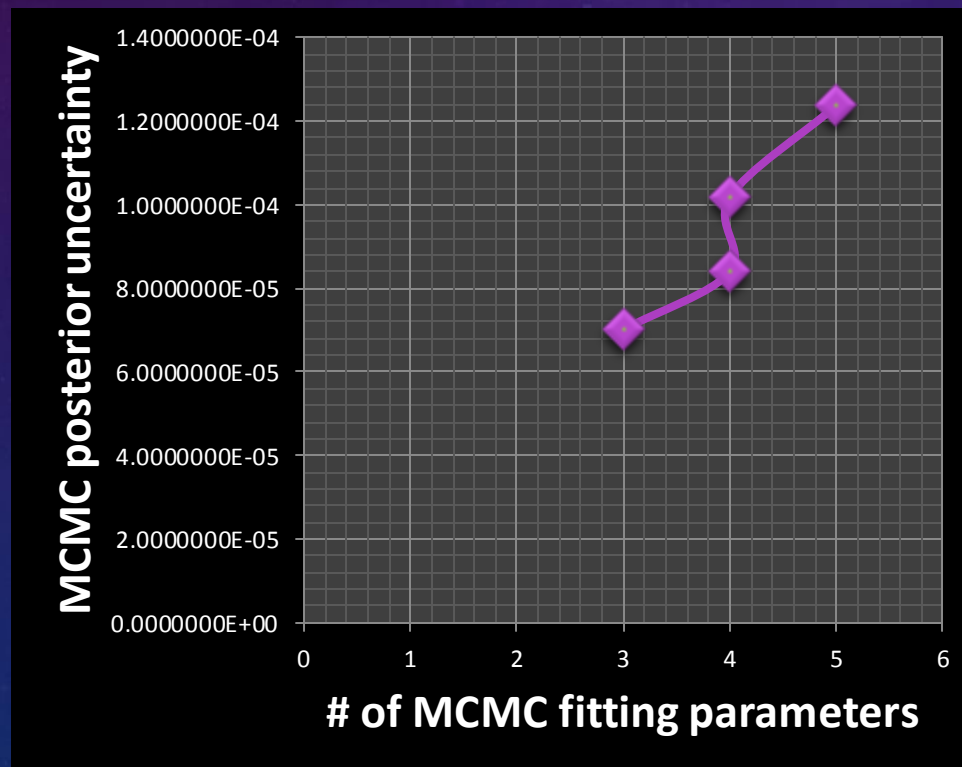
SOME PARTING THOUGHTS

- Increasing nWalkers seemed only to increase the error in the fits

- Increasing the number of parameters also increased the error in the fits

- Increasing the burn-in number had the most significant impact on decorrelating the triangle plots

- Our hypotheses were wrong...unless the evil dissenters are correct, in which case...

AXES OF EVIL

Fig. 1
The scatter plot IS DRIPPING BLOOD.

Fig. 2
The data reveal AN ANGRY MASK.

Fig. 3
A trend has developed toward RAZOR-SHARP FANGS.

Fig. 4
There is a bimodal distribution OF VENGEFUL SPIRITS.

[GRANT SNIDER (2011)]