



Detecting Class A Stellar Engines using Exoplanet Transit Curves

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Forgan (2013), JBIS, in press (arXiv:1306.1672)



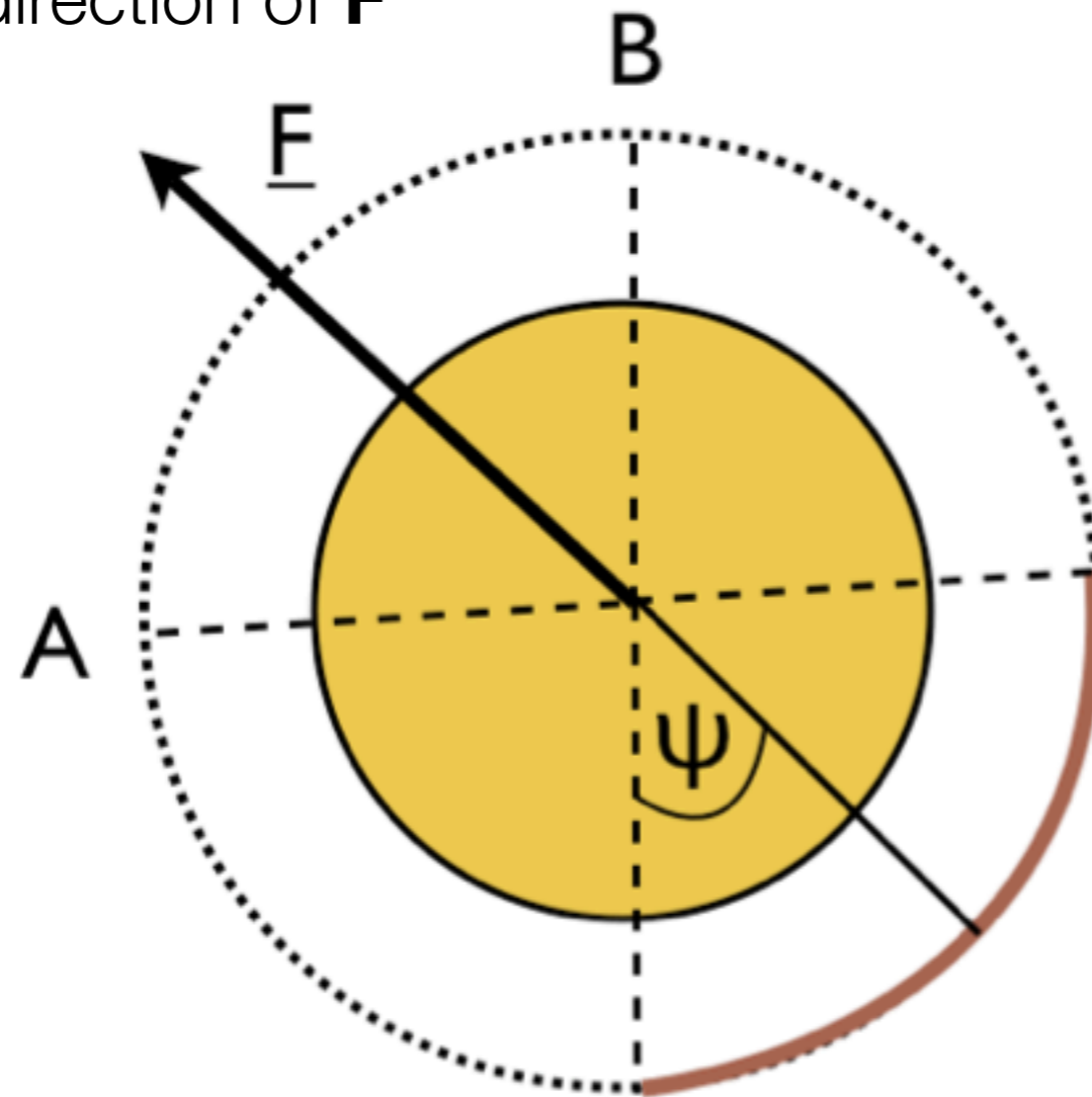
Outline



- Background - Class A Stellar Engines, Exoplanet Transit Curves
- How Transit Curves are affected by a Stellar Engine
- How to characterise these transits
- The probability of detecting a transit

Class A Stellar Engines

- Also known as Shkadov Thrusters - partial Dyson spheres
- Interior is mirrored to reflect stellar radiation --> force imbalance
- Net thrust in direction of \mathbf{F}





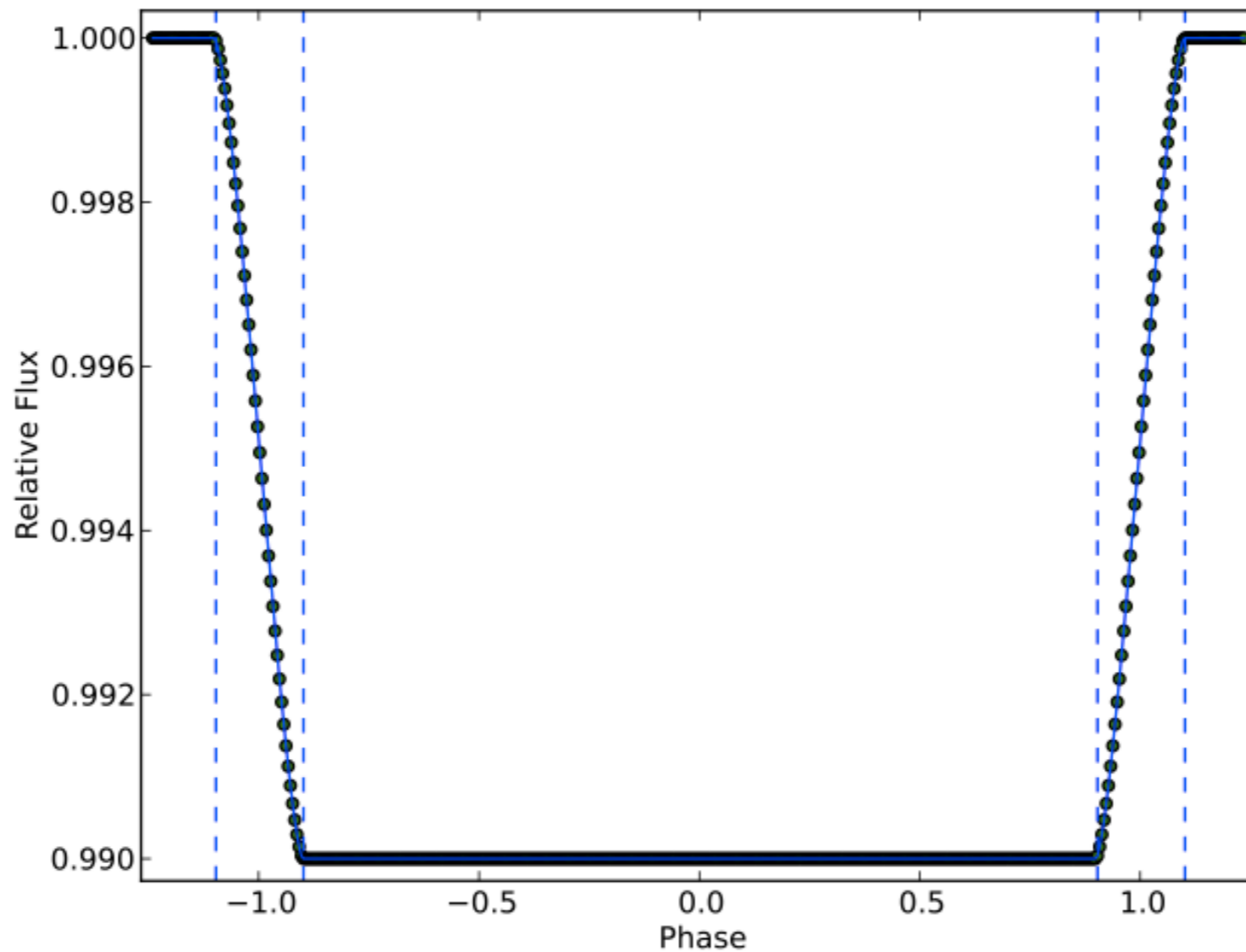
Exoplanet Transit Curves



Ingress Timescale



Transit Depth



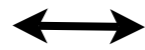
No limb darkening



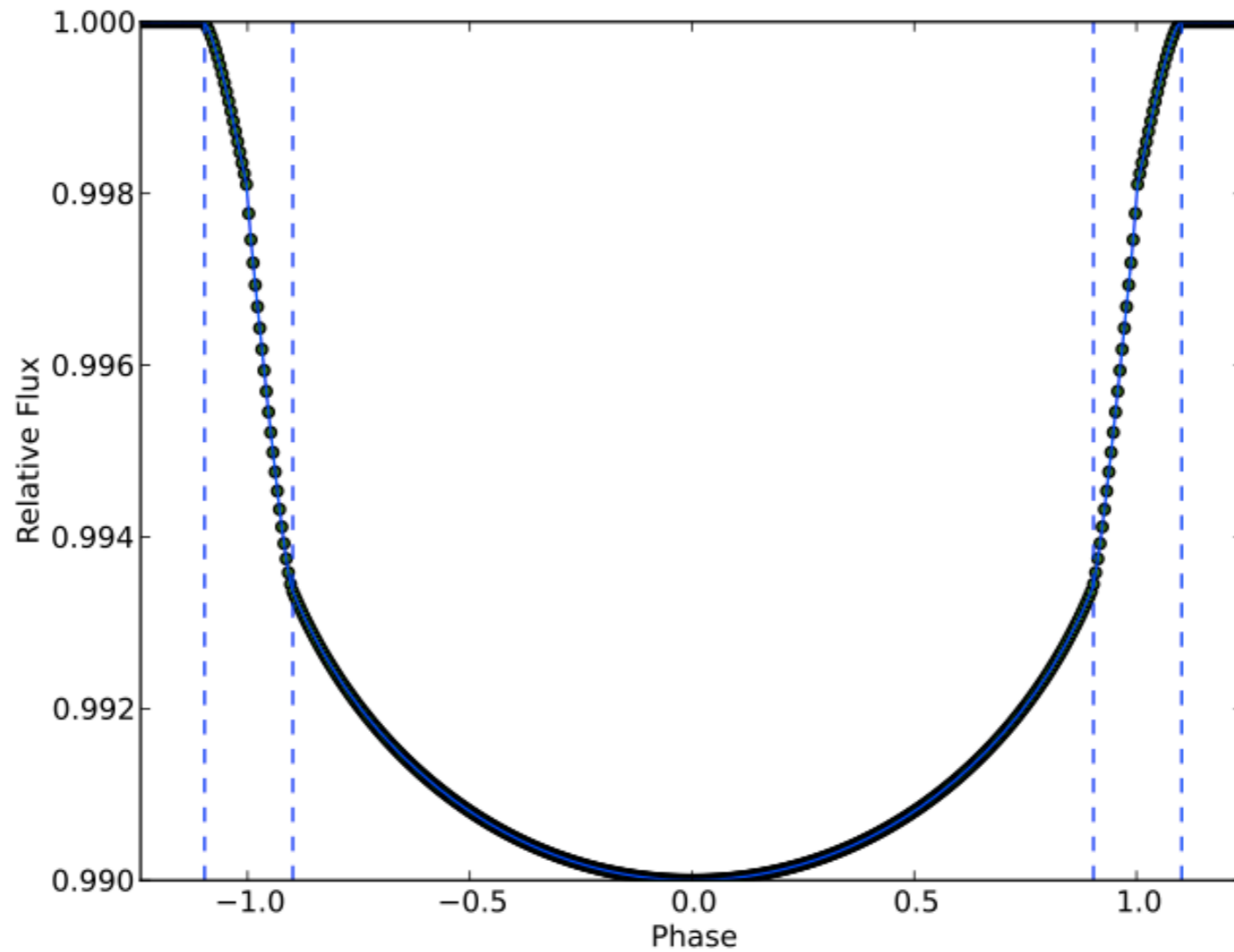
Exoplanet Transit Curves



Ingress Timescale

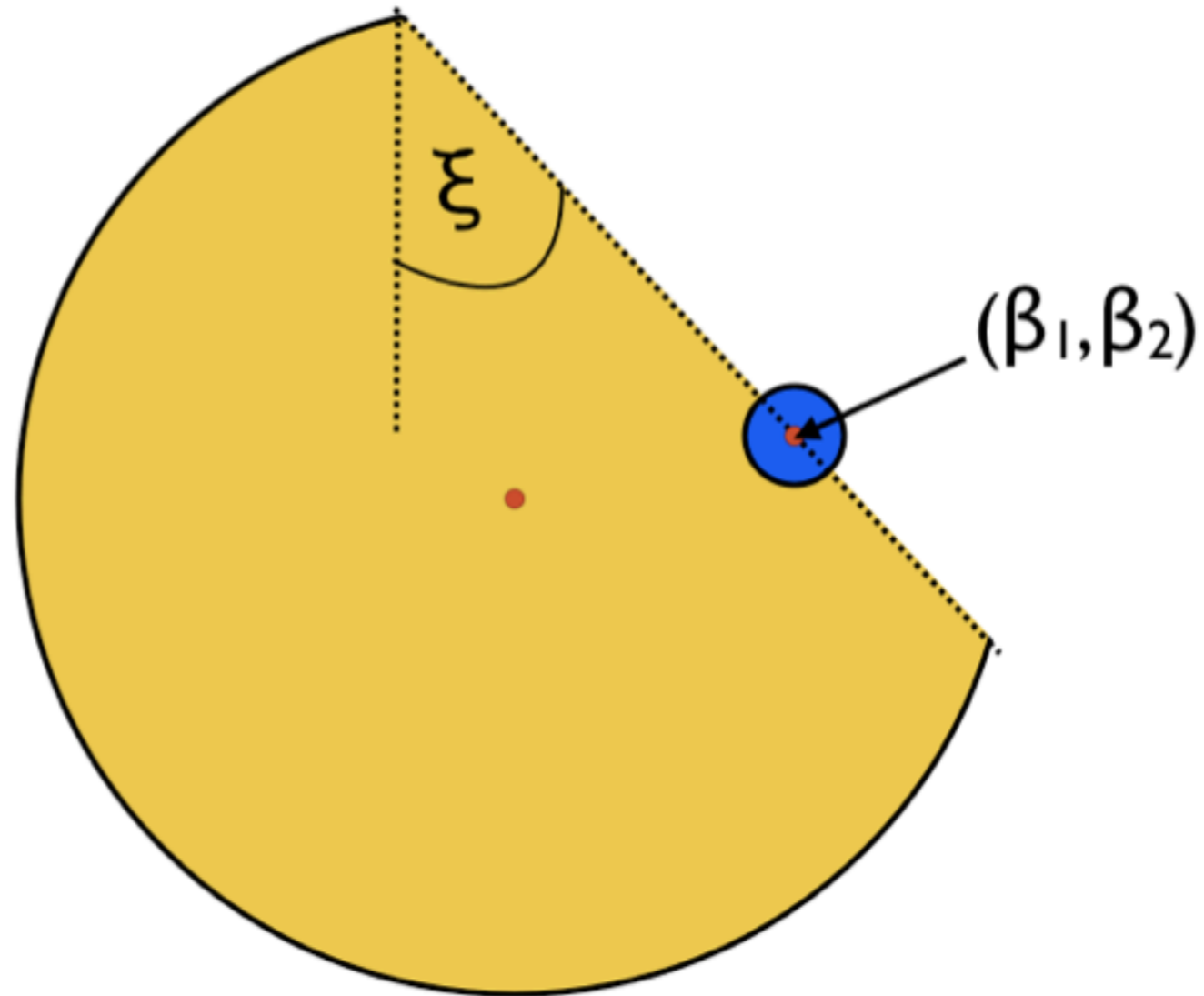


Transit Depth



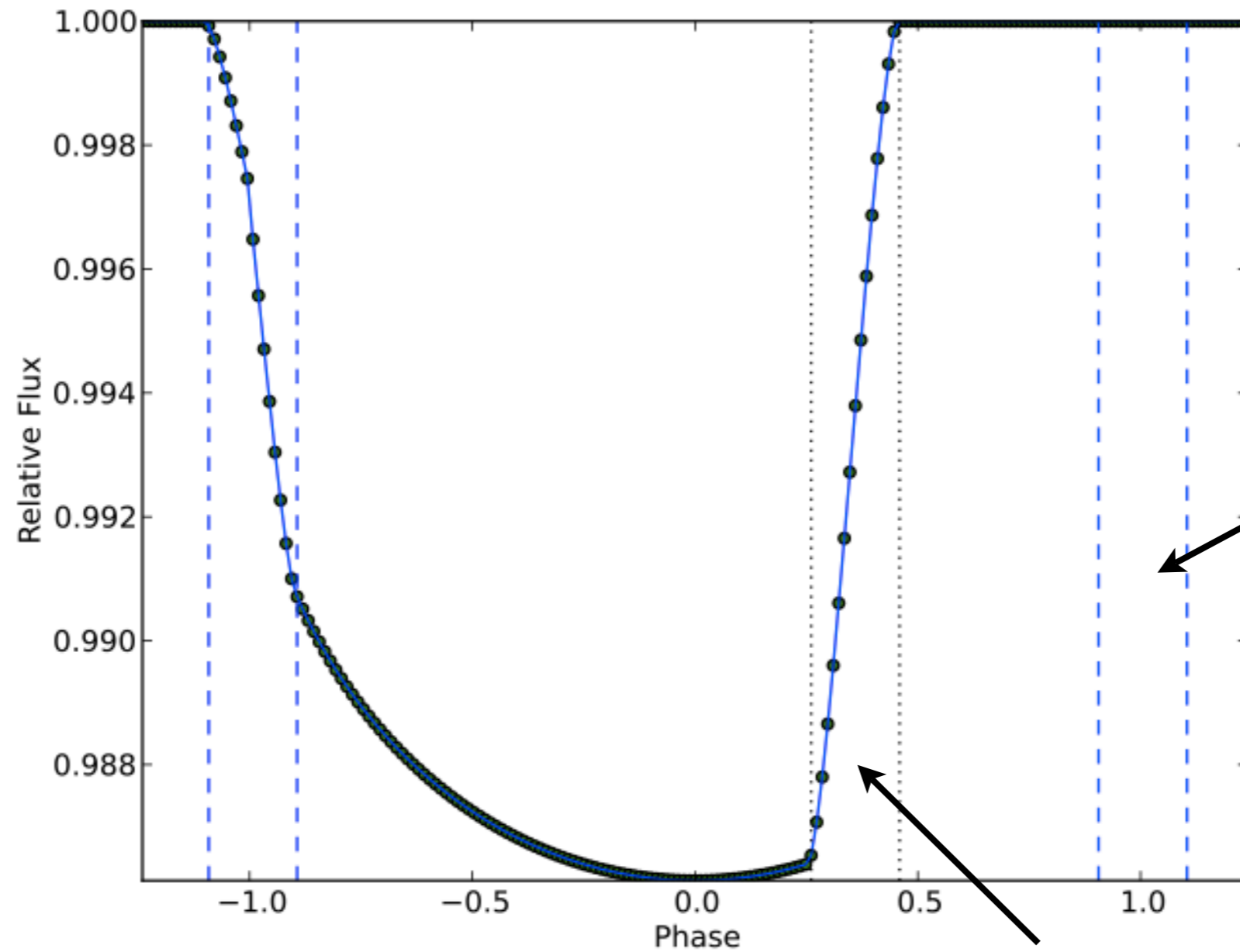
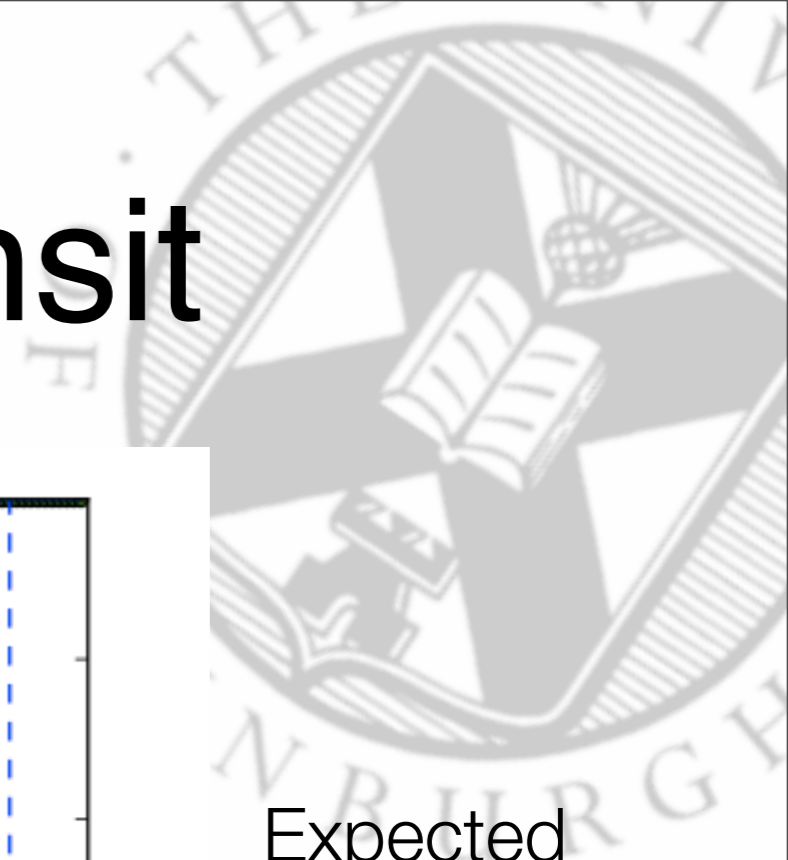
Limb darkening

Modelling the Thruster



- Assume thruster has a straight line edge

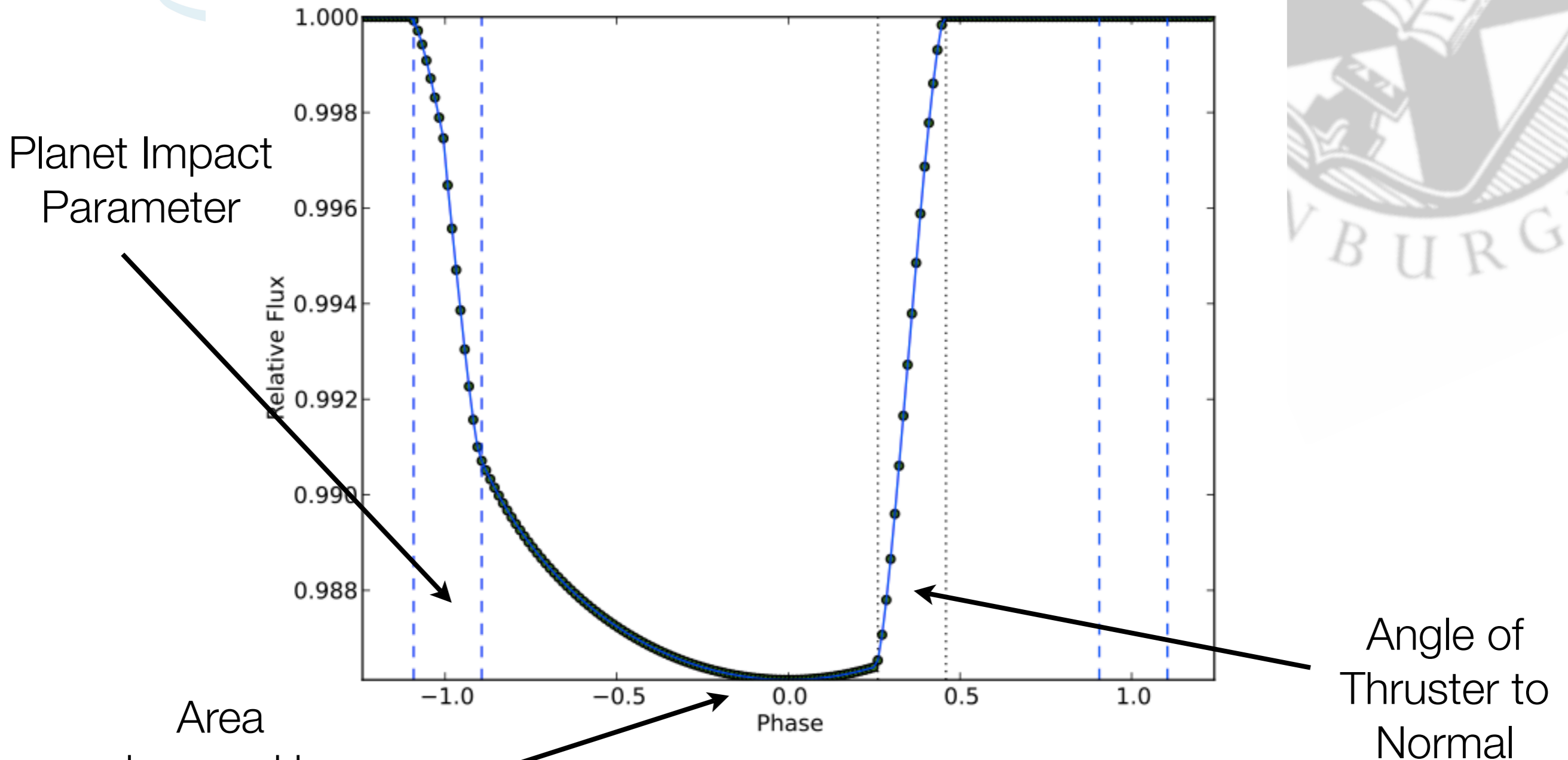
The Shkadov Transit



Expected
Egress
Time

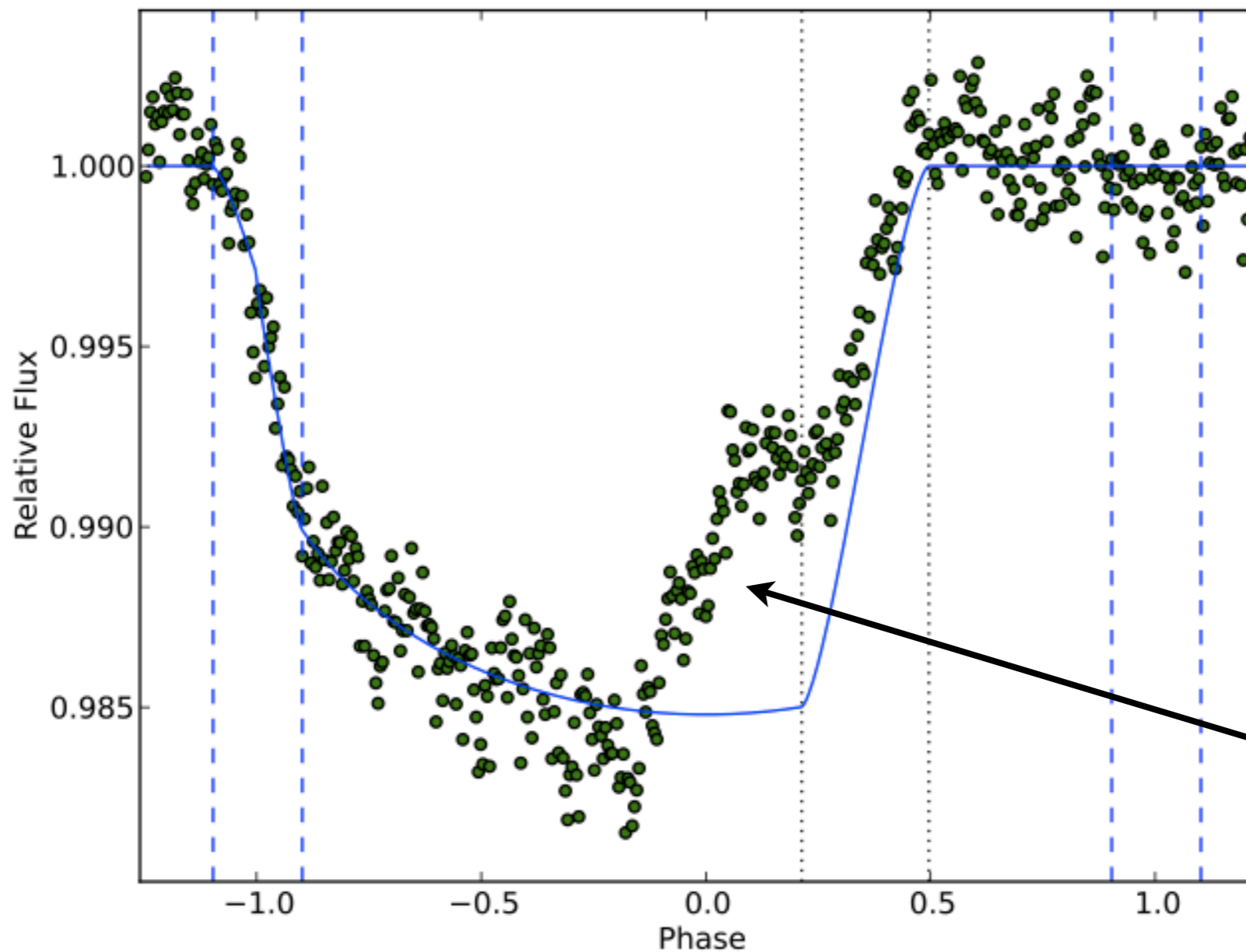
Observed
Egress
(Shkadov)

Deconstructing the Transit



- **Problem is multiply degenerate**
- Each component must be solved simultaneously

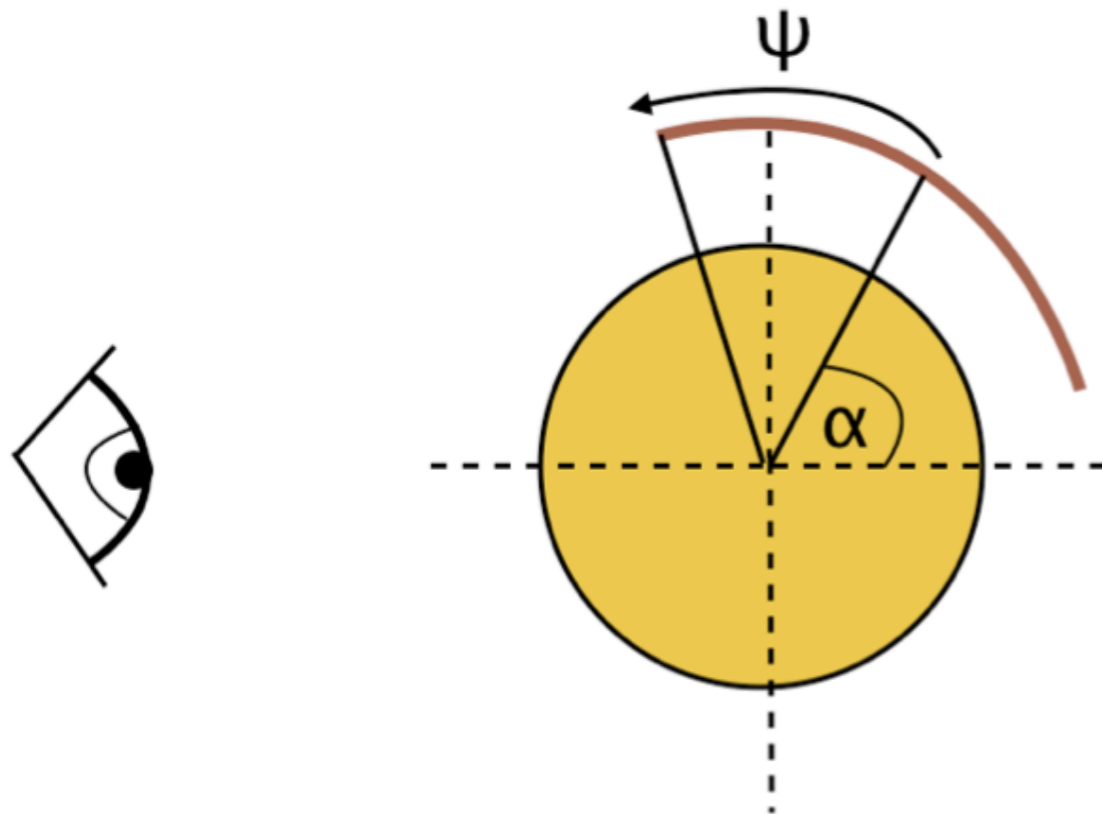
The Effect of Noise



Starspot

- Natural Phenomena can confuse the signal
- Careful modelling needed

The Probability of Shkadov Transits



$$P(D|T, S) = \frac{\pi + 2\psi}{2\pi}$$

$$P(D) = P(D|T, S)P(S|T)P(T)$$

$$P(S) = P(S|T)P(T) \approx 10^{-3} f_i f_T$$

- T - the system possesses a detectable transiting planet with a measurable curve
- S - the system possesses a Shkadov thruster
- D - the thruster is oriented such that its presence can be detected in the transit curve



Conclusions

- Class A Stellar Engines are detectable using exoplanet transit curves
- Characterising the curve will be challenging
- Inverse problem is **highly degenerate**, and noise can confuse signal
- The *a priori* **probability of detecting an engine is low**
- Even so, **many transit missions** in the pipeline
- **Lots of public data to trawl cheaply!**