Using Disintegrating Planets to Study Planetary Interior Composition

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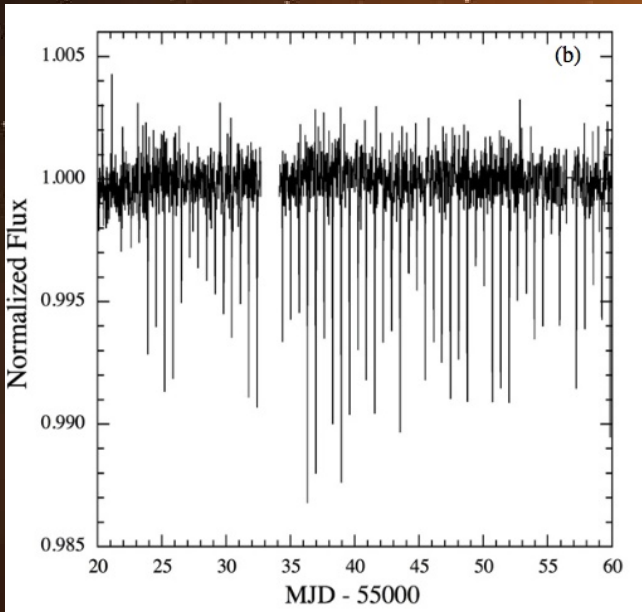
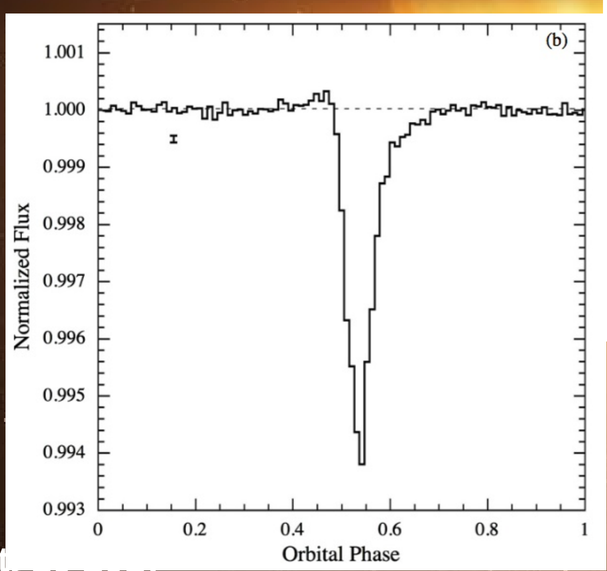
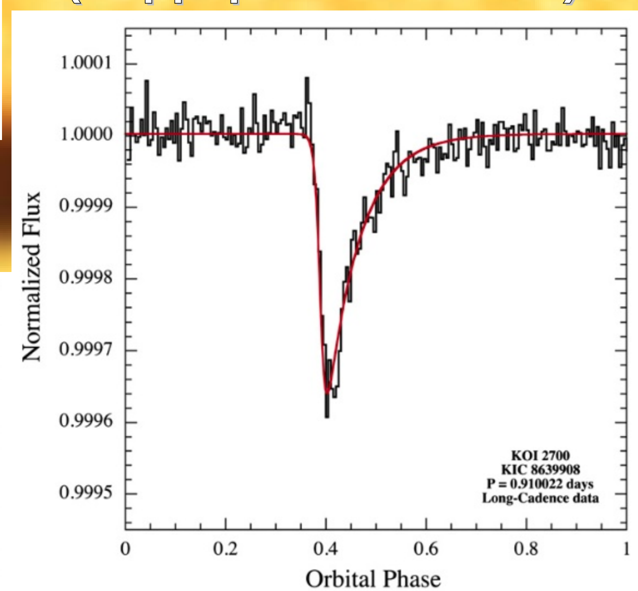
What is a Disintegrating Planet?

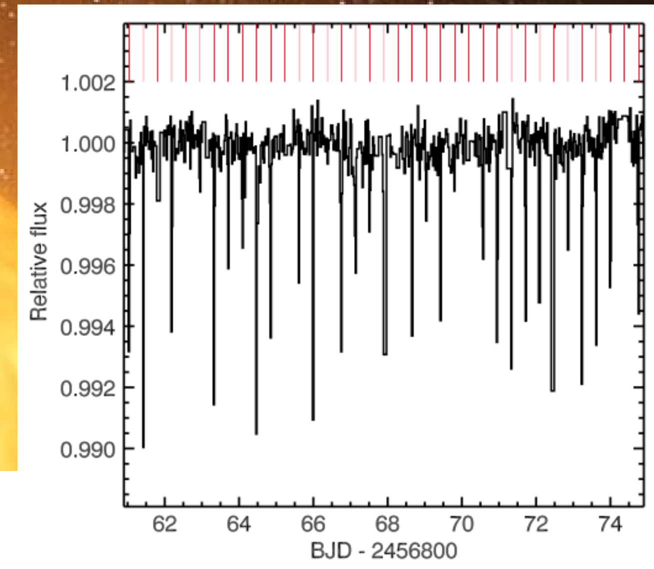


KIC 1255b
(Rappaport et al. 2012)

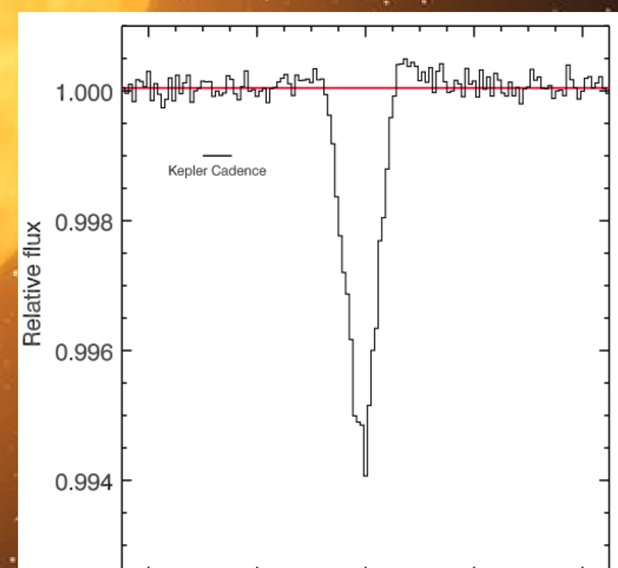


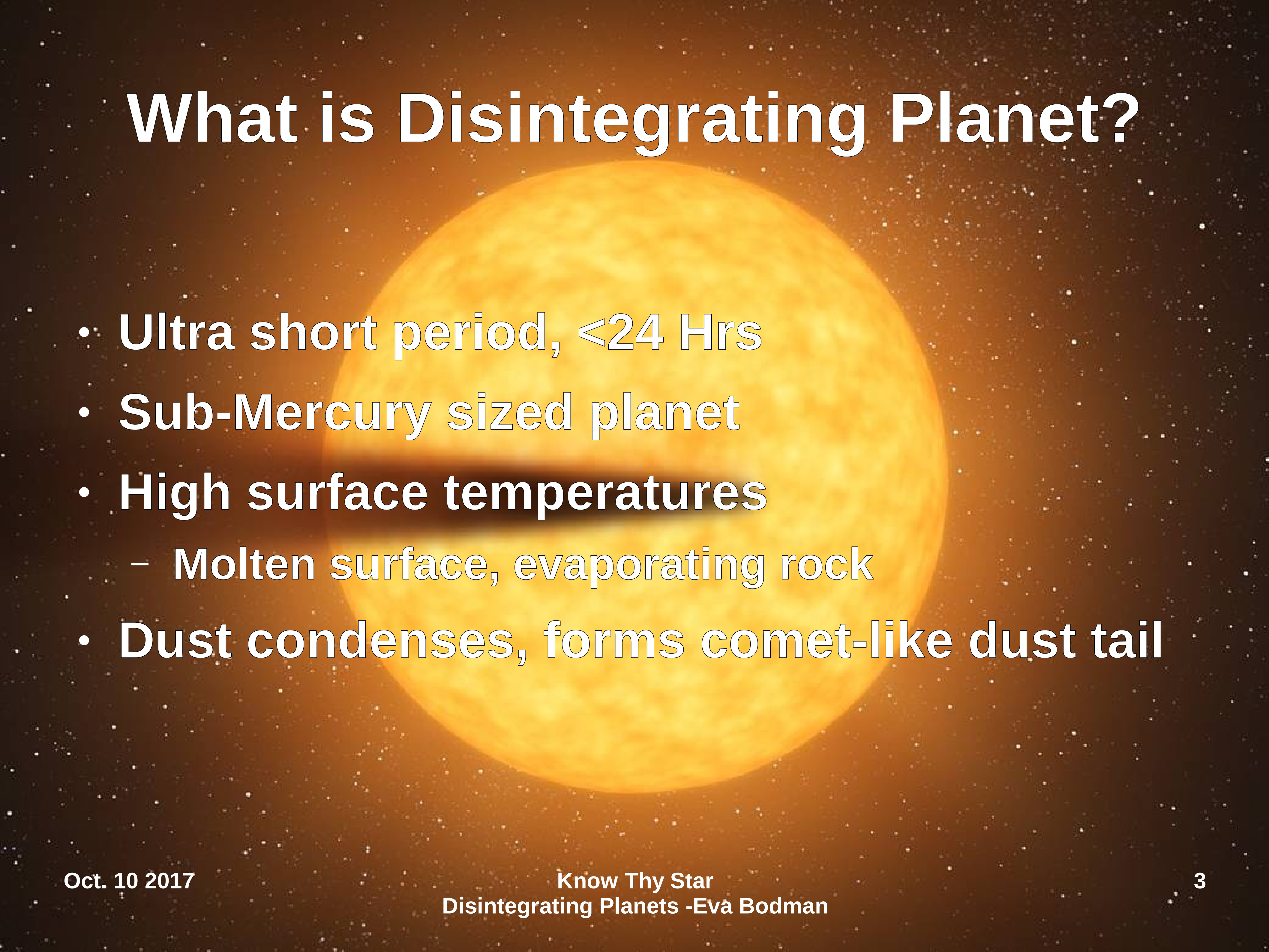
KOI 2700b
(Rappaport et al. 2014)





K2-22b
(Sanchis-Ojeda et al. 2015)

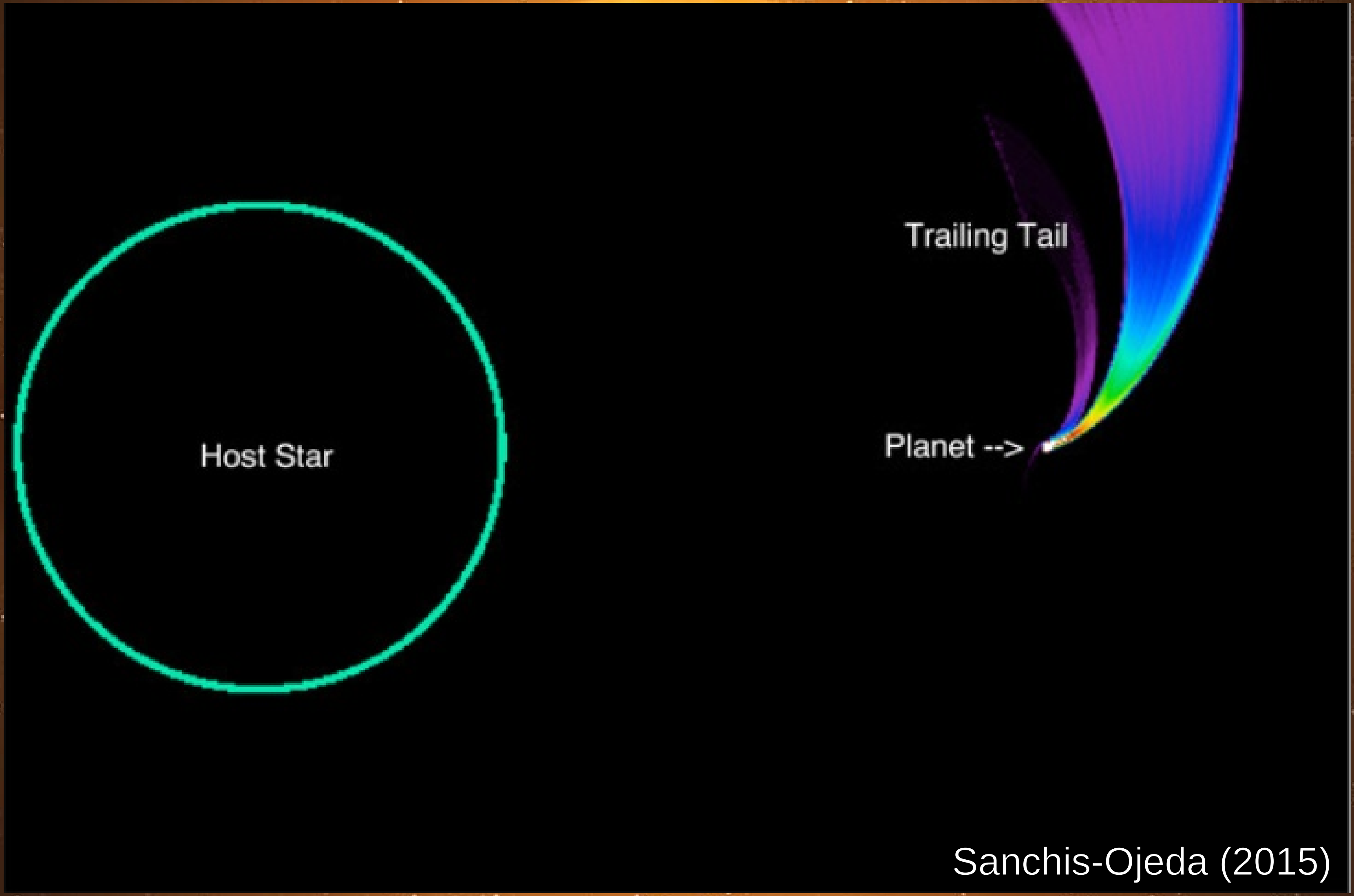




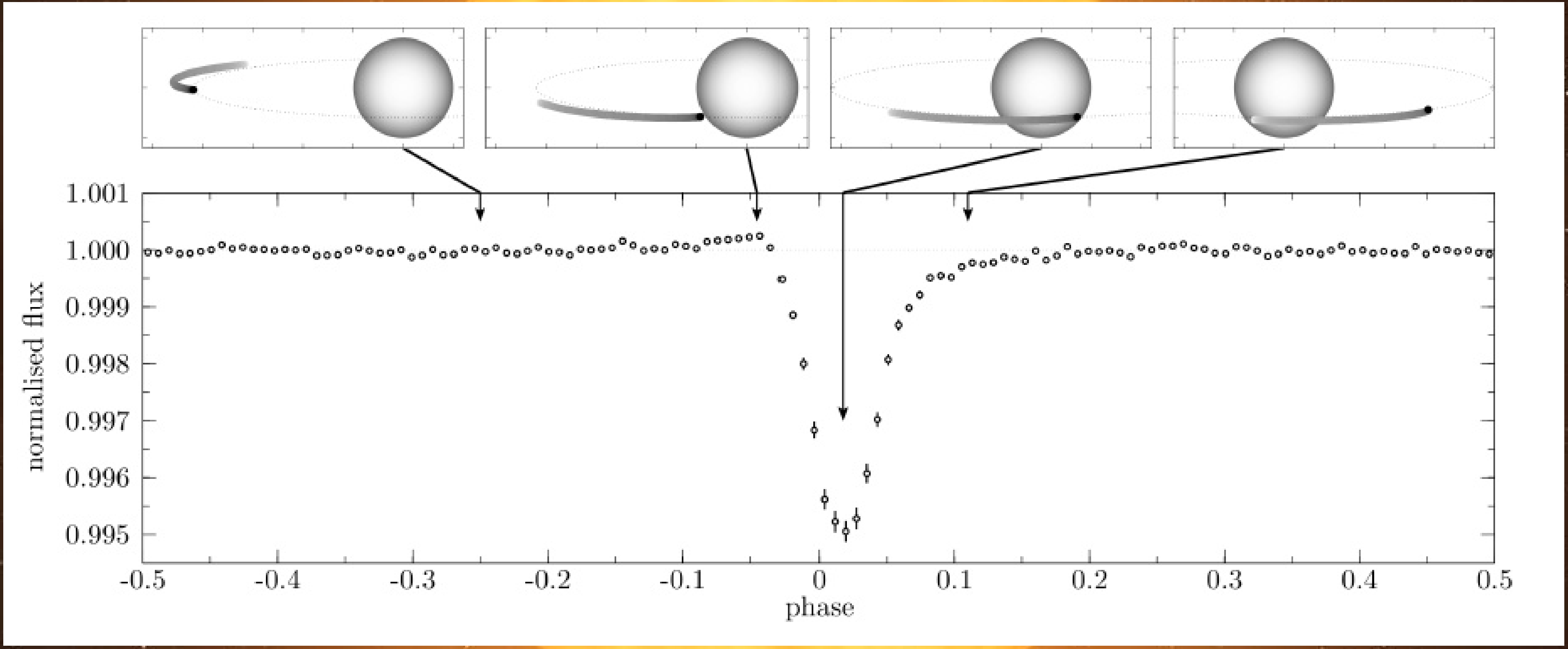
What is Disintegrating Planet?

- Ultra short period, <24 Hrs
- Sub-Mercury sized planet
- High surface temperatures
  - Molten surface, evaporating rock
- Dust condenses, forms comet-like dust tail

Disintegrating Planet



Disintegrating Planet Transit



van Lieshout et al. (2016)

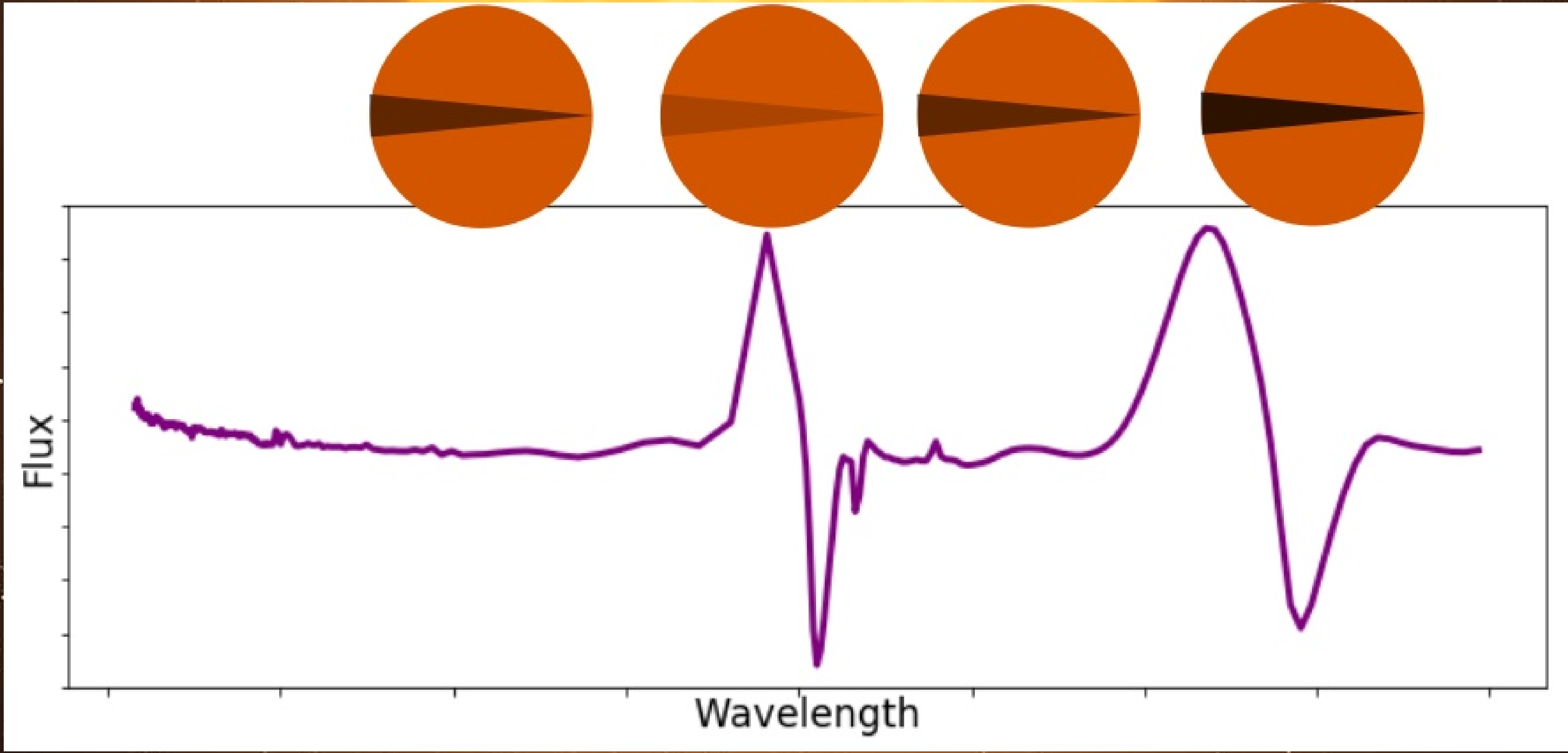
Unique Opportunity for Composition

- Bulk composition
  - Mass-radius relationships
  - WD pollution
  - Host star's abundances

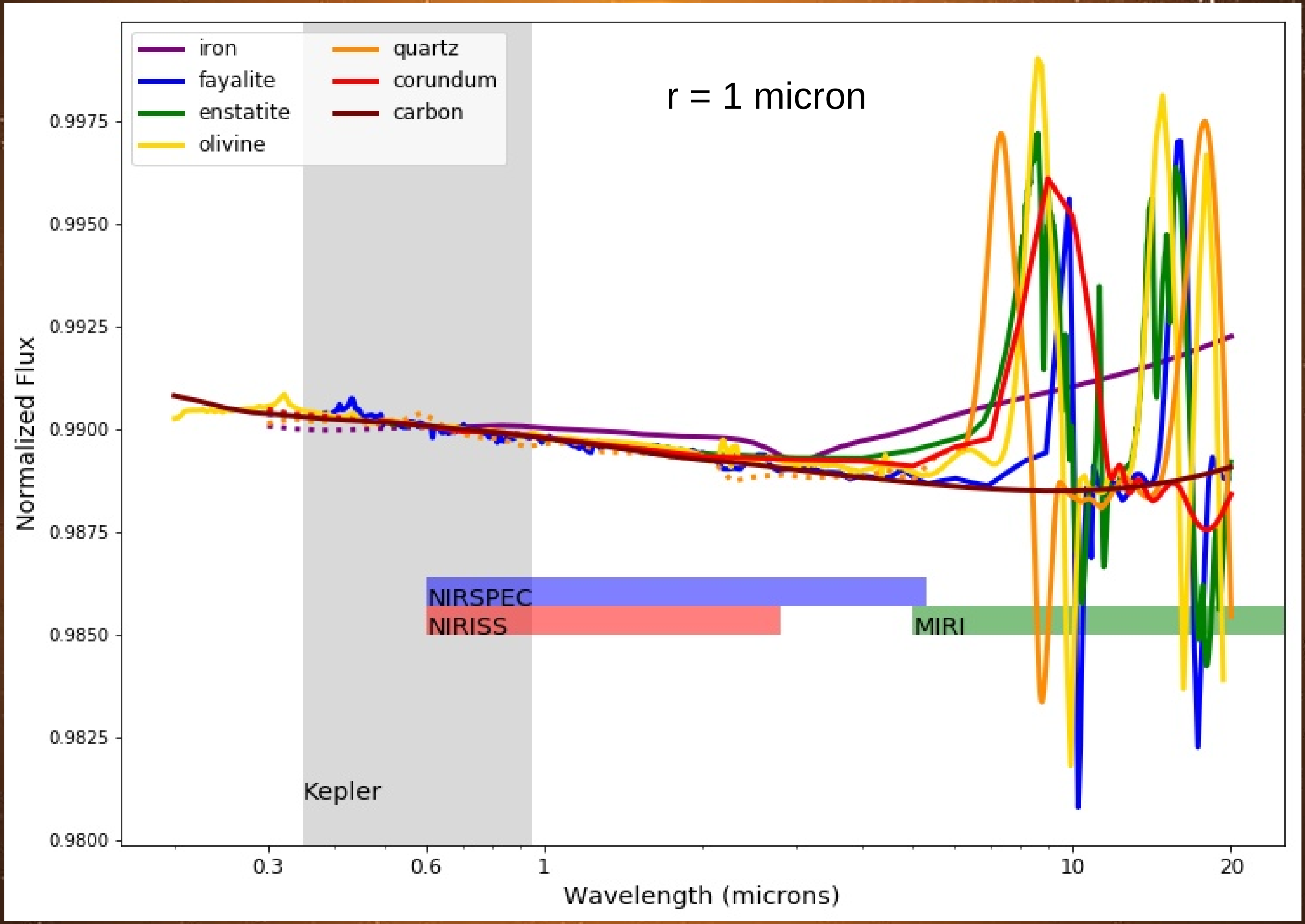
Disintegrating planets allow for direct composition of mantle material of an exoplanet

Model Spectra

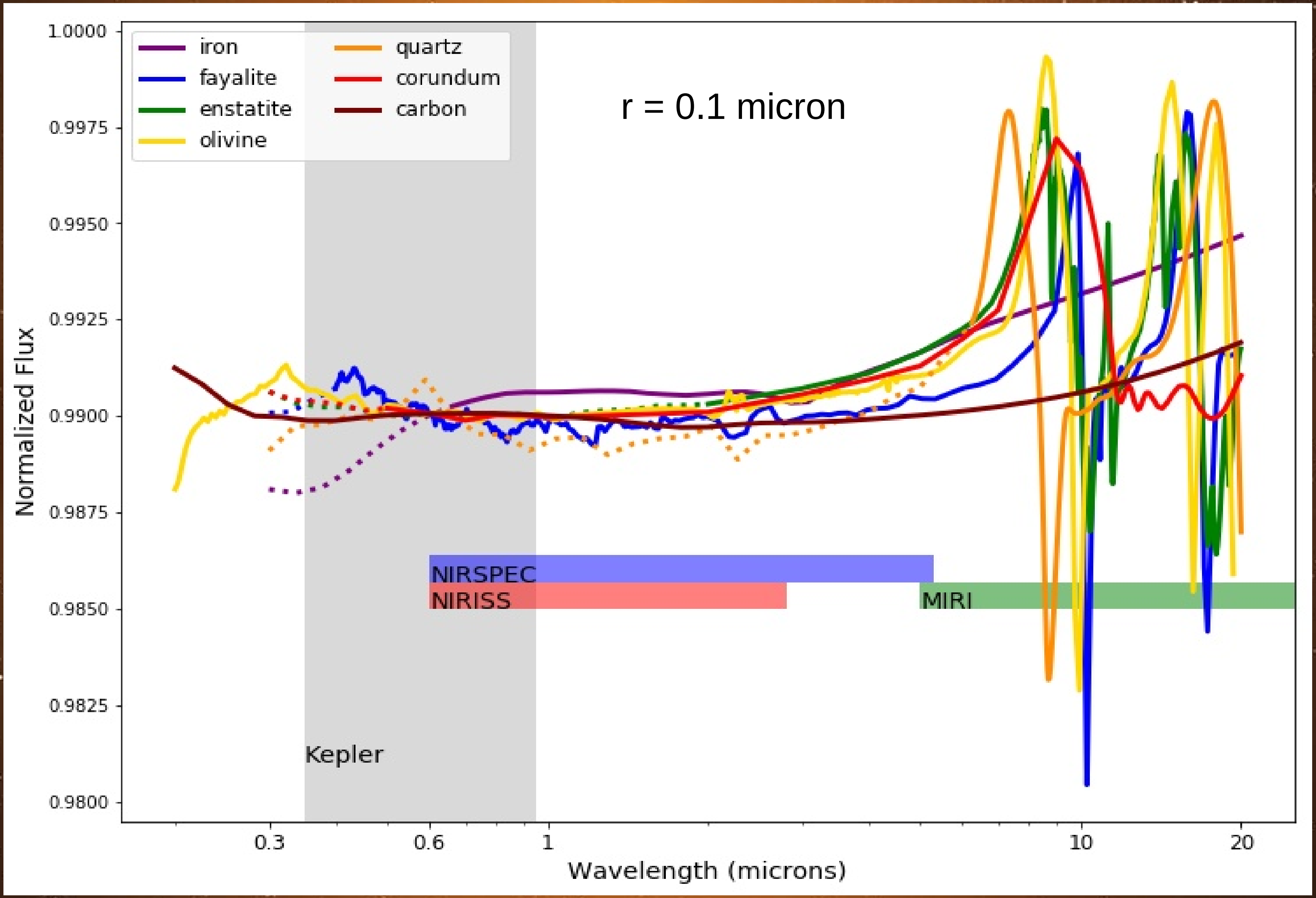
- Cloud with flat opacity
- Wavelength dependency from Mie Theory



Preliminary Results

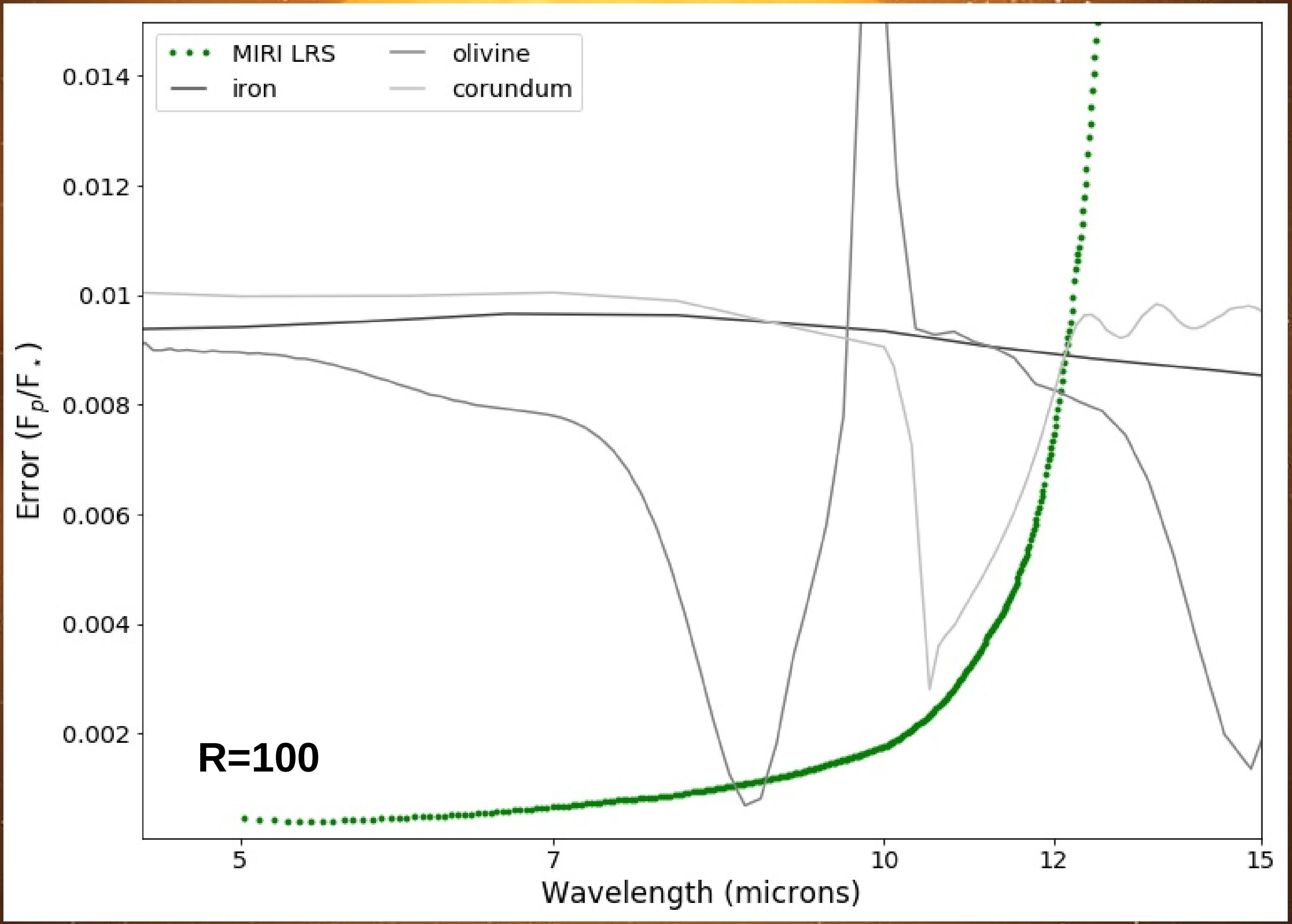


Size Dependencies



JWST Error Estimates

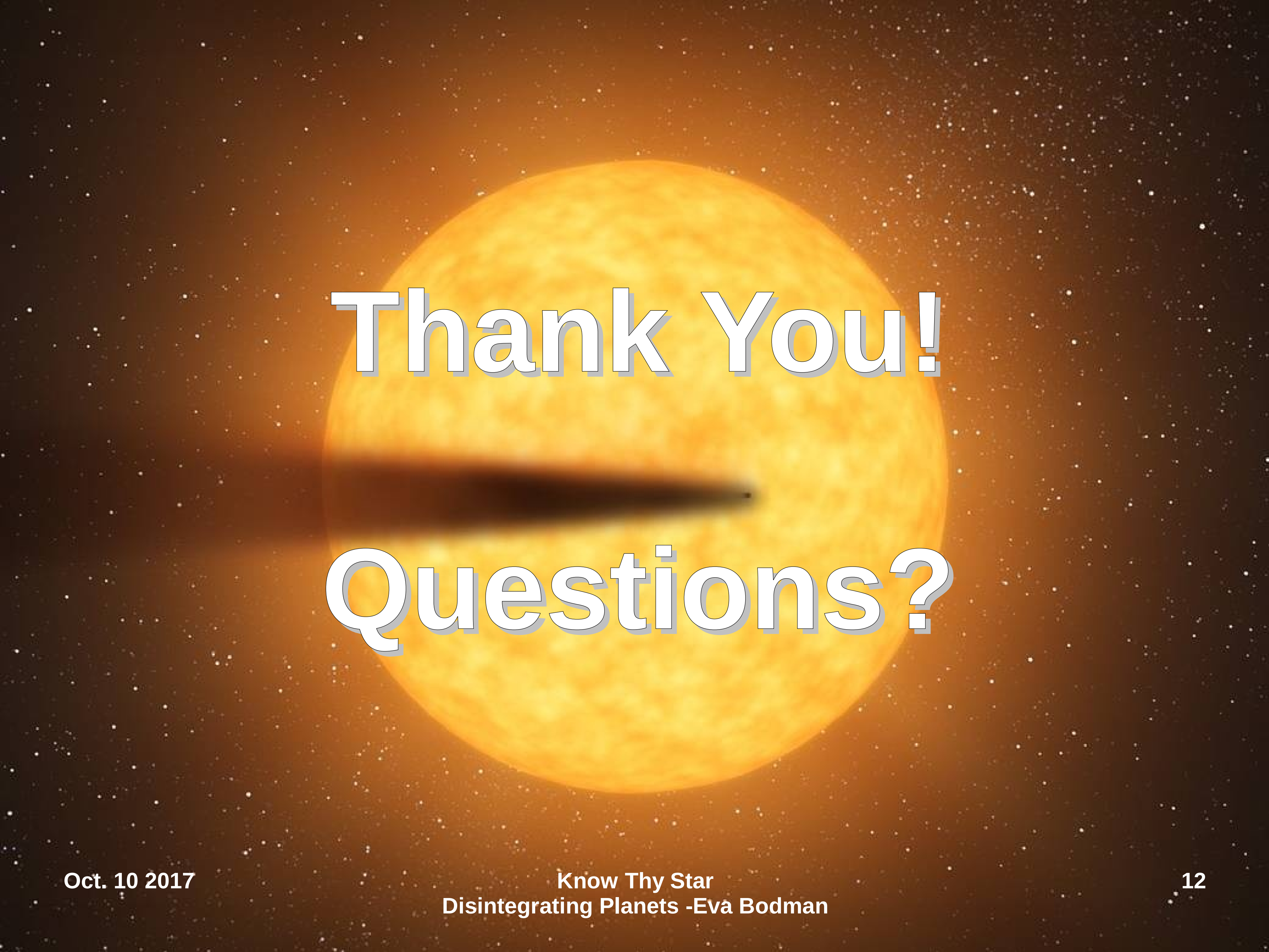
PandExo -Batalha et al. 2017



Star Properties

Parameter	Symbol [units]	KIC 1255b	KOI-2700b	K2-22b
Host star parameters				
Stellar temperature	$T_{\mathrm{eff},\star}$ [K]	4550 ± 135	4300 ± 140	3830 ± 100
Surface gravity	$\log g$ [cgs]	4.62 ± 0.04	4.71 ± 0.05	4.65 ± 0.12
Metallicity	[Fe/H]	-0.2 ± 0.3	-0.7 ± 0.3	0.03 ± 0.08
Stellar mass	$M_\star$ [$M_\odot$]	0.67 ± 0.06	0.55 ± 0.04	0.60 ± 0.07
Stellar radius	$R_\star$ [$R_\odot$]	0.67 ± 0.06	0.54 ± 0.05	0.57 ± 0.06
Stellar luminosity	$L_\star$ [$L_\odot$]	0.17 ± 0.04	0.09 ± 0.02	0.063 ± 0.008
Stellar rotation period	P_{rot} [days]	22.9	11.0	15.3
Maximum β ratio of dust[a]	β_{max}	0.19	0.12	0.07
Radial velocity variations[b]	K [m/s]	< 150	...	< 280

van Lieshout and Rappaport (2017)



Thank You!

Questions?

System Properties

Parameter	Symbol [units]	KIC 1255b	KOI-2700b	K2-22b
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Maximum β ratio of dust[a]	$\beta_{\rm max}$	0.19	0.12	0.07
Radial velocity variations[b]	K [m/s]	< 150	...	< 280
Planet: light curve properties				
Orbital period	$P_{\rm orb}$ [hr]	15.68	21.84	9.146
Transit depth (range)	δ [%]	0–1.4	0.031–0.053	0–1.3
Mean transit depth	$\langle\delta\rangle$ [%]	0.5	0.036	0.55
Variability		fast	slow	fast
Long egress		yes	yes	no
Pre-ingress bump		yes	?	weak
Post-egress bump		no	no	yes
Planet: derived parameters				
Planet radius	$R_{\rm p}$ [$R_\oplus$]	$\lesssim 1$	< 0.5	< 3
Semi-major axis	$a_{\rm p}$ [AU]	0.0129(4)	0.0150(4)	0.0088(8)
Scaled semi-major axis	$a_{\rm p}/R_\star$	4.3 ± 0.4	5.9 ± 0.4	3.3 ± 0.2
Transit impact parameter	b	0.6 ± 0.1	<1.0	0.42–0.78
Angular radius of star[c]	$\theta_\star$ [°]	13	10	17
Tail length[d]	$\theta_{\rm tail}$ [°]	~10–15	~24	< 6
Planet's peak temperature[e]	$T_{\rm eff,p}$ [K]	2100	1850	2100
Planet's dust mass-loss rate	$\dot{M}_{\rm d}$ [10^{11} g/s]	~2	~0.06	~2

van Lieshout and Rappaport (2017)

JWST Error Estimates (Continued)