NB A correction on n_j/n_i

Thanks to Christian, a point needs correction :

In a two level atom,

$$\frac{n_j}{n_i} = \frac{B_{ij}/B_{ji}}{\left(1+\frac{A_{ji}}{I_\nu B_{ji}}\right)} \rightarrow \frac{B_{ij}}{B_{ji}}\left(1-\frac{A_{ji}}{I_\nu B_{ij}}\right)$$

if I_ν is large. Thus, in the limit since $g_i B_{ij} = g_j B_{ji}$, we have

$$\frac{n_j}{n_i} \rightarrow \frac{g_j}{g_i} \text{ (essentially the limit of } T \rightarrow \infty)$$

and the system saturates without further amplification. To obtain an amplifier, we must increase the population n_j above this limit, beyond that obtained from the saturated value (in other words, we must drive the system away from equilibrium) by having a third level feeding the population n_j. Then $n_i B_{ij} - n_j B_{ji}$ can become negative so I_ν will increase with τ increasing.

$\Rightarrow$ as I'd also forgotten to mention, damping occurs from collisions, because these thermalize the levels by non-radiative depopulation ; remember that for upward collisions you need $E \geq \Delta E_{ij}$ but for downward rates there's no threshold to overcome.