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Transits of white dwarfs with *PLATO*

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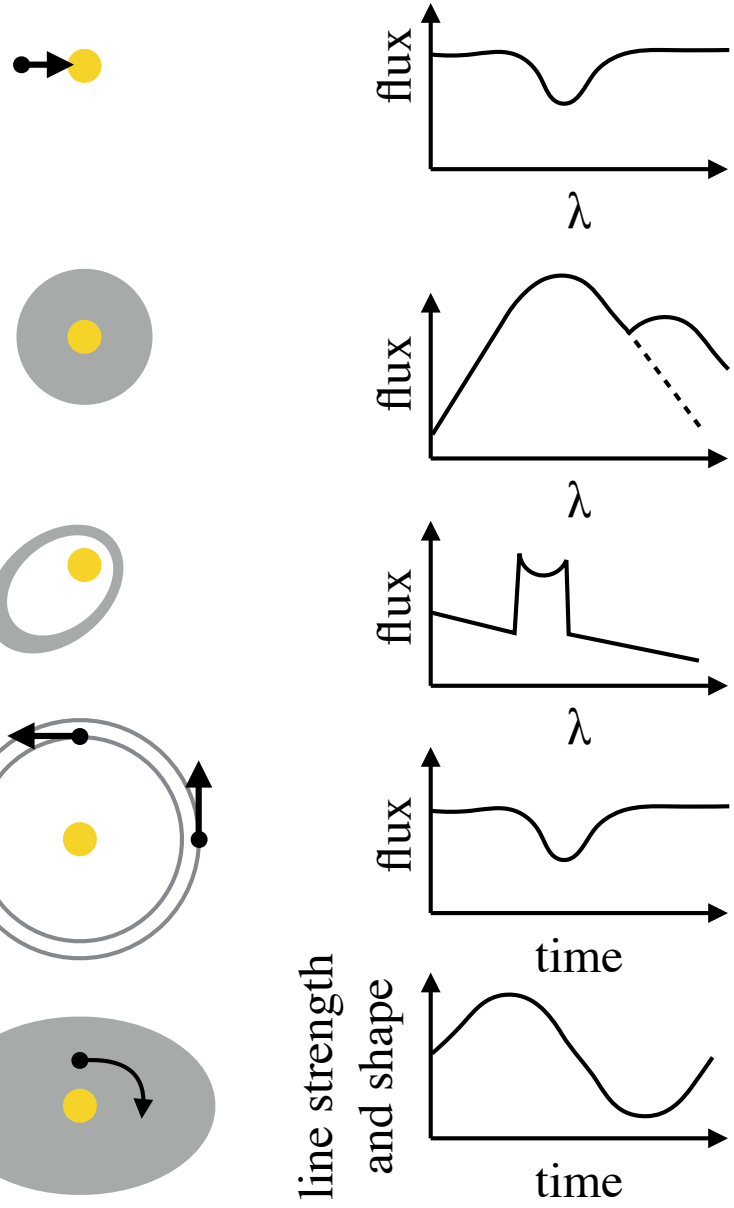
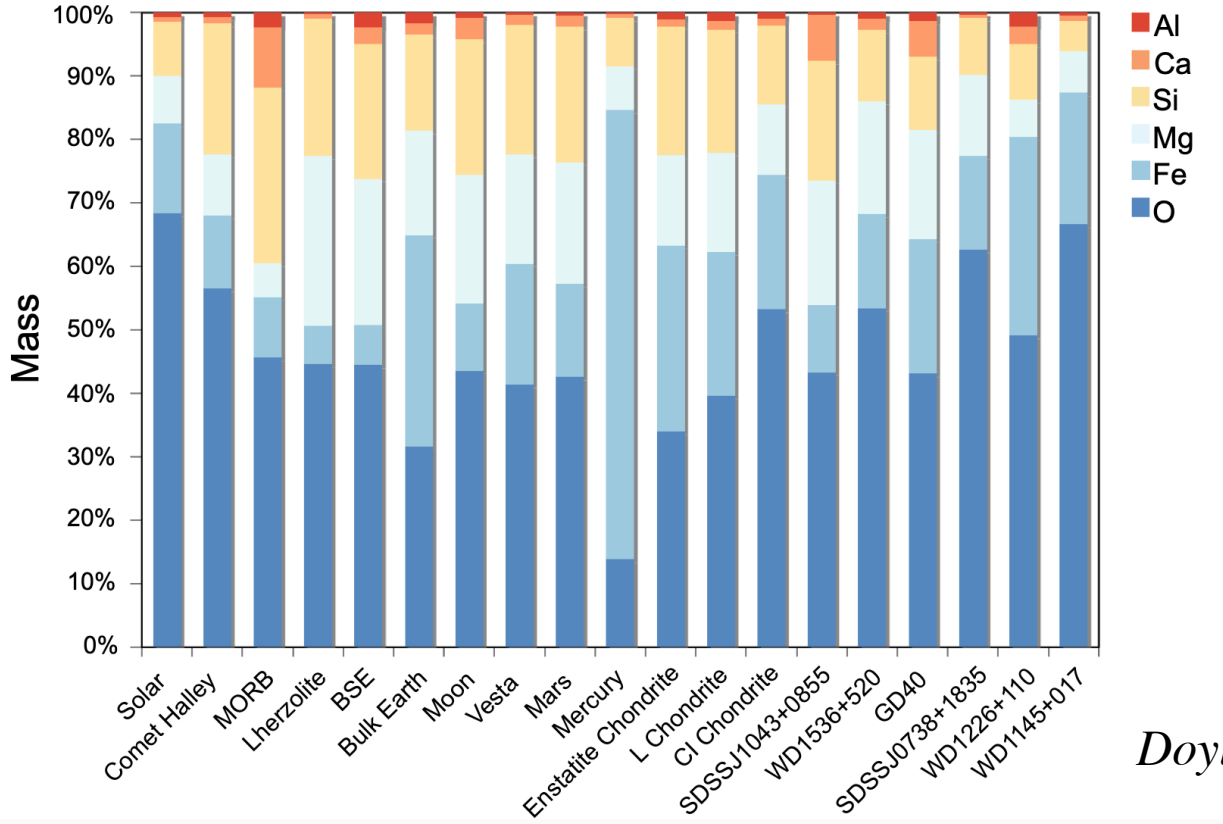
White dwarf planetary systems: discs and close-in planetesimals

- Spectroscopic signatures of accreted metals (~45% of WDs, Wilson *et al*. 2019) and possible planet (Gänsicke *et al*. 2019)
- Dust discs detected through IR excesses (~1.5% of WDs, Wilson *et al*. 2019), often variable
- Gas discs detected through Keplerian emission features (~0.1% of WDs, Gänsicke et al. 2007, Manser *et al*. 2020)
- Transits of disintegrating asteroids (Vanderburg *et al*. 2015, Vanderbosch *et al*. 2020) and planet (Vanderburg *et al*. 2020)
- Spectral signatures of non-transiting asteroids (1 known, Manser,…, Mustill *et al*. 2019)



White dwarfs tell us what extra-Solar planets and asteroids are made of

- ~45% of WDs show metal lines in their spectra
- Metals should sink on short timescales (d to Myr): accretion is ongoing or recent
- Leading candidate: pulverised asteroids/planets scattered close to the WD
- Composition gives us insight into planetary and asteroidal compositions and geochemistries beyond the Solar System (review: Xu *et al*, 2024)



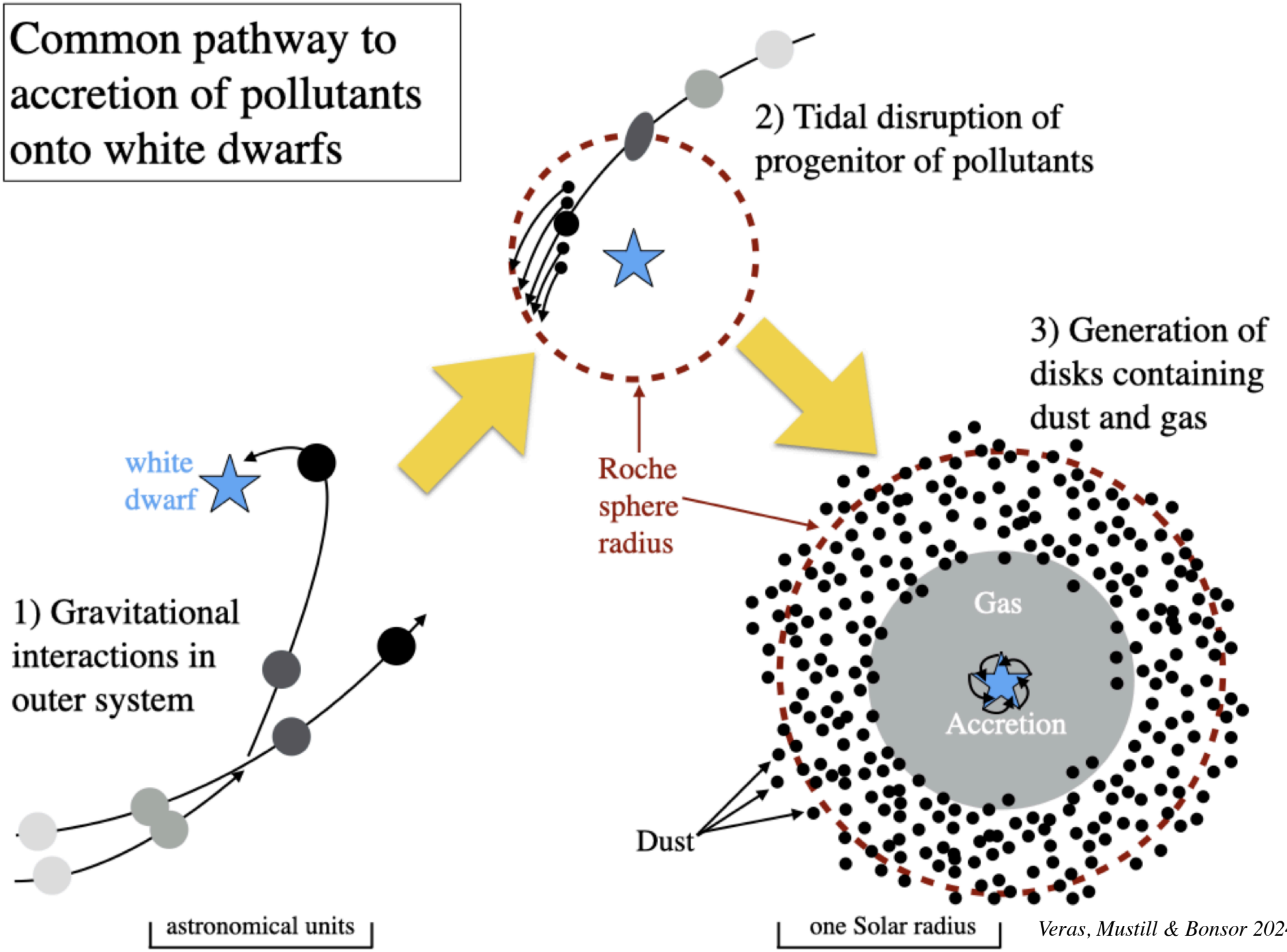
Doyle et al 2019

Theoretical paradigm:

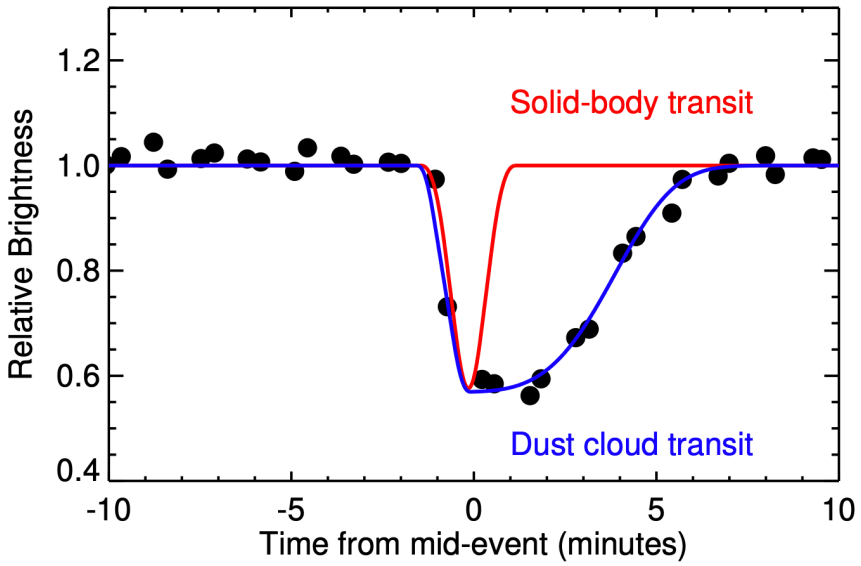
Inner system bodies (< few au) destroyed by RGB/AGB evolution.

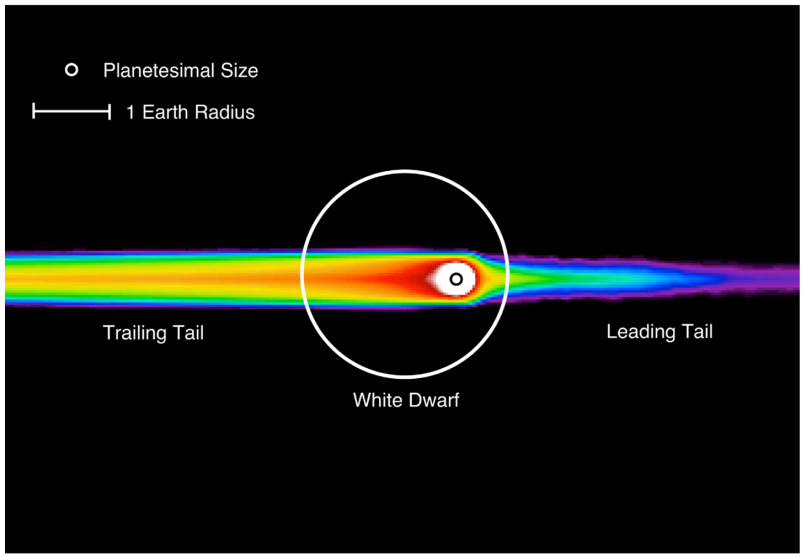
Material is driven towards the WD on highly-eccentric orbits by large bodies in the outer system. It undergoes orbital circularisation, pulverisation and vaporisation, forms a close-in disc, and ultimately accretes onto the WD.

Reviews: Veras, Mustill & Bonsor 2024, Malamud 2024


Common pathway to accretion of pollutants onto white dwarfs
2) Tidal disruption of progenitor of pollutants
3) Generation of disks containing dust and gas
white dwarf
Roche sphere radius
1) Gravitational interactions in outer system
Gas
Accretion
Dust
astronomical units
one Solar radius
Veras, Mustill & Bonsor 2024

First WD transits: WD1145+017





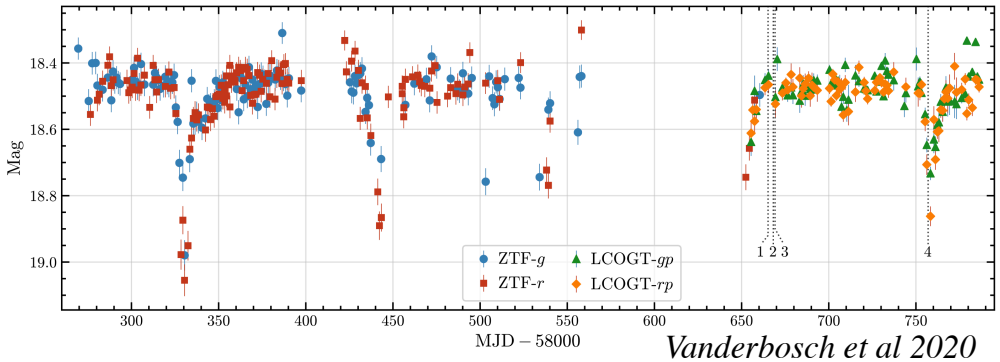
Vanderburg et al 2015

Periods ~4.5 hr, close to Roche limit

Transits are asymmetric: consistent with cometary geometry

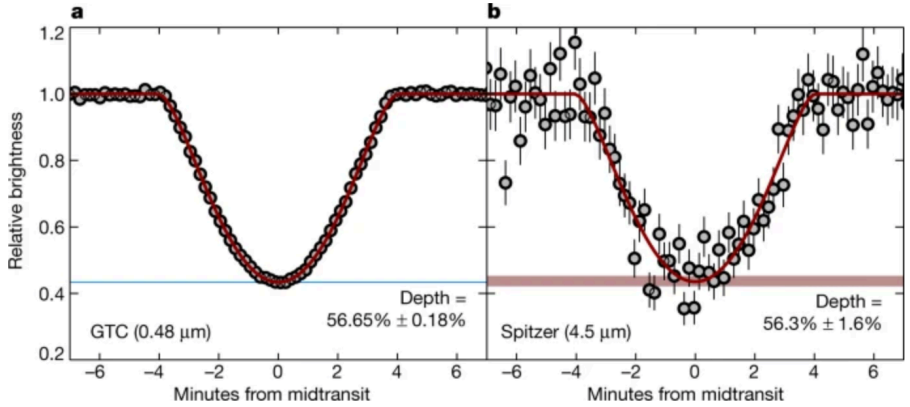
Transits are deep: easy to detect even round faint stars

More, and more diverse, transiting systems



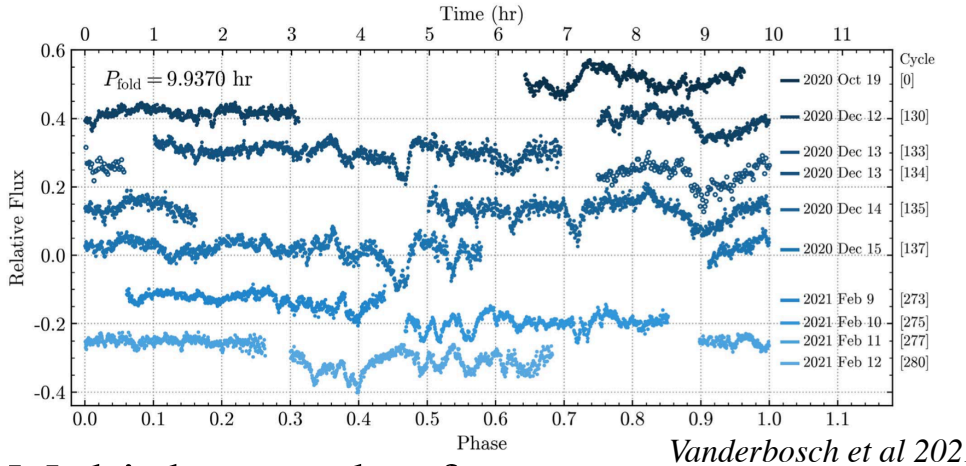
Vanderbosch et al 2020

Long-period, likely eccentric, being circularised?



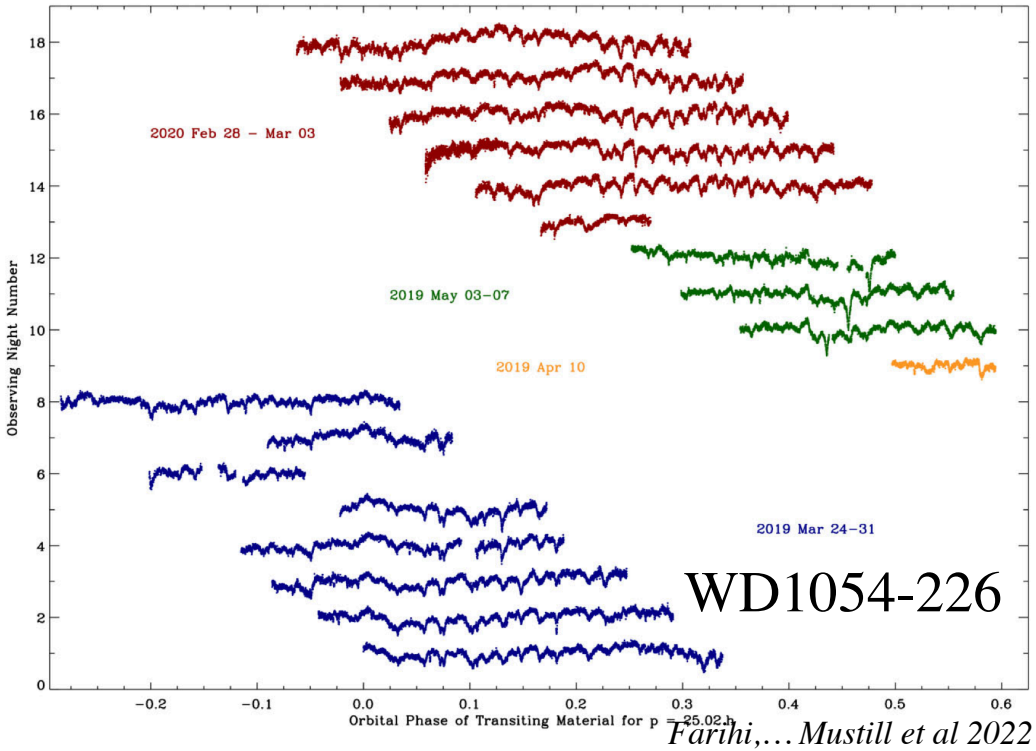
Vanderburg et al 2020

Gas giant planet



Vanderbosch et al 2021

Multiple complex features

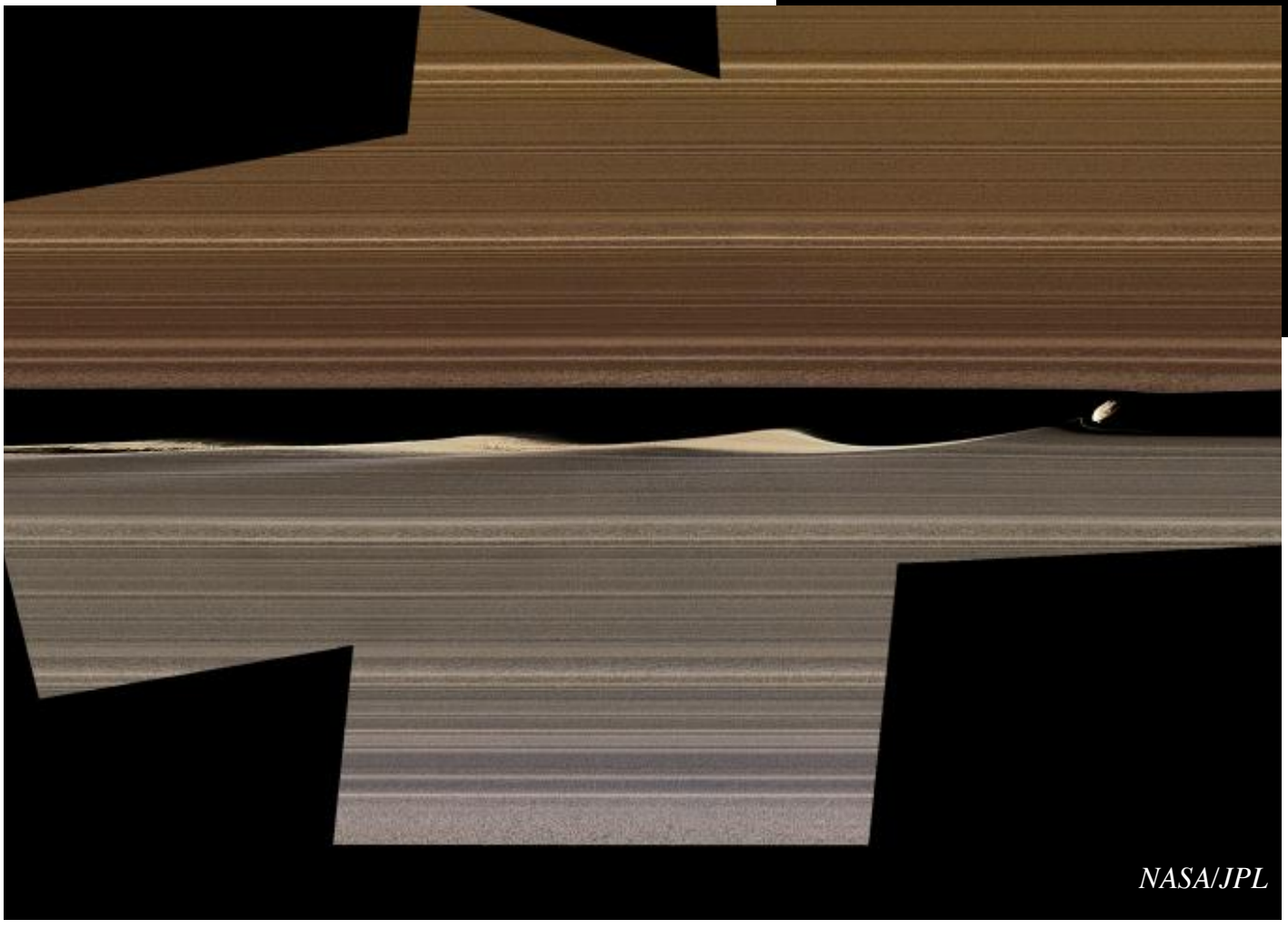


WD1054-226

Farihi,… Mustill et al 2022

More complex features with 65:1 commensurability: maybe resonant structure or waves (cf Saturn's rings perturbed by satellites)

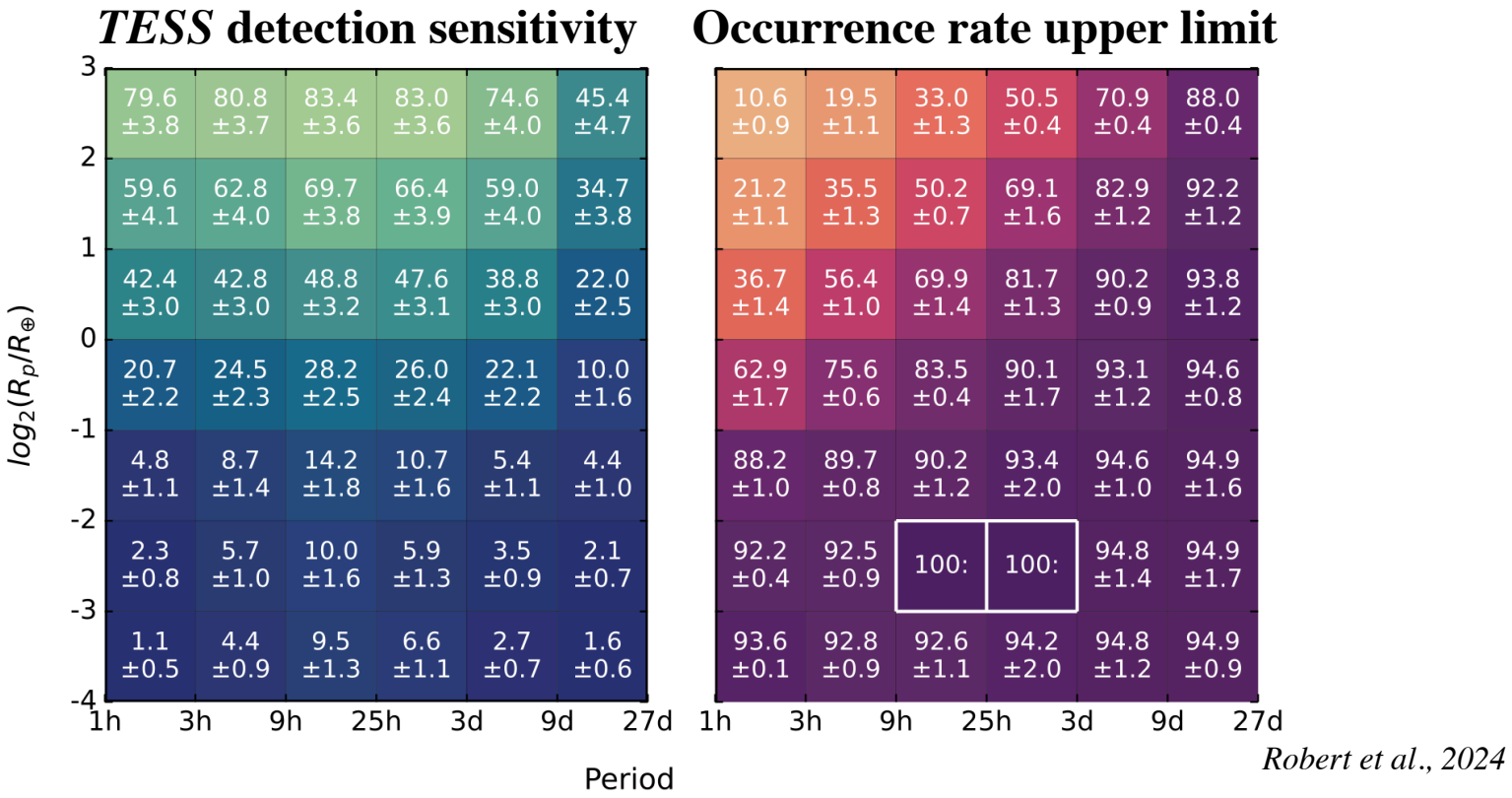
Cassini views of Saturn's rings



How common are WD transiting systems?

How would embedded bodies in discs affect accretion of disc onto WD?

Current occurrence rate estimates



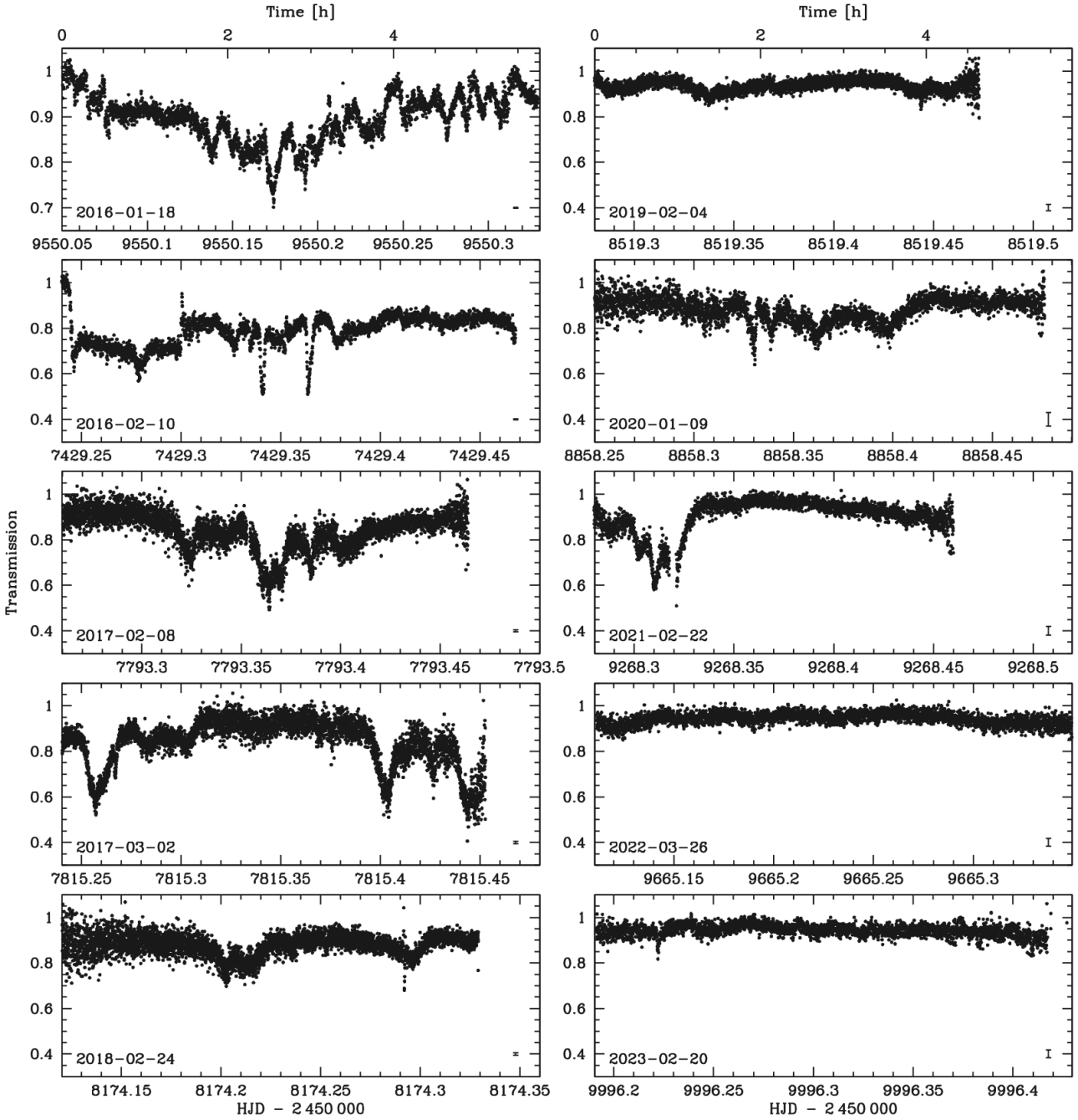
Robert et al., 2024

Robert *et al* (2024): ~1% of polluted WDs observed by *TESS* exhibit transits

Consistent with 100% of polluted WDs hosting transiting objects close to Roche radius (=> 10s % of all WDs)

Earlier surveys: WASP (Faedi *et al* 2011), PANSTARRS (Fulton *et al* 2014), *K2* (van Sluijs & van Eylen 2018)

Time variability of transits



Aungwerojwit et al 2024

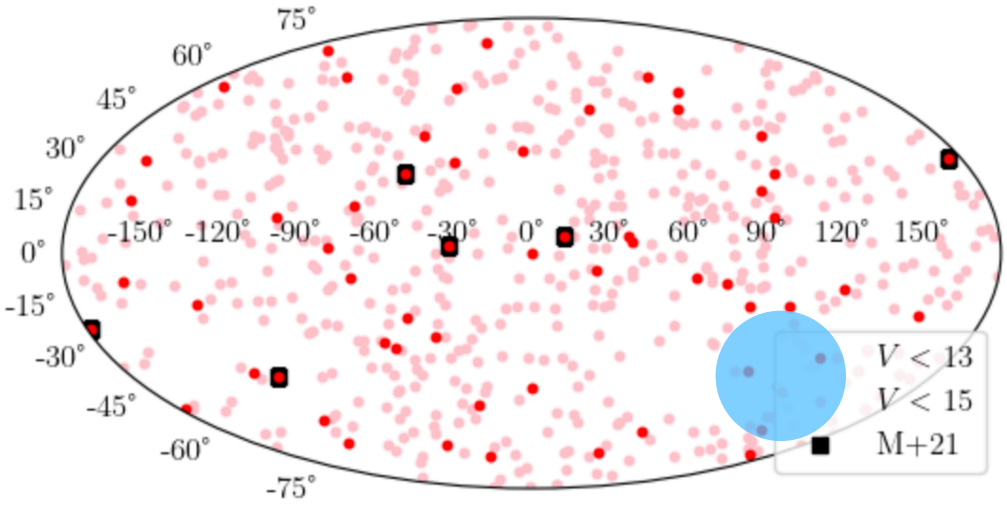
Variability of the original WD transiting system, WD1145+017, has reduced significantly

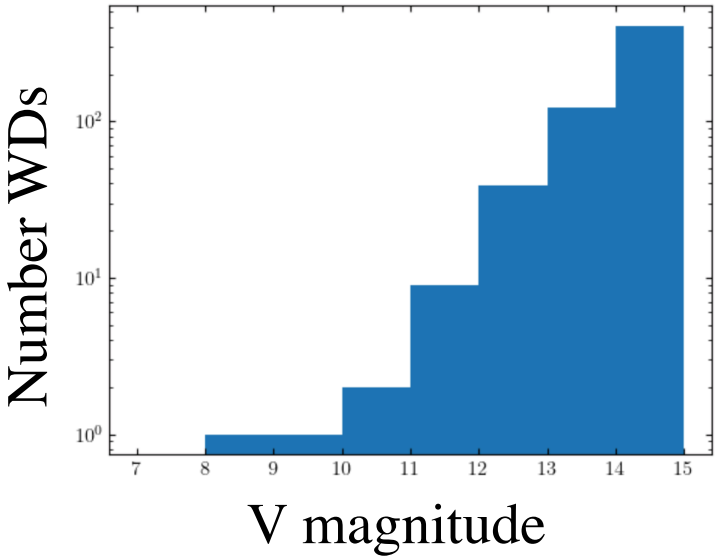
Consistent with a picture in which transits are caused by dust released from a parent body

=> just because a system wasn't showing transits in the past, doesn't mean it will not show them in the future

=> worth revisiting existing non-detections in future

PLATO prospects?





> 500 WD candidates with V<15 mag (Gaia Collaboration *et al*., 2023)

Black = survey with *CHEOPS* by Morris *et al*. (2021)

Blue = rough LOPS2 field (don't take it too precisely)

=> probably few targets in LOPS2 field, but better prospects in later pointings?

Unlikely to observe many more systems to improve occurrence rates but might get lucky with a detection or two…