

# **Know the Planet, Know the Star:** **Precise Stellar Parameters with** *Kepler*

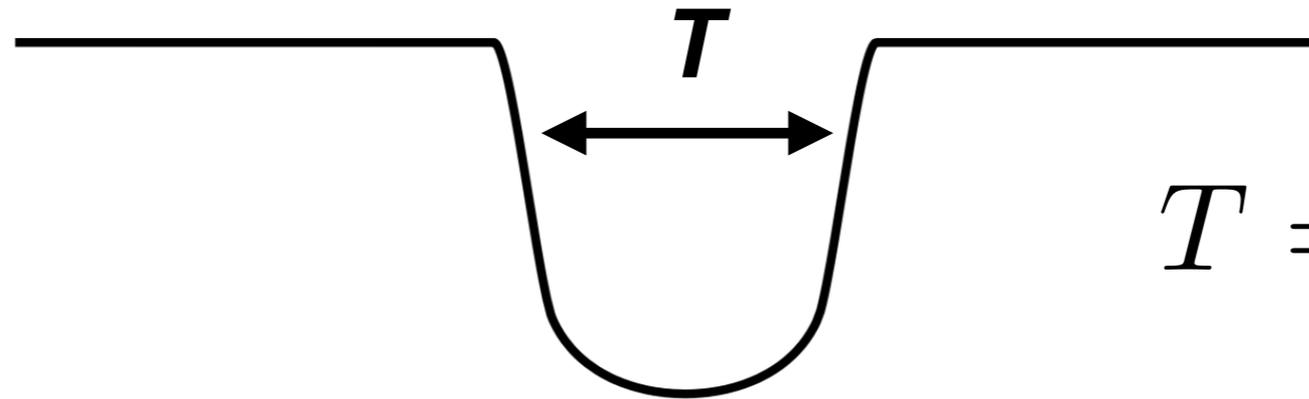
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ERES III, June 12, 2017

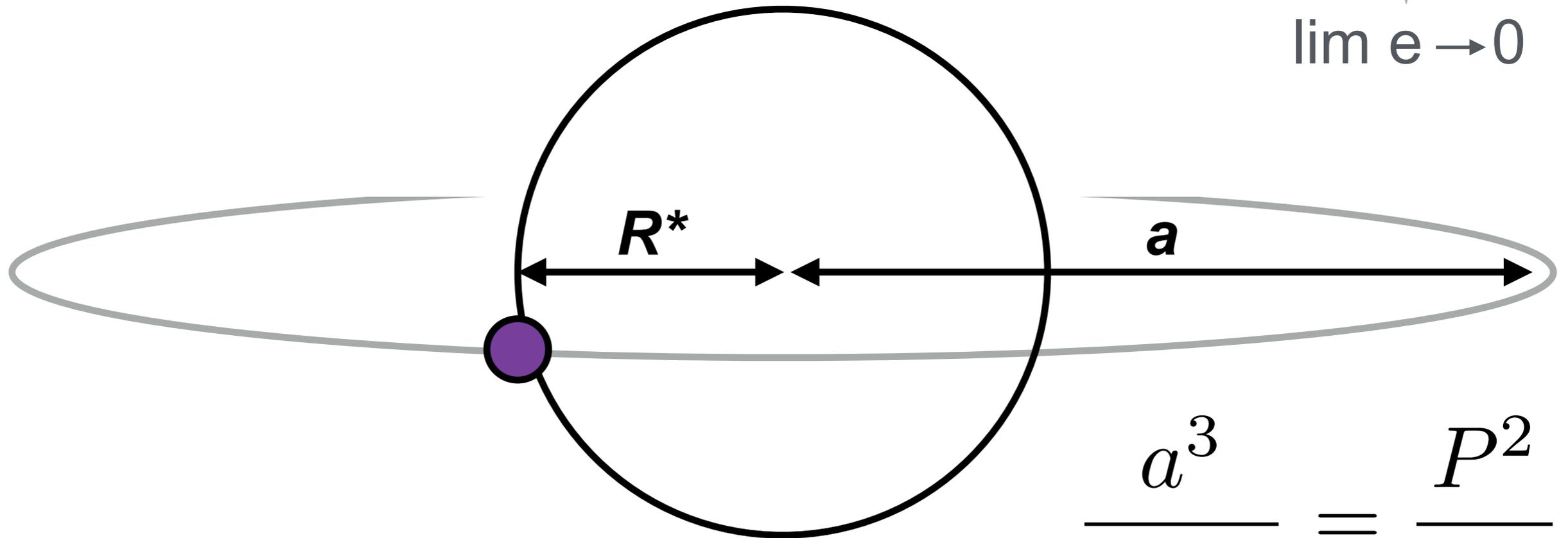
star → planet

- colors
- spectroscopy
- asteroseismology: typically constrains  $\rho^* \approx 5\%$
- flicker
- gyrochronology

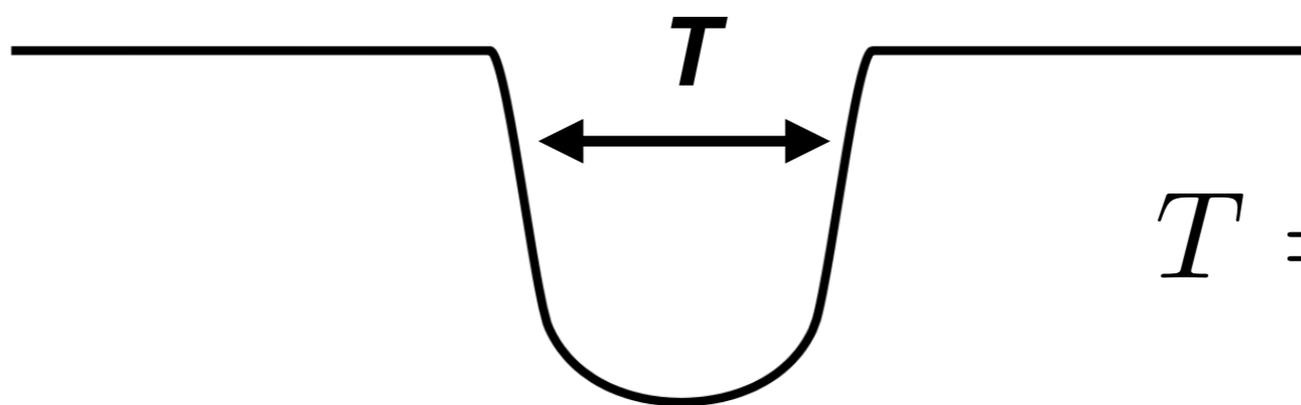
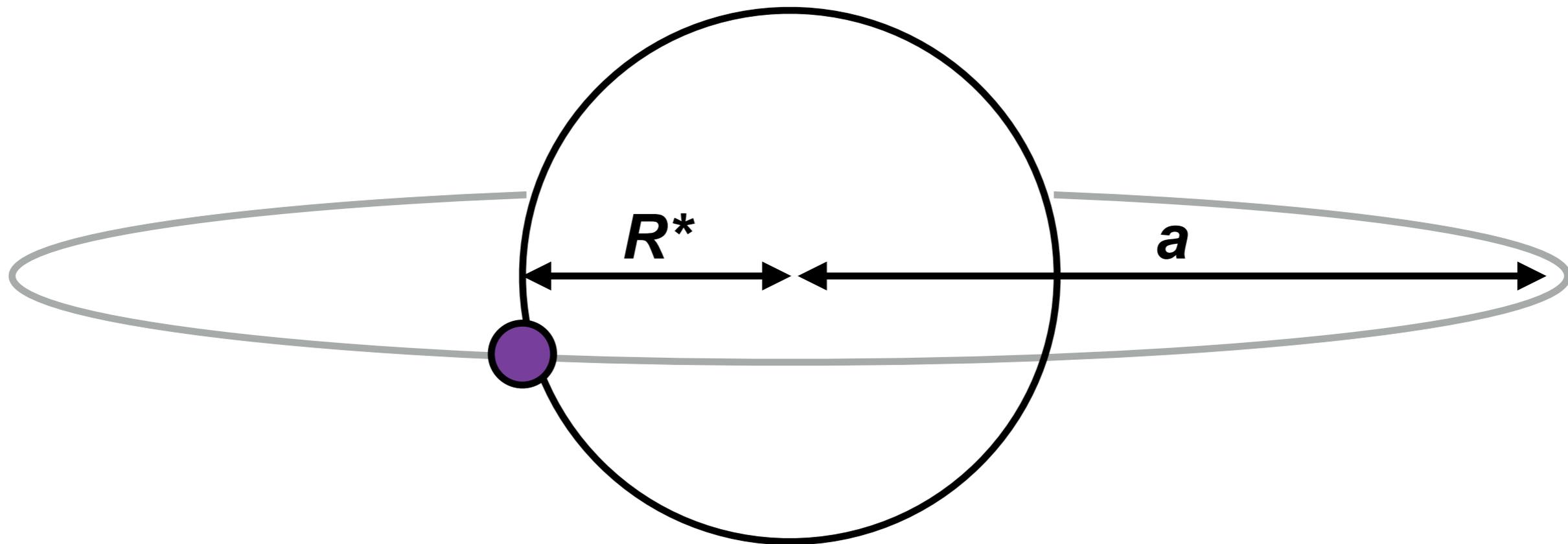
planet  $\longrightarrow$  star



$$T = \frac{2R_*}{\underbrace{(2\pi a/P)}_{\lim e \rightarrow 0}}$$



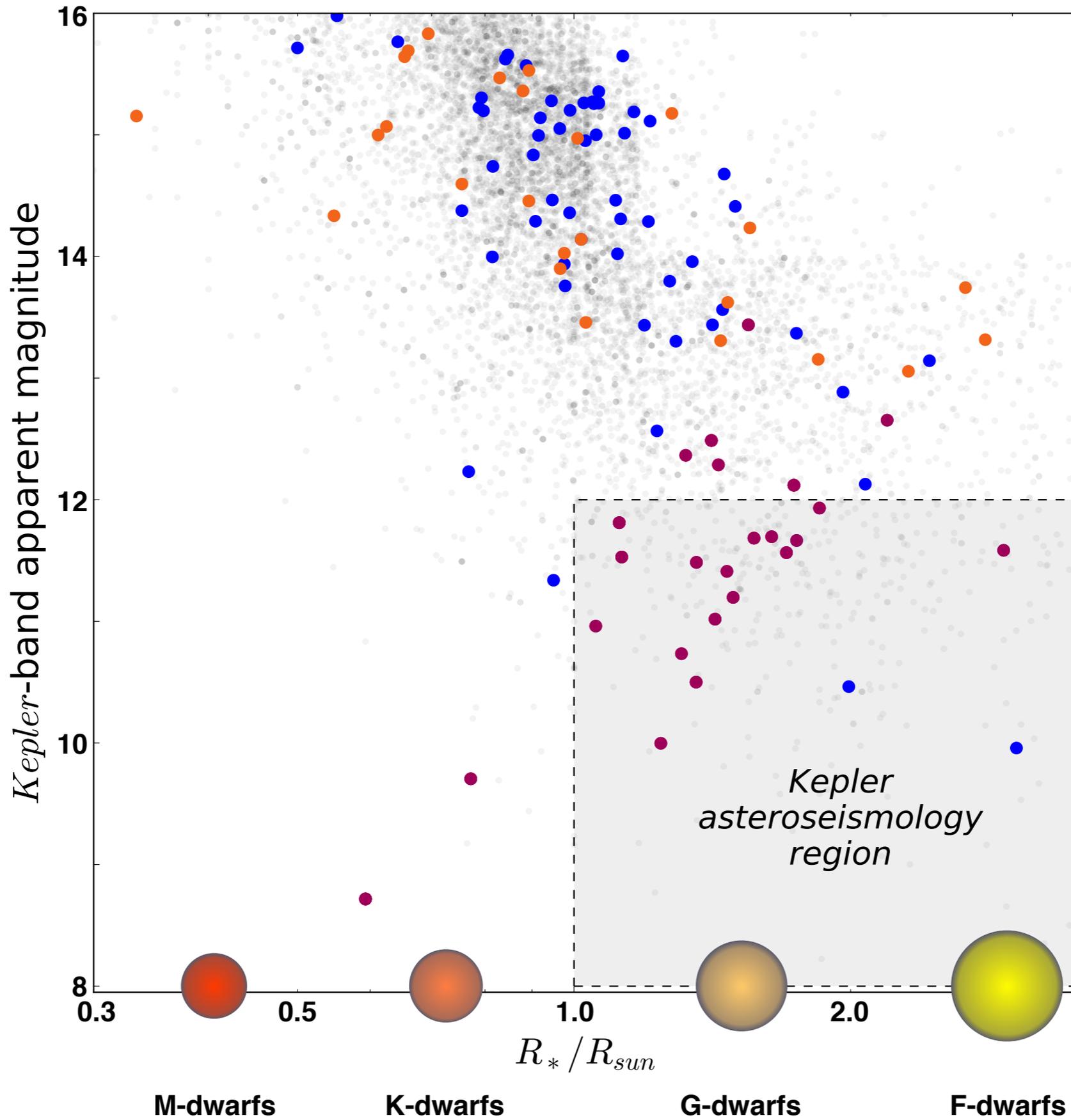
$$\frac{a^3}{GM_*} = \frac{P^2}{4\pi^2}$$

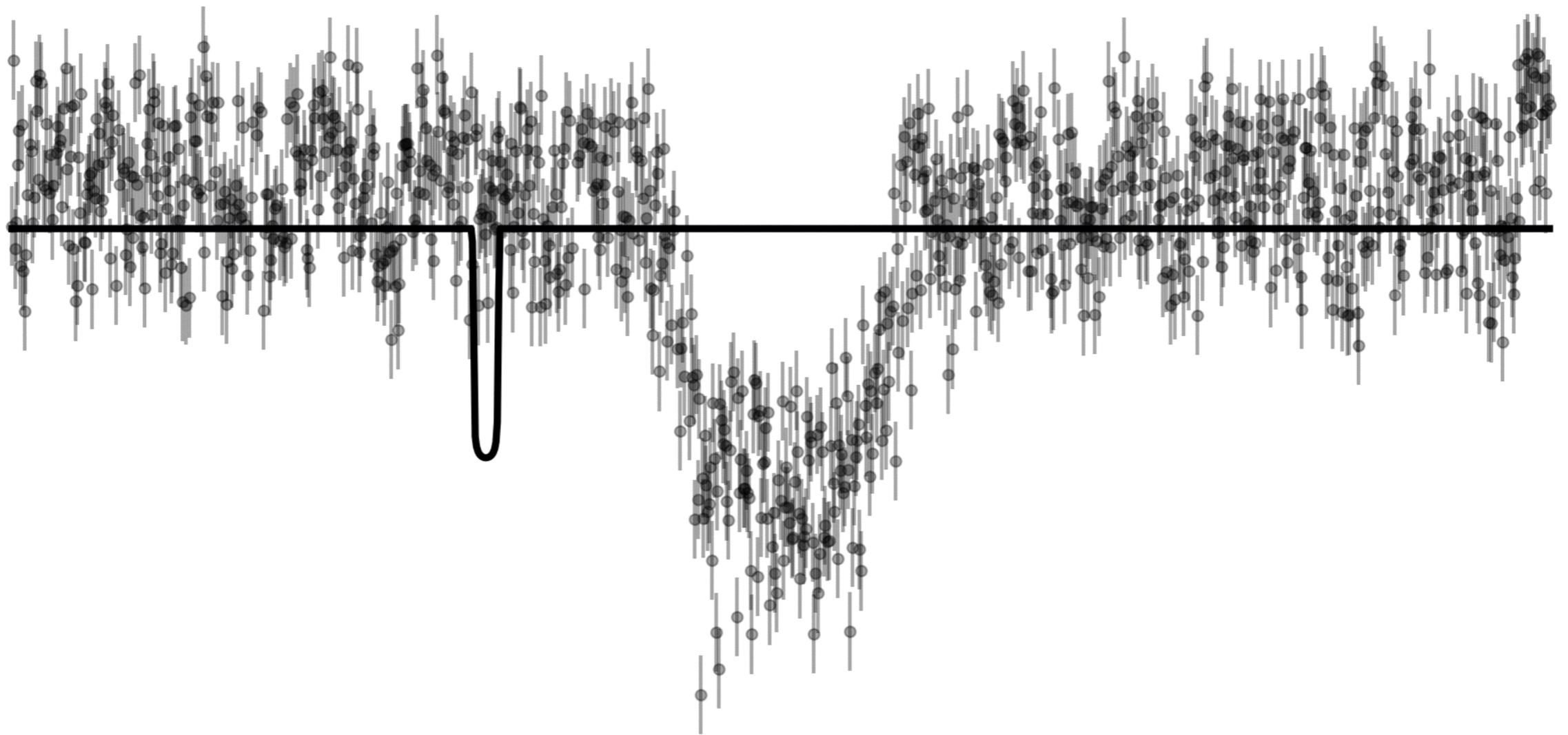


$$T = \frac{2R_*}{\underbrace{(2\pi a/P)}_{\lim e \rightarrow 0}}$$

# The sample: strong **e** prior

- Secondary eclipses
- Tidally circularized
- Multi-planet systems





This work

DR25 (Mathur+ 2016)

-1

0

1

2

3

4

$\log_{10} \rho_* [\text{kg}/\text{m}^3]$



-1

0

1

2

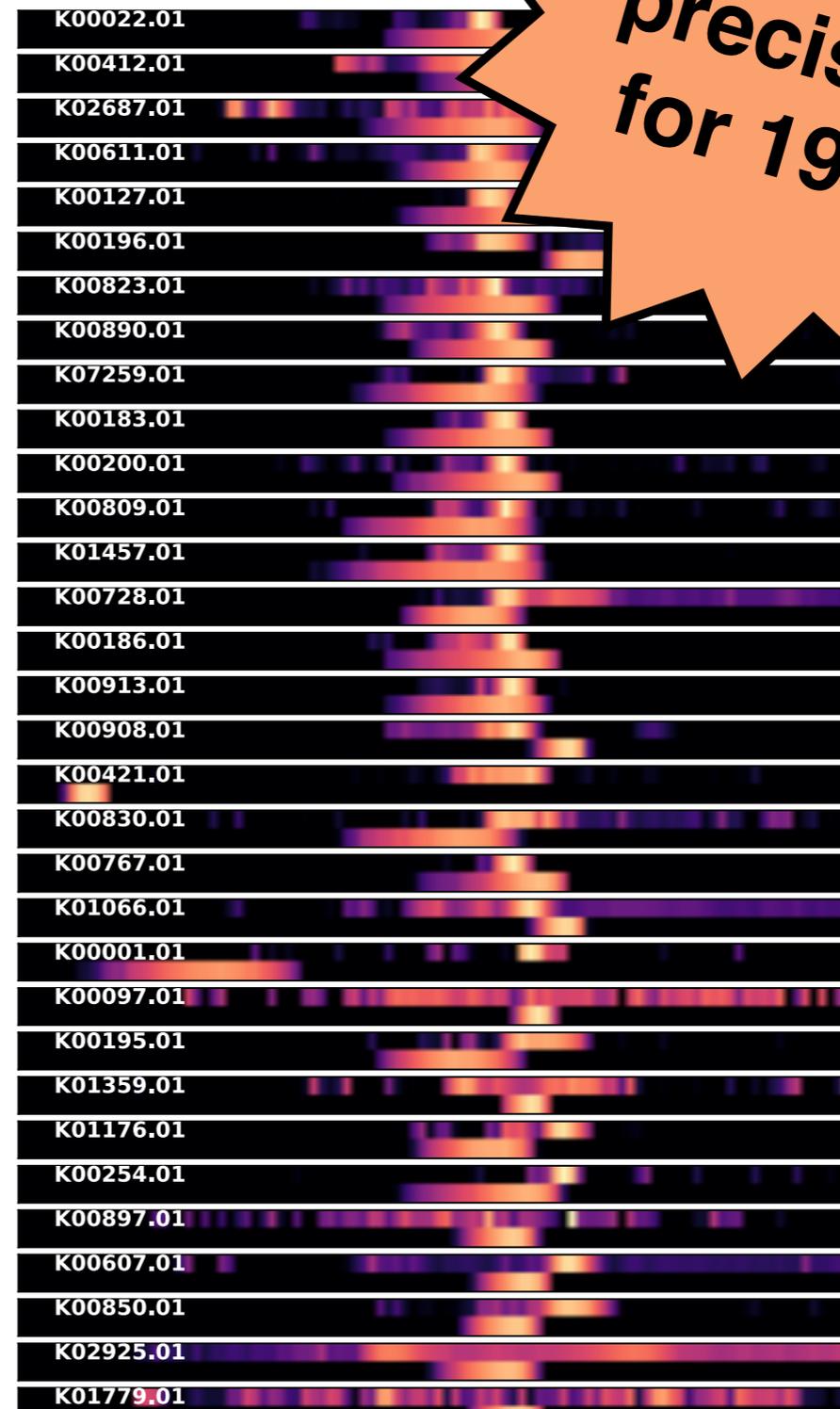
3

4

5

6

$\log_{10} \rho_* [\text{kg}/\text{m}^3]$



-1

0

1

2

3

4

5

6

$\log_{10} \rho_* [\text{kg}/\text{m}^3]$

**< 5%  
precision  
for 19%!**

# Know the Planet, Know the Star

- Method competes with asteroseismology...
  - but assumes only Kepler's 3rd law!
- posteriors online soon at [github.com/esandford](https://github.com/esandford)

- for more, see:

Monthly Notices  
*of the*  
ROYAL ASTRONOMICAL SOCIETY

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**Observational biases for transiting planets**

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# e priors

- Secondary eclipse targets:
  - Gaussian priors in  $e\cos(\omega)$ ,  $e\sin(\omega)$
  - Shabram+ 2016, Coughlin & López-Morales 2012
- Tidally circularized targets:
  - Exponential prior in  $e$ , with  $\lambda = 0.00796$
  - Wang & Ford 2011
- Multi-planet systems:
  - Rayleigh prior in  $e$ , with  $\sigma = 0.049$
  - Van Eylen & Albrecht 2015