String-like Collective Motion in the $\alpha$- and $\beta$- Relaxation of a Coarse-Grained Polymer Melt. JACK DOUGLAS, BEATRIZ BETANCOURT, Materials Science and Engineering Division, National Institute of Standards and Technology, Gaithersburg, MD 20899, FRANCIS STARR, Department of Physics, Wesleyan University, Middletown, CT 06459 — The relaxation of glass-forming liquids occurs as a two-stage process— a $\beta$-relaxation process having a relaxation time $\tau_\beta$ on the order of ps, followed by an $\alpha$-relaxation process having a relaxation time $\tau_\alpha$ that ranges from ps to min as the fluid is cooled towards its glass transition temperature. Of course, the dramatic change of $\tau_\alpha$ with temperature garners the most attention because the impressive changes in $\tau_\alpha$ and direct relevance of these changes to applications of glassy materials, but there has also been much interest in $\beta$-relaxation observed in neutron and other high frequency measurement methods. We investigate a model glass-forming polymer melt and establish that collective motion has a large influence on relaxation in both the $\beta$- and $\alpha$-relaxation regimes where in both regimes the collective motion takes the form string-like exchange motion of the polymer segments. The temperature dependence of the average string length is inverted in the $\beta$- and $\alpha$-relaxation regimes where we see a progressive suppression of collective motion upon cooling in the $\beta$-relaxation regime leads to a corresponding increase in the scale of collective motion in the $\alpha$ relaxation regime. We are able to model the string formation in both regimes in terms of equilibrium polymerization models.