Evaluation of Exoplanet Detection Methods: The Limits of Current Knowledge

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The limitations of four prominent exoplanet detection methods-direct imaging, radial velocity, transit, and gravitational microlensing-were analyzed. It was hypothesized that ranges of descriptive parameters of the exoplanet population are undetectable by current methods due to limitations in technology. This study focuses on the parameters of mass, semi-major axis, and eccentricity. The ranges were determined through an analysis of scatter plots that depict the parameters of known exoplanets, illuminating regions where no exoplanets have been detected. Power law and linear statistical analyses were next used to model each parameter distribution and to determine more specific regions. These models were utilized to determine the probability that exoplanets with particular masses, semi-major axes, and eccentricities would be detected, using the population of known exoplanets to represent the discovery capabilities of current technology. The desired regions were ranges of parameters containing 5% of detected exoplanets. The hypothesis was supported by the results. The ranges of parameters are: mass > 11.7 Mjup and semi-major axis > 34.5 au. However, there are no regions of values of eccentricity. Despite that the quantity of existing exoplanets within these ranges is unknown, the constraints of current technology make it impossible to detect exoplanets within these regions whether they exist or not. If the technology does not have the capability to detect them, the number of existing exoplanets within these ranges will remain unknown. These results will be used to assess new technology currently being developed to improve the detection methods.

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