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To be or not to be a planet: multi-wavelength verification of deep desert Neptunes

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Very few planets have been discovered in the Neptunian desert, a region of period-radius parameter space encompassing Neptune-sized, short-period planets. The lack of planets in this region is explained by photoevaporation and high-eccentricity migration coupled with tidal disruption. However, since the launch of TESS a handful of planets have been discovered deep inside the Neptunian desert, defying formation and evolution theories, and several more candidates remain open to question. Confirming the existence of more deep desert planets would point at unusual formation and evolution pathways for close-in Neptune-sized planets. However, one dangerous source of false-positives in this candidate population is hierarchical triple systems. Hierarchical triple systems have a compact inner binary and a more distant outer tertiary star. If the inner binary eclipses, it can mimic the transit of a Neptune-sized planet, due to dilution from the tertiary companion, and the presence of the tertiary companion is extremely difficult to identify with radial velocity measurements. Observing changes in the transit depth when observing in different wavelengths is the best technique to distinguish an eclipsing inner binary from a transiting Neptune. We present the results of simultaneous multi-wavelength photometry of 6 deep desert Neptunes with MuSCAT.

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