Figure 4. The widths of the overlapping N:1 resonances are shown in maroon as a function of planet eccentricity and semi-major axis. The innermost planet of each pair is shown in green while the outer is shown in yellow. The growth in eccentricity due to the interaction with the 6:1 resonance is represented with a blue arrow. The inner planet is scattered once it reaches the point of N:1 resonance overlap while the other planet pair is stable since the inner planet does not overlap with any N:1 resonance and therefore no eccentricity growth occurs.

Figure 5. Left: The evolution of a planet migrating inward in eccentricity-semi-major axis space while in resonance with an outer planet, colored by time. The planet migrates while damped to $e=0.16$ until it encounters the 8:1 resonance with the binary where it is ejected. Right: The semi-major axis and eccentricity of a migrating planet as it encounters the N:1 resonances. The N:1 resonances excite eccentricity growth of the planet, shown in red. The planet is able to migrate through a number of N:1 resonances before the eccentricity grows to the point of N:1 overlap. After encounters with the 11:1-9:1, the eccentricity is damped back to 0.16. When it encounters the 8:1 resonance overlap occurs and the planet is ejected. This instability is largely independent of planet mass.

minimized and planets are initially just outside of a 2:1 resonance so PPRs are more well separated. The innermost planet’s eccentricity is damped to and librates around $e = 0.2$ until encountering the 7:1 resonance. The 7:1 resonance grows the eccentricity of the planet but is not able to grow into the overlapping resonances, thus the planet is able to pass through the resonance without becoming unstable as the eccentricity does not reach the point at which the 7:1 and 6:1 resonances overlap. The planet’s eccentricity returns to 0.2 after exiting the resonance. It then encounters the 6:1 resonance and the eccentricity grows until it reaches the point of overlap with the 5:1 and is ejected.

4.3 Planet-Planet Resonance Overlap due to Eccentricity Pumping from Resonances with Binary

PPR overlap described in Section 4.1 happens at large distances from the binary but with closely separated planet-planet resonances while instabilities due to N:1 resonances overlap, as described in Section 4.2, happen close to the binary in more