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Analog simulation to explore and teach exoplanetology concepts

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In this work we present a proposal of analog simulation that allows to generate light curves for simple simulated exoplanetary systems, in transit with the purpose to use this resource to explain how to know from the analysis of the light curve, the semi-major axis, orbital period and reason of exoplanet/star sizes from an exoplanetary system. The assembly is set up for two exoplanetary systems, referred to: System A System B, obtaining a margin of error in their sizes estimation of 1.5% for system A and 4.25% for system B. The frequency spectrum of the time series for both systems leads to a reliable estimation about the traslation period for both of the systems arranged in the assembly. The high sampling rate of the light sensor incorporated in an average cell phone (100 ms), allows to make a test scaling 1 second = 1 day, in order to bring the framework of the test proposal in line with the scientific data in the study of exoplanet light curves. Due to the uncertainty of the fluxes measured for each light curve obtained (≈ 1e-7 lx), the setup is efficient and could be used to develop more rigorous investigations taking into account better analysis criteria (a ratio of star sizes/exoplanet more concordant with known exoplanetary systems), and better controlled laboratory conditions, in addition to being a low-cost proposal.

This proposal seeks to replicate, within a controlled indoor environment, the light curve readings of uncomplicated exoplanetary systems. Specifically, we aim to simulate Keplerian systems characterized by zero eccentricity and orbital inclination, utilizing the light sensors typically found in mobile devices, through the mobile application Arduino Science Journal (ASJ).

The assembly provides calibration details for an astronomy teaching proposal, aligning with scientific processes for determining measurable properties of real exoplanets via the planetary transit method. By modifying assembly parameters, real exoplanetary systems can be modeled, using more sensitive sensors with a minimum sampling time interval of 1 ms. The setup's efficiency, reflected in low error percentages (1.5% and 4.25%) for determining exoplanet sizes, allows for analogous simulations of exoplanetary systems.

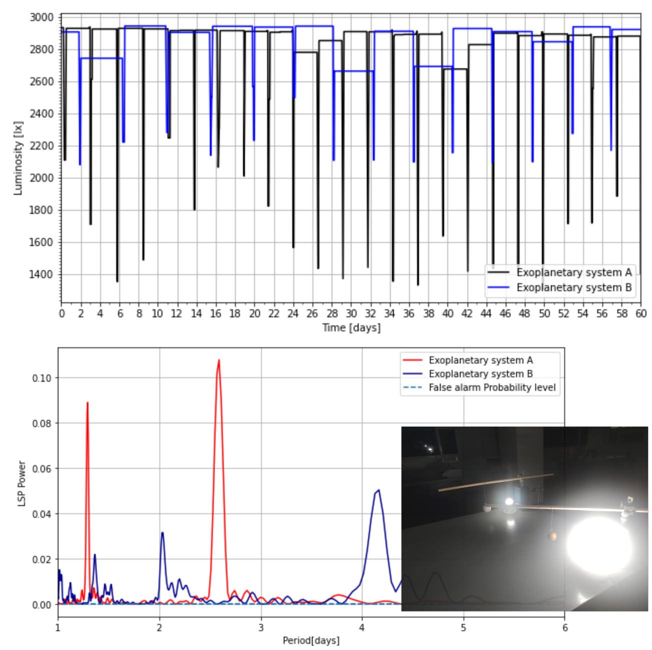

Figure 1. Up: Light curves of systems organized in the montage under the parameters: same star, different orbital speeds of translation, and 2 exoplanets of different sizes. Down. Frequency spectra obtained for each exoplanetary system. Bottom right: Final assembly photography.