

Accurate, Empirical Masses and Radii with *TESS* and *Gaia*: Single Stars



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Empirical masses and radii of *single* stars

Basic methodology:

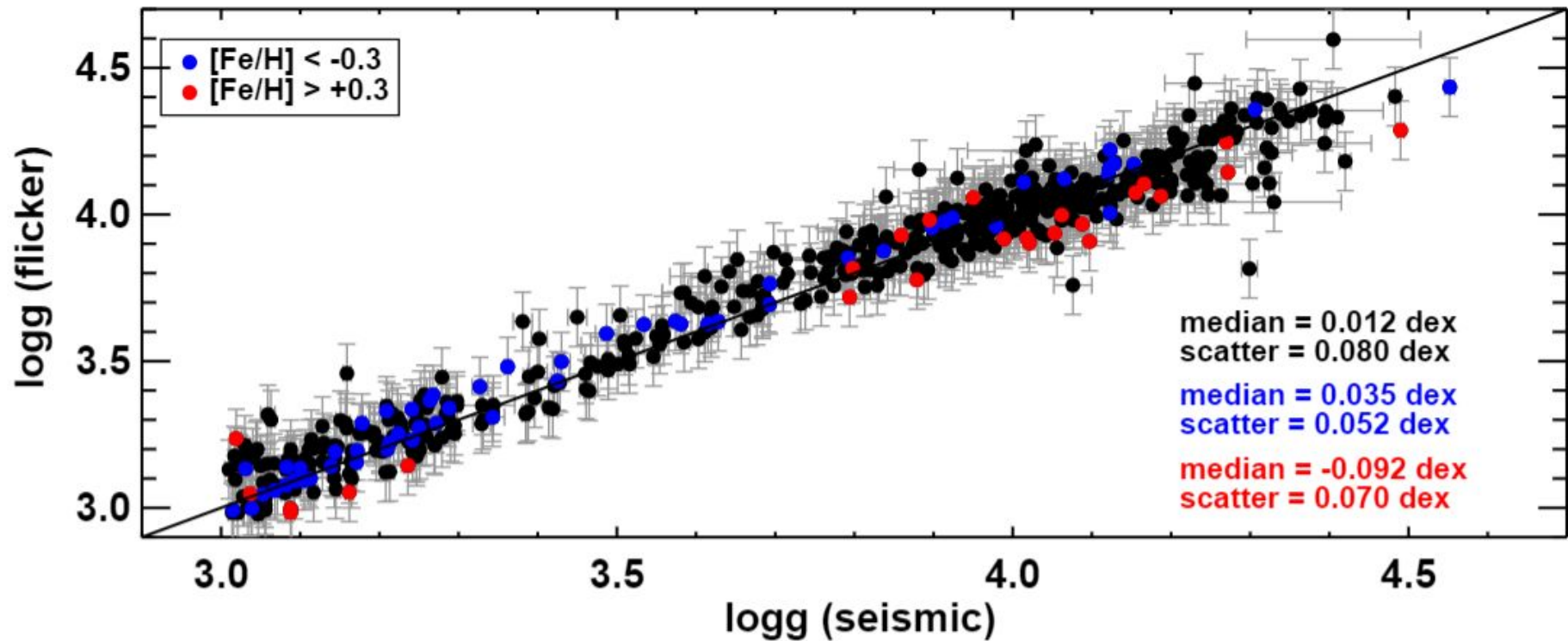
1. Stellar surface gravity via granulation-driven brightness variations
2. Stellar radius via broadband spectral energy distribution
3. Stellar mass from 1 and 2.

Stassun, Corsaro, Pepper, & Gaudi (2017, submitted)

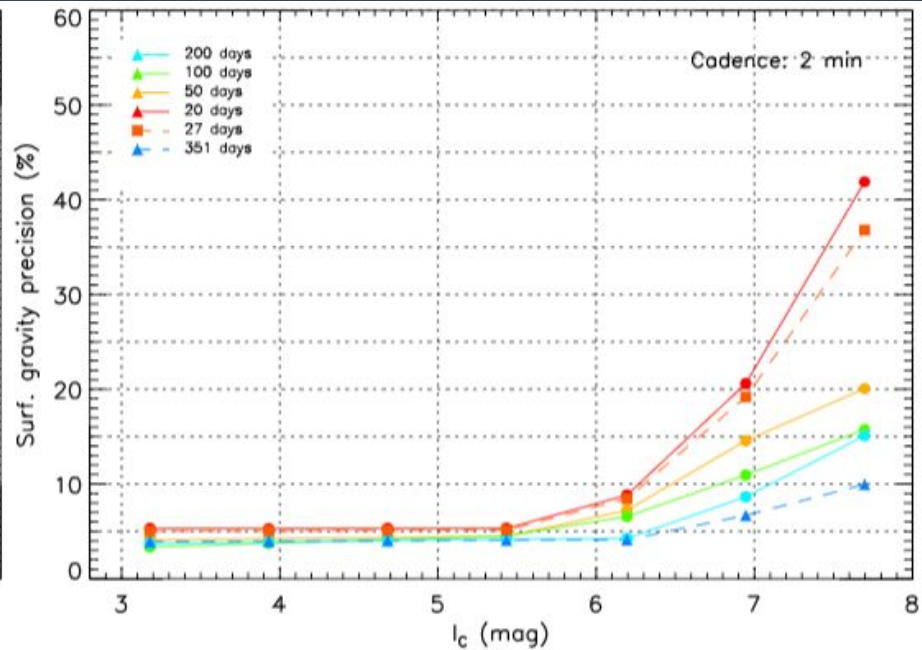
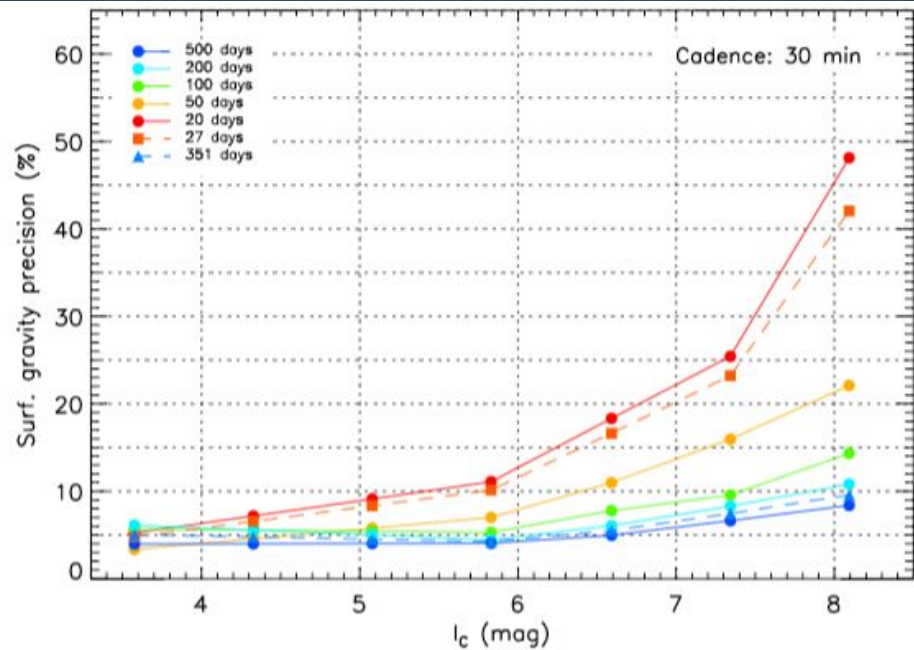
arxiv:1710.01460

Sample: 675 *Kepler* stars

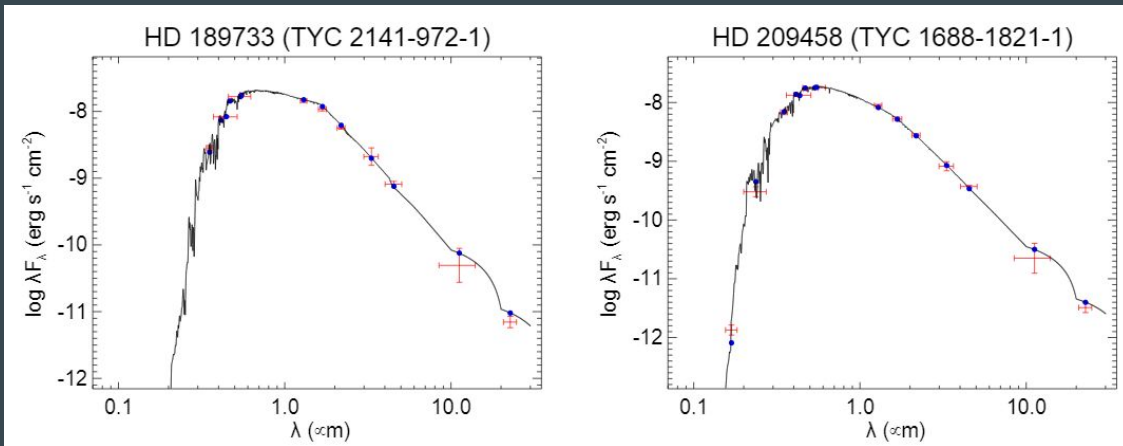
	Asteroseismic (gold standard)	Test method
Surface gravity (log g)	Huber et al. (2017)	Flicker: Bastien et al. (2016) Background modeling: Kallinger et al. (2016) Metallicity correction: Corsaro et al. (2017)
Radius	Huber et al. (2017)	Spectral energy distribution: Stassun & Torres (2016a) Teff: APOGEE (Holtzman et al. 2015) Parallax correction: Stassun & Torres (2016b)
Mass	Huber et al. (2017)	$M = gR^2/G$: Newton (1687)



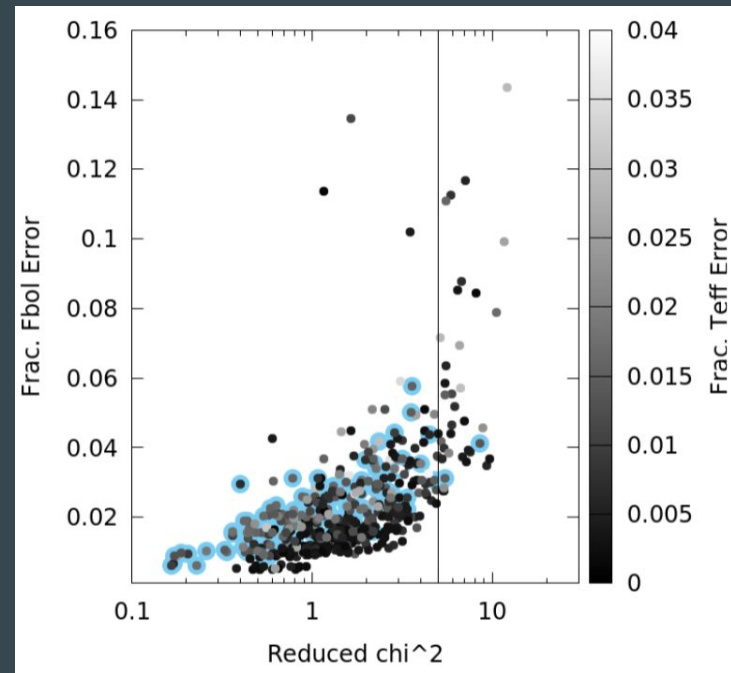
Surface gravity: Flicker



Surface gravity: Background modeling

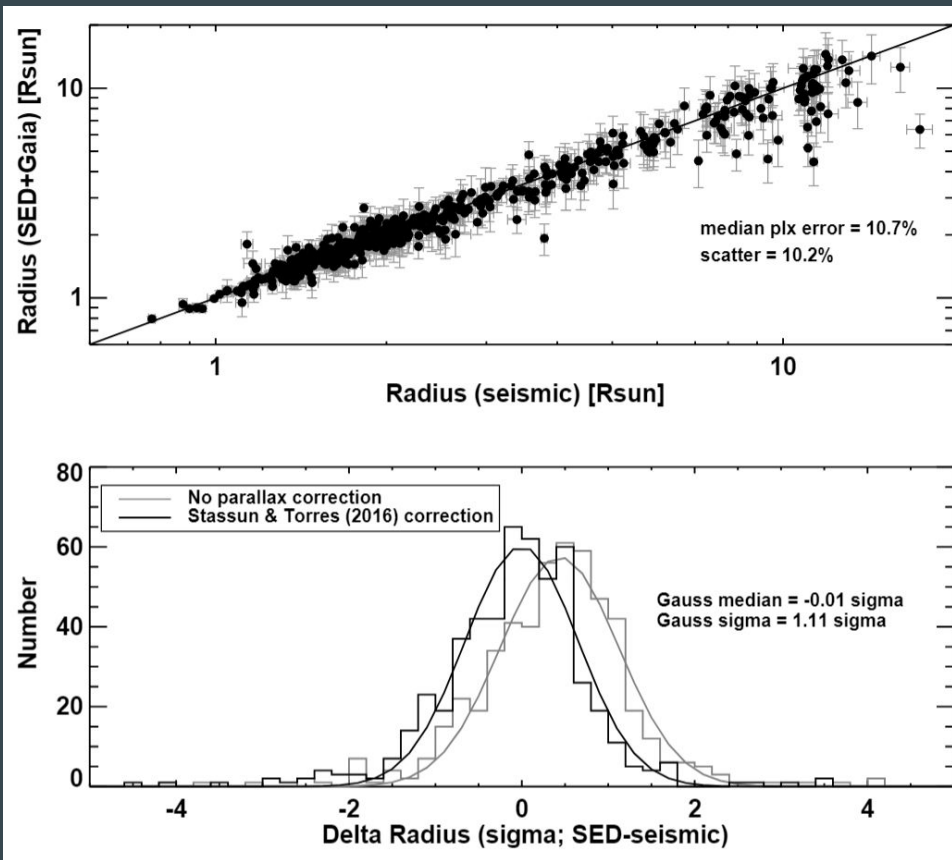


		Boyajian et al. (2015)	Stassun et al. (2017a)
HD 189733	$2 \times \Theta$ (mas)	0.3848 ± 0.0055	0.391 ± 0.008
	F_{bol} (10^{-8} erg s $^{-1}$ cm $^{-2}$)	2.785 ± 0.058	2.87 ± 0.06
HD 209458	$2 \times \Theta$ (mas)	0.2254 ± 0.0072	0.225 ± 0.008
	F_{bol} (10^{-8} erg s $^{-1}$ cm $^{-2}$)	2.331 ± 0.051	2.33 ± 0.05

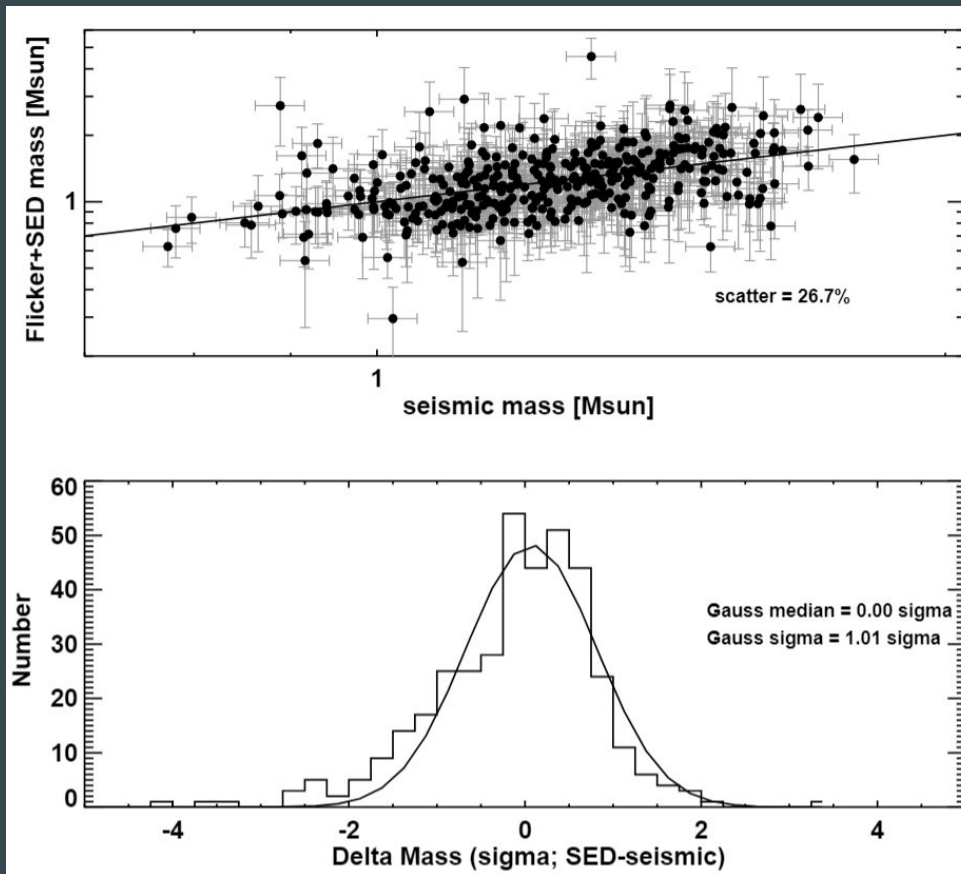


Angular radius: Spectral Energy Distribution

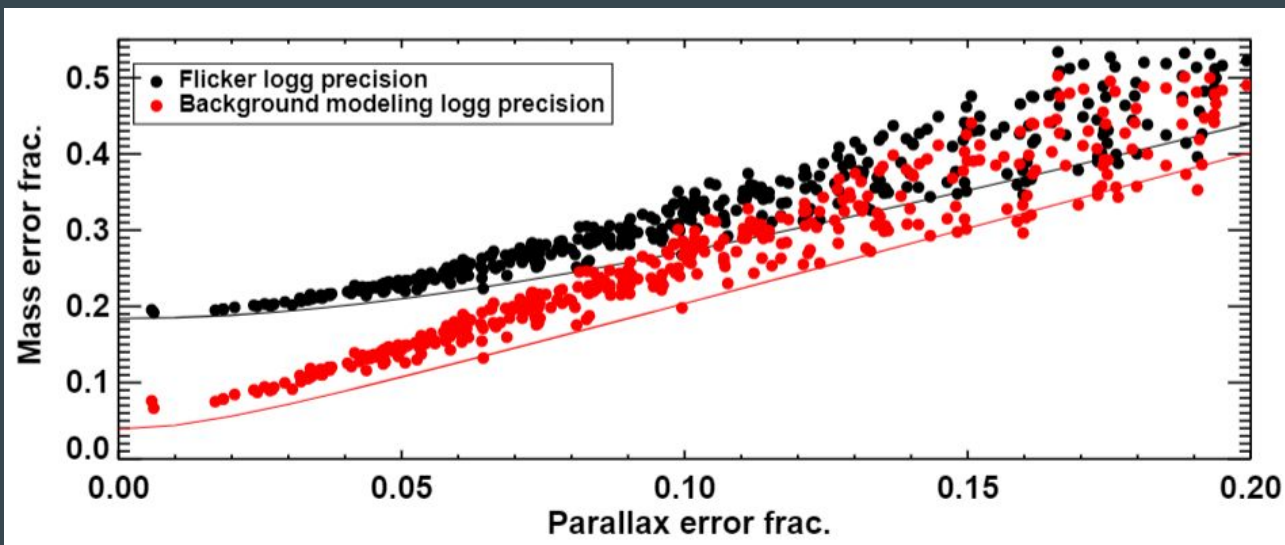
$$\Theta = \left(F_{\text{bol}} / \sigma_{\text{SB}} T_{\text{eff}}^4 \right)^{1/2}$$



Radius: SED + parallax



Mass: gravity + radius



	<i>GALEX</i> (UV)	<i>Gaia</i> (Visible)	<i>2MASS</i> (near-IR)	<i>WISE</i> (mid-IR)
R_{\star} for TIC stars in <i>Gaia</i> DR-2	28M	97M	448M	311M
M_{\star} via flicker, 30-min ($T_{\text{mag}} < 10.5$)	73k	1.5M	1.5M	1.5M
M_{\star} via gran. modeling, 2-min ($T_{\text{mag}} < 6.5$)	5k	13k	13k	13k
M_{\star} via gran. modeling, 30-min ($T_{\text{mag}} < 6$)	5k	13k	13k	12k

Mass: Expectations with TESS

100 million radii to 3%

1.5 million masses to 25%

25 thousand masses to 10%