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Title: The Confirmation of a Third Planet in the Kepler-47 Circumbinary System
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Kepler-47 remains the only binary star system that is known to host more than one transiting planet. Kepler-47b (hereafter the "inner planet") has an orbital period of 49.5 days and a radius of about three Earth radii. Kepler-47c (hereafter the "outer planet") has an orbital period of 303.2 days and a radius of about 4.6 Earth radii. In the discovery paper we discussed one "orphan" transit seen in the Q12 data that could not be attributed to either of the two planets known at that time. Since then, we have identified two more unambiguous transits that can be tied to the orphan. These transits show the transit timing variations that are characteristic of a circumbinary body, confirming the planetary nature of this object. This new planet, Kepler-47d (hereafter the "middle planet"), has a radius that is similar to that of the outer planet and an orbital period of 187.3 days. Using a full photodynamical model, we show that transits of the middle planet prior to Q12 event are present in the data. However, owing to precession of the orbit, the impact parameter for these earlier events was close to 1, resulting in very shallow transits. The impact parameter of the middle planet is expected to decrease for the next several years, resulting in higher signal-to-noise transits. On the other hand, the updated dynamical model for the inner planet shows that this planet will not transit for roughly a four year period that began in July, 2013.