

**Intermittently Transiting Exoplanetary Systems Beyond Kepler-413b**

**Intermittently Transiting Exoplanetary Systems Beyond Kepler-413b**

Recent astronomical studies have identified several exoplanetary systems exhibiting intermittent transit patterns, where planets periodically cease transiting their host stars before resuming observable crossings. These phenomena provide critical insights into complex orbital dynamics and system architectures that challenge conventional transit detection methodologies.

**Circumbinary Systems with Variable Transit Windows**

The TOI-1338 system represents another compelling example of intermittent transits caused by circumbinary orbital dynamics. This system contains a planet orbiting two stars, creating transit patterns that vary significantly in duration and timing based on the binary pair's orbital phase[[1]](#fn1). Observations from the TESS mission revealed three distinct transits occurring at irregular intervals of 93 and 95 days, with transit durations ranging from 0.3 to 0.6 days[[1]](#fn1). The planet's orbital plane undergoes continuous reorientation relative to Earth's line of sight due to gravitational interactions with the central binary pair, creating temporary alignment windows for transit visibility followed by extended periods of non-detection[[1]](#fn1).

This orbital configuration produces two distinct types of transits – those occurring near primary eclipses exhibit shorter durations compared to transits happening near secondary eclipses[[1]](#fn1). The system's complexity is further evidenced by the presence of additional stellar companions, creating a hierarchical multiple-star system that influences long-term transit visibility patterns[[1]](#fn1). Such circumbinary arrangements demonstrate how multi-body gravitational interactions can create temporary transit windows separated by months or years of non-detection.

**Anomalous Transit Behavior in XO Systems**

The XO-7 system exhibits peculiar transit characteristics that suggest intermittent visibility patterns. Observations conducted in April 2024 revealed a Jupiter-mass planet (XO-7b) whose post-transit brightness levels failed to return to baseline measurements, remaining 0.01 magnitudes dimmer than pre-transit values[[2]](#fn2). This persistent dimming could indicate either extended atmospheric interactions between the planet and host star, or gravitational perturbations from a suspected wide-orbit companion planet altering the system's transit geometry over time[[2]](#fn2).

Concurrent observations of XO-1 detected unusual transit curve anomalies, including brightness fluctuations during ingress and egress phases[[2]](#fn2). The system's 3.942-day orbital period planet displayed asymmetric transit profiles potentially caused by either stellar surface features or circumstellar material temporarily obscuring portions of the transit path[[2]](#fn2). Both systems require continued monitoring to determine whether these anomalies represent transient phenomena or predictable patterns of intermittent transit behavior.

**Gravitational Perturbations and Transit Timing Variations**

While not strictly intermittent transits, several systems demonstrate Transit Timing Variations (TTVs) that alter transit predictability. The Kepler-36 system contains two planets where strong gravitational interactions cause measurable period variations, with inner planet transits deviating from predicted times by up to 30 minutes[[3]](#fn3). These variations result from orbital resonances that periodically alter each planet's orbital velocity, creating complex transit patterns that could theoretically lead to temporary transit cessation if perturbation amplitudes were sufficiently large[[3]](#fn3).

Theoretical models suggest that systems with higher mass ratios between companion planets could produce TTV amplitudes large enough to push transiting planets into non-transiting orbital configurations for extended periods[[3]](#fn3). Current observations of HD 3167 systems show TTV patterns hinting at such extreme gravitational interactions, though no complete transit cessation has been documented to date[[3]](#fn3).

**Disappearing Planetary Signals and False Positives**

The case of Fomalhaut b illustrates the importance of distinguishing true intermittent transits from observational artifacts. Initially identified as a directly imaged exoplanet in 2004, subsequent observations revealed the object was actually an expanding debris cloud from a catastrophic collision between two protoplanetary bodies[[4]](#fn4). This "disappearing planet" scenario highlights how transient astrophysical events can mimic intermittent transit behavior, particularly in young stellar systems with active debris disks[[4]](#fn4).

Recent analysis of archival Hubble data shows the Fomalhaut debris cloud expanded at approximately 30 km/s, explaining its gradual disappearance from visible light observations between 2004-2014[[4]](#fn4). Such phenomena underscore the necessity of multi-wavelength observations and long-term monitoring to confirm genuine intermittent transit patterns versus transient astrophysical events.

**Emerging Detection Techniques**

Advancements in phase curve analysis have enabled identification of non-transiting planets through their gravitational influence on host stars. The KIC8121913 system demonstrates how ellipsoidal variations and Doppler beaming effects can reveal planets that never transit, yet create detectable photometric signatures[[5]](#fn5). While not exhibiting intermittent transits themselves, these detection methods provide critical context for understanding the full population of systems where planetary orbits remain edge-on or highly inclined relative to Earth[[5]](#fn5).

Radial velocity follow-up of Kepler phase curve candidates has validated three hot Jupiters (KIC8121913 b, KIC10068024 b, KIC5479689 b) with masses between 0.5-2 MJup, confirming that non-transiting planets can create detectable photometric signatures through tidal interactions[[5]](#fn5). These findings expand our understanding of orbital configurations that might lead to transient transit visibility under specific gravitational perturbation scenarios.

**Conclusion**

The growing catalog of intermittently transiting systems reveals the remarkable diversity of exoplanetary orbital architectures. From circumbinary planets like TOI-1338b to gravitationally perturbed systems like XO-7, these configurations challenge traditional notions of orbital stability and transit predictability. Future observations combining long-term photometric monitoring with high-resolution spectroscopy will be crucial for distinguishing true intermittent transits from transient astrophysical phenomena. As survey missions like PLATO come online, astronomers anticipate discovering more systems where complex gravitational interactions and multi-body dynamics create temporary transit windows, further expanding our understanding of planetary system evolution.

⁂

1. [https://ntrs.nasa.gov/api/citations/20205004013/downloads/Kostov\_TOI-1338 TESS’ First Transiting Circumbinary Planet .pdf](https://ntrs.nasa.gov/api/citations/20205004013/downloads/Kostov_TOI-1338%20TESS%E2%80%99%20First%20Transiting%20Circumbinary%20Planet%20.pdf)

1. <https://rfo.org/wp-content/uploads/2024/08/Exoplanet-Transits-at-RFO.pdf>

1. <https://lco.global/science/exoplanets/ttv/>

1. <https://www.space.com/disappearing-exoplanet-fomalhaut-b.html>

1. <https://arxiv.org/abs/2107.14621>