Part 1: A convenient way of frequency-stabilizing a laser cavity is by observing the beat frequency between two orthogonally polarized modes and using the frequency error to readjust the cavity length. The modes are produced by inserting a wave plate with retardation, $a\lambda$, in a cavity of length $L = 1.5$ meters. If the desired beat frequency is 10 MHz, what is the fraction retardation, $a\lambda$? (2 pts)

Part 2: Some bi-stable optical elements depend upon the saturation of an optical absorber to detune a Fabry-Perot cavity. Consider such a cavity with mirror reflectance $R = 0.9$ and length $\ell$. The power absorption at the atomic resonance ($\nu = \nu_0$) is $\exp(-\alpha(\nu_0)\ell) = \exp(-0.2)$. At low optical power input, the Fabry-Perot cavity is tuned to resonate at $\nu_c$, the lower half-power frequency of the atomic transition as shown in the figure. As the input power at $\nu_c$ increases, the transition saturates ($N_2 \approx N_1$) and the cavity is detuned. Find the intensity transmission $I$ under fully saturated conditions.