**MSc Astrophysics Research Project Outline**

**Title: Investigating the orbital decay and nearby companions of “hot Jupiter” exoplanets using TESS data**

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“Hot Jupiters” are gas giant exoplanets with an orbital period of less than ten days. They orbit in close proximity to their host star and earn their name due to high surface-atmosphere temperatures. Such exoplanets are relatively easy to find using transit detection and radial velocity measurements due to their short orbital period and comparatively large size, but they are rare in occurrence. This project will focus on two outstanding research questions regarding hot Jupiter planetary formation.

First, how do such large planets lie so close to their host star despite the relative lack of material in the protoplanetary disk at such distances? One possible explanation is they form further out and migrate to their eventual close orbit by a variety of mechanisms including tidal dissipation. Alternatively, such planets may be the result of planetary collisions.

Secondly, why is there an apparent lack of nearby companion planets to the vast majority of identified hot Jupiter systems? As of September 2021, there were only three confirmed systems containing a hot Jupiter with nearby companion planets. It is possible transit signals from small inner rocky planets are being missed in the noisy data, but the paucity of inner planets may also provide evidence for migration theories, as migrating host Jupiters may disturb the orbits of any inner planets of a system.

To this end, the project will primarily make use of photometric all-sky surveys from the Transiting Exoplanet Survey Satellite (TESS) to identify hot Jupiter exoplanets and impose constraints on their orbital decay, as well as to identify any shallow transit signals of small companions to hot Jupiters. Two of the three confirmed companion planet systems were discovered using Kepler and K2 (previous generation experiments) however TESS’s all-sky coverage means there is now a significantly expanded dataset to investigate. Since long time-series datasets are required for measuring small changes in orbital period over time, other data sources reaching further back than TESS may also be considered for further investigation of systems of particular interest.

INITIAL TIMELINE OF TASKS:

Over the next three months to March 2023:

* Literature review
* Initial investigations into existing identified hot Jupiter systems using the *lightkurve* library
* Learning how to model planetary transits using ML techniques

March 2023 onwards:

* Finish research essay
* Measuring orbital decays in identified hot Jupiter systems
* Creating a pipeline to attempt to identify nearby companions in identified hot Jupiter systems