SPF HW 4 Paper Analysis - The Role of Core Mass in Controlling Evaporation: The Kepler Radius Distribution and the Kepler-36 Density Dichotomy (Lopez & Fortney (2013)

Lopez and Fortney (2013) explore how photo-evaporation, the process where a planet's atmosphere is stripped away by high-energy radiation, affects the structure and density of exoplanets. They focus on the Kepler-36 system, which has two planets with similar orbits but drastically different densities. Their work shows that differences in the core mass of planets are key to explaining why one planet (Kepler-36b) is rocky, while the other (Kepler-36c) still has a thick gaseous atmosphere. Using models that combine thermal evolution and atmospheric loss, the authors predict how much of a planet's atmosphere can be lost over time, depending on factors like the planet's size, how much radiation it gets, and the makeup of its atmosphere. They also predict a "radius valley" in exoplanet populations, where planets in high-radiation environments lose their atmospheres and shrink, leaving fewer planets of intermediate size. This prediction fits well with trends observed in Kepler data, where inner planets tend to be smaller due to greater exposure to radiation.

This research ties closely to topics in the course material, such as planet-forming disks, protoplanet evolution, and planetary demographics. For example, it helps explain how gas dynamics and radiation affect a planet's ability to retain its atmosphere, connecting to discussions about angular momentum transport in disks. It also highlights how factors like photo-evaporation influence whether planets form as rocky bodies or gas-rich planets, which relates to studies of protoplanet evolution. Additionally, their findings on the distribution of planet sizes and the predicted radius valley are important for understanding the overall population of exoplanets.

In summary, their results generally support their claims, although there could be alternative explanations like how late-stage collisions or migration might affect planetary atmospheres. Overall, the study effectively explains why exoplanets show the variety of sizes and densities we see today and provides a strong framework for understanding planet formation and evolution.