Searching for transiting circumplanetary disks in the Galaxy

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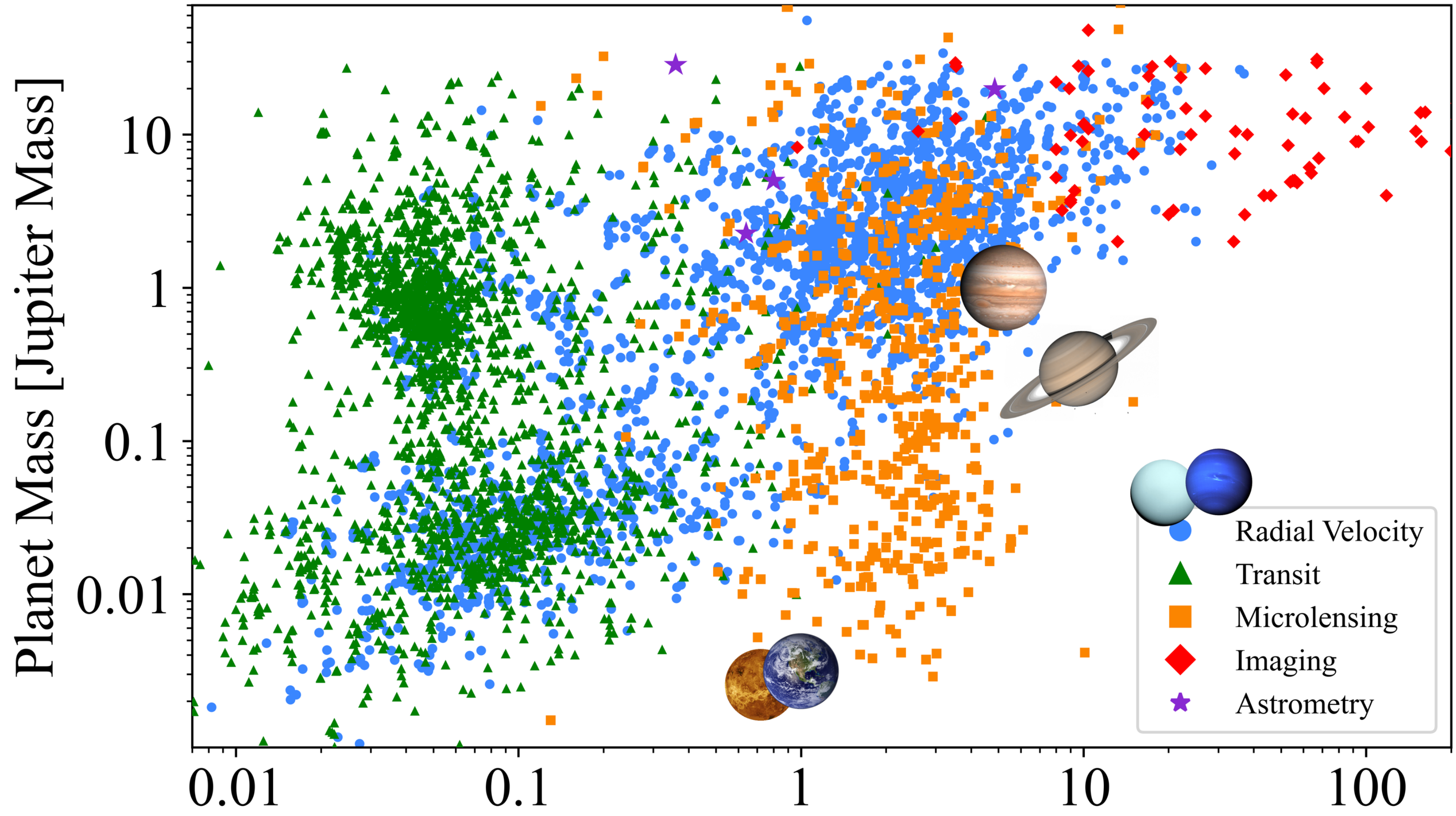
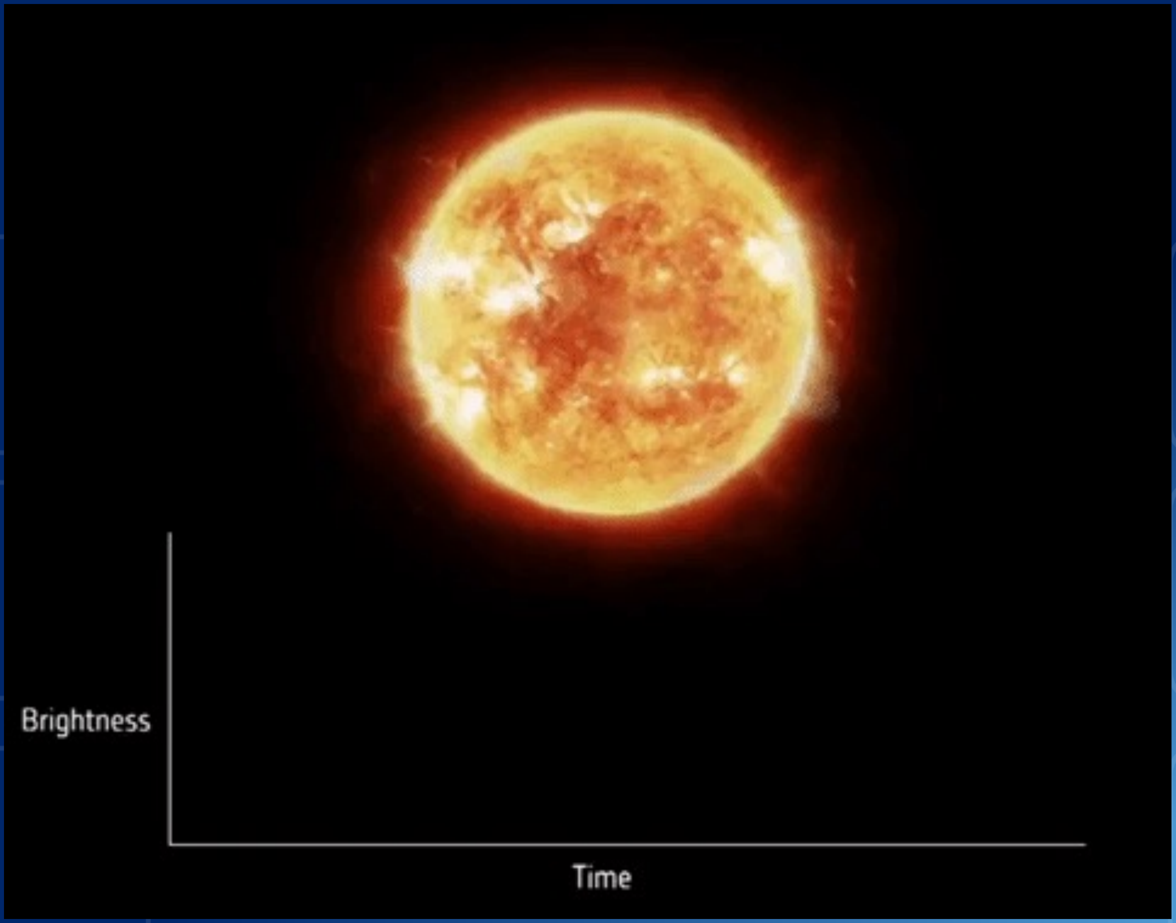
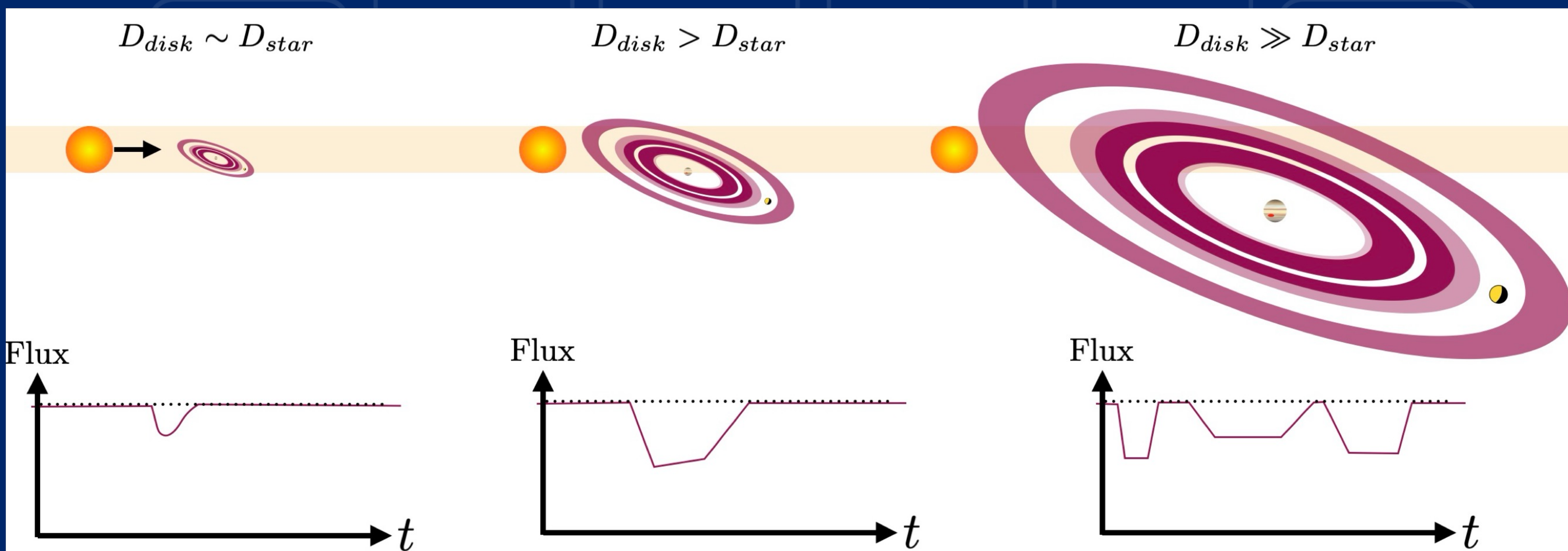


Data from NASA Exoplanet Archive

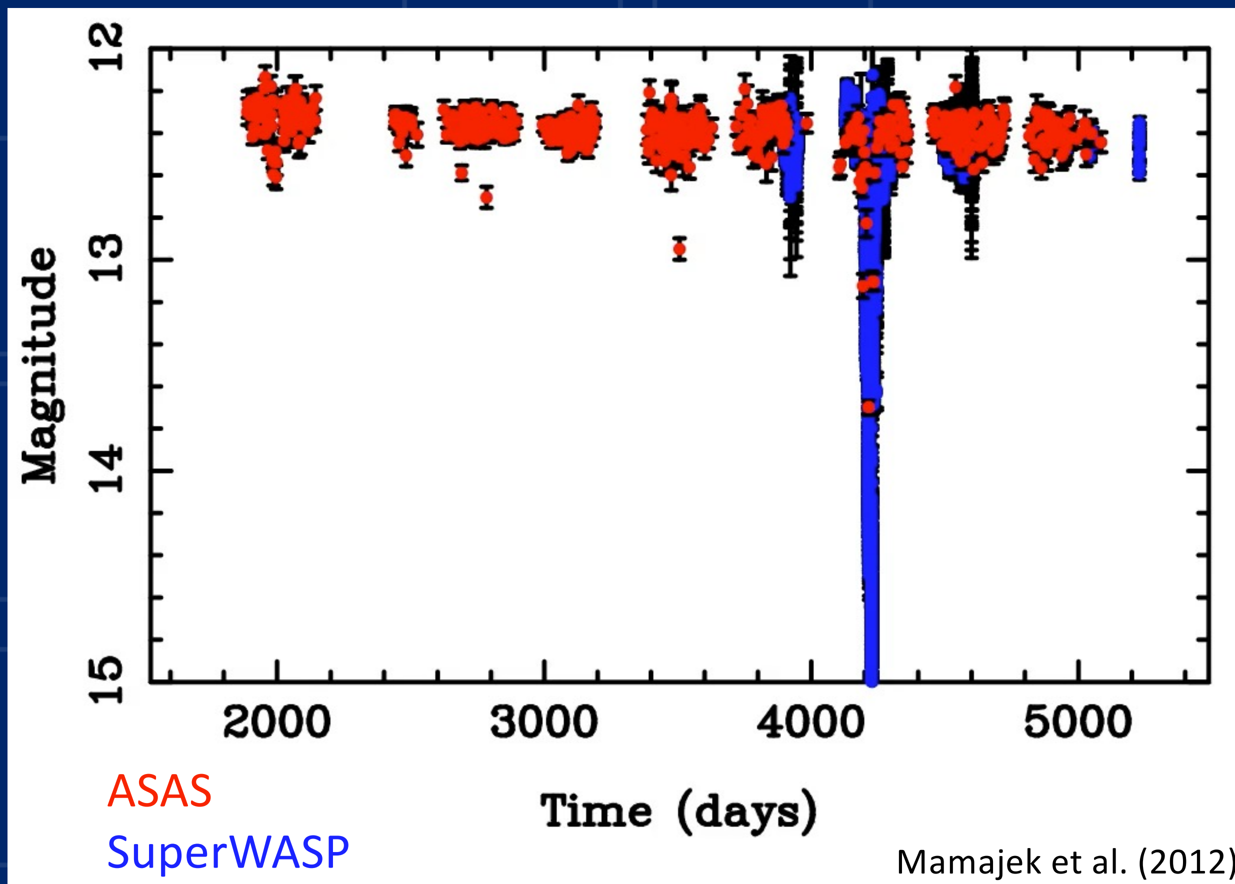

Brightness
Time

What if the planet has rings?

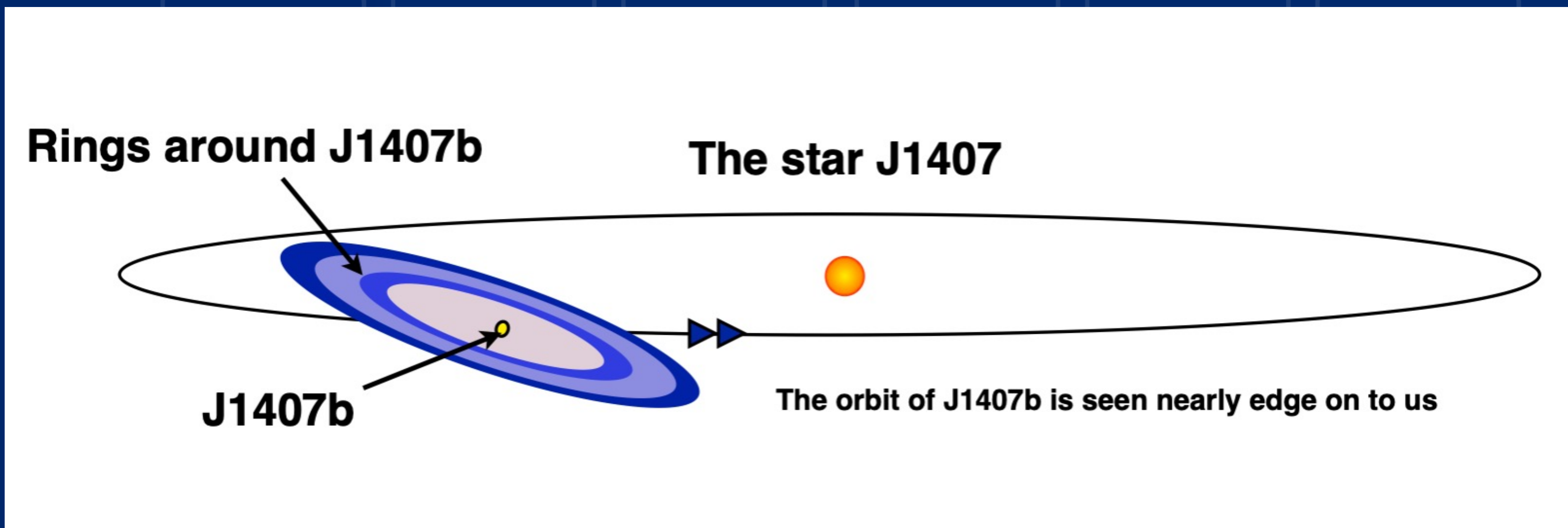


Kenworthy (in prep)

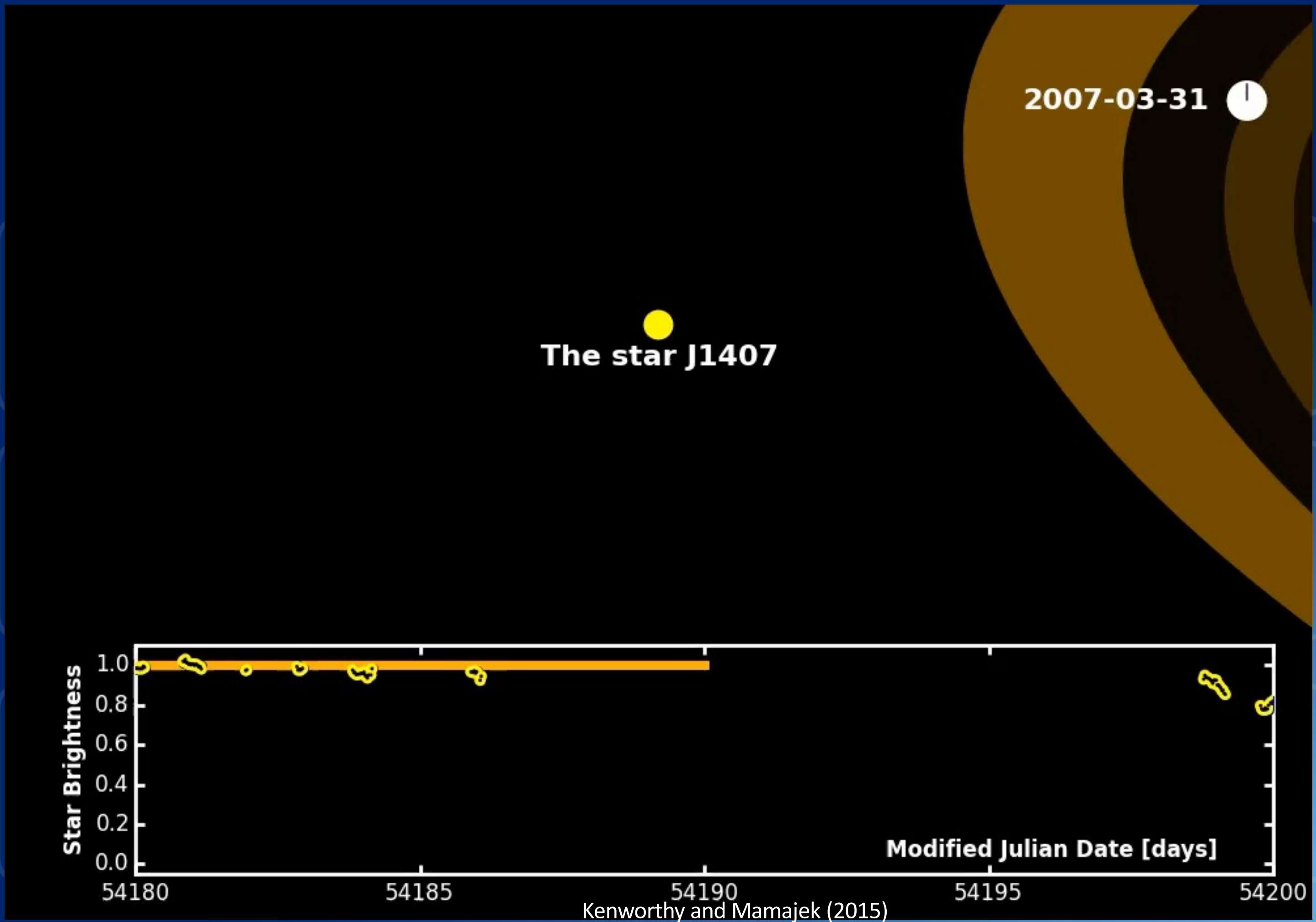
A complex and extended eclipse



56 day transit of J1407-- a transiting giant exoring?

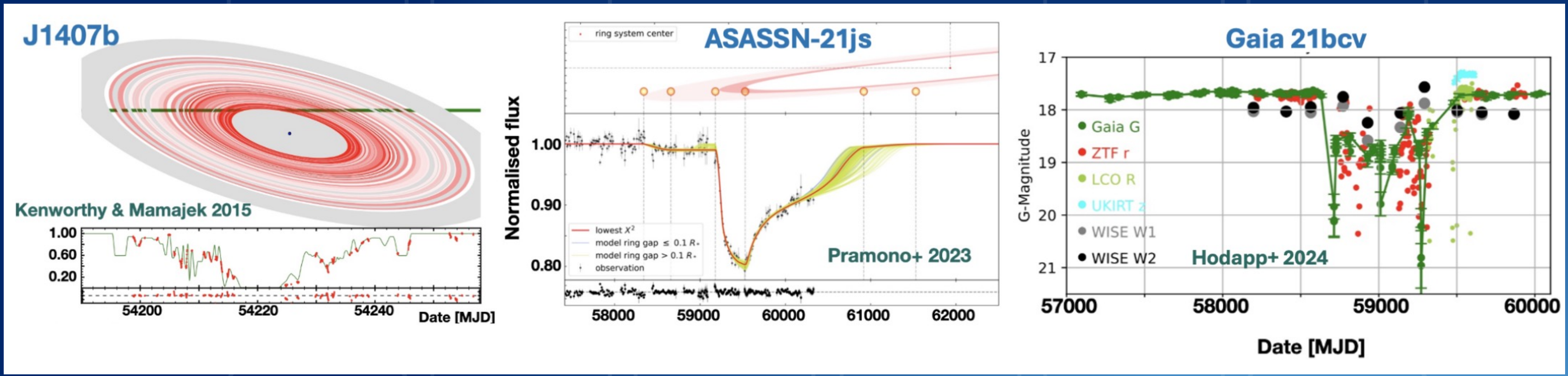


Kenworthy and Mamajek (2015)



Kenworthy and Mamajek (2015)

How many giant occulting exorings have been found?



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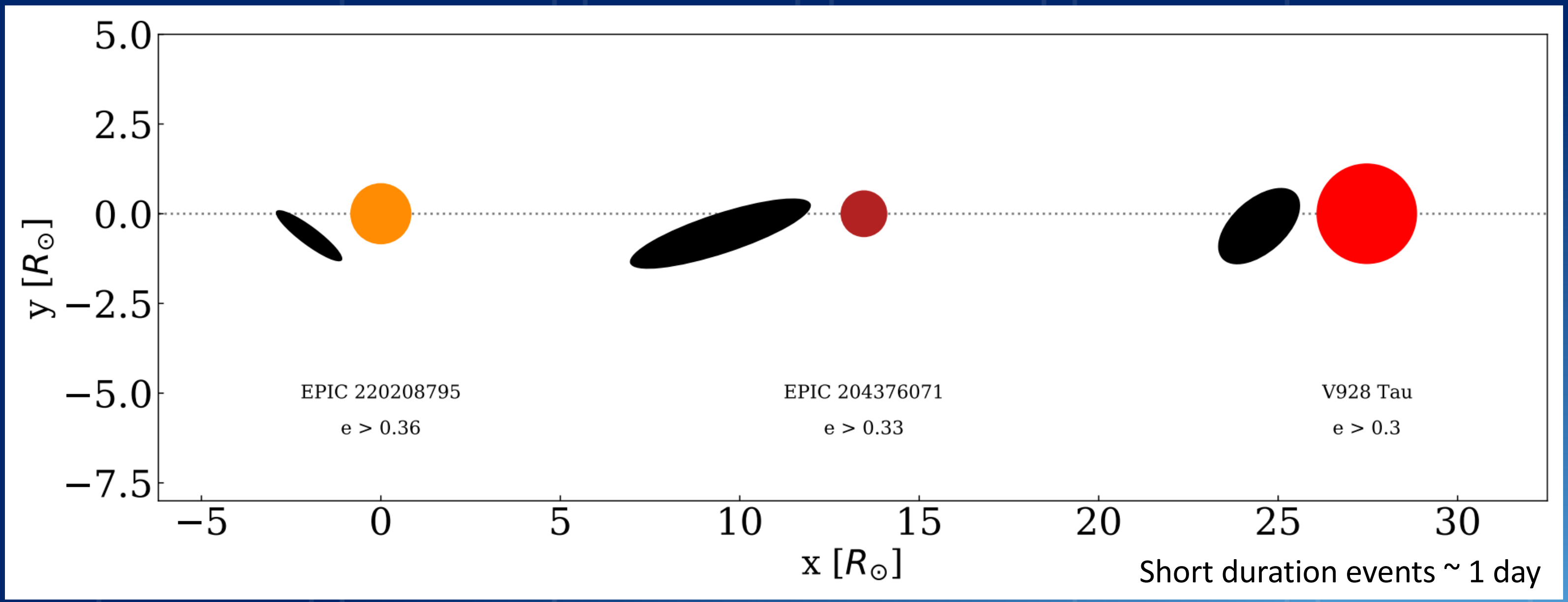
How many compact occulting exorings have been found?



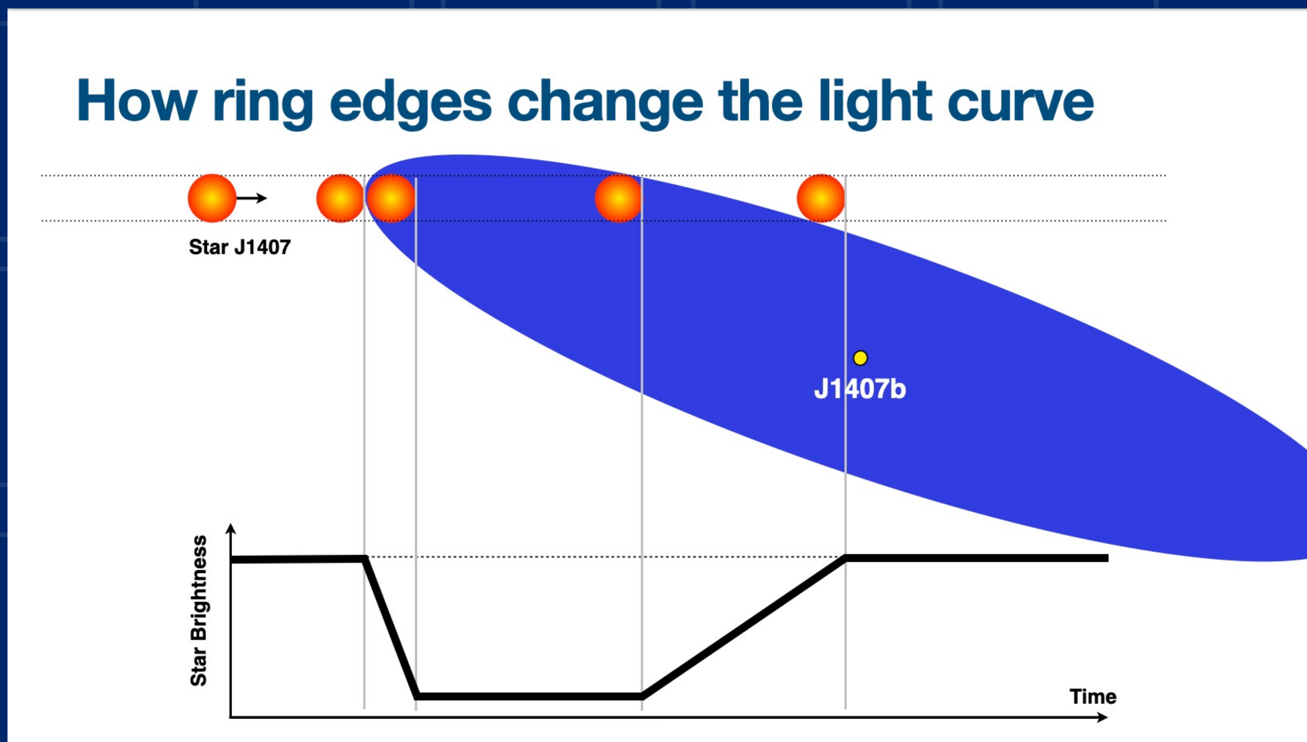
van der Kamp et al. (2022)

Three tilted exoring transit systems found in 4 years of Kepler/K2 data

Roman Galactic Bulge Time Domain Survey

- Monitor ~60 million stars towards the galactic bulge
- ~70 continuous days per season
- 12 minute cadence
- S/N~100 -- F146~21 mag
- Can detect exoring systems in transit!
  - Compact exorings (hours to day)
  - Giant exorings (days to weeks)
  - Sharp ring edges, gaps

How Roman GBTDS will find exorings

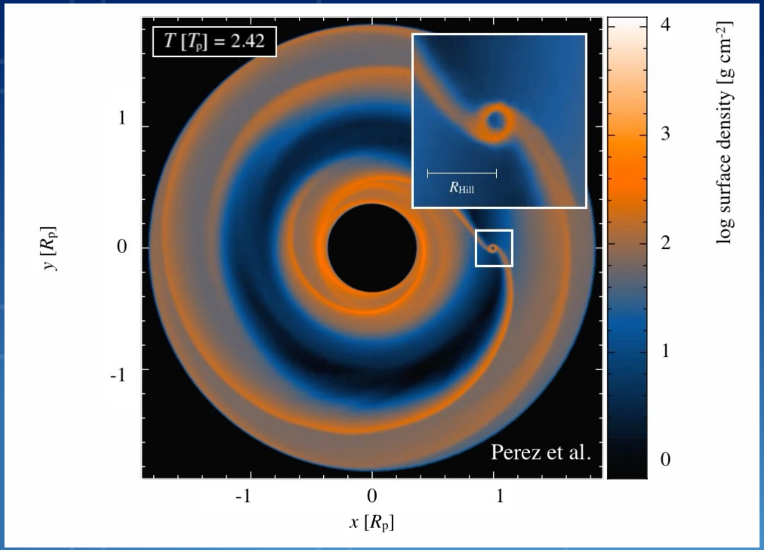


Roman GBTDS Analysis plan

- Use the photometry and light curves generated by Roman
- ~60 million stars → cannot identify events by visual inspection alone!
- Pre-filtering
  - Remove bright saturated stars, known variables, insufficient photometric precision
- Automated detection
  - Sliding window algorithm (exocomets in Kepler; Kennedy et al. 2019) to intentionally search for asymmetric events with sharp ingress and gradual egress
- Candidate validation
  - Dual-band consistency checks (F146 vs F087/F213)
  - Manual inspection of the photometry and astrometry to rule out blending or crowding
  - PSF fitting to extract a new light curve

What might we learn?

- How common are exorings?
  - Exorings/Circumplanetary disks are a predicted by product of giant planet formation
  - Ballpark estimating to find 50-1000 exorings in the Roman GBTDS
- What are these rings made of?
  - Multi-band GBTDS observations
  - Follow-up spectroscopic observations
    - Disk composition as a function of disk radius
- How long are the exoring lifetimes?
  - GBTDS probes field-age stars
- How do the rings form?
  - Scattering interactions between gas giants

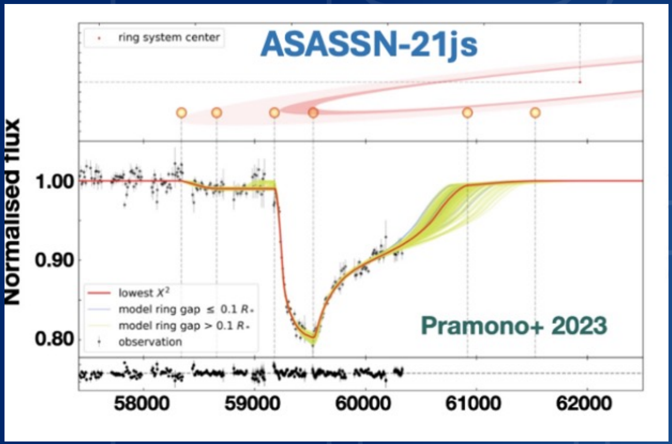


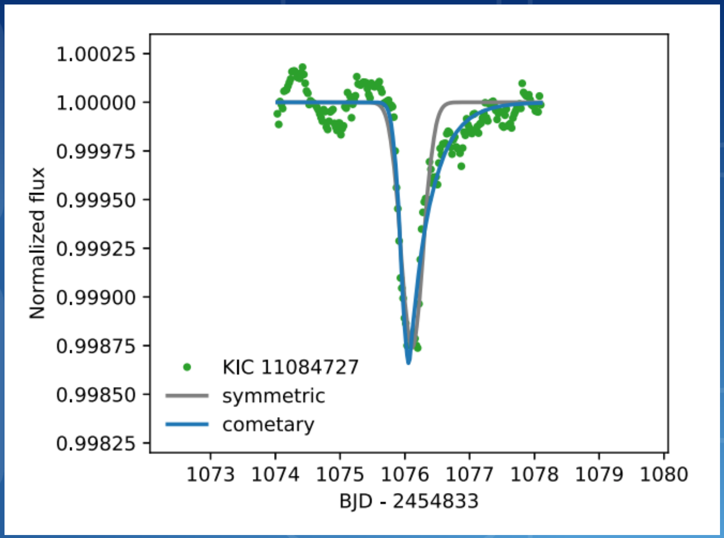
Conclusion

- Roman GBTDS will find many exoring systems!
  - Even detections of a few dozen events will greatly increase the number of known exoring systems
- These detections help our understanding of how giant planets form, exoring formation, exoring lifetimes, etc
- Sheds light on planets with rings in our solar system

BONUS SLIDES

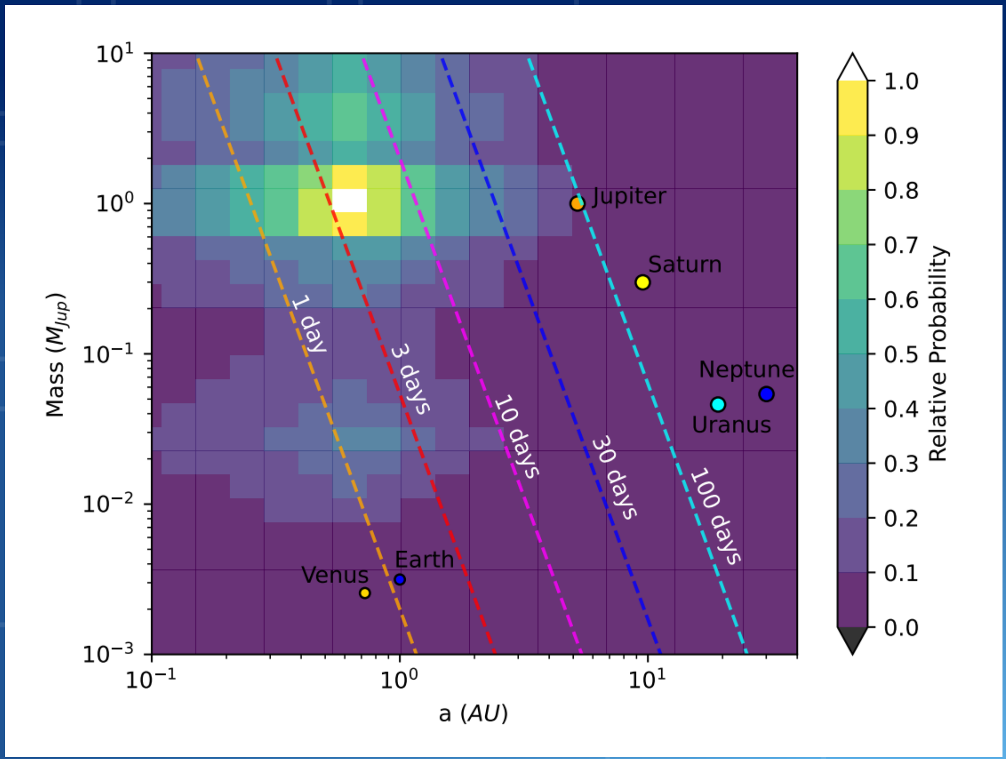
How to separate exorings transits from exocomets





Yield estimate

- Relative probability of detecting an exoring in transit in GBTDS
- Combines geometric transit probability, disk inclination, and planet occurrence
- Peaks at 1 Mjup and 0.7 au where Hill sphere transit times of ~3 days are well covered by GBTDS
- Assuming a conservative disk lifetime of 10 Myr disk for 5 Gyr star yields 60-100 detections.



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Why not TESS?

- 230k stars in 2 minute cadence, covering each subfield of stars for 21-27 days
- This limits discoveries to short period planets (10-20 day orbits)
- These exoring systems need to be at larger semi-major axes for their CPD to not be disrupted