Far Out! Analyzing NASA's Kepler Space Telescope Data Using the Transit-Timing Variation Method to Discover Additional Exoplanets in Planetary Systems

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The goal of this project is to utilize the public database of NASA's Kepler Space Telescope and analyze the data of single-star-single-planet systems to potentially discover additional exoplanets. Kepler discovers planets using the transit method, where the light of a star is observed continually. If a planet is orbiting the star, it periodically crosses in front of it, creating a small decrease in its host star's light. The transit-timing variation method is a well understood but technically challenging way to discover additional exoplanets in these systems. Using a pre-confirmed planet's light curve file, one can calculate and investigate differences in the discovered planet's orbital period, indicating that the gravitational force of an additional object in the system is having an effect on the confirmed planet's orbit. I developed a computer program that could model a one-star-one-planet system with a second planet in order to observe to what extent an additional object's gravitational effect would affect a "discovered" object's orbit. I then developed a computer program to find the exact start and end of planetary transits and used that information to calculate the orbital period of each planet I was investigating. In the end, after sorting through and analyzing the data of about 300 Kepler objects, I discovered three potential planetary candidates. Their orbital periods varied consistently and by a large margin over time, indicating the presence of an additional object in the system.

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