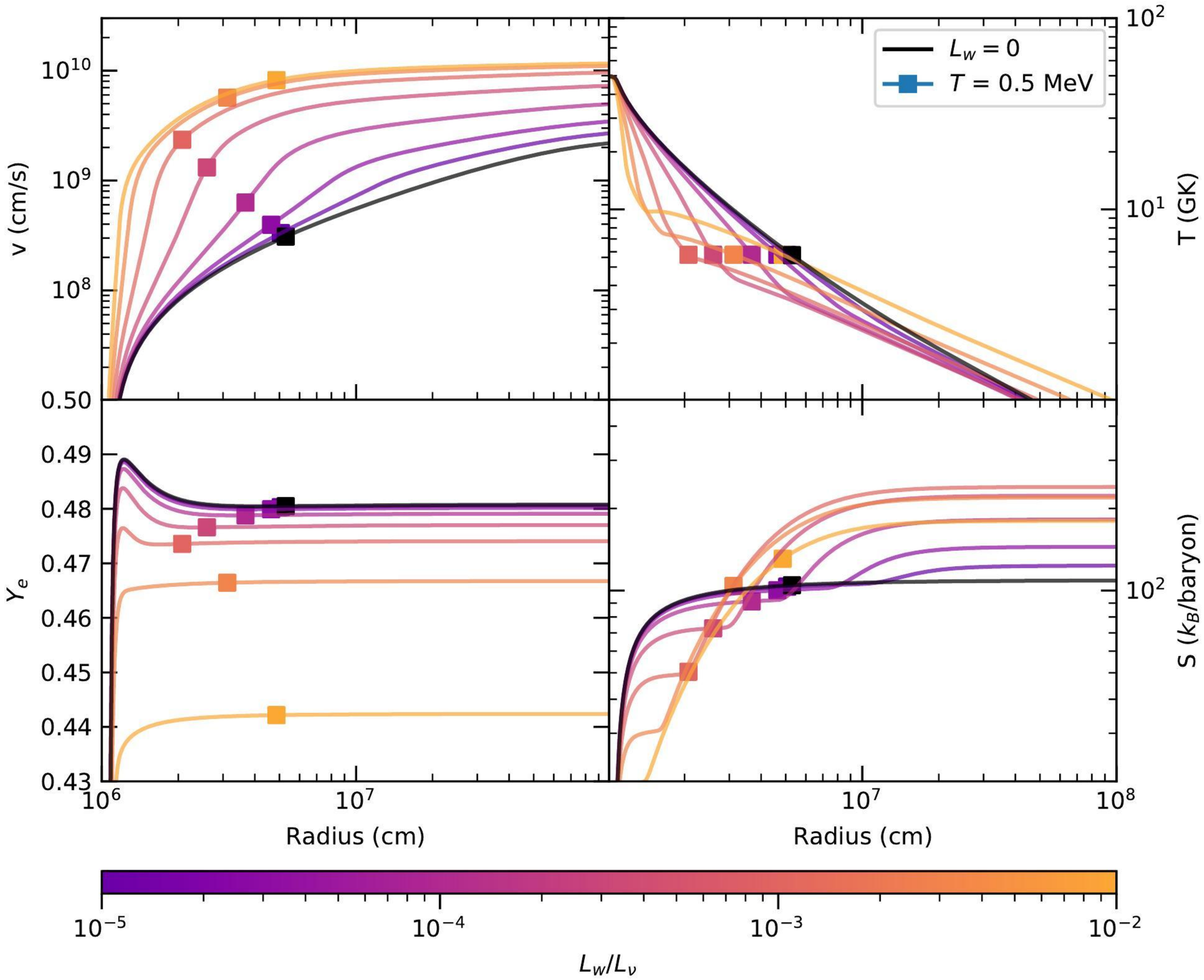

Figure 4. Radial profiles of the velocity, density, temperature, and entropy in the NDW. Different lines correspond to different L_w. Other parameters in the wind models were fixed to $M_{\rm NS} = 1.5\,M_\odot$, $L_\nu = 3\times10^{52}$ erg s^{-1}, and $\omega = 2\times10^3$ rad s^{-1}. The beginning of seed formation for each model is marked a square.

τ_d[1]. This can hinder or abet an alpha-rich freezeout depending on the relative strength of these two effects. After shock formation, s is increased relative to the $L_w = 0$ case, but potentially at temperatures that are too low to impact the alpha-richness of the NDW. Therefore, to better understand the impact of gravito-acoustic wave heating on the wind, detailed nucleosynthesis calculations are required.

The radius at which the waves shock and the rate at which they damp will depend on their frequency content, with the shock formation radius approximately scaling as ω^{-1} (see equation 13) and the damping length $l_d \propto \omega^{-1}$ for a fixed L_w. Therefore, larger wave frequencies will result in wave heating impacting the thermodynamic conditions of the NDW at smaller radii and higher temperatures. In figure 5, we show the impact of varying ω on the entropy of the wind. Clearly, larger ω results in a higher entropy at higher temperature, which is potentially more favorable for an alpha-rich freezeout. The limiting case ($\omega \to \infty$) corresponds to instantaneous shock formation in the wind, but also implies a damping length that goes to zero. Nevertheless, we also show a case with fixed ω in l_d but assuming instantaneous shock formation, as this has been assumed in previous work looking at secondary heating mechanisms in the NDW (Suzuki & Nagataki 2005; Metzger et al. 2007). It is not clear what shock formation radii are favored, given the uncertainty in the range of frequencies excited by PNS convection and the approximate nature of equation 13.

[1] We define the dynamical timescale τ_d at a given point in the wind as $T/\dot{T}$, similar to the $r/\dot{r}$ used by Hoffman et al. (1997).

5.2.2 *Nucleosynthesis*

We now present nucleosynthesis calculations based on the steady-state, gravito-acoustic wave-heated NDW models described in the previous section. Throughout, we assume $Y_{e,\rm eq} = 0.48$ (unless otherwise noted), given that models of neutrino emission from PNSs suggest the NDW will at most be marginally neutron rich. Note that for larger L_w/L_ν the actual value of Y_e at the beginning of nucleosynthesis can substantially differ from $Y_{e,\rm eq}$ (see figure 4).

First, we consider the impact of varying L_w/L_ν for a fixed $\omega = 2\times10^3$ rad s^{-1}. The final abundances for NDW models with $M_{\rm NS} = 1.5 M_\odot$ and $L_\nu = 3\times10^{52}$ erg s^{-1} are shown in figure 6. These correspond to the NDW models shown in figure 4. In the absence of wave heating, this parameter set only undergoes an α-process that terminates with a peak around mass 90 (Woosley & Hoffman 1992)