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# Tidal Decay and Disruption of Short-Period Gaseous Exoplanets

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**Abstract** Many gaseous exoplanets in short-period orbits are on the verge or are actually in the process of tidal disruption. Moreover, orbital stability analysis shows tides can drive most known hot Jupiters to spiral inexorably into their host stars. Thus, the coupled processes of orbital decay and tidal disruption likely shape the observed distribution of close-in exoplanets and may even be responsible for producing the shortest-period rocky planets. However, the exact outcome for a disrupting planet depends on its internal response to mass loss and variable stellar insolation, and the accompanying orbital evolution can act to enhance or inhibit the disruption process, depending on the geometry of the atmospheric outflow. In some cases, strong stellar insolation can produce a deep radiative zone in a planet's atmosphere, which can also influence the disruption and therefore the orbital evolution. Understanding these coupled processes and making accurate predictions requires a model that includes both the internal and the orbital evolution of the planet. In this presentation, we will discuss our preliminary work on tidal decay and disruption of close-in gas giants using the fully-featured and robust Modules for Experiments in Stellar Astrophysics (MESA) suite, the capabilities of which were recently upgraded to model gaseous planets with inert, rocky cores.

**Keywords** First keyword · Second keyword · More

## 1 Introduction

## 2 Introduction

As a first approximation to the mass-period relationship expected for the remnants, we use the $M_{\rm p} - R_{\rm p}$ relationship for sub-Neptunes provided in [], produced by fitting a combination of power laws to their more detailed atmospheric models:

$$R_{\rm p} \approx 2.06\ {\rm R_{Earth}} \left(\frac{M_{\rm p}}{{\rm M_{Earth}}}\right)^{-0.21} \left(\frac{f_{\rm env}}{0.05\%}\right)^{0.59} \left(\frac{F_{\rm p}}{{\rm F_{Earth}}}\right)^{0.044} \left(\frac{\rm age}{5\ {\rm Gyrs}}\right)^{-0.18} + R_{\rm core}, \quad (1)$$

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where $f_{\rm env}$ is the fraction of the planet's mass in the gaseous envelope, $F_{\rm p}$ the stellar insolation received by the planet, and $R_{\rm core}$ is the radius of the planet's solid, rocky core. Equation 1 involves a number of approximations, including neglecting the contribution to $R_{\rm p}$ of a radiative outer atmosphere, which [] indicate is usually small (0.1 $\mathrm{R_{Earth}}$). [] also provides the following relationship between the core mass and radius, $M_{\rm core}$ and $R_{\rm core}$:

$$R_{\rm core} \approx \left(\frac{M_{\rm p}}{\mathrm{M_{Earth}}}\right)^{0.25}. \tag{2}$$