

# Transit Fitting: Oversampling and Parameterization

With Some Additional CoRoT-7b Stuff

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RoPACS Network Workshop - September 2010  
08.09.2010

# Part I

## Notes for Young Transit Fitters

# Points to Take Back Home

## If you use long exposure time or bin the data

- Supersample (or integrate) the fitted model
- Read "Binning is Sinning: morphological light-curve distortions due to finite integration time." by D. Kipping

## There are many ways to parameterize the transit model

- Use a set that minimizes the correlations between parameters
- Do not use the physical parameterization  
(Transit center, period, depth, semimajor-axis, impact parameter)
- Read Kipping's "Investigations of Approximate Expressions for the Transit Duration"

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- ⇒ Increase ingress and egress duration
- ⇒ Lead to overestimated impact parameter
- ⇒ Lead to underestimated semi-major axis
- ⇒ Lead to underestimated stellar mass and density

## Bad Parameter Set

- ⇒ Increases optimization time
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# Model Supersampling and Integration

## Supersampling

- Use a high-resolution model lightcurve
- Bin it to the observation resolution
- Time resolution can be increased where necessary
- Binning can be optimized

## Integration of the Model

- Integrate (numerically) the model over the timespan of a single observation or bin
- Slightly more complex
- Not necessarily more efficient than simple resampling

# Model Supersampling and Integration

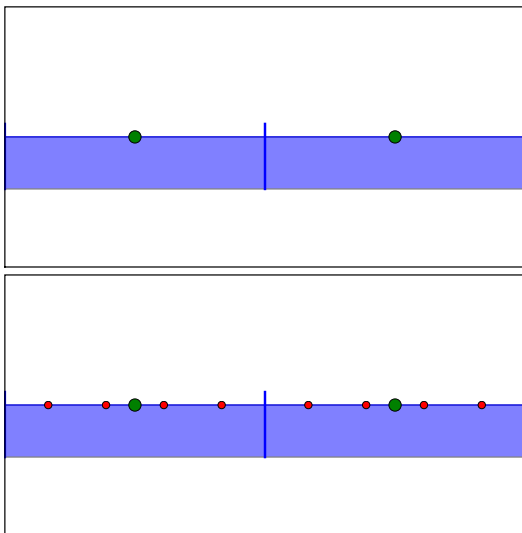
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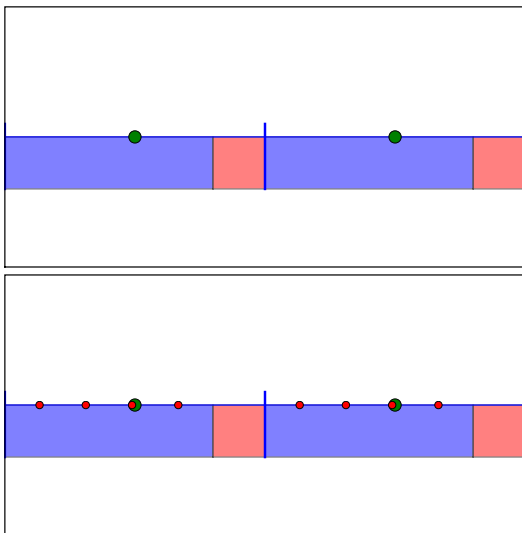
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# Supersampling



# Supersampling



# Case Study: CoRoT-7b

# Fitting Setup

## Preliminary Results

- That is, I started this work last monday

## The Question

- How stable is the best-fit result under varying bin width?

## Three Cases

- Simulated noiseless  $I_c$
- Simulated noisy  $I_c$
- Real  $I_c$

## Optimization

- Differential Evolution
- Global optimization

## Transit Model

- Giménez model
- Kipping's parameterization
- Linear limb darkening

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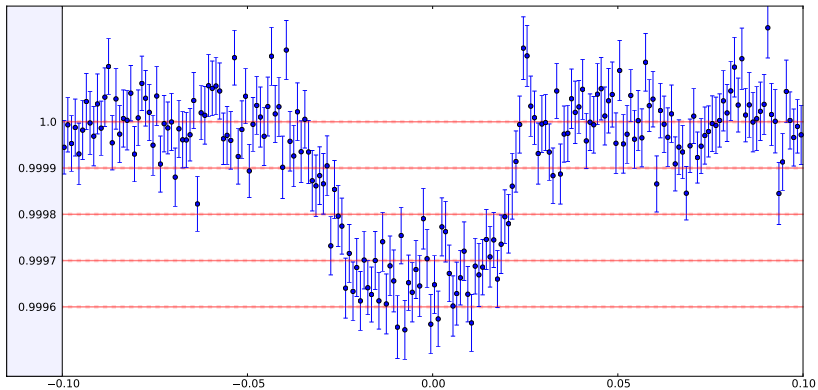
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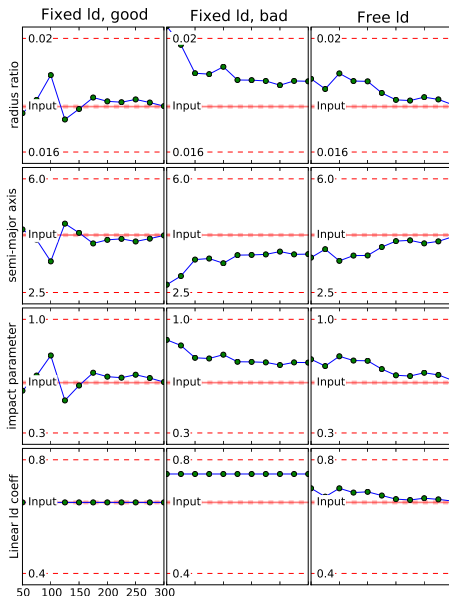


## Simulations: clean

- Published parameter values
- No noise

## Results

- No surprises
- Unstable solution for large bin widths
- Semi-major axis and impact parameter anticorrelated
- Correct solution found when bin width decreases

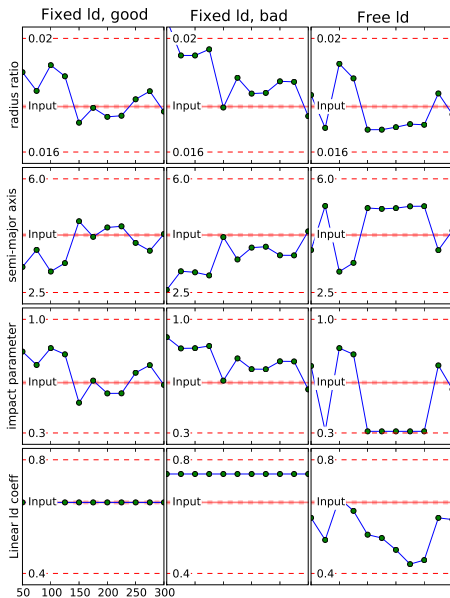


## Simulations: noisy

- Gaussian noise added
- Noise statistics from real lightcurve

## Results

- Several separate minima for free Idc

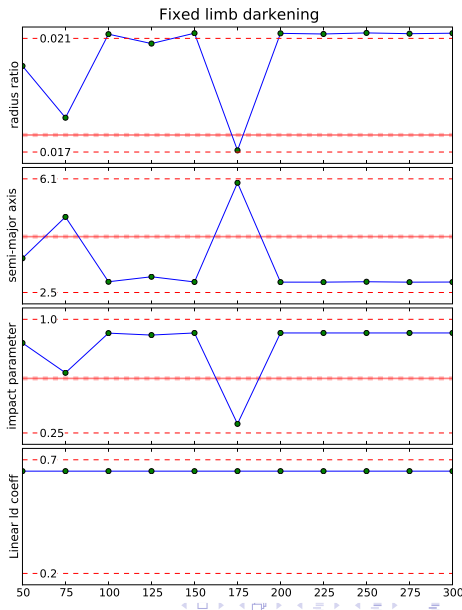


## Real transit: Fixed $l_{dc}$

- Fixed  $u = 0.65$
- No physical constraints

## Results

- Two nearly equal minima
- Sensitive to binning
- Neither minima is very close to published values

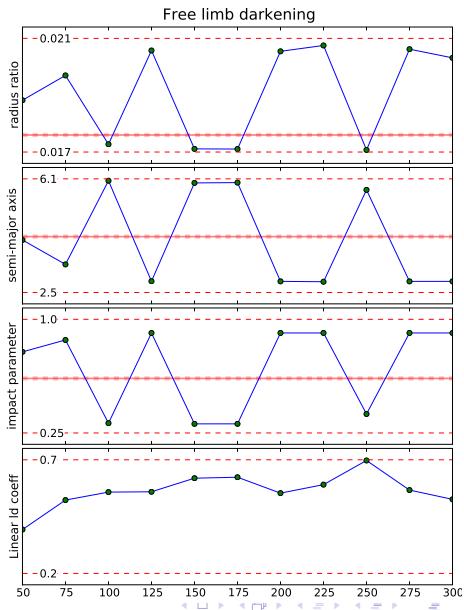


## Real transit: free Ldc

- Ldc a free parameter
- No physical constraints

## Results

- Two minima
- Ldc relatively stable
- ... and close to the theoretical value
- coincidence?



# Discussion

## Problems

- Best-fit points without confidence limits practically useless
- Need to sample the parameter space in detail (MCMC)
- TTV's might be present
- But hard to detect due to low S/N of a single transit

## Stellar constraints

- The star CoRoT-7 is well characterized
- Constraint on semi-major axis could stabilize the fit

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