

Lab Notebook

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# THE INTERNAL STRUCTURAL ADJUSTMENT DUE TO TIDAL HEATING OF SHORT-PERIOD INFLATED GIANT PLANETS

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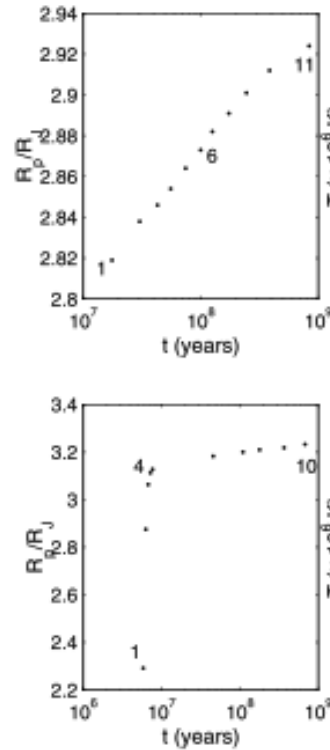
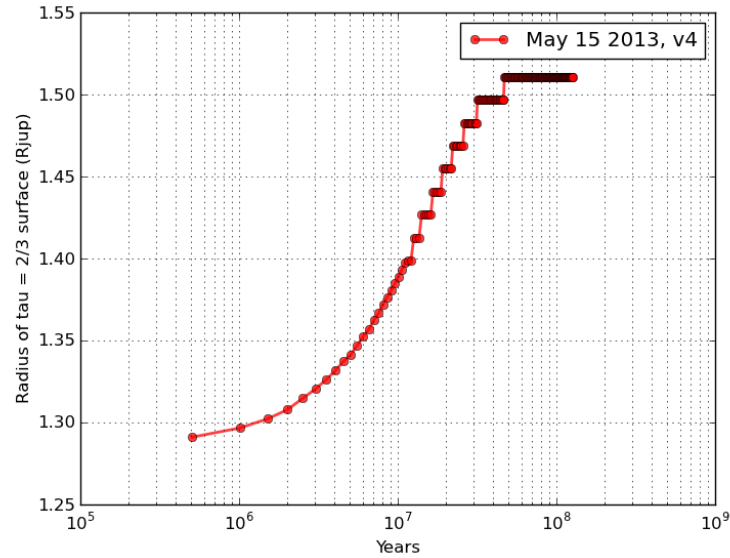


FIG. 6.—Evolution of  $R_p$ , the temperature profile, and the density profile for models 11 (top) and 12 (bottom) in Table 1. While we only show the data after the planet has reached a quasi-thermal equilibrium in model 11, in model 12 the planet is not in the quasi-thermal equilibrium until data point 4 (bottom left panel). The three solid curves from right to left in each of the temperature and density plots for model 11 (model 12) correspond to the three different stages marked by 1, 6, and 11 (1, 4, and 10), respectively, in the  $R_p$ -vs.- $t$  plot. The vertical dashed lines in the temperature and density plots mark the location of the maximal heating of the Gaussian heating profile for model 11 ( $m_0/M_p = 0.9$ ) and model 12 ( $m_0/M_p = 0.7$ ). The temperature and density profiles for the uniform heating per unit mass represented by model 9 (dot-dashed curve) and for the surface heating denoted by model 10 (dotted curve) are also plotted for comparison.

From Figure 6 in the Gu, Lin & Bodenheimer paper, we see that it takes  $\sim 10^7$  yrs for the planet to inflate due to the tidal energy input. This is roughly what my own simulations show, as well. (See Figure 2).

The difference b/w the simulations in their paper and mine is that theirs center their gaussian energy inputs farther out (in mass) in the planet than mine do. Also, their simulations include stellar irradiation in the overall planets' structure and energy budget.

**Lab Notebook****Figure 2:**

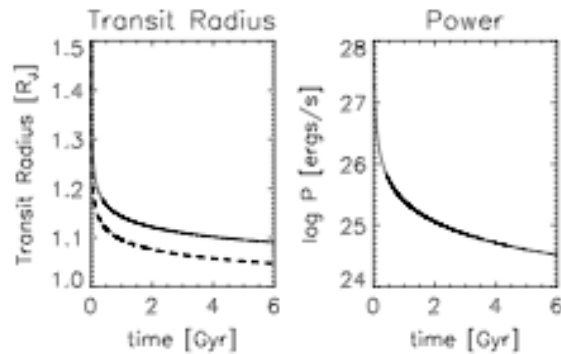
Simulation of a  $1M_{\text{jup}}$ , starting age =  $3e7$  yrs,  $\text{efac} = 10$ , gaussian energy input profile (centered at 0), with a time-indep. amplitude, set equal to the time averaged value of the sinusoidal (in time) energy input for all timesteps.

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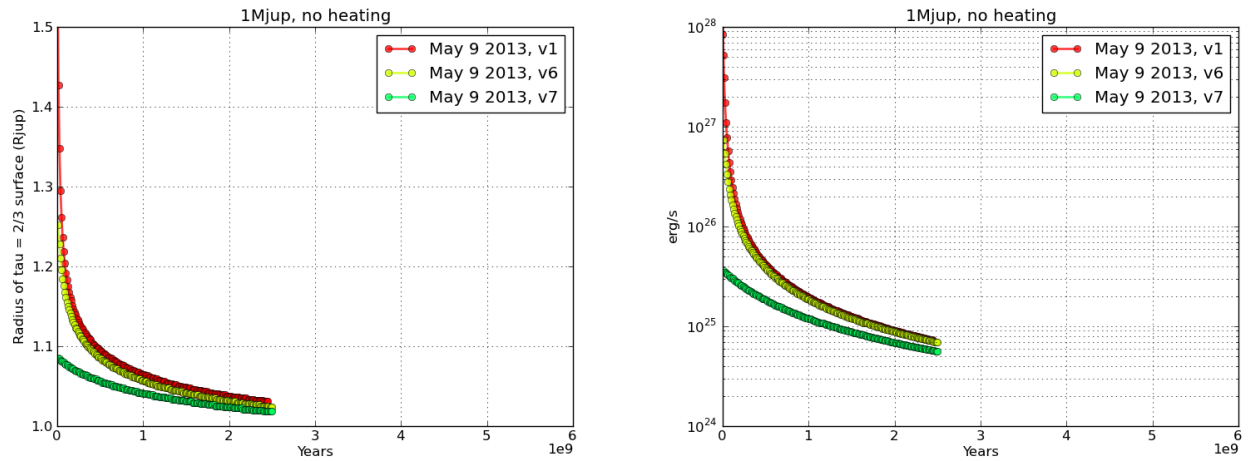
### INFLATING AND DEFLATING HOT JUPITERS: COUPLED TIDAL AND THERMAL EVOLUTION OF KNOWN TRANSITING PLANETS

N. MILLER<sup>1</sup>, J. J. FORTNEY<sup>1</sup>, AND B. JACKSON<sup>2</sup>



**Figure 1.** Radius and intrinsic planet luminosity evolution for a  $1 M_J$  planet at  $0.05$  AU around a  $1 M_{\odot}$  star without any tidal effects. In the left panel, the dashed line is the radius at  $1$  kbar, near the convective/radiative boundary at gigayear ages. The solid line is the radius where the atmosphere reaches  $1$  mbar—approximately the radius that would be observed in transit.

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**Figure 3:**

Results from my runs for a 1Mjup planet with no tidal heating inputs, for comparison with Figure 1 from the Miller, Fortney & Jackson paper above.

My evolution curves have lower L and R values at 2Gyrs than theirs do. This may be because their simulations include the effects of stellar irradiation on the planet, while mine do not.