Chapter 4

The Vee (V) scheme is different from the lambda (Λ) and ladder (Ξ) schemes. In V-system both probe and pump are connected to the ground state. The fact that the strong pump field interact directly with the ground state $|1>$ cause depletion of population to higher excited state $|2>$ therefore Vee scheme suffers optical pumping and simultaneously probe and pump decay rates (spontaneous decay rates), contribute dephasing on unlinked transition between $|2>$ - $|3>$ which is much larger compared to lambda (Λ) and ladder (Ξ) dephasing rate. Recently there is an ambiguity has arisen on absorption dip in EIT phenomena in a V-system. This is similar to that of Autler-Townes (AT) splitting and saturation effect at exact resonance. In order to reslove the ambiguity and understand these phenomenon (EIT, AT splitting and saturation) in a V systen, it is necessary that, a comprehensive study is needed on homogeneous and inhomogeneous (Doppler broaden) medium.

4.1 Introduction

Quantum coherence and interference among atomic states coupled by laser field provide EIT in a V-type atomic system. It can be engineered by the action of two fields, one weak field (thin line) called the probe and one stronger field (thick line) called the pump, on two different atomic transitions which share a common ground level shown in Figure 4.1(a). The combined effect of the two fields is to excite only that combination of the two upper levels that enhances stimulated emission by the interference of the two paths [1] and the interference of two excitation paths is shown in Figure 4.1(b). It is of special interest to demonstrate EIT via quantum interference because no population trapping is involved in V-type atomic system. One of the most potential applications of the atomic coherence is to extend the conventional laser sources to ultra-violet and possibly X-rays and even Gamma-ray spectral range, where the conventional methods based on population inversion are not available or difficult to implement. Mismatched (unequal probe and pump field frequency) V-type system with coupling field frequency lower than the probe field frequency are the ideal candidates for the high-frequency inversionless laser systems [2]. On that account, the study of electromagnetically induced transparency in such systems represents the first step in a high frequency inversionless lasers realization. EIT creates the reduction (dip) in absorption upon which the lasing without inversion (LWI) is realized.
Fig.4.1 (a): Schematic diagram of a three-level V-type atomic system driven by a weak probe field of Rabi frequency ($\Omega_p$) and strong pump field of Rabi frequency ($\Omega_c$). (b) Shows the interference of two excitation paths of pump and probe.

The reduced (dip) absorption in EIT is due to destructive interference between two competing excitation pathways. In optical regime, some cases where the Autler-Townes (AT) splitting (ac equivalent of the dc stark effect) [3] effect is mistaken for EIT because the features of AT splitting caused by a strong field also look very similar to that of EIT at the line center. Both phenomena display a reduction (dip) in absorption at line center. An explicit study on AT effect conducted by Cohen-Tannoudji [4,5] showed that the absorption line is made up of two Lorentzian like lines that are located next to each other. Thus in a V-system the reduction (dip) in absorption can be interpreted as either EIT or a gap between two resonances known as AT splitting. Although reduction (dips) in the absorption lines has been experimentally reported in a three-level V–system [2, 6-11], still a certain ambiguity remains as to whether these results are consequences of EIT or AT splitting effect. Along with this ambiguity the strong field connected to ground state |1> leads to saturation effect in a V- system. As a result reduced (dip) absorption appears in probe absorption profile. These three effects (EIT, AT splitting and saturation) look similar to each other and work in tandem to make the medium transparent at exact resonance by monitoring the standard probe absorption profile and gave a miss interpretation about each other.

In this chapter we investigate the possibility of EIT phenomena occurring and the observed reduced (dip) absorption can be differentiated from EIT and that consequence of saturation, AT splitting effects, by considering a homogenous and an inhomogeneous Doppler broaden medium through a V- type interaction scheme. We solve the steady-state density-matrix
equations for this system and perform a Doppler average over atomic velocity distribution. Atomic susceptibility and expressions for probe absorption, dispersion and group index are numerically estimated and we demonstrate that with the use of EIT it is possible to control the speed of the light at line center (on resonance) in an inhomogeneous Doppler broadened medium, whereas it is not possible to observe an EIT & the associated slow light effect in a homogenous medium at lower Rabi frequency ($\Omega_c$).

4.2 Formulation

We consider typical V type three-level atomic system depicted in Fig. 1(a). The spontaneous emission rates from the upper level $|3\rangle$ ($|2\rangle$) to ground level $|1\rangle$ is $2\gamma_{31}$ ($2\gamma_{21}$). A coupling field $\vec{E}_c = \vec{e}_c \exp[i(\vec{k}_c \cdot \vec{r} - \omega_c t)] + \text{c.c.}$, of frequency $\omega_c$, wave vector $\vec{k}_c$ and Rabi frequency $\Omega_c = (\vec{m}_{21} \cdot \vec{e}_c)/\hbar$ is driving the $|2\rangle \leftrightarrow |1\rangle$ transition and a weak probe field $\vec{E}_p = \vec{e}_p \exp[i(\vec{k}_p \cdot \vec{r} - \omega_p t)] + \text{c.c.}$, of frequency $\omega_p$, wave vector $\vec{k}_p$ and Rabi frequency $\Omega_p = (\vec{m}_{31} \cdot \vec{e}_p)/\hbar$, is applied on the transition $|3\rangle \leftrightarrow |1\rangle$. Here $\vec{m}_{31}$ and $\vec{m}_{21}$ are respectively, the dipole moment of $|2\rangle \leftrightarrow |1\rangle$ and $|3\rangle \leftrightarrow |1\rangle$ transitions. The probe and the pump fields may in general be collinear.

4.2. a) Interaction Hamiltonian

Using Eq. (1.15) the interaction picture Hamiltonian $V^{\text{int}}$ under near resonant conditions and rotating wave approximation is

$$V^{\text{int}} = -\hbar[\Omega_p \exp[i(\vec{k}_p \cdot \vec{r} + \Delta_p t)] |3\rangle \langle 1| + \Omega_c \exp[i(\vec{k}_c \cdot \vec{r} + \Delta_c t)] |2\rangle \langle 1| + \text{H.C}]$$  (4.1)

Where $\Delta_p = (\omega_{31} - \omega_p)$ and $\Delta_c = (\omega_{21} - \omega_c)$ denote detuning of the probe and control filed frequencies $\omega_{31}$ and $\omega_{21}$ respectively and $|i\rangle\langle j|(i,j=1-3)$ are the atomic raising or lowering operators.

4.2. b) Density matrix equation of motions:

(i) Inhomogeneous medium:

Thermal motion atoms in hot vapor produce significant Doppler broadening on optical transitions because of non-zero velocity distribution of atoms. The density matrix equations for a V-scheme can be derived using the interaction picture Hamiltonian $V^{\text{int}}$ given by Eq.(4.1) substituting in Eq.(1.9) and Doppler broadening effect can be incorporated by Eq.(1.10).
Thereafter using appropriate transformations in these equations to eliminate fast oscillating (exponential) terms, equations describing time evolution of the slowly varying components of the density matrix elements $\tilde{p}_{jk}(v, t)$ can be obtained as

\begin{align*}
\dot{\tilde{p}}_{31} &= -A_{31}\tilde{p}_{31} + i\Omega_p(\rho_{11} - \rho_{33}) - i\Omega_c\tilde{p}_{32}, \\
\dot{\tilde{p}}_{21} &= -A_{21}\tilde{p}_{21} + i\Omega_c(\rho_{11} - \rho_{22}) - i\Omega_p\tilde{p}_{23}, \\
\dot{\tilde{p}}_{32} &= -A_{32}\tilde{p}_{32} - i\Omega_c^*\tilde{p}_{31} + i\Omega_p\tilde{p}_{12}, \\
\dot{\tilde{p}}_{11} &= i\Omega_p\tilde{p}_{31} - i\Omega_p^*\tilde{p}_{13} + i\Omega_c\tilde{p}_{21} - i\Omega_c^*\tilde{p}_{12} + 2\gamma_{31}\rho_{33} + 2\gamma_{21}\rho_{22}, \\
\dot{\tilde{p}}_{22} &= i\Omega_c\tilde{p}_{21} - i\Omega_c^*\tilde{p}_{12} - 2\gamma_{21}\rho_{22}, \\
\dot{\tilde{p}}_{33} &= i\Omega_p\tilde{p}_{13} - i\Omega_p^*\tilde{p}_{31} - 2\gamma_{31}\rho_{33}.
\end{align*}

where

\begin{align*}
A_{21} &= \gamma_{21} + i(\Delta_c + k_cv_z), \\
A_{31} &= \gamma_{31} + i(\Delta_p + k_pv_z), \\
A_{32} &= \gamma_{32} + i(\Delta_p - \Delta_c), \\
\gamma_{32} &= \gamma_{21} + \gamma_{31}.
\end{align*}

We solve the set of density-matrix equations in the usual limit of a weak probe and an arbitrarily strong control fields using the following approach. Initially all the population is in the ground level $|1>$ and exited level $|2>$ with Maxwell velocity distribution as

$$\rho_{11}^{(0)} + \rho_{22}^{(0)} = M(v),$$

Where

$$M(v) = \left(\frac{1}{\bar{v}}\sqrt{\frac{\ln 2}{\pi}}\right)\exp(-\ln 2\frac{\bar{v}^2}{v^2}).$$

is the Maxwell velocity distribution of atoms with $\bar{v} = \sqrt{\ln 2}v_{th}$ and $v_{th} = (2k_BT/m_A)^{1/2}$ is the most probable thermal velocity at a temperature $T$ of an atom of mass $m_A$. We assume the probe to be sufficiently weak so as not to induce any population transfer to upper levels $|3>$. For this purpose we consider the standard weak probe case in which one makes perturbation expansion of the density matrix elements as follows:
\( \tilde{\rho}_{ij} = \tilde{\rho}_{ij}^0(v, t) + \lambda_p \tilde{\rho}_{ij}^1(v, t) \)  \hspace{1cm} (4.5)

The zero order solutions obtained from Eqs (4.2) in the absence of probe (i.e., putting \( \Omega_p = 0 \)) is

\[
\rho_{11}^{(0)} = \frac{\Omega_c^2 \left[ \frac{1}{A_{12}} + \frac{1}{A_{21}} \right] + 2\gamma_{21}}{2\Omega_c^2 \left[ \frac{1}{A_{12}} + \frac{1}{A_{21}} \right] + 2\gamma_{21}} M(v),
\]

\[
\rho_{22}^{(0)} = \frac{\Omega_c^2 \left[ \frac{1}{A_{12}} + \frac{1}{A_{21}} \right]}{2\Omega_c^2 \left[ \frac{1}{A_{12}} + \frac{1}{A_{21}} \right] + 2\gamma_{21}} M(v),
\]

\[
\tilde{\rho}_{12}^{(0)} = \frac{i\Omega_c \left[ \rho_{22}^{(0)} - \rho_{11}^{(0)} \right]}{A_{12}}.
\]

And the rest of other zeroth-order density matrix elements vanish. The relevant first-order (i.e., to leading order in probe amplitude) density-matrix equations are found as

\[
\dot{\tilde{\rho}}_{31}^{(1)} = -A_{31}\tilde{\rho}_{31}^{(1)} + i\Omega_p \rho_{11}^{(0)} - i\Omega_c \tilde{\rho}_{32}^{(1)},
\]

\[
\dot{\tilde{\rho}}_{32}^{(1)} = -A_{32}\tilde{\rho}_{32}^{(1)} - i\Omega_c \tilde{\rho}_{31}^{(1)} + i\Omega_p \tilde{\rho}_{12}^{(0)}.
\]

We solve the above set of density-matrix equations under steady state condition by setting the time derivative to zero on left hand side of Eq.(4.7). The one photon coherence in a inhomogeneously broaden medium \( \langle 1_{31}^{(1)} \rangle_{inh} \) is obtained as

\[
\langle 1_{31}^{(1)} \rangle_{inh} = \int \tilde{\rho}_{31}^{(1)} M(v) dv = i\Omega_p \int \frac{A_{32} M(v) dv}{(A_{32} A_{31} + |\Omega_c|^2)}
\]

\[
-\int i\Omega_p |\Omega_c|^2 \int \frac{(A_{32} + A_{21}) M(v) dv}{(A_{32} A_{31} + |\Omega_c|^2) (2 |\Omega_c|^2 + A_{21} A_{12})}.
\]

The imaginary and the real parts of \( \langle 1_{31}^{(1)} \rangle_{inh} \) describe probe absorption and dispersion, respectively, in an inhomogeneously (Doppler) broadened three-level V- system. The susceptibility of the medium is related to the one-photon coherence of medium (consider velocity averaged coherence of an inhomogeous Doppler broadened medium) as follows:
\[ \chi^{(1)}(\omega_p) = N \frac{\mu_{31}^2 (I_{31}^{(1)})_{inh}}{\Omega_p} \]  

(4.9)

Where \( N \) is the atomic density of the vapor. From Chapter 2 using Eq (2.14), (2.13) and from Eq. (4.9) we obtain probe intensity absorption coefficient [twice the imaginary part of \( k_p \)] and dispersion coefficient as

\[ \alpha_{inh} = \frac{\omega_p}{c} 4\pi N \frac{\mu_{31}^2}{\hbar} \text{Im} \left( \frac{I_{31}^{(1)}}{\Omega_p} \right)_{inh}, \]  

(4.10a)

\[ \beta_{inh} = \frac{\omega_p}{c} \left[ 1 + 2\pi N \frac{\mu_{31}^2}{\hbar} \text{Re} \left( \frac{I_{31}^{(1)}}{\Omega_p} \right)_{inh} \right]. \]  

(4.10b)

Thus in addition to absorption characteristics, dispersion spectrum is also of importance since \( n_g \) is directly proportional to the derivative (slope) of the dispersion curve (estimation is given in chapter 2) described as

\[ (n_g)_{inh} = 2\pi N \frac{\omega_p}{c} \frac{\mu_{31}^2}{\hbar} \frac{d}{d\omega_p} \text{Re} \left( \frac{I_{31}^{(1)}}{\Omega_p} \right)_{inh}, \]  

(4.11a)

\[ (n_g)_{inh} = \frac{2\pi N \omega_p}{c h} \left\{ \int \frac{(A_{32}^2 - |\Omega_c|^2)(|\Omega_c|^2 + A_{21} A_{12}) - |\Omega_c|^2 A_{21} (A_{32} + A_{31})}{(A_{32} A_{31} + |\Omega_c|^2)^2 (2|\Omega_c|^2 + A_{21} A_{12})} M(\nu)d\nu \right\}. \]  

(4.11b)

(ii) Homogeneous medium:

In this standard stationary atom case the expression for the one photon coherence \( (I_{31}^{(1)})_h \) is obtained from Eq.(4.8) by putting velocity (\( \vec{v} = 0 \)) as

\[ (I_{31}^{(1)})_h = \tilde{p}_{31}^{(1)} = i\Omega_p \frac{[\gamma_{32} + i(\Delta_p - \Delta_c)]}{[(\gamma_{32} + i(\Delta_p - \Delta_c)(\gamma_{31} + i\Delta_p) + |\Omega_c|^2]} - \frac{[\gamma_{21} + i(\Delta_p - \Delta_c)]}{[(\gamma_{32} + i(\Delta_p - \Delta_c)(\gamma_{31} + i\Delta_p) + |\Omega_c|^2)(2|\Omega_c|^2 + \gamma_{21}^2 + \gamma_{22}^2)} \]  

(4.12a)

Therefore the probe absorption (dispersion) coefficient \( \alpha (\beta) \) at exact resonance of pump field \( (\Delta_c = 0) \) as
System

\[ \alpha_h = \frac{\omega_p}{c} \frac{|\mu_{31}|^2}{\hbar} \frac{1}{4\pi N} \text{Im} \left( \frac{\Omega_p^{(1)}}{\Omega_p} \right)_h, \]  \hspace{1cm} (4.12b)

\[ \beta_h = \frac{\omega_p}{c} \left[ 1 + 2\pi N \left( \frac{|\mu_{31}|^2}{\hbar} \right) \frac{1}{\text{Re} \left( \frac{\Omega_p^{(1)}}{\Omega_p} \right)_h} \right]. \]  \hspace{1cm} (4.12c)

The group index \((n_g)_h\) can be estimated in a homogenous medium at on resonance \((\Delta_p = \Delta_c = 0)\) from Eq.(4.13) as

\[ (n_g)_h = 2\pi N \frac{\omega_p}{c} \frac{|\mu_{31}|^2}{\hbar} \frac{d}{d\omega_p} \text{Re} \left( \frac{\Omega_p^{(1)}}{\Omega_p} \right)_h, \]  \hspace{1cm} (4.13a)

\[ (n_g)_h = -2\pi N \frac{\omega_p}{c} \frac{|\mu_{31}|^2}{\hbar} \left[ \frac{(\gamma_{32}^2 - |\Omega_c|^2)(|\Omega_c|^2 + \gamma_{21}^2) - |\Omega_c|^2 \gamma_{21}(\gamma_{32} + \gamma_{31})}{(\gamma_{32} \gamma_{31} + |\Omega_c|^2)^2(2|\Omega_c|^2 + \gamma_{21}^2)} \right]. \]  \hspace{1cm} (4.13b)

4.3 Results and Discussion:

There are three phenomena called EIT, saturation and AT splitting effects which have a remarkable effect on probe absorption & dispersion. These effects look similar to each other if one observes the probe absorption profiles. Usually the probe absorption profile has a dip under EIT condition (quantum mechanical destructive interference of transition probabilities) at exact resonance; which indicates a reduction in probe absorption. Along with reduction in probe absorption, EIT resonances are extremely narrow. But the absorption profile under saturation and AT splitting effects will also look very similar to that of EIT absorption profile. We now present numerical results for probe absorption and dispersion in a homogenous and inhomogeneous (Doppler broadened) medium. We first consider the case of homogeneous broadening. The typical V-scheme is realized in Na\(^{23}\) where pump & probe both fields are applied to same transition \(3S_{1/2} \rightarrow 3P_{1/2}\). The transition wave length and spontaneous emission rates are 5896 Å and \(2\gamma_{21}=2\gamma_{31}=2\pi (10 \text{ MHz})\) respectively. The effective width (half width at half maximum) in a homogenous medium \(\gamma = 2\pi (5 \text{ MHz})\) and for in an inhomogeneous medium as \(\gamma_D = 2\pi (1000\text{MHz})\)
Figure 4.2(i)&(ii) shows probe absorption (dispersion) (calculated numerically using Eqs (4.12)) plotted as a function of the probe detuning for various pump field Rabi frequencies ($\Omega_c/\gamma$) in a homogenous medium. From figure, it is clear that probe (curve a) is totally absorbed at lower pump Rabi frequency ($\Omega_c < \gamma$). The dispersion (curve a) corresponds to normal dispersion which is exactly replica of a two level system, if the pump Rabi frequency $\Omega_c \approx \gamma$ (curve b) absorption is lowered and absorption profile is broader than previous curve a. The reduction in absorption is due to population transfer from lower level $|1>$ to upper level $|2>$. The dispersion curve b still remains as a normal dispersion. Slightly higher pump Rabi frequency ($\Omega_c > \gamma$) probe absorption profile (curve c) has a dip and the dispersion deviates from normal dispersion. This behavior is mainly due to saturation effect where population is almost equally distributed between the two levels $|1>$ & $|2>$ shown in figure (iii). At higher pump Rabi frequency ($\Omega_c >> \gamma$) probe absorption (curve d) has two separately distinct resonances which is a clear signature of AT splitting effect, absorption vanishes at line center (on resonance). The probe dispersion (curve d) has two separate normal dispersion curves which are well separated, but at line center dispersion curve slope is positive (very small).

To understand the behavior of probe dispersion at line center, we numerically estimated group index $n_g$ at exact resonance. Figure 4. 2(iv) display the effect of group index $n_g$ at exact resonance (calculated numerically using Eqs (4.13)) plotted as function of pump Rabi frequency ($\Omega_c/\gamma$). From figure at lower pump Rabi frequency ($\Omega_c \leq \gamma$) the group index $n_g$ sign is negative whereas at higher pump Rabi frequency ($\Omega_c > \gamma$) group index $n_g$ sign remains as positive but very small. The probe group velocity $v_g (= c/n_g)$ initially suffers superluminal (fast) light effect, but compared to group velocity $v_g$ absorption is much more dominant, so initially probe is absorbed in the medium at lower Rabi frequency ($\Omega_c \leq \gamma$). At higher Rabi frequency ($\Omega_c > \gamma$) the group velocity $v_g (= c+n_g)$ suffers subluminal (slow) light effect, whereas probe is transparent due saturation and AT splitting effect at line center (on resonance).
Fig. 4.2 (i) & (ii) Shows probe absorption and dispersion as a function of probe detuning (Δp/γ). (iii) & (iv) Shows population difference and group index ng as a function of pump field Rabi frequency (Ωc/γ ) in a homogeneous medium. Curves a, b, c and d corresponds to pump Rabi frequency values 0.1γ, 1γ, 1.5γ, and 5γ respectively, and N=2x10^12 atoms/cm³.

It is clear evidence that in a homogenous medium the probe nonabsorption (dip) behavior at line center (on resonance) is mainly due to saturation and AT splitting effects. In a homogenous medium a large two photon dephasing (γ32) between the levels |2> & |3> is of an order of spontaneous decay rate (γ32=2γ) mask EIT effect on probe.

To beat two photon dephasing (γ32) effect we considered inhomogeneous Doppler broadened medium where two photon dephasing (γ32) effect can be minimized. Figure 4.3 (i) & (ii) shows probe absorption (dispersion) (calculated numerically using Eqs (4.10)) plotted as a function of the probe detuning for various pump field Rabi frequencies (Ωc/γD ) in an inhomogeneous Doppler broadened medium. At lower pump Rabi frequency (Ωc ≪ γD ) Curves
a, b, c are depicted as probe absorption (dip) & dispersion due to EIT effect. It is confirmed from Figure (vi) where the group index $n_g$ (calculated numerically using Eqs (4.11)) is plotted as function of pump field Rabi frequency ($\Omega_c/\gamma_D$) that the group index $n_g$ has a positive sign and the corresponding group velocity $v_g (c/n_g)$ of probe, initially suffers subluminal (slow) light effect. If pump Rabi frequency ($\Omega_c \ll \gamma_D$) probe absorption (dip) & dispersion is still due to EIT effect, simultaneously population transfer takes place from lower level $|1>$ to upper level $|2>$ (where population is not equally distributed in the levels shown in Figure 4.3(v)). At higher pump Rabi frequency ($\Omega_c \leq \gamma_D$) it is very difficult to distinguish between EIT & saturation effect on probe absorption (dip), but a qualitative analysis from population difference and group index $n_g$ provides distinction between EIT and saturation effect. Figure 4.3 (iii) & (iv) the curves $a', b'$ are probe absorption (dispersion) at $\Omega_c \leq \gamma_D$. The population is distributed between the levels $|1>$ & $|2>$ and group index $n_g$ has positive and very small shown in Figure 4.3 (v) & (vi). From this indirect evidence, we can conclude that EIT and saturation effect both are indistinguishable and the dominant mechanism on probe absorption (dip) is mainly due to saturation effect. If the pump Rabi frequency is further increased beyond $\gamma_D$ ($\Omega_c \gg \gamma_D$) then AT splitting effect will take place and the probe absorption (dispersion) has two resonance peaks which are well separated as shown in Figure 4.3 (iii) & (iv) by curve $c'$. Therefore higher pump Rabi frequency probe absorption (dip) at exact resonance is mainly due to AT splitting effect.
Fig. 4.3 (i- iv)) Shows probe absorption (dispersion) as a function of probe detuning ($\Delta_p/\gamma_D$).

(vi) shows population difference and group index $n_g$ as function of pump field Rabi frequency ($\Omega_c/\gamma_D$) in a Doppler broadened medium. Curves $a$, $b$, $c$ and $a'$, $b'$, $c'$ corresponds to pump Rabi frequency ($\Omega_c$) values are as 0.005$\gamma_D$, 0.05$\gamma_D$, 0.1$\gamma_D$ and 0.5$\gamma_D$, 1$\gamma_D$, 3$\gamma_D$ respectively and $N=2x10^{12}$ atoms/cm$^3$. 
4.4 Conclusions:
To summarize, we have studied the effect of homogenous and inhomogeneous Doppler broadening medium influence on probe absorption (dispersion) and slow light phenomena in a V-type atomic system on closely spaced levels. In homogenous medium the reduction of probe absorption (dip) is mainly due to saturation and AT splitting effect at exact resonance, where a large two photon dephasing \( (\gamma_{32}) \) mask EIT process. To overcome the effect of two photon dephasing \( (\gamma_{32}) \) introduce inhomogeneous Doppler broadening effect (by heating cell), then under EIT condition it is possible to observe slow light effect at very small pump Rabi frequency \( \Omega_c \) in a simple three level V-system. Finally we conclude that in an inhomogeneous Doppler broadened medium it is feasible to observe EIT effect under lower pump Rabi frequency whereas in a homogenous medium it is impossible to observe EIT effect. At higher pump Rabi frequency the probe absorption (dip) at line center (on resonance) is mainly due to AT splitting effect in both homogeneous and inhomogeneous Doppler broaden medium.
4.5 References: